TCNJ THE COLLEGE OF NEW JERSEY

Department of Chemistry

Majors Handbook

2017-2018

Current and prospective student material included.
This handbook is also available on the web at
http://chemistry.tcnj.edu/academics/student-handbook/
(Academics/Student Resources/Student Handbook)

TABLE OF CONTENTS

The material contained herein is subject to revision.
Students will be notified of any such changes.

INTRODUCTION

The Chemistry Department hopes that students majoring in Chemistry will find this handbook useful. Its purpose is to provide a single source of information on the opportunities and resources available at TCNJ and to outline the requirements of the major and related activities.

Because there is more to a major than just taking courses, we encourage students to become actively involved in departmental activities and if interested, in independent research. Chemistry faculty members have diverse backgrounds and research interests, which are summarized below.

THE FACULTY

Heba Abourahma **(Organic)** B.Sc., Saint Mary's University, 1997; M.Sc., University of Ottawa, 1999; Ph.D., University of South Florida, 2004; Postdoctoral, University of Iowa, 2004-2005. Dr. Abourahma joined the TCNJ faculty in 2008. Her Ph.D. work, which focused on the synthesis of nanoscale metal-organic materials with diverse architectures, has been published in a number of peer-reviewed journal articles. Prior to coming to TCNJ, she was an assistant professor at Indiana University of Pennsylvania where she taught organic and general chemistry. Her research interests involve the synthesis of functional materials using non-covalent interactions and coordination chemistry.

John Allison **(Analytical; Director of the Forensic Chemistry Program)** B.S., Widener University, 1973; Ph.D., University of Delaware, 1977; Postdoctoral, Stanford University, 1979. Dr. Allison joined the TCNJ faculty in 2004 after 25 years with the Department of Chemistry at Michigan State University. His research interests are in the application of mass spectrometry and other analytical techniques to the forensic sciences, with a special interest in questioned document examination and the analysis of colorants as used in art. He's also interested in applying the methods used in forensic science to get answers to questions that do not fall into one of the other areas of Chemistry.

Joseph Baker **(Physical/Theoretical)** B.S., Physics, University of Nevada Las Vegas, 2003; M.S. Physics, University of Arizona, 2006; Ph.D. Physics, University of Arizona, 2011; Postdoctoral, University of Chicago, 2012-2014. Dr. Baker joined TCNJ's Chemistry Department in the fall of 2014. In his research, Dr. Baker uses theoretical and computational methods to investigate the structure and dynamics of "sticky" proteins that facilitate bacterial adhesion to cells and surfaces, as well as the influence of ionic liquids on protein folding and membrane permeability.

Joanne Billmers **(Organic/Nursing Chemistry)** B.S., Drexel University, 1980; Ph.D., Drexel University, 1984. Dr. Billmers joined the TCNJ faculty in 1998 as an Adjunct Professor and has been a full-time temporary faculty member since 2004. Her industrial experience includes pharmaceutical process development and the production of anti-cancer, statin and bulk fiber drugs. Her current research interests include an interdisciplinary collaboration in cognitive science exploring the transfer of abstract principles in complex systems and assessing depth of learning in chemistry.

Lynn Bradley **(Organic)** B.A., College of the Holy Cross, 1985; Ph.D., Duke University, 1990. Dr. Bradley joined the TCNJ faculty in 1993. Her research interests include mechanistic studies of benzamide systems, the study of reactions leading to the formation of heterocyclic ring systems, and the development of advanced experiments in organic chemistry.

Michelle Bunagan **(Physical)** B.A., Douglass College of Rutgers University, 2003; Ph.D., University of Pennsylvania, 2008. Dr. Bunagan joined the TCNJ faculty in 2008. Her research primarily focuses on the spectroscopy of biological molecules with a particular interest in the investigation of protein dynamics, which are relevant for folding, as well as protein-ligand and oligomerization reactions. She is a recipient of a Camille and Henry Dreyfus Faculty Award.

Benny Chan **(Inorganic/Analytical)** B.S., Franklin and Marshall College, 1996; Ph.D., Penn State University, 2003; Postdoctoral, Colorado State University, 2002-2005. Dr. Chan joined the TCNJ faculty in 2006. His research interests include the synthesis and structural characterization of solid state materials to develop structure-property relationships for potential applications such as superconductivity, nuclear materials, and thermoelectrics. His work has been funded by the Petroleum Research Fund and the National Science Foundation.

Christopher Fazen **(Biochemistry, Teacher-Scholar Fellow)** B.S., Lafayette College, 2002; M.A., University of Scranton, 2006; Ph.D., Syracuse University, 2012; Postdoctoral, Princeton University, 2013-2014. Dr. Fazen joined the TCNJ faculty in 2015. His research interests focus on studying the interactions between antimicrobial peptides and bacterial persister cells.

Danielle Guarracino **(Biochemistry)** B.A., Cornell University, 2002; M.S., Yale University, 2004; Ph.D., Yale University, 2008; Postdoctoral, New York University, 2008-2010. Dr. Guarracino joined the TCNJ faculty in the fall of 2010. Her work involves the use of tools from chemical biology and organic chemistry to probe ligand-protein interactions implicated in disease processes and sequence-related control of peptide folding.

Donald Hirsh **(Department Chair, Physical)** B.S., Stanford University, 1984; Ph.D., Yale University, 1993; Postdoctoral, Washington University-St. Louis, 1997. Dr. Hirsh joined the TCNJ faculty in 2003. His interests lie within the broad area of biophysical chemistry; more specifically the application of spectroscopy (electron paramagnetic resonance, UV-VIS, circular dichroism and fluorescence) to questions of how biological macromolecules (proteins and DNA) function.

Jinmo Huang **(Analytical)** B.S., Chung Shing University, 1972; M.S., New Mexico Highlands University, 1984; Ph.D., University of North Texas, 1987. Dr. Huang joined the TCNJ faculty in 1992. His research interests include analytical methods development, improvement, and validation for biological samples, concentrating on the analyses of amino acids, sulfonic acids, and vitamins for clinical applications.

David A. Hunt **(Associate Chair, Organic/Medicinal)** B.S., Marshall University, 1973; M.S., Marshall University, 1975; Ph.D., Duke University, 1979. Dr. Hunt joined the TCNJ faculty in 2005. His research interests, broadly defined, are organic synthesis, heterocyclic chemistry, organolithium/metalation chemistry, and drug discovery/development. Of particular interest is the development of new synthetic methodology centered on the construction of carbocyclic and heterocyclic systems with applications to the life sciences. Prior to joining TCNJ, he worked in private sector research laboratories for 26 years, primarily in the agricultural and pharmaceutical discovery areas. During his industrial research career, he held adjunct teaching positions at Marshall University (Graduate School), TCNJ, Stevens Institute of Technology (Graduate School), and East Carolina University.

Mirela Manea-Krichten **(General/Analytical)** B.S., Chestnut Hill College 1981; M.S., University of California, Irvine 1986; Ph. D., University of California, Irvine 1991. Dr. Krichten joined the TCNJ faculty in 2005 as Adjunct Professor and has been a full-time temporary faculty member since 2009. Her research interests include studies in analytical radiochemistry using neutron activation analysis of archaeological and geological samples. Her industrial experience has involved method development for water treatment applications.

Abby O'Connor **(Organometallic/Inorganic)** B.S., Lafayette College 2003, Ph.D., University of North Carolina-Chapel Hill, 2008, Postdoctoral, University of Washington, 2008-2010. Dr. O'Connor joined the TCNJ faculty in 2010. Her research interests are focused on the design and synthesis of novel organometallic homogeneous catalyst systems designed for stereospecific hydrogenation.

Stephanie Sen **(Bioorganic/Biochemistry)** B.A., Bryn Mawr College, 1984; Ph.D., Stony Brook University, 1989, NIH Postdoctoral Fellow at Scripps Research Institute, 1989-1990 and at Stanford University, 1990-1991. Dr. Sen joined TCNJ in 2008. Prior to joining TCNJ, she was an Associate Professor of Chemistry and an Adjunct Associate Professor of Biology at Indiana University/Purdue University Indianapolis where she served for 16 years. Her research interests are in plant and insect metabolism and the development of agriculturally-relevant synthetic agents.

