Chemistry

MAJORS, MINOR

PROFESSORS: Sandy Boatman, Bansi L. Kalra
ASSOCIATE PROFESSOR: Daniel R. Derringer (chair)
CURATOR: Patricia Tucker

By nurturing the student's intellect and by fostering the student's growth of literacy in science and technology, the programs offered by the chemistry department prepare the student to meet the challenges of a complex global society. Facilitated by modern instruments and by close working relationships with faculty, students receive expert theoretical and practical instruction in all fundamental areas of modern chemistry, including analytical chemistry, biochemistry, inorganic chemistry, organic chemistry, and physical chemistry. Three program options are available: chemistry (B.A. or B.S.), chemistry with a biochemistry concentration (B.A. and B.S.), and chemistry with a business concentration (B.A. only). Depending on the program a student completes, she will be qualified for graduate study in many areas related to chemistry such as: biochemistry, environmental chemistry, chemical engineering, medicine, veterinary medicine, and pharmacy. Furthermore, any one of the three programs will prepare the student to teach chemistry at the high school level or to work in chemical industry.

REQUIREMENTS FOR A MAJOR IN CHEMISTRY (B.A.):

Eight lecture courses, the associated laboratory courses, and senior research (52 credits)

- CHEM 102: General Chemistry II and CHEM 102L (4, 2) **or**
  CHEM 105: Principles of Chemistry and CHEM 105L (4, 2)
- CHEM 214: Analytical Chemistry and CHEM 214L (4, 2)
- CHEM 221: Organic Chemistry I and CHEM 221L (4, 2)
- CHEM 222: Organic Chemistry II and CHEM 222L (4, 2)
- CHEM 241: Inorganic Chemistry I and CHEM 241L (4, 2)
- CHEM 244: Inorganic Chemistry II and CHEM 244L (4, 2)
- CHEM 331: Physical Chemistry I and CHEM 331L (4, 2)
- CHEM 332: Physical Chemistry II and CHEM 332L (4, 2)
- CHEM 480: Senior Research (4)
  [Laboratory numbers reflect the course number + L]

REQUIREMENTS FOR A MAJOR IN CHEMISTRY WITH A BIOCHEMISTRY CONCENTRATION (B.A.):

Eight lecture courses (seven with the associated laboratory courses) and senior research (50 credits)

- CHEM 102: General Chemistry II and CHEM 102L (4, 2) **or**
  CHEM 105: Principles of Chemistry and CHEM 105L (4, 2)
- CHEM 214: Analytical Chemistry and CHEM 214L (4, 2)
- CHEM 221: Organic Chemistry I and CHEM 221L (4, 2)
- CHEM 222: Organic Chemistry II and CHEM 222L (4, 2)
- CHEM 241: Inorganic Chemistry I and CHEM 241L (4, 2)
- CHEM 331: Physical Chemistry I and CHEM 331L (4, 2)
- CHEM 351: Biochemistry and CHEM 351L (4, 2)
- CHEM 352: Advanced Biochemistry (4)
- CHEM 480: Senior Research (4)
  [Laboratory numbers reflect the course number + L]

The major in chemistry and the major in chemistry with a biochemistry concentration have the following core requirements: CHEM 102 (or CHEM 105), CHEM 214, CHEM 221, CHEM 222, CHEM 241, CHEM 331, the corresponding laboratory courses, and CHEM 480: Senior Research. A student in the chemistry track is required to take CHEM 244, CHEM 332, and their associated laboratory courses. A student in chemistry with a biochemistry concentration is required to take CHEM 351 and the associated laboratory course and CHEM 352. Courses selected from among BIOL 220, BIOL 236, and BIOL 312 are strongly recommended for the biochemistry concentration. For both tracks, statistics and computer science are recommended. Students should note that calculus and calculus-based physics are required for physical chemistry. Prerequisites for any course may be satisfied by examination.

REQUIREMENTS FOR A MAJOR IN CHEMISTRY WITH A BUSINESS CONCENTRATION (B.A.):

14 lecture courses and two laboratory courses (60 credits)

