Roanoke College

Chemistry and Biochemistry Programs

Chair's Welcome

Dear Prospective Student,

Hello! Thank you for your interest in the Roanoke College Chemistry Department. In this brochure, you'll find more information about our programs. We offer majors in Chemistry and Biochemistry, a minor in Chemistry, and a concentration in Medicinal Chemistry. For more details on these program options, please visit our website.

We offer a full range of Chemistry courses and electives, to prepare you for whatever your future holds. Classes are small, mostly under 24 students per section, and all our classes and labs are taught by faculty members with advanced degrees. Elective options include Environmental Chemistry and Pharmaceutical Chemistry. You can also broaden your learning with electives from Physics, Nanomaterials, Biology, Public Health, Neuroscience, or any of the other great course offerings across campus.

Instrumentation is a major strength of our department. We have a wide array of research-grade instrumentation, including a 400 MHz NMR, a GC/MS, HPLCs, a transmission electron microscope (TEM), ICP and AA, a fluorimeter, cell culture equipment, and more. Notably, undergraduates use all of our instruments. Even our first-year lab courses include instruments that some institutions only make available to graduate students. You'll be a "power user" on our instruments before you graduate, and several of our recent graduates have turned that expertise into great jobs as field service technicians.

Chemistry faculty members offer research opportunities each semester and summer for interested students. These are real research projects, with students and their faculty mentors engaged in solving problems and creating new knowledge. You'll work closely with your faculty research mentor. You'll present it on- and off-campus, too! Many of our research students present their work to national meetings of the American Chemical Society. Our students co-author academic papers with their faculty mentors, too!

As you'll see on the next few pages, a Roanoke College Chemistry or Biochemistry degree can prepare you for a variety of exciting career paths. Throughout your time at Roanoke College, you'll work closely with your faculty advisor(s) to choose courses, plan your future, and grow into the person you want to become. We'll be there to support your job search or your applications to graduate school, pharmacy school, medical school, teacher certification, or whatever you choose. Close relationships between faculty and students help to make that all possible.

If you have any questions, please don't hesitate to get in touch! You can reach me by phone (540-375-2438) or email (sarisky@roanoke.edu). You can also visit the Chemistry Department website at http://www.roanoke.edu/chemistry.

Warmly,

C. A. Sarisky

Dr. Catherine Sarisky
Associate Professor and Chair

p.s. I think we're pretty awesome, but don't just take my word for it! Read on to see what our alumni have to say!

Where can a Chemistry or Biochemistry major take you?

Thane Jones ('17)
Ph. D. candidate, North Carolina State University

"I am currently pursuing my PhD in Synthetic Organic Chemistry at NC State University. My Teaching Assistantship (TA) pays me and covers tuition while I study here for the next five years! In exchange, I teach laboratory sections, proctor tests, and grade for the professors.

The RC chemistry department has given me an exceptionally strong knowledge base for graduate school and has produced many talented chemists alongside me. Best of luck at Roanoke and study hard!"

Salihah Ali ('16)
Pharmacy student, VCU School of Pharmacy

"I am currently a 3rd year pharmacy student. This is my last didactic year and next year I will be in Charlottesville, VA completing my rotations.
I was prepared for the intensity of pharmacy school due to my professors teaching me fundamental principles along with finite details within biology and chemistry. I would say it's the best of both worlds.

Whatever your goal may be, Roanoke College has the best professors and resources to get you where you want to go. If you are exploring multiple options or have no idea at all, your professors will be there to help you find your way. My two pieces of advice are: don't limit yourself, make yourself stand out through the resources, opportunities and experiences that being are being provided to during your time at Roanoke College. Finally, your time at Roanoke College is what you make of it. The more you put in, the more you will get out of it."

Kelly Fletcher ('09)
Senior Food Technologist, Perdue Foods

"While at Roanoke majoring in chemistry, I had the opportunity to attend a guest lecture on flavor chemistry. The speaker opened my eyes to the application of chemical science to food, and I went on to earn a master's degree in food science. Now I work as a Senior Food Technologist in Research and Development for Perdue Foods, where I create and commercialize new products for food service and national account customers, including several well-known restaurant chains.