ADJUNCT FACULTY

Michael Aucott B.A., Haverford College, 1968, M.S., Environmental Science, Rutgers University, 1987, Ph.D., Environmental Science, Rutgers University, 1997.

Robert Billmers B.S., Drexel University, Ph.D., Organic Chemistry, Drexel University, 1983, Postdoctoral, West Virginia University, 1983-1984.

Jack Johnson B.S., Carleton College, 1972, Ph.D., Inorganic Chemistry, University of Wisconsin-Madison, 1976.

Thuy Le B.S., University of Bloomsburg, 1983, M.S., Medicinal Chemistry, University of South Florida, 1989, Ph.D., Organic Chemistry, University of Maryland-College Park, 1995.

Brent Podlogar B.S., University of Wisconsin-Parkside, 1984, Ph.D., Organic Chemistry, University of South Florida, 1989, Postdoctoral, Washington University of Medicine-St. Louis, 1989-1991.

Dora Schnur B.S., Bucknell University, 1977, Ph.D., Organic Chemistry, Temple University, 1988.

George Theodoridis B.S., University of Leeds (UK), 1974, M.S., Food Chemistry, University of Leeds (UK), 1975, Ph.D. Chemistry, Rensselaer Polytechnic Institute, 1980.

DEPARTMENTAL STAFF

Pamela Schmierer **(Stockroom/Laboratory Manager)** joined the department in 2000. She is a chemistry alumna of Caldwell College (B.A., 1970). Prior to arriving at TCNJ, Ms. Schmierer attended Northeastern School of Pharmacy, was a research associate in biochemistry specializing in radio-receptor tagging for Princeton Laboratories, and was the QA/QC Lab Supervisor for International Hydronics Environmental Laboratory. She maintains the chemistry stockroom and teaching laboratories, through organization of instruments and tools and by keeping accurate inventory of chemicals and supplies. In addition, she handles most aspects of ordering and receiving and supervises student assistants with preparing teaching laboratories.

Marc Brescia **(Scientific Instrumentation Coordinator)** B.S., Virginia Polytechnic Institute, 1993; Ph.D., University of Maryland, 1997. Dr. Brescia joined the department in 2015. Prior to his arrival at TCNJ, Dr. Brescia was a research scientist at both Merck Research Laboratories and Pharmacopeia, Inc. He is responsible for maintaining laboratory instrumentation and related equipment. He also prepares written instrumentation guides for students and assists in training.

Cathie Allison **(Departmental Program Assistant)** joined the department in 2016. Ms. Allison has served as a staff member of the Department of Chemistry, Michigan State University and as program assistant at the College in the Music Department. As the Department's program assistant, she works closely with the faculty and staff to ensure they have the necessary support to conduct the functions of the Department.

THE DEPARTMENT

The Department of Chemistry at The College of New Jersey has 15 full-time faculty members. The Department is housed in a modern, state-of-the-art facility that is part of the TCNJ Science Complex.

The Department of Chemistry serves the entire TCNJ community in addition to chemistry majors. The Department offers a major with three B.S. degree tracks in Chemistry, which require coursework in math, physics, and in each of the five subdivisions of chemistry. The degree provides excellent training for students intending to enter the chemical profession, pursue graduate work in chemistry, or in preparation for advanced study in medicine or in life science areas such as biochemistry, molecular biology, pharmacy, pharmacology, and food science. Students who successfully complete the requirements for the **ACS-certified B.S. degree** will receive a certificate from the American Chemical Society (ACS) indicating that their degree meets the standards set by The Committee on Professional Training. Many industrial companies consider this certification a requirement for employment as a professional chemist. There are currently 130-140 students majoring in chemistry at TCNJ. Students may conduct research as part of the degree and must complete 2 units of research to qualify for the Department's ACS-certified B.S. *with research* degree.

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. Assistance is also provided through a comprehensive seminar program spanning three of the four-year curriculum that incorporates discussions of the roles and responsibilities of chemists in today's society and introduces students to "the tools of the trade."

Many TCNJ chemistry graduates pursue advanced degrees in all of the major sub-disciplines of chemistry (analytical, organic, inorganic, physical chemistry, biochemistry) at leading graduate programs throughout the country. Some of the graduate programs into which our students have recently been accepted include:

Boston College
City University of New York
Colorado State University
Cornell University
Duke University
Emory University
Florida International University
Florida State University
George Washington University
Harvard University
Indiana University
Johns Hopkins University
Lehigh University
Michigan State University
New York University
North Carolina State University
Ohio State University
Penn State University
Princeton University
Rutgers University
Scripps Institute (La Jolla, CA)
SUNY - Stony Brook, Upstate
Syracuse University
Temple University
Texas A&M
UCLA
University of California - Berkley
University of California - Irvine
University of California - Davis
University of California - San Francisco
University of Chicago
University of Colorado
University of Connecticut
University of Delaware
University of Florida
University of Illinois
University of Maryland
University of Michigan
University of Minnesota
University of North Carolina - Chapel Hill
University of Notre Dame
University of Pennsylvania
University of Pittsburgh
University of Rochester
University of South Carolina
University of Texas - Dallas
University of Texas - Austin
University of Virginia
University of Wisconsin - Madison
West Virginia University
Yale University

Our graduates are also well-suited for entrance into dental, medical, pharmacy, engineering, law, and other professional schools. A major in chemistry also provides adequate preparation leading directly to professional employment in local or national industries producing chemical products such as polymers, pharmaceuticals, consumer products, and metals. Graduates may also be employed by state and national governmental research laboratories as well as local testing laboratories monitoring water purification and waste treatment. Graduates with chemistry backgrounds also are able to pursue opportunities in diverse areas such as business, consulting, purchasing, health and safety, science writing, and environmental science.

In addition to preparing students for careers in global chemical industries, our students are also well prepared to enter fields such as teaching, medicine, and law. Students interested in pursuing a career in sales and marketing can combine a major in chemistry (CHMA) with a minor in marketing. A forensic chemistry specialization is available as well to further broaden the career options for graduates.

DEPARTMENTAL FACILITIES

Students have the opportunity to train and work with faculty members in each sub-discipline of chemistry in well-equipped research laboratories. Students have hands-on access to an array of modern instrumentation, including:

Spectroscopy

- Bruker Biospin Ascend 400 MHz Nuclear Magnetic Resonance Spectrometer
- Bruker Biospin Ultra Shield 400 MHz Nuclear Magnetic Resonance Spectrometer
- Bruker APEX II CCD single crystal X-ray diffractometer (XRD)
- Bruker AXS D8 FOCUS powder XRD
- Bruker Microflex MALDI-TOF mass spectrometer
- Perkin-Elmer LS50B Luminescence Spectrometer
- Perkin-Elmer Spectrum Lambda XLS Fourier Transform Infrared (FT-IR) Spectrometers (5)
- Perkin-Elmer Lambda 750 Ultraviolet/Visible/Near Infrared Spectrometer
- Perkin-Elmer AAnalyst 400 Atomic Absorption Spectrometer
- Varian Cary Bio 1 and 100 Ultraviolet/Visible Spectrophotometers (2)
- Jasco J810 Spectropolarimeter (Circular Dichroism System)
- Beckman DU64 and 530 Spectrophotometers
- Ocean Optics USB Ultraviolet/Visible Integrated Sampling System equipped with USB 2000 Miniature Fiber Optic Spectrometers
- Applied Biosystems Voyager-DE MALDI-TOF Spectrometer
- Beckman-Coulter DU 730 Life Science Ultraviolet/Visible Spectrophotometer
- Molecular Devices Flexstation 3 Platereader

Chromatography (Separations)