- CHEM 102: General Chemistry II and CHEM 102L (4, 2) **or**
  CHEM 105: Principles of Chemistry and CHEM 105L (4, 2)
- CHEM 214: Analytical Chemistry and CHEM 214L (4, 2)
- CHEM 221: Organic Chemistry I (4)
- CHEM 222: Organic Chemistry II (4)
- CHEM 241: Inorganic Chemistry I (4)
- CHEM 331: Physical Chemistry I (4)
- BUS 125: Accounting I (4)
- BUS 226: Accounting II (4)
- BUS 228: Marketing (4)
- BUS 349: Corporate Finance (4)
- ECON 157: Principles of Microeconomics (4)
- ECON 158: Principles of Macroeconomics (4)
- Two elective courses: one from chemistry (CHEM 354: Pharmaceutical Chemistry; CHEM 351: Biochemistry) and one from business/economics (BUS 203: Investments; BUS 222: Business Law; BUS 252: Organizational Behavior; BUS/ECON 266: International Finance; BUS 330: Entrepreneurship; or ECON 386: Managerial Economics) (8)
- Students are required to complete at least one internship with a chemical or pharmaceutical firm during a Short Term or during the summer. During the semester following the completion of the internship, the student must submit a written report and give an oral presentation to the chemistry faculty describing the work experience.
  [Laboratory numbers reflect the course number + L]

REQUIREMENTS FOR A MAJOR IN CHEMISTRY (B.S.):

10 lecture courses (9 with associated laboratory courses), senior research, and allied courses (70 credits)

REQUIRED COURSES IN CHEMISTRY:

- CHEM 102: General Chemistry II and CHEM 102L (4, 2) **or**
  CHEM 105: Principles of Chemistry and CHEM 105L (4, 2)
- CHEM 214: Analytical Chemistry and CHEM 214L (4, 2)
- CHEM 221: Organic Chemistry I and CHEM 221L (4, 2)
- CHEM 222: Organic Chemistry II and CHEM 222L (4, 2)
- CHEM 241: Inorganic Chemistry I and CHEM 241L (4, 2)
- CHEM 244: Inorganic Chemistry II and CHEM 244L (4, 2)
- CHEM 331: Physical Chemistry I and CHEM 331L (4, 2)
- CHEM 332: Physical Chemistry II and CHEM 332L (4, 2)
- CHEM 351: Biochemistry and CHEM 351L (4, 2)
- One additional 300-level course (4)
- CHEM 480: Senior Research (4)
  [Laboratory numbers reflect the course number + L]

REQUIRED ALLIED COURSES:

- PHYS 310: Modern Physics (4) or PHYS 335: Quantum Mechanics (4)
- CMPS 160: Computer Science I (4)

REQUIREMENTS FOR A MAJOR IN CHEMISTRY WITH A BIOCHEMISTRY CONCENTRATION (B.S.):

9 lecture courses (8 with associated laboratory courses), senior research, and allied courses (68 credits)

REQUIRED COURSES IN CHEMISTRY:

- CHEM 102: General Chemistry II and CHEM 102L (4, 2) **or**
  CHEM 105: Principles of Chemistry and CHEM 105L (4, 2)
- CHEM 214: Analytical Chemistry and CHEM 214L (4, 2)
- CHEM 221: Organic Chemistry I and CHEM 221L (4, 2)
- CHEM 222: Organic Chemistry II and CHEM 222L (4, 2)
- CHEM 241: Inorganic Chemistry I and CHEM 241L (4, 2)
- CHEM 331: Physical Chemistry I and CHEM 331L (4, 2)

- CHEM 332: Physical Chemistry II and CHEM 332L (4, 2)
- CHEM 351: Biochemistry and CHEM 351L (4, 2)
- CHEM 352: Advanced Biochemistry (4)
- CHEM 480: Senior Research (4)

REQUIRED ALLIED COURSES:

- Two courses and the associated laboratory courses from:
  BIOL 220: Human Physiology and BIOL 220L (4, 2)
  BIOL 236: Molecular and Cell Biology and BIOL 236L (4, 2)
  BIOL 312: Microbiology and BIOL 312L (4, 2)
  BIOL 314: Genetics and BIOL 314L (4, 2)
  BIOL 322: Developmental Biology and BIOL 322L (4, 2)
  BIOL 332: Immunology and BIOL 332L (4, 2)
  [Laboratory numbers reflect the course number + L]

REQUIREMENTS FOR A MINOR IN CHEMISTRY:

Five courses and the associated laboratory courses (30 credits)

- Four courses at or above the 200 level
- One additional course at any level
  (CHEM 101: General Chemistry I may not be counted among courses offered for the minor)

ADVANCED PLACEMENT CREDITS: A student with a score of 4 or 5 on the College Entrance Examination Board Advanced Placement Test in chemistry will receive four credits in chemistry and may enroll in CHEM 214: Analytical Chemistry, CHEM 221: Organic Chemistry I, or CHEM 241: Inorganic Chemistry I in the first year.

RESEARCH: All students are required to carry out supervised laboratory research. This requirement may be fulfilled in one of two ways. For students not seeking departmental honors, the requirement is Senior Short Term (see below) and one semester of CHEM 480. For students seeking departmental honors, the requirement is Senior Short Term and two semesters of CHEM 490.