I had an amazing experience at Roanoke and I know others will too. And now, I get to eat my experiments."

EVERYWHERE!

Matt Hall (‘09)
Chief Resident of Preventative Medicine, UNC-Chapel Hill

“I am a Navy physician and current chief resident of Preventive Medicine at the University of North Carolina at Chapel Hill. I conduct population level research focused on the maternal and fetal health outcomes associated with electronic cigarette exposure during pregnancy.

Roanoke College provided me a unique opportunity to interact with professors who fostered the ability to think critically about problems and develop meaningful solutions.”

Sydney Strickland (’11)
Technical Director in Clinical Chemistry, LabCorp

“I am currently working at LabCorp in Burlington, NC as a Technical Director in Clinical Chemistry.

After I graduated from Roanoke in 2011, I attended UVA for my Ph. D. and Fellowship in experimental pathology and clinical chemistry. I received a stipend to cover living expenses and waived tuition and health insurance during my Ph. D. training and a salary during my fellowship training in the UVA Medical Center.”

Dana Layo (‘16)
Ph. D. Candidate, UTenn Knoxville

“I am a third year PhD candidate at the University of Tennessee Knoxville in the Biochemistry & Cellular and Molecular Biology department.

I didn’t realize just how much Roanoke College helped prepared me for the rigor of graduate school until I got here and it became evident that I was ahead of most of the students in my program (the proof being that I’m the first and only student thus far to pass my qualifying exams!!)

I am currently working on understanding the molecular mechanisms behind learning and the retention of neural connections using a mouse model of Rett Syndrome, which is a rare neurological disorder.”

David MIller (‘18)
Field Service Engineer, SUEZ

“I have found an amazing job thanks to the RC Chem department! I am currently working for the company SUEZ on TOC analyzers in the municipal and pharmaceutical world. I am a field service engineer and get to travel to labs for installs, repairs, calibrations, and maintenance of these incredible instruments.

My best advice to students is to keep an open mind, you never know what you might find and it’s okay to follow your own path.”

Claire Brooks (‘17)
M. Ed candidate, University of Virginia

“I’m currently getting my Master’s degree in education at UVA. I’m hoping to become an elementary or middle school science teacher.

Roanoke allowed me to foster my love for science by giving me the greatest mentors out there! Being able to have real relationships with my professors and peers was an experience that I will never take for granted.”

Adam Skaff (‘12)
Pediatrics Resident, University of Virginia

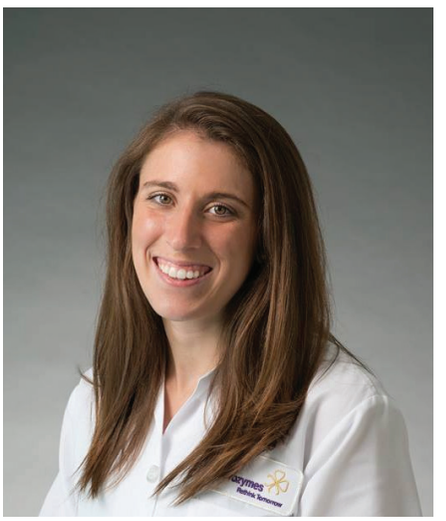
“I graduated from Roanoke College with a degree in Biochemistry in 2012. Since graduating, I attended West Virginia University for medical school and I’m now completing my Pediatrics Residency at the University of Virginia with hopes of continuing my training in Pediatric Cardiology.

My time at Roanoke College helped me prepare very well for my medical school career and career as a physician. The smaller class sizes allowed for more one-on-one instruction and a greater understanding of the underlying science that continues to benefit me in my career today.”

Meagan Hale (‘13)
Research Associate, Novozymes

“I am working at Novozymes in Salem as a Research Associate in R&D. I just celebrated 5 years in the spring. I am currently working in our animal health and nutrition group focusing on developing probiotic solutions for animals.

My undergraduate research experiences in biochemistry really contributed to me learning that I love doing research in a lab, and my experiences in labs has propelled me in my career at Novozymes. The intimacy Roanoke College provided and being pushed to do more than show up for class really set me up for an exciting future doing what I love.”



Emily Searles (‘18)
Graduate student, Rice University

“I graduated from Roanoke College in May and headed to Texas where I am a graduate student at Rice University.