- HP 1050 Liquid Chromatographs (4)
- Pickering Laboratories Post Column Reaction Module
- Shimadzu 8A Gas Chromatographs (2)
- Agilent Capillary Electrophoresis System
- Varian 3900 Gas Chromatograph with FID and 8410 Autoinjector (2)
- Dionex Bio LC Ion Chromatograph with ED50A electrochemical detector, GS50 gradient pump, and AS50 autosampler
- AKTA Pure FPLC System.
- Biotage *Isolera* Flash Chromatography System

Chromatography/Spectroscopy

- Agilent 6890 Gas Chromatograph/5973 Quadrapole Mass Spectrometer System with a7683B Autoinjector
- Agilent Technologies 6130 Liquid Chromatograph- Quadrupole Mass Spectrometer w/Infinity 1260 pumps
- Agilent Model 1200 HPLC System with degassing module, autosampler, thermostated column compartment, quaternary pump, diode array detector, and deuterium/tungsten lamp (3)
- Bruker Scion TQ GC/MS GC-Quadrupole Mass Spectrometer

Thermal Analysis

- Perkin Elmer Pyris 6 Thermogravimetric Analyzer (TGA)
- Perkin Elmer Pyris 6 Differential Scanning Calorimeter (DSC)

Electrochemistry

- Princeton Applied Research Model 394 Electrochemical Trace Analyzers

Microscopes

- Spencer Microscopes
- Meiji Techno ML9400 Series Polarizing Microscope with reflected and transmitted light illuminators
- Reichert Scientific Instruments Micro Star Microscope
- Motic B3 Professional Series Microscope
- Leitz Laborlux D Microscope
- Olympus BX41 Polarizing Microscope

Sample Handling

- Vac Nexus Glove Box
- Vac Omni-Lab Glove Box
- Buchi Rotavapor R-200 Rotary Evaporators
- Eppendorf 5810R Refrigerated Centrifuge
- Eppendorf 5417C Microcentrifuge
- Innova 4230 Refrigerated Incubator-Shaker
- Johnson Matthey Mark I Magnetic Susceptibility Balances
- Labconco Centrivap DNA Concentrator
- Leica Mark II Plus Refractometer
- Misonix S3000-NT Sonicator
- Parr Model 3910 Hydrogenation Apparatus
- VWR Model SR-6 Polarimeter
- Yamato Model DC41 Freeze Dryer
- Beckman Coulter Allegra X22 Centrifuge
- Beckman Coulter Optima Max Benchtop Ultracentrifuge

Miscellaneous

- Biotage Initiator+ Microwave Reaction System with Robot 60 attachment
- Biotage Initiator+ SP Wave Peptide Synthesis System
- American Optical Abbe Mark II Refractometer
- Johnson Matthey Mark I Magnetic Susceptibility Balances (2)
- Leica Mark II Plus Refractometer
- VWR Model SR-6 Polarimeter

Research and advanced study is supplemented by a comprehensive journal (hard copy and electronic) and monograph collection housed in the College's library. A full-time science librarian, Ms. Valerie Tucci (vtucci@tcnj.edu), is available to assist in database and technical searches.

PROGRAM PREREQUISITES AND PLACEMENT

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 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.

AP Scores

The Chemistry Department policy is for all student course selections to be made by the student in consultation with his/her 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 when they are taken during the first year of college.

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 the Department Chair.

OVERVIEW OF THE CHEMISTRY CURRICULUM

The Chemistry major can serve as preparation for many career paths after college, including the profession of chemistry, graduate studies in other branches of science, medicine, law, secondary school teaching, and many fields in the business world. The number and type of courses students take to complete and supplement their major should be dictated by their interests and the career path they are considering after TCNJ. For example, students planning to pursue graduate studies in chemistry would benefit from additional advanced level courses in their area of interest. Students interested in meeting the national standards in chemistry should consider completing the requirements for an American Chemical Society certified chemistry major.

The Department stresses the importance of independent study through research and believes that these experiences provide a realistic exposure to science beyond that gained from course work alone. The Department strongly encourages students to engage in independent research during their time at TCNJ. Opportunities are available during the academic year through independent study, and are also available during the summer through the *MUSE* (Mentored Undergraduate Summer Experiences) Program. Academic year research at the advanced level (with enrollment in CHE 493) can be used to meet requirements for the chemistry major. For all projects, students share with their faculty adviser the responsibility for planning, executing, and reporting their investigations. These research experiences also provide an excellent opportunity to develop a relationship with a faculty mentor, who will then be able to provide valuable guidance and write informed letters of recommendation for future education and employment opportunities. There is currently a formal mechanism to identify potential research advisors and to enroll in independent research. Although this process generally begins during the second semester sophomore and junior years, students may participate in research at any point during their studies at TCNJ.

The Department encourages students to round out their chemistry major with courses in other departments depending on individual needs. In many cases a degree with honors, or a minor in another discipline can be obtained. Additional courses might include electives that provide opportunities for learning another language, marketing and business, other areas of science, or courses concerned with social, ethical, and environmental issues. Students interested in providing a particular interdisciplinary emphasis to their chemistry major should consider additional courses in biology, biochemistry, computer science, economics, education, mathematics, or physics.

The Department currently does not offer a Biochemistry major, but will assist those who are interested to develop a self-designed major in this chemistry sub-discipline. The self-designed major in biochemistry is an interdisciplinary offering that combines programming features from the chemistry and biology departments at TCNJ. This Bachelor of Arts major is designed for students who are interested in understanding living organisms at the cellular and molecular level.

While most students are able to develop expertise in biochemistry through traditional TCNJ Chemistry and Biology majors and/or minors, some students may find it more appropriate to obtain

the Self-Designed Major in Biochemistry instead. It is recommended that students complete their first year in the biology or chemistry departments before considering changing to this major, and consult with their academic advisor. If they believe the self-designed major track is right for them, students will need to apply to be accepted into the major.

Bachelor of Science Degree Options

Students can obtain one of three possible BS degrees in Chemistry, two of which are 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. TCNJ Chemistry degrees include:

1) **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.
2) **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.
3) **BS Chemistry Degree**. This degree is suited for students pursuing careers in secondary education, health related fields or interested in obtaining a double-major or a minor in another field.

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

1) **Forensic Chemistry Specialization.** This specialization is appropriate for students interested in crime lab work, industrial forensics, analytical chemistry, and graduate programs in chemistry and forensic science.
2) **Chemistry and Physics of Condensed Matter 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 majoring in chemistry and who were admitted as first year students to the TCNJ/NJMS seven-year BS/MD program. Students must be admitted to the Seven-year BS Chemistry/MD Program prior to matriculation at TCNJ– see 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 the non-ACS program after faculty advisement and department approval. Students who identify a research advisor and begin enrollment in CHE 493 may immediately transfer into the ACS-certified with research track.

The Chemistry curriculum is divided into two general areas: core courses and options courses. Core courses provide a foundation in the five sub-disciplines of chemistry (analytical chemistry, biochemistry, inorganic chemistry, organic chemistry, and physical chemistry), while options courses provide more in-depth study in one or more of the chemistry subdisciplines.