SENIOR SHORT TERM: Students must enroll in an independent study and carry out supervised laboratory research in chemistry, biochemistry, or a closely related field. The research is usually conducted at Hollins and is usually a continuation of the work carried out in CHEM 480 or CHEM 490.

SENIOR PRESENTATIONS: All students must write and defend a report (a thesis in the case of students seeking departmental honors), which is based upon research carried out in the senior year (this must be completed before the end of April); furthermore, each student must make a research presentation at the Hollins University Science Seminar or at another meeting sponsored by a professional society in chemistry.

DEPARTMENTAL HONORS: Students who wish to apply for participation in the honors program should consult the chair of the department no later than the end of the second term of the junior year.

COURSES IN CHEMISTRY:

CHEM 101: GENERAL CHEMISTRY I (4) **Kalra**
Introduction to fundamental principles of chemistry with emphasis on structure behavior correlation. Open to first-year students. Not open to students who have taken Chemistry 105. No prerequisite. Offered Term 1. (SCI: must take lab to fulfill SCI)

CHEM 101L: LABORATORY FOR GENERAL CHEMISTRY I (2) **Kalra**
This course allows students working in the lab to make measurements, synthesize and analyze compounds, and use Microsoft Excel to analyze the data obtained from their experiments. Students use both the traditional as well as modern instruments in this course. Open to first-year students. Corequisite: CHEM 101. Offered Term 1. (SCI)

CHEM 102: GENERAL CHEMISTRY II (4) **Derringer**
Fundamental principles of chemistry, including the study of molecular structure, chemical bonding, states of matter, thermodynamics, chemical kinetics, chemical equilibria, and electrochemistry. Open to first-year students. Not open to students who have taken CHEM 105. Prerequisite: CHEM 101. Offered Term 2. (SCI: must take lab to fulfill SCI)

CHEM 102L: LABORATORY FOR GENERAL CHEMISTRY II (2) **Derringer**
Introduction to aspects of gases, colligative properties, chemical kinetics, equilibrium, and spectrophotometry. Open to first-year students. Corequisite: CHEM 102. Offered Term 2. (SCI)

CHEM 105: PRINCIPLES OF CHEMISTRY (4) **Derringer**
This one-semester course in general chemistry is designed for students who have had chemistry in high school. It is open to students who by placement examination demonstrate that they have a good working knowledge of important principles of chemistry. Topics include stoichiometry, equilibria, reaction rates, atomic structure, bonding, molecular structure, thermodynamics, and electrochemistry. Open to first-year students. Not open to students who have taken CHEM 101 or CHEM 102. Offered Term 1. (SCI: must take lab to fulfill SCI)

CHEM 105L: LABORATORY FOR PRINCIPLES OF CHEMISTRY (2) **Derringer**
Introduction to selected aspects of synthesis, classical and instrumental analysis, safety, and the laboratory notebook. Open to first-year students. Corequisite: CHEM 105. Offered Term 1. (SCI)

CHEM 112: ENVIRONMENTAL ANALYSIS (4) **Kalra**
This class is mainly a hands-on class. It introduces the student to some of the chemistry background, the analytical techniques, and instruments used in the chemical analysis of environmental pollutants. Meetings: Lecture 1.5 hour, lab 3 hours. Open to first-year students. Prerequisite: q, one to two years of high school chemistry. Also listed as ES 112. Not offered in 2017-18. (*Q*, SCI)

CHEM 115: FORENSIC SCIENCE – CSI HOLLINS (4) **Boatman**
Forensic science is any science used in public, in court, or in the justice system—any science used for the purposes of the law. Forensic scientists are involved in all aspects of criminal cases; their work serves both the defense and the prosecution. The forensic scientist's goal is the even-handed use of all available information to determine the facts and, subsequently, the truth. This interdisciplinary course will explore and give students hands-on experience with many areas of scientific activity in forensics where laboratory and field investigation are important. Not intended for students majoring in biology or chemistry. Open to first-year students. Not offered in 2017-18. (*o*, SCI)

CHEM 120: CHEMISTRY AND COOKING (4) **Derringer**
As Harold McGee, author of On Food and Cooking, a book which is arguably one of the most important treatises on the culinary arts, puts it, "[c]ooking is applied chemistry, and the basic concepts of chemistry—molecules, energy, heat, reactions— are keys to a clearer understanding of what our foods are and how we transform them." In this course we examine the nature of food and explore the fascinating changes it undergoes during cooking processes. Some attention will be given to human nutrition, and the course will have an integrated laboratory component. No prerequisite. Open to first-year students. Not offered in 2017-18. (*o*, SCI)