The opportunities provided to me by the RC chemistry department, including the ability to participate in research throughout my undergraduate career, allowed me to pursue my doctorate in physical chemistry. My research background and course work has more than prepared me for work at Rice!”

Research Opportunities

Students from freshmen to seniors are encouraged to participate in research projects in our department. Roanoke College students work closely with faculty mentors, present their work at national conferences, and are co-authors on research publications.

Dr. Kelly Anderson: Exploring chemical systems using molecular simulation
My research focuses on using molecular simulation to examine a variety of chemical systems. This means all of the work is computational – there is no traditional "wet" chemistry in my lab. Using computers allows us to look at chemical interactions truly on the atomic and/or molecular level. Often our models are able to explain macroscopic properties or provide justification for experimental lab results. Sometimes, the processes that we are interested in occur on such a small scale that we can't measure it with the equipment currently available. Simulation provides a window into what may be happening "in the real world."

Currently, I'm involved in research that aims to develop a new thermal energy storage system that could be coupled to power plants in order to better integrate traditional and renewable energy sources into the energy grid. We are looking at one small piece of this very large puzzle – how does the melting point of a fluid change upon confinement? To this end, we're simulating simple metals confined in cylindrical pores of varying diameter as a simple model of a fluid confined in a porous medium, the basis of the proposed thermal storage system. Understanding the melting behavior of simple fluids will help us design more complex fluids that exhibit the properties of interest.

Dr. Tim Johann: Determination of the Function of Tuberculosis Proteins
Tuberculosis (TB) is a deadly disease to which an estimated half of the world's population is at risk. In 2011 there were almost 9 million new cases of TB and 1.4 million deaths caused by this disease. While progress has been made in treating this disease over the last decade, its cost in lives is still enormous. One of the difficulties in treating TB is that the bacterium that causes it is becoming resistant to antibiotics. We will use a range of techniques from the fields of chemistry and biology to produce and characterize proteins that contribute to antibiotic resistance in TB. Our work will help improve the understanding of this resistance and will hopefully aid others in the design of more effective therapies.

Dr. Gary Hollis: Using Diels-Alder Reactions to Model Self-Healing Polymer Systems
My research interests lie primarily in the area of synthetic organic and organometallic chemistry. Synthetic methods are developed in order to facilitate the conversion of one molecule into another. In addition to this goal of investigating molecular construction, methods development contributes basic chemical knowledge concerning the properties of the species and the reactions being studied. Student collaborators will learn basic techniques in organic and organometallic synthesis (including inert atmospheres, syringe techniques, extractions, etc.), methods of purification of organic compounds (including distillation, recrystallization, and column chromatography), and the means to identify compounds using modern spectroscopic instrumentation.

My current research is on synthesizing, purifying, and characterizing fluorinated dienes and dienophiles to use as Diels-Alder substrates. This work is part of a larger effort through a collaboration with Dr. Paul Deck at Virginia Tech. While my lab at Roanoke makes small molecule species, Dr. Deck's research group uses these monomers in Diels-Alder polymerization reactions with the goal of making polymers that can self-repair.

Dr. Catherine Sarisky: Biosynthesis Enzymes and Inhibitors.
Students in my research group work on biosynthetic enzymes from a variety of organisms. I'm particularly interested in answering questions about purine biosynthesis and interconversion in archaea and in human pathogens. The ability to make purines (the As and Gs of DNA) is fundamental, yet the pathways used are quite variable between organisms. Studying thiese pathways could lead to new industrially-useful enzymes, new inhibitors for pathogens, and a clearer understanding of the origins of life.

Dr. Steve Hughes: Inorganic semiconductor nanocrystals for light downshifting applications

One of the greatest sources of energy loss in current light emitting diodes (LEDs) is the light down-shifting phosphor. The phosphor converts the blue or ultraviolet (UV) light of the bare LED to longer wavelengths of visible light. Depending on this phosphor layer, one can make the LED emit a single color of light or a mixture of colors in order to produce white light. Traditional phosphors in the past have used inorganic molecules incorporating rare-earth metals that are expensive and absorb the UV light of the LED very poorly. Because of this, there has been a strong push to replace these materials with inorganic semiconductor nanocrystals. These nanocrystals strongly absorb the UV light, and have the potential to be produced at much lower costs.