Chemistry Core Courses

CHE 201 General Chemistry I/HON 201 Honors General Chemistry I
CHE 202 General Chemistry II/HON 202 Honors General Chemistry II (prerequisite CHE/HON 201)
CHE 331 Organic Chemistry I (prerequisite CHE/HON 202)
CHE 332 Organic Chemistry II (prerequisite CHE 331)
CHE 310 Analytical Chemistry (prerequisite CHE 202)
CHE 371 Quantum Chemistry (prerequisite PHY 202; CHE 331; MAT 128)
CHE 372 Thermodynamics/Kinetics (prerequisite PHY 202; CHE 331; MAT 128)
CHE 430 Biochemistry (prerequisite CHE 332 and either CHE 371 or CHE 372)
CHE 451 Inorganic Chemistry - Structure and Bonding (Co-requisite CHE 371) *or* CHE 452 Inorganic Chemistry - Reactions and Mechanisms (Co-requisite CHE 372)
CHE 099 Orientation to Chemistry
CHE 316 Sophomore Seminar
CHE 317 Junior Seminar

Chemistry Options Courses
(3 courses from this list are required, see specific requirements for each degree track)

CHE 360 Forensic Chemistry (prerequisite CHE 332)
CHE 370 Special Topics In Chemistry - Environmental Chemistry
CHE 410 Instrumental Analysis (prerequisite CHE 310, CHE 371 or CHE 372)
CHE 451 Inorganic Chemistry - Structure and Mechanisms (may be taken in lieu of CHE 452)
CHE 452 Inorganic Chemistry - Reactions and Mechanisms (may be taken in lieu of CHE 451)
CHE 471 Forensic Applications of Mass Spectrometry (prerequisite CHE 332; CHE 310)
CHE 474 Special Topics in Biochemistry (prerequisites vary, rotating course topics)
CHE 476 Special Topics in Organic Chemistry (prerequisites vary, rotating course topics)
CHE 478 Special Topics in Condensed Matter (prerequisites vary, rotating course topics)
CHE 493 Independent Research (application required, enrollment requires departmental permission)

In addition to Chemistry courses, students must complete both correlate and liberal learning courses, including:

Correlate Courses (regardless of degree track - 4 courses)
MAT 127 Calculus A
MAT 128 Calculus B
PHY 201 General Physics I
PHY 202 General Physics II

Liberal Learning
FSP - First Seminar (1 Course)
IDS 102 Information Literacy
WRI 102 Requirement (exceptions to this requirement may apply)
Second Language - A second language is required up to the 103-level. Students may place out of a portion of their language requirement by AP credit and/or placement exam.
Liberal Learning Breadth Requirement (5 courses in Arts and Humanities and Social Sciences).

In consultation with their academic advisor and with the approval of the Department, students may create unique degree paths within the chemistry major.

Chemistry Options Details

1) The ACS-certified B.S. Chemistry Degree with Research (5 chemistry options total)

i. 1 Chemistry option (300 or 400 level) with or without laboratory;
ii. 2 Chemistry options (400 level) with or without a laboratory;
iii. CHE 493 Independent Research (2 units)

For this degree path, the independent research course completes the remaining required laboratory hours required by the ACS (400 total hours required). Note that only one 300-level course may be taken to satisfy a chemistry options course. Courses (300 or 400 level) outside the department, which complete the disciplinary requirements of ACS-certification, may be substituted for one chemistry options course, pending approval by the Department. Finally, a third unit of CHE 493 Independent Research may replace requirement i.

2) The ACS-certified B.S. Chemistry Degree without Research (3 chemistry options total)

i. 1 Chemistry option (300 or 400 level) with laboratory;
ii. 2 Chemistry options (400 level) with laboratory

For this degree track, all three chemistry options must have a laboratory component to complete the remaining laboratory hours required by the ACS (400 total required). One semester of CHE 493 Independent Research may replace requirement i.

3) The Non-ACS Certified B.S. Chemistry Degree (3 Chemistry options total)

i. 1 Chemistry option (400 level) with or without laboratory;
ii. 2 Chemistry options (300 or 400 level) with or without laboratory

For this degree track, one course outside the department may be substituted with prior approval of the Department and Chair. One unit of CHE 493 Independent Research may be substituted for one of the two courses in ii. Student Teaching may also substitute for one of the two courses in ii.

The table, below, provides a quick comparison of the chemistry course requirements for the three general degree paths.

Chemistry Core & Option Courses (Units)	**ACS-certified Program with Research**	**ACS-certified Program with no Research**	**Non-ACS Program**
CHE 201, HON 201, or transfer/AP credit	√	√	√
CHE 202, HON 202, or transfer/AP credit	√	√	√
CHE 331 *and* CHE 332	√	√	√
CHE 310	√	√	√
CHE 371 *and* CHE 372	√	√	√
CHE 430	√	√	*Yes or CHE 350*
CHE 451 *or* CHE 452	√	√	√
300/400 level CHE options courses *without* lab	√	*No*	√
CHE 493	√	√ *(substitutes for 300-level options course)*	√ *(substitutes for 300-level options course)*
Seminar sequence (CHE 099, CHE 316, and CHE 317)	√	√	√
	14.5 Course Units	*12.5 Course Units*	*12.5 Course Units*

In addition to these degree options, the Department provides the following specializations:

1) The Forensic Chemistry Specialization (CFOR)

The Forensic Chemistry Specialization builds on the TCNJ B.S degree in Chemistry and is open to all majors in the Chemistry Department. Completion of the C.FOR Program provides specialized training into the chemical aspects of the applied field of forensic chemistry. B.S. 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 B.S. in chemistry program: 1) two criminology courses (CRI 200 or 201, and 301) and 2) two Forensic Chemistry courses, CHE 360 and CHE 471. Enrollment in CHE 410 Instrumental Analysis is strongly recommended, as well as a research experience or internship in an area related to forensics science. 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 apply for the Forensic Chemistry Specialization (CFOR) as their specialization.

2) The Chemistry and Physics of Condensed Matter Specialization (CPCM)

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 B.S. 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 Chemistry and Physics of Condensed Matter 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 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 PHY course greater than 200-level and at least one 300/400-level CHE 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 the Chemistry and Physics of Condensed Matter Specialization (CPCM) as their second major/concentration.

3) Chemistry Teaching (CHMT)

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 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. In order to be admitted to the program required for the preparation of science secondary education teachers, a student must have satisfied one of the following: 1) passed the Praxis Core Academic Skills of Educators test (https://www.ets.org/praxis/about/core/content/); 2) achieved a combined SAT score of 1660 or higher (reading, math, writing); or 3) achieved an ACT score of 23 or higher. In addition, a student must meet the following GPA requirements as a prerequisite to field placements: 2.75 for Junior Field Experience (JFE) and a 2.75 for student teaching (CHE 490). Finally, a student must have an overall GPA (CGPA) of 3.0 for graduation in the secondary education program. 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 fulfill the CHE 300-level options course requirement with an Advanced Physics course and take a second Advanced Physics course. Teacher-education candidates will be provisionally certified for their 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.

Professional Education Sequence (9 Course Units)	
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).

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

Biochemistry Self-Designed Major

Although the chemistry department does not provide a biochemistry major, students may obtain a self-designed biochemistry major through the College. It is a B.A. degree that includes the following course sequence:

CHE/HON 201 General Chemistry I
CHE/HON 202 General Chemistry II
BIO 201 Foundations of Biological Inquiry
BIO 211 Eukaryotic Cell Biology
BIO 231 Genetics
CHE 331 Organic Chemistry I
CHE 332 Organic Chemistry II
CHE 310 Analytical Chemistry
CHE 372 Thermodynamics/Kinetics
CHE 430 Biochemistry
CHE 099 Orientation to Chemistry
CHE 316 Sophomore Seminar
CHE 317 Junior Seminar
Three CHE 400-level and BIO 400-level course with a molecular emphasis
(at least one BIO and one CHE course)

Registration in CHE 493 Independent Research in a project with a biochemical emphasis is highly recommended for students pursuing a degree in biochemistry.

Pre-Health Profession Option for Chemistry Majors

Students interested in health-related careers such as medicine, dentistry, pharmacy, etc., may find that the non-ACS certified B.S. degree may best suit their needs. Careful selection of courses within this major and within free electives from Biology will prepare the student to meet health professional school admission requirements. Refer to the Medical Career Advisory Committee webpage for more information.

The Seven-year B.S. Chemistry (Non-ACS)/M.D. Program Degree (3 Chemistry options total)

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 options 300 level course) • Phase I: Core Biomedical Curriculum/Molecules Cells, and Systems at NJMS (counts as CHE 430)

TRANSFERRING INTO THE MAJOR

Students may transfer majors as either internal or external transfers. Whatever the circumstances, students transferring into the TCNJ Chemistry major must take a minimum of four course units of chemistry (courses numbered CHE 300 or above) for graduation as chemistry majors from The College of New Jersey.