CHEM 214: ANALYTICAL CHEMISTRY (4) **Kalra**
An introduction to the basic processes of chemical analysis and the theories that govern them. Open to first-year students. Prerequisites: CHEM 105 and CHEM 105L (or CHEM 102 and CHEM 102L). Offered Term 2. (SCI: must take lab to fulfill SCI)

CHEM 214L: LABORATORY FOR ANALYTICAL CHEMISTRY (2) **Kalra**
This course will introduce you to different analytical techniques used in the academic, industrial, and government laboratories. You will learn to separate components of a mixture and analyze them quantitatively using classical methods like gravimetry and volumetric titrations and modern instrumental techniques such as atomic absorption, FTIR, and diode array spectrophotometery. Corequisite: CHEM 214. Offered Term 2. (SCI)

CHEM 221: ORGANIC CHEMISTRY I (4) **Boatman**
An introduction to structure, bonding, nomenclature, and physical properties of aliphatic and aromatic compounds, conformational analysis, stereochemistry, functional groups, and organic reactions. Prerequisites: CHEM 105 and CHEM 105L (or CHEM 102 and CHEM 102L) or permission. Offered Term 1.

CHEM 221L: LABORATORY FOR ORGANIC CHEMISTRY I (2) **Boatman**
Introduction to the procedures involved in preparing, purifying, separating, and analyzing simple organic compounds using microscale techniques. Introduction to the use of gas chromatography for qualitative and quantitative analysis and of infrared spectrophotometry for structural analysis of organic compounds. Corequisite: CHEM 221. Offered Term 2.

CHEM 222: ORGANIC CHEMISTRY II (4) **Boatman**
Organic reactions and their mechanisms. Prerequisites: CHEM 221 and CHEM 221L. Offered Term 2.

CHEM 222L: LABORATORY FOR ORGANIC CHEMISTRY II (2) **Boatman**
Syntheses and analyses of more complex organic compounds using microscale and small-scale techniques. Practice in developing experimental procedures. Use of gas chromatography and infrared and UV-Vis spectrophotometry in structural analysis of organic compounds. Introduction to nuclear magnetic resonance spectrometry. Corequisite: CHEM 222. Offered Term 2.

CHEM 241: INORGANIC CHEMISTRY I (4) **Derringer**
Introduction to the structures, physical properties, and reactivities of the elements and their compounds. Both theoretical and descriptive aspects of this material will be covered. Prerequisites: CHEM 105 and CHEM 105L (or CHEM 102 and CHEM 102L) or permission. Offered Term 1.

CHEM 241L: LABORATORY FOR INORGANIC CHEMISTRY I (2) **Derringer**
Introduction to inorganic synthesis and to classical and instrumental methods of qualitative and quantitative analysis in inorganic chemistry. Corequisite: CHEM 241. Offered Term 1.

CHEM 244: INORGANIC CHEMISTRY II (4) **Derringer**
Introduction to the chemistry of the d-block elements and their compounds. Specific topics include symmetry; structures of and bonding in complexes; reactions and reaction mechanisms of complexes; nuclear magnetic resonance, electronic absorption, and infrared spectra of complexes; organo-metallic complexes; and selected chemistry of the first-row transition elements. Prerequisites: CHEM 241 and CHEM 241L. Offered Term 2.

CHEM 244L: LABORATORY FOR INORGANIC CHEMISTRY II (2) **Derringer**
Introduction to synthesis and analysis of complexes of first-row transition metal ions. Corequisite: CHEM 244. Offered Term 2.

CHEM 290: INDEPENDENT STUDY (2 or 4) **Department**
Independent study conducted below the advanced level. Application must be made with faculty prior to registration. Offered any term.

CHEM 320: ADVANCED ORGANIC CHEMISTRY (4) **Boatman**
Selected topics in organic chemistry. Prerequisites: CHEM 214 and CHEM 214L; CHEM 222 and CHEM 222L. Not offered in 2017-18.

CHEM 320L: LABORATORY FOR ADVANCED ORGANIC CHEMISTRY (2) **Boatman**
Advanced techniques of organic synthesis. Experimental design. Instrumental analysis of organic compounds. Short research project. Corequisite: CHEM 320. Not offered in 2017-18.

CHEM 331: PHYSICAL CHEMISTRY I (4) **Kalra**
Fundamental principles of physical chemistry, including the laws of thermodynamics, study of phase equilibria and of ideal solutions. Also listed as PHYS 331. Prerequisites: PHYS 202 and PHYS 202L; CHEM 105 and CHEM 105L (or CHEM 102 and CHEM 102L); MATH 242; or permission. Offered Term 1.