The materials system my students and I are working on is silver gallium sulfide (AGS). In addition to having the ideal light absorption and re-emission properties that are desired for this application, AGS also has the added benefit of being a tunable, ternary system. This means that by careful control of the growth parameters, the emission color of these particles can be tuned across our visible spectrum, from blue to red.

Dr. Richard Keithley: Electrochemical Sensor Development

My research is in the field of analytical chemistry which can be thought of as the development of novel instrumentation and sensors to measure complex chemical phenomena. Research in my lab is focused on fabrication of devices that can be used to monitor molecules of biological importance including neurotransmitters and molecular oxygen. Specifically, students will be involved in the construction of a novel type of carbon-fiber ultramicroelectrode, a sensor that is 10-100 times smaller than a human hair. This type of research is not the traditional “wet chemistry” students are used to in a lab, but if you are good at building things with your hands, this project is for you!

Dr. Skip Brenzovich: Designing Magnetic Catalysts for Easy Recovery and Reuse

From drugs to plastics, organic (or carbon-based) molecules are an important part of modern life; however, building the molecules that we need is often an expensive and time-consuming process. Our lab is interested exploring how metals interact with organic compounds and utilizing that understanding to design cheaper, faster, and cleaner ways to construct molecules. Students in my lab will become familiar with a variety of different modern techniques involved in the synthesis, purification, and characterization of organic and metal-containing compounds.

My current area of exploration is in the creation of palladium catalysts that can be easily separated and isolated from reactions through magnetism. Palladium is an amazing metal, and one of the most commonly used transition metals in the design and production of important pharmacological agents. While these palladium catalysts are not used up in the course of a reaction, their recovery and reuse is often difficult. We are designing and testing modified magnetic nanoparticles to support palladium catalysts for a variety of important reactions with an eye towards activity and recyclability.

Dr. Emily Hardy: Synthesizing New Lanthanide Coordination Compounds

My research interests lie in the area of synthetic organic and inorganic chemistry, and more specifically in f-block coordination chemistry. The often forgotten lanthanide and actinide metals have large f-orbitals that make them potentially useful as catalysts or molecular magnets, and they often have interesting emission properties. Lanthanides can bind to organic molecules which enhance these properties and are commonly found in MRI-contrast agents and a variety of other drug therapies. I plan on making highly conjugated organic molecules to use as ligands for lanthanide metals and to investigate their properties. Students in my lab will become familiar with fundamental organic and inorganic synthesis, purification, and learn a variety of characterization techniques to investigate these organic molecules and the metal-containing coordination compounds.

Chemistry Courses

CHEM 111, 112 General Chemistry: Foundations I & II (with labs): The introductory courses in chemistry. Topics include atoms and molecules, subatomic particles, chemical bonding, solution chemistry, balancing equations, stoichiometry, thermodynamics, gases, intermolecular forces, phase diagrams, kinetics, equilibrium, acids and bases, electrochemistry, nuclear chemistry.

CHEM 117, 118 General Chemistry: Advanced Principles and Applications I & II (with labs): The introductory courses in chemistry. Suitable for students with strong chemistry and math backgrounds. Topics covered include atomic and molecular structure, stoichiometry, bonding, reactions, equilibrium, thermodynamics, kinetics, solutions, and acid -base chemistry. Particular emphasis will be placed on applications of fundamental chemical concepts.

CHEM 221, 222 Organic Chemistry I & II (with labs): A study of the chemistry of the compounds of carbon. Fundamental concepts of chemical bonding are employed to develop chemical models and to correlate structure-property relationships within and among the various classes of carbon compounds.

CHEM 255 Quantitative Chemical Analysis: A study of the theoretical principles and technical practices relating to quantitative measurements within chemical systems. Topics include solution preparation, gravimetric and volumetric technique, data handling and analysis and use of chemical instrumentation.

CHEM 260 Descriptive Inorganic Chemistry (with lab): A study of the elements and their compounds. The properties of these substances, spanning the entire periodic table, will be described and explained through the connections to chemical theories and concepts. The occurrence, isolation, uses, and compounds of elements will be explored. Biochemical and industrial applications will be considered. Lab experiments include a strong emphasis on quantitative techniques.