Students are admitted to TCNJ with a specified plan or may choose to enter as Open Option students in a designated school. 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 Change of Major/Second Major Form or pick up a copy in the main Chemistry Office C108 or the office in Green Hall 112. Students should also print a copy of their TCNJ unofficial transcript from the PAWS Student Services Center and submit it and other required information to the department into which the change is requested. A short explanation for the reason for transferring into the major is recommended and will help with the evaluation process. With this information and discussion with the student, Chairs (and their designated committees) will make determinations as to whether program/plan changes are approved. When students are admitted to a program/plan, they should be provided with a statement of degree requirements along with a new academic advisor. The student is expected to follow the requirements for the year in which the change takes effect unless special exemption is made by the Department Chair and noted on the form. Approved changes will be effective on the date they are received by the Office of Records and Registration and will be recorded as of that date. Recently, successful applications for internal transfer to the chemistry major have:

i. completed 2 semesters at TCNJ (this must include, at minimum, one graded chemistry course);
ii. received at least a C+ in all chemistry courses and at least a C in correlate courses taken at TCNJ;
iii. have a TCNJ GPA of 3.0 or higher.

Qualification for consideration does not necessarily guarantee acceptance. Acceptance (external and internal transfer) is based on number of applicants, their relative qualifications, and the number of available positions within the major. Prior to submitting the application, the candidate should schedule an appointment to meet with the Department Chair to discuss the process and plan course selection.

The Chemistry Department accepts internal transfer applications over a two week period each semester from October 1-15, and February 25-March 10. Students are strongly urged to consider transfer into the major prior to the completion of their sophomore year. Transfers later in the academic career may have difficulty completing requirements for graduation within four years.

DEPARTMENTAL EVENTS AND SEMINARS

There are a number of events and activities that take place during the academic year to enhance the Chemistry major experience. They range from formal seminars and meetings to informal social gatherings such as faculty-student potluck dinners and cookouts. Seminars normally take place on Wednesday mornings from 11:00 am-12:00 pm and on Tuesdays and Fridays from 12:30-1:30 pm. Social events normally occur in the early evenings, weekends, and Friday afternoons. All majors are expected to attend seminars and are urged to participate in other activities. The faculty views the seminars as a particularly valuable part of the academic program and assumes that students with a serious commitment to a broad education in chemistry would want to attend all seminars regardless of areas of focus. Seminar speakers often provide insight into graduate programs, job recruitment, and a wealth of experience in the field. Students should check their email and the bulletin boards for posting of seminars and special events.

PROGRAM ENTRANCE, RETENTION, EXIT STANDARDS, GRADE POLICY, COURSE SELECTION POLICY, AND REPEAT POLICY

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 chemistry programs. Minimum grades are noted in parentheses:

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. 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 the Student Conduct Code.

To enroll in	A minimum grade of C- is required in	Performance Standard for the Major	
CHE 202	CHE 201/HON 201	CHE 201/HON 201	C
CHE 310	CHE 202/HON 202	CHE 202/HON 202	C
CHE 331	CHE 202	CHE 331	C
CHE 332	CHE 331	CHE 310	C

Retention in the Chemistry program is based on the following performance standards in these "critical content courses": CHE 201 General Chemistry I and CHE 202 General Chemistry II (C); CHE 331 Organic Chemistry I (C); CHE 310 Analytical Chemistry (C). Students are expected to maintain a minimum level of academic performance in the courses offered for the Chemistry and self-designed Biochemistry majors.

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). Once a student is accepted into the Chemistry major at TCNJ, all of the student's Chemistry courses must be completed at TCNJ unless pre-approval is granted by the Department. Enrollment in 300-level or higher equivalent courses at another institution are generally not approved except under extenuating circumstances (e.g., enrollment in a chemistry course during a study abroad semester, enrollment in a course currently not scheduled at TCNJ). Approval for a Chemistry course substituted from another college or university must be granted prior to enrollment in the course. Approval will not be granted if the student has failed or withdrawn from the corresponding course at TCNJ.

Transfer students are required to take a minimum of four course units of chemistry (courses numbered CHE 300 or above) for graduation as chemistry majors from The College of New Jersey.

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 critical content course if the course was passed with a grade of D or better and the lab grade was 80% or better. The lab component must be repeated regardless of the lab grade if a student is repeating 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.

STUDENT ADVISING: ACADEMIC AND BEYOND

Chemistry faculty advisement goes beyond ensuring proper course selection and completion of degree requirements. Advisement is rooted in helping students develop holistically across all areas, including non-academic ones, during their studies at TCNJ. The role of faculty advisors in Chemistry is to help their students develop sound educational goals and assist in implementing strategies to achieve these goals. Some of the ways advisors do this are by helping their students learn about the profession and assisting them with identification and preparation for internship and employment opportunities, as well as identifying opportunities for continuing postgraduate education. Advisors also assist students in identifying campus resources, even those that span beyond academics. Advisors do not always hold the answer to every question related to the College; however, they have broad knowledge of institutional resources and make referrals regarding campus offices and services. Regarding their discipline, they have in-depth knowledge of academic policies and program requirements, and are instrumental in helping their students make sound decisions regarding their academic plans.

The Chemistry Department makes advising assignments prior to the beginning of matriculation for incoming first year and transfer students. Typically, unless the student changes their major, they will remain with the same faculty advisor for the duration of their studies within the Chemistry Department. On occasion, to balance faculty advising loads, students are reassigned advisors. Students can request an advisor reassignment from their department chairperson. Advising assignments are posted in student and faculty PAWS accounts.

Faculty and students are encouraged to introduce themselves upon learning of their advising assignment. Chemistry faculty contact information is available on the TCNJ Online Directory and on the Chemistry website. The Chemistry Department Main Office (C108) can assist students in locating a faculty member's office. Faculty teaching schedules and office hours are posted by office doors and are also on the School of Science webpage.
Chemistry majors are expected to become knowledgeable of College and Department resources, College-wide and program-specific academic policies and procedures as outlined in the Undergraduate Bulletin and discussed in the CHE 099, 316, and 317 courses. Students are expected to develop realistic, sound educational and career goals. With the help of their academic advisor, students implement strategies to achieve such goals. Students are to be active participants in the advisement process. Ultimately, responsibility for decisions made in consultation with the advisor lies with the student.

Guidelines for Effective Advisement - Making the Most Out of the Advisement Process For Students

- Familiarize yourself with College and program specific policies, as outlined through the Division of Student Affairs and the Undergraduate Bulletin.
- Actively monitor TCNJ e-mail (official communication mode of the College) for academic related announcements. The Department regularly distributes advising information by e-mail.
- Have reasonable expectations regarding the availability of your advisor to meet with you or respond to your e-mail.
- Arrive prepared for advising sessions.
- Be able to express your personal goals and interests.
- Do not expect to be told what to do.
- Be proactive and not reactive.
- Be honest when discussing progress and identifying strengths and weaknesses.
- Accept responsibility for decisions made during the advisement process.

Required Registration-related Advising Sessions

Every term prior to the registration cycle for the subsequent semester, Chemistry students receive an advising hold that prevents them from processing registration-related transactions. The Office of Records and Registration notifies students that an academic hold has been placed on their account and approximately 2 weeks prior to the registration window, an advising sign-up schedule is prepared for students to meet with their respective advisors and discuss registration, programming, and career plans. Students should sign up for their advising meeting by going to the main office (C108 Student Kiosk area). Advising holds will only be lifted following a formal in-person advising session whereby the student and advisor agree upon course selection for the subsequent semester, and record the course plan in the Chemistry Department Registration Planning form.

The following registration-specific topics will be covered during these advisement sessions:

- Academic Requirements Report review
- Course History review
- Transfer Credit report review
- Shopping cart selection
- Appropriateness of degree track

Below is a list of possible advising session discussion topics, that students should consider when preparing for their advising meetings.