CHEM 331L: LABORATORY FOR PHYSICAL CHEMISTRY I (2) **Kalra**
The experiments carried out in the lab relate to the main topics covered in the class, including heat capacities of gases, thermodynamic properties of different systems, and phase diagrams. Also listed as PHYS 331L. Corequisite: CHEM 331. Offered Term 2.

CHEM 332: PHYSICAL CHEMISTRY II (4) **Kalra**
Thermodynamics of solutions of electrolytes and nonelectrolytes, electrochemistry, kinetic molecular theory of gases, transport properties of gases, and chemical kinetics. Also listed as PHYS 332. Prerequisites: CHEM/PHYS 331 and CHEM/PHYS 331L. Offered Term 2.

CHEM 332L: LABORATORY FOR PHYSICAL CHEMISTRY II (2) **Kalra**
The experiments carried out in the lab relate to the main topics covered in the class, including electrochemistry, transport properties of liquids, ionic conductance, and chemical kinetics. Also listed as PHYS 332L. Corequisite: CHEM 332. Offered Term 2.

CHEM 335: QUANTUM MECHANICS (4) **Department**
Also listed and described as PHYS 335. Not offered in 2017-18.

CHEM 340: ADVANCED INORGANIC CHEMISTRY (4) **Derringer**
Selected topics in inorganic chemistry, including chemical and physical behavior of some of the less familiar elements, nonstoichiometric compounds, types and structures of complexions, ligand and crystal field theories. Investigation into both the factual and the theoretical aspects of inorganic chemistry that are of use or interest to the students enrolled. Prerequisites: CHEM 222 and CHEM 222L; CHEM 244 and CHEM 244L; CHEM 331 and CHEM 331L. Corequisites: CHEM 332 and CHEM 332L. Not offered in 2017-18.

CHEM 351: BIOCHEMISTRY (4) **Boatman**
The chemical nature of biological molecules and the relationship between their structures and function; the function of carbohydrates, nucleic acids, proteins, and lipids in living systems. Introduction to metabolism. Also listed as BIOL 351. Prerequisites: CHEM 222 and CHEM 222L; or the equivalent. Offered Term 1.

CHEM 351L: LABORATORY FOR BIOCHEMISTRY (2) **Boatman**
Experimental techniques used in biochemistry: potentiometry, centrifugation, chromatography, electrophoresis, spectrophotometry, isolation, purification, and characterization of proteins and nucleic acids, enzymology. Also listed as BIOL 351L. Corequisite: CHEM 351. Offered Term 1.

CHEM 352: ADVANCED BIOCHEMISTRY (4) **Boatman**
Topics such as enzyme kinetics, structure-function relationships in biological molecules, bioinorganic chemistry, and the physical chemistry of biological systems will be discussed. Also listed as BIOL 352. Prerequisites: CHEM 351 and CHEM 351L. Offered Term 2.

CHEM 352L: LABORATORY FOR ADVANCED BIOCHEMISTRY (2) **Boatman**
Study of formation and properties of lipid micelles, denaturation of proteins and protein folding; isolation and characterization of a protein obtained using techniques of recombinant DNA. Short research project. Also listed as BIOL 352L. Corequisite: CHEM 352. Not offered in 2017-18.

CHEM 354: PHARMACEUTICAL CHEMISTRY (4) **Boatman**
Selected topics related to pharmaceuticals, their discovery, testing, regulation, and manufacture, including: structures and modes of action of the major classes of drugs; new methods used in drug discovery and development of clinically useful drugs; assessment of pharmacokinetics, pharmacodynamics, safety and efficacy of promising drug candidates; the roles of various regulatory agencies in approval and use of drugs. Prerequisite: CHEM 222 and CHEM 222L. Offered Term 2.

CHEM 390: INDEPENDENT STUDY IN CHEMISTRY (2 or 4) **Department**
Independent study conducted at the advanced level. Experimental component is normally required. May be offered during the summer and may be repeated up to a total of three courses. Application must be made with faculty prior to registration. May be proposed in any term.

CHEM 399: INTERNSHIP (4) **Department**
Application must be made with faculty prior to registration. May be proposed in any term.

CHEM 480: SENIOR RESEARCH (4) **Department**
Open to seniors majoring in chemistry, chemistry with biochemistry concentration, and to other qualified students with permission of the department. Application must be made with faculty prior to registration.

CHEM 490: SENIOR HONORS RESEARCH (4, 4) **Department**
Open to majors with permission of the department. Interested majors should consult the chair of the department no later than the end of the second term of their junior year. Application must be made with faculty prior to registration.