CHEM 270 Environmental Chemistry (with lab): This course focuses on the role chemistry plays within the environment (terrestrial, aquatic, and atmospheric), with a significant focus on the application of chemical principles. The analysis of real-world environmental samples by chemical instrumentation will also be presented within both the lecture and laboratory settings.

CHEM 331, 332 Physical Chemistry I & II (with labs): The physical aspects of chemical phenomena, including the properties of solids, liquids, gases and solutions; thermodynamics; kinetics; electrochemistry; and elementary quantum theory.

CHEM 340 Pharmaceutical Chemistry: A study of the chemistry of pharmaceuticals, with emphasis on the molecular-level interactions between drugs and the body. Drug metabolism, drug-receptor interactions, and drug development are explored with case studies including cancer drugs, opiates, and antibiotics.

CHEM 341 Biochemistry I: Structure and Function (with lab): This course provides an overview of the structure and function of biological monomers and polymers, using examples from medicine. Proteins, carbohydrates, nucleic acids, and lipids are studied in detail with an emphasis on intermolecular interactions, kinetics, and thermodynamics.

CHEM 342 Biochemistry II: **Metabolism (with lab)**: This course provides and overview of the major metabolic pathways found in animals, plants, and prokaryotes, including connections to medicine and health. The catabolism and anabolism of carbohydrates, lipids, and proteins are studied in detail, along with oxidative phosphorylation and photosynthesis. The laboratory consists of a semester-long project in which students modify, express, purify, and study a protein important to the metabolism of currently-used chemotherapeutics.

CHEM 350 Instrumental Analysis (with lab): Regardless of their interests, all chemists rely on the use of equipment to characterize chemical phenomena. In this course we will study how chemical systems can be monitored using instrumentation, the construction of instrumentation capable of such measurements, and the application of these tools to a variety of complex systems. The laboratory is focused on providing students significant hands-on opportunities to operate chemical instrumentation independently.

CHEM 420 Advanced Organic Chemistry: An in-depth study of selected topics in organic chemistry, with particular emphasis on physical organic chemistry.

CHEM 460 Advanced Inorganic Chemistry: Advanced topics in inorganic chemistry with an emphasis on bonding and structure.

In addition to the courses listed, students can earn academic credit for research and internships.

Programs of Study

Chemistry is the study of matter at the molecular level. Chemists consider our field to be the "Central Science", with overlaps with biology, physics, and environmental science. Major subfields include computational chemistry, physical chemistry, analytical chemistry, organic chemistry, inorganic chemistry, and biochemistry. An ACS-certified B. S. degree and a B. A. degree and minor are offered in Chemistry.

Biochemistry is the study of the chemical processes of living organisms, including the molecular structures of biomolecules, their reactions (e.g. metabolism, genetic expression), and regulation of those reactions. The biochemistry curriculum at Roanoke College includes substantial curricular components from both the biology and chemistry departments. Students may have their degrees certified by ASBMB. We offer a B. A. and a B. S. in Biochemistry.

The **Medicinal Chemistry** concentration provides additional coursework in chemistry for students interested in a deeper understanding of chemistry as it relates to pharmaceutical development, production, and the practice of medicine. Students may declare this concentration in combination with any major.

For a list of requirements for these programs, please visit http://roanoke.edu/chemistry

Additional Courses for Biochemistry Majors

BIOL 190 Exploring Unity in Biology: An investigation of three of six themes central to the field of biology (Information Flow, Matter and Energy Transformation, and Structure/Function Relationships).

BIOL 210 Cell Biology: A study of the fundamental processes that occur within eukaryotic cells, focusing on the structures and functions of the organelles, the cell cycle, and cell signaling.

BIOL 315 Genetics: A study of the principles of Mendelian, population, and molecular genetics.

BIOL 380 Advanced Genetics: A study of the eukaryotic genome with particular reference to chromosome structure and function.

BIOL 400 Molecular Biology: A detailed analysis of information flow from DNA to RNA to protein, with emphasis on both prokaryotic and eukaryotic gene regulation.