Campus Resources	Co-curricular Opportunities
• Tutoring Center • Counseling and Psychological Services • Center for Student Success • Student Health Services • Student Accounts • Student Financial Aid • Records and Registration	• Liberal learning courses • Minors, Specializations, and Concentrations • Study abroad • Honors and honor societies • Summer REUs (Research Experiences for Undergraduates) • Mentored Undergraduate Research Experience (MUSE) • Clubs/organizations • Athletics

College, School and Departmental Policy Review	Career Development
• Student conduct code, academic integrity and plagiarism policies • Disabilities and inclusion policies • Approval process for taking courses at another institution • Transitioning to another chemistry track, or to another major • Retaking a course • Research and Independent Study (CHE 493) • Retention, probation and dismissal policies • Withdrawal and leave of absence	• Internships • Career options • Graduate and professional school placement • Employment opportunities

STUDY ABROAD

Students pursuing a degree in Chemistry have the option to study abroad for a semester. This includes Spring, Fall, Winter, and Summer sessions. Any student interested in studying abroad should meet with his/her faculty advisor early in 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 Center for Global Engagement is also required. The student must receive prior approval from the Chair if courses taken abroad are to count as chemistry options toward requirements for the major.

RESEARCH

Independent research in chemistry generally involves carrying out a laboratory investigation in chemistry or a chemistry-related area. If the research is done in the Chemistry Department, a major registers for CHE 493 (1 or 0.5 course units). Research courses taken outside the Chemistry Department require approval in order to count toward chemistry major requirements. Summer research and internships cannot be used for CHE 493 credit.

The Chemistry Department considers research important both for the opportunity to work closely with a faculty member and his or her research group on a research project, and for the advancement of basic knowledge in science. The research results of independent study projects have appeared in many publications in professional journals, with the chemistry major being listed as a co-author. While it is not anticipated that the research project will be originated by the student, it is expected that the student will provide a high degree of independent thought and effort in the solution of the problem. For this reason it is essential that a student develops a firm foundation in the principles and practices of chemistry, and in using the chemical research literature.

Joining a Research Group

Participation in independent study usually involves joining an existing research group, which may be located in the Chemistry Department, or in a chemistry-related department elsewhere on campus. To join a research group, students should first decide what kind of research they find truly interesting. A deep interest will be essential to surviving some failures that are likely to occur prior to success.

Every year, faculty who have research opportunities in their group will provide a short research talk as part of the departmental seminar schedule. Students are encouraged to go online and look up research interests of faculty in Chemistry, or a related department, and to talk to students already working in research groups. Links to research interests of faculty in several departments are given at http://www.tcnj.edu/~science/facultyprofiles.html. In addition, several faculty maintain their own websites. Frequently these web sites will also include links to recent publications that students will find very helpful in determining a match for their interests. There will also be opportunities to learn about faculty research efforts by shadowing research groups.

Students should feel free to contact those faculty members whose research areas appeal to them to find out if the faculty have openings in their research groups. If so, students should arrange to meet with them and discuss specific research topics that they have available. Students will generally be asked to consider projects that are already available rather than creating a research project on their own.

Joining a research group involves a two-way selection process. Once students have established who they want to conduct independent research with, they should complete the research application form by the biannual deadline (7 weeks into the respective semester). An evaluation of the applications will be conducted to match research faculty with interested students and the Department will notify all applicants of the decision.

Disseminating Research Results

At the conclusion of their research project, students communicate the results of their investigation in writing in the form of a formal research paper. At the conclusion of each semester a student is registered for CHE 493, an oral presentation in the form of a poster session is required. In addition, many students will present their research at regional or national meetings (such as the American Chemical Society).

Summer Research Programs

Summer research opportunities are available at TCNJ as well as at other institutions. The program at TCNJ is referred to as *MUSE* (Mentored Undergraduate Summer Experience). TCNJ undergraduate students spend eight weeks in residence at The College of New Jersey during the summer, conducting research or engaging in creative activity in mentored collaboration with TCNJ faculty. The program funds research stipends and on-campus housing for the students, and consists of a vibrant mix of ideas and projects in the Humanities, Arts, Social Sciences, Sciences, and in the professional disciplines of Engineering, Education, Business, and Nursing, Health and Exercise Science. *MUSE* includes a coordinated program of intellectual and social activities to build an exciting community of scholars that reaches across all academic disciplines.
The selection process involves a joint faculty/student application with proposal which is evaluated by an interdisciplinary panel of faculty members. Students interested in this program are urged to speak with faculty regarding *MUSE* participation by December since proposals with all supporting documentation are typically due by the beginning of February.

REUs (Research Experiences for Undergraduates) at other institutions are very competitive by nature and are typically funded by the National Science Foundation (NSF). Flyers advertising these opportunities will be posted on the bulletin boards adjacent to and across from the Chemistry Department Main Office (C108) as they are received (usually in the period December-January). Interested majors should apply directly to all programs of interest well before the deadlines indicated on their flyers (usually February or March). Students applying for these opportunities are reminded that faculty letters of recommendation are required to support student applications, and requests for letters should occur in a timely manner.

PREPARATION FOR LIFE AFTER TCNJ

The Chemistry section of the TCNJ Undergraduate Catalog contains an extensive discussion of the coursework needed in preparation for careers in chemistry. The following recommendations supplement those comments.

Completing as many foundation/sub-discipline courses (CHE 201, 202, 310, 331, 332, 371, 372, 451/452 and 430) as possible by the end of the second semester of a student's junior year will permit students a wider and more informed choice of advanced electives and independent study projects, thereby preparing them for a greater number of research opportunities. Some of the CHE option courses offered recently or planned include:

Environmental Chemistry	Computational Chemistry
Biophysical Chemistry	Resonance Spectroscopy
Medicinal Chemistry	Chemical Biology
Stereochemistry	Toxicology
Organometallic Chemistry	Polymer Chemistry
Crystal Engineering	Synthesis

An advanced laboratory experience is highly advisable, through advanced courses and/or in independent laboratory investigations. Most advanced electives offered have a laboratory component. Independent laboratory work can be accomplished through a summer Research Experience for Undergraduates (REU) and/or through 1-4 semesters of undergraduate research with a faculty member (CHE 493). TCNJ has a *MUSE* program for our own students which is funded through college, corporate, and private granting agencies. In addition to this program, many of our students have participated in National Science Foundation (NSF)-funded REU programs at colleges and universities throughout the nation. Both the TCNJ MUSE and NSF REU programs are quite competitive.

Some students undertake 4 semesters of independent study commencing the first semester of their junior year. Independent study is the only for-credit offering in the department that can be taken in half course units.

Industrial internships or another research option to explore. There are several chemical, pharmaceutical, and biotech companies in the general area which often seek students to work in their research labs over the summer. This is an excellent opportunity for the student with a career in industry in mind.

Students who intend to undertake graduate work in chemistry or related fields or to secure immediate employment as a laboratory chemist, should take courses beyond the minimum requirements for the major. Other specific courses selected will depend in part on the student's intended area of specialization and/or interest. Students should consult early with their academic advisor in order to plan their choice of electives. Additional mathematics courses such as multivariable calculus, linear algebra, differential equations, and statistics may also be advisable.

Some of our students enter directly into the CHMT program as first year students while some of our students express an interest in secondary public/private school teaching after being well into their academic careers. Teaching at private and parochial schools often does not require state certification; however, for those students who did not participate in the CHMT program as undergraduates but are interested in public school teaching, the MAT degree (Master of Arts in Teaching) is offered. There are several programs throughout the region; however, TCNJ has a 15 month MAT program (in sequence: a summer term, 2 semesters, and a final summer term) which our majors often find quite convenient. Upon receipt of this degree, the student will possess all necessary certifications to teach in the State of New Jersey.

There are many job opportunities in the private sector for which preparation in chemistry is desirable. Many of these opportunities are discussed in the chemistry seminar series CHE 316 and 317. In addition to the normal coursework affiliated with the major, a summer research internship would be a valuable experience for the student and would be favorably viewed by any prospective employer. The ACS-certified degree is also favorably viewed since it is indicative of a thorough lab-based level of preparation. Should a student be interested in private sector employment immediately upon graduation, they should begin planning as early as the first semester of their junior year. For students interested in work with the Federal Government, they will need to fill out a SF-171 form (obtained online) plus other possible supplementary information depending on the agency of interest. Go to http://www.usajobs.gov for a complete listing of federal jobs.