SHOWCASING OUR WORK

Where will your work take you? A national conference? Or a co-authored paper in an academic journal?

Student Publications (undergraduates underlined)

Donahue, Caitlin E. T.; Miller, David R., Jr.; Beger, Tyler W.; Johann, Timothy W.; Keithley, Richard B. Improved formation of electrically-deposited enzyme-embedded chitosan coatings onto carbon fiber microelectrodes. *Analytical Methods* (2018), 10(13), 1565-1576.

Moore, Desiree L.; Denton, Allison E.; Kohinke, Rose M.; Craig, Brandon R.; Brenzovich, William E., Jr. Silica sulfuric acid as a highly efficient catalyst for the synthesis of diarylacetic acids. *Synthetic Communications* (2016), 46(7), 604-612.

Paderick, Sky; Kessler, Matthew; Hurlburt, Tyler J.; Hughes, Steven M. "Synthesis and characterization of AgGaS2 nanoparticles: a study of growth and fluorescence" *Chemical Communications* (2018), 54(1), 62-65.

Tolley, Meagan; Bickford, Lydia; Clare, Kristen; Johann, Timothy W. Investigations of amino acids in the ATP binding site of 5,10-methenyltetrahydrofolate synthetase. *Protein Journal* (2012), 31(6), 519-528.

Student Presentations (undergraduates underlined)

Maust, Mark C.; Brenzovich, William E. Jr. "Investigations into the effect of alkoxy substitution on palladium-catalyzed olefin difunctionalization" 255th ACS National Meeting & Exposition, New Orleans, March 2018.

Croft, Zacary L.; Brenzovich, William E. Jr. "Mechanistic investigations into a novel palladium-catalyzed oxidative difunctionalization reaction" 255th ACS National Meeting & Exposition, New Orleans, March 2018.

Miller, David R., Jr.; Keithley, Richard B. "Improving the fabrication of carbon fiber microelectrode sensors." 255th American Chemical Society National Meeting, New Orleans, March 2018.

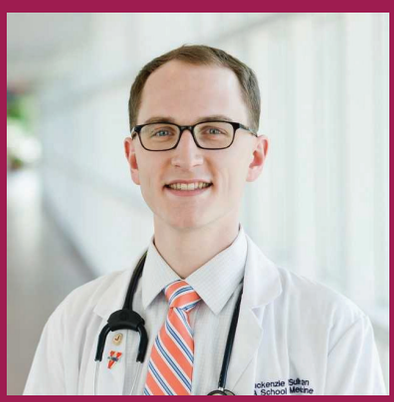
Kosko, John; Hollis, W.; Deck, Paul A. "Kinetic & thermodynamic studies of 2-furylmethyl benzoate and 2-(methoxymethyl)furan in model Diels-Alder reactions", 255th ACS National Meeting & Exposition, New Orleans, March 2018.

Beger, Tyler W.; Keithley, Richard B. "The Effect of Carbon Fiber Microstructure on Electrochemical Performance of Disk-Shaped Microelectrodes for Fast-Scan Cyclic Voltammetry." Pittsburgh Conference, Chicago, March 2017.

Stum, Danielle; Hollis, W. Gary Jr.; Deck, Paul A. "Equilibrium Constants in the Diels-Alder Reactions of Furan Derivatives with N-(4-Fluorophenyl) maleimide," 253rd American Chemical Society National Meeting, San Francisco, April 2017.

"Roanoke's small size was instrumental in my undergraduate success as it facilitated strong faculty-student relationships and experiential opportunities—for example, I was able to get involved in undergraduate research my first year. I hope you'll consider Roanoke and please don't hesitate to reach out with any questions throughout the process."