Applying to Graduate School

Applying to graduate school can seem bewildering. The following is meant to provide some guidance about procedures and strategies for selecting appropriate universities to which to apply. Reading this is a first step in the academic advisor planning process. Students should discuss their graduate school plans and interests with their major advisor and if applicable, research advisor, during the latter part of their junior year. Students should also talk to second semester senior Chemistry and Biochemistry majors who have applied to graduate schools.

Selecting a School

A major factor to consider in selecting a graduate school is the quality of the program. But how does one evaluate a particular program? Begin by asking professors, especially those whose research interests are in an area in which you plan to continue your studies. Examine appropriate journals over the last five years and tally up which universities seem to be the most active in publishing in your field of interest. The ACS Directory of Graduate Research (available through the ACS website) is a very useful resource for learning about different graduate programs.

Once the choice of schools has been narrowed, try to visit them. You will learn at least as much from your student colleagues as from the faculty, so try to judge what sort of interactions you will have with them. Ask about graduate student life and the quality of life in the local town or city. Inquire also about the financial situation, particularly the availability of research stipends, of teaching assistantships and summer funding. In chemistry, at least, every university should provide some sort of financial aid.

Apply to several programs (6-8), but not more than 8. Visiting more than a handful of schools after acceptance is difficult during your final academic semester. There are numerous reasons for being rejected from a particular graduate program, many of them out of your control, such as retirement or departure of the most appropriate potential advisor, or the shortage of funds to support graduate students. Increase your odds by sending out more than one application, although don't lower your standards so much that you end up enrolling in a weak program just because you were accepted there.

Graduate schools consider a variety of factors in selecting students. Although undergraduate grades and breadth of course work are important, a strong score on the Graduate Record Exam (GRE) can go a long way towards compensating for a modest grade point average. What is most important is evidence of independent research and summer research experiences. Students should plan on taking the GRE in the Spring/Summer after the beginning of their junior year. A student's performance on their research project will be described in the letter of recommendation from your research advisor.

The application essay should highlight what you have done outside of the classroom. Although nobody really expects an undergraduate to be able to propose a specific Ph.D. thesis topic, the essay should define general scientific interests and demonstrate familiarity with current problems in the field. A prospective advisor will be most concerned about your interest in, commitment to, and potential success in his or her field. The best way to give your essay and application substance, then, is to have done something in the field as an undergraduate. During the junior/senior summer or earlier, try to find an interesting summer research job, even if it doesn't pay as much as "normal" summer jobs. Ask your college professors if they know of summer opportunities at TCNJ or elsewhere. Read the bulletin board outside the departmental offices for summer job/program announcements. You will discover a wide range of opportunities, stipends, and grants at various institutions across the country.

Letters of recommendation can carry a huge amount of weight. So think carefully about whom you want to write letters on your behalf, get to know them personally, and impress them with your promise. Clearly, your research advisor is a key recommender.

During the fall of your senior year, consider applying for a National Science Foundation Predoctoral Fellowship – don't miss the early November deadline! Such fellowships often rely heavily on undergraduate grades, research experience, and letters of recommendation.

Preparation for Graduate Study in Biochemistry, Medicine, Dentistry

In addition to chemistry major requirements, chemistry students planning careers in medicine or dentistry must complete at least two biology courses with laboratory. Students interested in a career in biochemistry should either pursue the self-designed biochemistry major or obtain formal or informal training in organismal biology if possible. Many medical schools recommend an undergraduate biochemistry course, with medical and dental schools requiring a year each of mathematics and English. Contact The Medical Careers Advisory Committee no later than the beginning of the junior year to initiate plans.

Letters of Recommendation

Faculty welcome the opportunity to write letters of recommendation for their students. In order to strengthen the reference and be sure that it is finished in a timely fashion, please follow these guidelines when requesting a recommendation.

1. Do NOT leave a request for a recommendation in a faculty member's mailbox a few days before the deadline. Out of common courtesy, at least 3 weeks' notice is required.

2. Make an appointment to talk with the faculty member writing your recommendation well in advance of the recommendation deadline. Be aware that some faculty will have their own requirements for writing letters of recommendation, such as:
    - a certain minimum grade;
    - a certain number of classes for which the student must have been enrolled;
    - or a maximum number of letters which the faculty member will write per student.

3. Bring the following to the appointment: recommendation form(s) on which you have completed the sections that you, the applicant, should complete (don't forget the waiver section):
    - a written program description (or job description, if for an employer); addressed and stamped envelopes (if the reference needs to be mailed, rather than picked up by you);
    - a recent CV/resumé
    - a copy of your personal statement/essay.

4. As a courtesy to faculty, try to keep those who have written letters on your behalf informed of the outcome of your applications.

LABORATORY SAFETY & ETIQUETTE

We take safety seriously! Safety is of utmost importance in every TCNJ laboratory. Work in the laboratory should be a safe experience. It will be safe, however, only if certain safety precautions are followed without exception. Safety is up to you. Everyone working in the chemistry laboratories must follow the following rules. Your instructor will discuss specific safety precautions relevant to each experiment during the pre-lab lecture. Do not hesitate to consult with your instructor if you have questions regarding any safety precautions. Failure to observe laboratory safety rules and procedures may result in injury to you or to fellow students. Students who do not follow these safety rules (including proper attire) will be asked to leave the laboratory. Repeat offenders may be dropped from the course at the discretion of the instructor.

General Safety Precautions:

1) Protective glasses must be worn in the lab at all times – NO EXCEPTIONS!!!!!! Failure to comply with this rule will constitute sufficient grounds for dismissal from the lab and a zero for the laboratory experiment.
2) Know the location of all laboratory exits and know the location and proper operation of all safety equipment in the laboratory.
3) All injuries, no matter how trivial, must be reported to the instructor immediately.
4) Food or beverages are never permitted in the lab at any time.
5) Unauthorized experiments and unauthorized personnel are not permitted.
6) In case of fire or accident, immediately notify the instructor.
7) Working alone in the laboratory in expressly forbidden.
8) Do not taste anything in the lab. Exercise caution in noting odors and avoid breathing fumes.
9) Shoes completely covering the feet should be worn in the lab. Long pants (jeans) are advisable in the lab.
10) A lab apron or lab coat, is available for all students working in the lab. This personal protective equipment should be worn at all times.
11) Long hair should be tied back.
12) A laboratory is a dangerous place intended for serious study. HORSEPLAY WILL NOT BE TOLERATED!

There are a few principles of *general etiquette*:

- Respect others' projects/property as you would expect others to respect yours.
- When you leave, the lab should not look like you have been there. In fact, you should leave the lab in equal or better shape than you found it. Only leave out what is necessary and appropriate, and what is neatly organized.
- Maintain a professional environment, professional techniques, and professional attitude toward others.

- Provide collegial support for your colleagues. Share your knowledge and understanding. Keep distracting noise to a minimum. Minimize the use of cell phones. Since space is limited, have only what you need in your work space. Coats, bags and other possessions should be placed where they cannot interfere with productivity.
- Take responsibility for the facility and your colleagues.
- The lab is our asset and we must take the responsibility to maintain it and the safety of our colleagues. If you see some behavior that is inappropriate, take responsibility and collegially provide leadership in correcting it. Provide support in ensuring the safety of colleagues coming to, using, and leaving the lab. Only those who have a legitimate right to be in the lab should be in the lab.
- Always check your station and equipment for potential problems with the necessary support facilities. If there appears to be a problem(s), report it, supplying as much information as you can. Leave a note so others won't have to waste time finding the same problem in the interim, and will know it has been reported.
- Help maintain the supplies and facilities in working, accessible, usable order.
- Don't make a mess getting supplies and putting them away. Leave your work area as clean (if not cleaner) as you found it. This especially applies to shared work areas, such as teaching and instrumental laboratories and associated prep areas.