--Mackenzie Sullivan ('15)



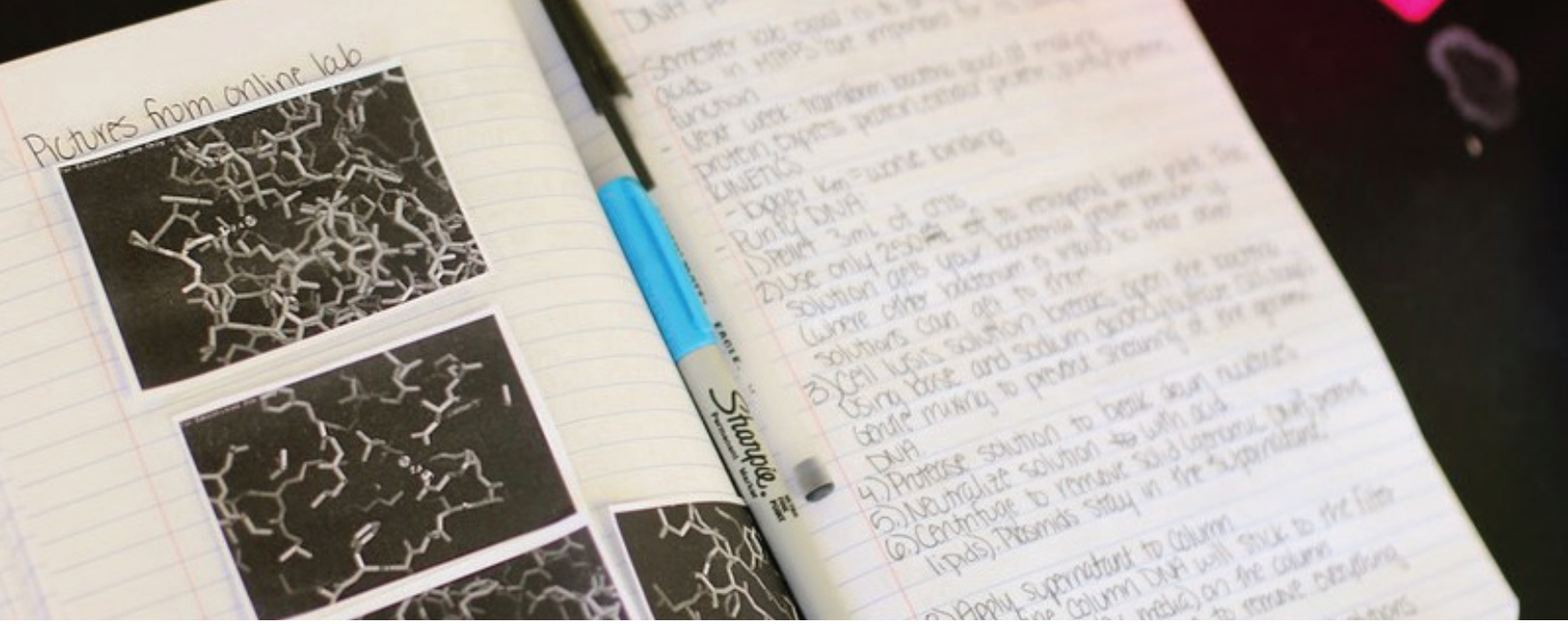
"Roanoke College provided me with numerous opportunities including seminar talks, research opportunities, and the ability to present my research at numerous conferences. However beyond these opportunities, the invaluable advice and support I received from the chemistry department was a key factor in helping me achieve my goal of attending graduate school."

--Caitlin Donahue ('17)

Enrichment Program in Chemistry

The Chemistry Department offers a seminar series, called the Enrichment Program in Chemistry, or EPiC, each semester. The EPiC program provides numerous opportunities for students to learn about chemical/biochemical topics beyond those covered in courses, to interact with visiting speakers, and to make contacts with our alumni. Below is a list of some recent EPiC presentations:

- Charged-Up Polymers: Advanced Materials for Sports to Space
- How Chemistry Intersects Law and Policy of Food Additives
- Voyage to Mars: Red Planet Chemistry
- Vascular Stents: The Intersection of Materials, Design, Patents, Manufacturing, and Business
- Cathepsin K Inhibitors for the Treatment of Osteoporosis: An Example of the Drug Discovery Process
- The New Adventures of Boron Trihalide Chemistry
- The Magic of Chemistry (Demo show)
- The Role of Size Exclusion Chromatography in Polymer Characterization
- Long Strange Trip: Adventures of an Analytical Chemist
- Forensic Chemistry: Now and Then
- The Biochemistry of Addiction: Caffeine and Heroin
- What Can I Do with a Major in (Bio)Chemistry? (Alumni panel)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ROANOKE
COLLEGE