4-YEAR PLANNERS

On the pages that follow are several course planning scenarios for several chemistry tracks. Please note that these are examples only and are only meant to show how students can complete their degree requirements in 4 years.

Example 1. BS ACS-Certified Degree in Chemistry, with Research

(Actual courses may vary with advisement and course availability)

Fall Semester	Spring Semester
FSP First Seminar **CHE 099 Orientation to Chemistry** **CHE 201 General Chemistry I**[a] *PHY 201 General Physics I or* Language or Liberal Learning Course *MAT 127 Calculus A or MAT 096*	**CHE 202 General Chemistry II** *MAT 127 Calculus A or MAT 128 Calculus B* *PHY 201 General Physics I or PHY 202 General Physics II* Language or Liberal Learning Course[c]
Fall Semester	**Spring Semester**[d]
CHE 331 Organic Chemistry I **[CHE 316 Sophomore Seminar]** **[CHE 310 Analytical Chemistry] (may be taken Spring semester)** *MAT 128 Calculus B and/or PHY 202 General Physics II or* Language, Liberal Learning or Elective course(s)	**CHE 332 Organic Chemistry II** **CHE 371 Quantum Chemistry** **[CHE 310 Analytical Chemistry]** Language, Liberal Learning or Elective courses (1-2)
Fall Semester[d]	**Spring Semester**[d]
CHE 372 Thermodynamics **CHE 300 400 Advanced Options Class**[e] **[CHE 317 Junior Seminar]** Liberal Learning or Elective courses (2)	**CHE 430 Biochemistry or** **CHE 451/452 Inorganic Chemistry** Liberal Learning or Elective courses (3)
Fall Semester	**Spring Semester**
CHE 493 Independent Research **CHE 300/400 Advanced Options**[e] Elective courses (2)	**CHE 430 Biochemistry or** **CHE 451/452 Inorganic Chemistry** **CHE 493 Independent Research** **CHE 300/400 Advanced Options**[e] Elective course

[a] HON 201 can be substituted for CHE 201 by qualified students. [b] HON 202 can be substituted for CHE 202 by qualified students. [c] Students interested in entering graduate or professional programs in Biochemistry or Medicine should enroll in BIO 201 for the Spring semester. [ ] offered every semester. [d]May take CHE 493 research. [e] An additional unit of CHE 493 can be taken and will be counted as satisfying a CHE 300 level course.

Advanced Options course requirements. Students may only take one CHE 300 Advanced Options course to satisfy the BS_01 degree.

300 level options include those offered by the department (CHE 360 and CHE 370), CHE 490 Student Teaching, and an additional unit of CHE 493. Other options must be approved at the discretion of the Chair of the Department.

For those students interested in Biochemistry, this course should always be taken Year 3, Spring semester.

For those students interested in working in industry, enrollment in CHE 410 Instrumental Analysis or CHE 471 Forensics Application to Mass Spectrometry is strongly recommended.

Example 2. Study Abroad Junior Year - ACS-certified, B.S. with Research

Fall Semester	Spring Semester
FSP First Seminar **CHE 099 Orientation to Chemistry** **CHE 201 General Chemistry I**[a] *PHY 201 General Physics I* *MAT 127 Calculus A*	**CHE 202 General Chemistry II**[b] *MAT 128 Calculus B* *PHY 202 General Physics II* Language or Liberal Learning Course[c]
Fall Semester	**Spring Semester**[d]
CHE 331 Organic Chemistry I **[CHE 316 Sophomore Seminar]** **[CHE 310 Analytical Chemistry]** Language, Liberal Learning or Elective courses (2)	**CHE 332 Organic Chemistry II** **CHE 371 Quantum Chemistry** Language, Liberal Learning or Elective courses (2)
Fall Semester[d]	**Spring Semester**[d]
CHE 372 Thermodynamics **CHE 300/400 Advanced Options Class**[e] **[CHE 317 Junior Seminar]** **CHE 493 Independent Research** Liberal Learning or Elective courses (2)	Abroad **(CHE 430, CHE 451, or CHE 300/400 Advanced Options equivalent)** Abroad– Liberal Learning or Elective courses (2)
Fall Semester	**Spring Semester**
CHE 493 Independent Research **CHE 300/400 Advanced Options**[e] Elective courses	**CHE 430 Biochemistry or** **CHE 451/452 Inorganic Chemistry** **CHE 493 Independent Research** **CHE 300/400 Advanced Options**[e] Elective course

[a] HON 201 can be substituted for CHE 201 by qualified students. [b] HON 202 can be substituted for CHE 202 by qualified students. [c] Students interested in entering graduate or professional programs in Biochemistry or Medicine should enroll in BIO 201 for the Spring semester. [ ] offered every semester. [d]May take CHE 493 research. [e] An additional unit of CHE 493 can be taken and will be counted as satisfying a CHE 300 level course.

Advanced Options course requirements. Students may only take one CHE 300 Advanced Options course to satisfy the BS_01 degree.

300 level options include those offered by the department (CHE 360 and CHE 370), CHE 490 Student Teaching, and an additional unit of CHE 493. Other options must be approved at the discretion of the Chair of the Department.

Many students opt to study abroad their sophomore year, in which case, students will complete the equivalent of CHE 332, CHE 310, or options course at their abroad institution.

Students wishing to complete the non-ACS degree may do so without enrolling in an equivalent chemistry course abroad.

Example 3. Course Schedule for Students Who Want to Pursue Secondary Education CHMT – Non-ACS

Fall Semester	Spring Semester
FSP First Seminar **CHE 099 Orientation to Chemistry** **CHE 201 General Chemistry I**[a] *PHY 201 General Physics I* *MAT 127 Calculus A*	**CHE 202 General Chemistry II**[b] *MAT 128 Calculus B* *PHY 202 General Physics II* Language or Liberal Learning Course*
Fall Semester	**Spring Semester**[c]
CHE 331 Organic Chemistry I **[CHE 310 Analytical Chemistry]** SED 224 Adolescent Learning and Development EFN 299 School and Communities	**CHE 332 Organic Chemistry II** **CHE 371 Quantum Chemistry** **[CHE 316 Sophomore Seminar]** Language, Liberal Learning or Elective course (2)
Fall Semester[d]	**Spring Semester**[d]
CHE 372 Thermodynamics **CHE 300/400 Advanced Options Class**[e] **[CHE 317 Junior Seminar]** PHY 390 Methods of Teaching Science Elective course	**CHE 430 Biochemistry or** **CHE 451/452 Inorganic Chemistry** SPE 323 Secondary Content Literacy in Inclusive Classrooms Liberal Learning or Elective courses (3) SED 399 Pedagogy in Secondary Schools
Fall Semester	**Spring Semester**
CHE 300/400 Advanced Options Class[e] EFN 398 Historical and Political Context of Schools Elective course	Elective course CHE 490 Student Teaching SED 498 Collaborative Capstone for Professional Inquiry

[a] HON 201 can be substituted for CHE 201 by qualified students. [b] HON 202 can be substituted for CHE 202 by qualified students. [c] Students interested in entering graduate or professional programs in Biochemistry or Medicine should enroll in BIO 201 for the Spring semester. [ ] offered every semester. [d]May take CHE 493 research. [e] An additional unit of CHE 493 can be taken and will be counted as satisfying a CHE 300 level course.

Advanced Options course requirements. Students may only take one CHE 300 Advanced Options course to satisfy the BS_01 degree.

300 level options include those offered by the department (CHE 360 and CHE 370), CHE 490 Student Teaching, and an additional unit of CHE 493. Other options must be approved at the discretion of the Chair of the Department.

Many students opt to study abroad their sophomore year, in which case, students will complete the equivalent of CHE 332, CHE 310, or options course at their abroad institution.

Students wishing to complete the non-ACS degree may do so without enrolling in an equivalent chemistry course abroad.