



THE UNIVERSITY
of NORTH CAROLINA
at CHAPEL HILL

COLLEGE OF ARTS & SCIENCES

STUDY ABROAD OFFICE

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Administrative Board of the College of Arts & Sciences

Proposed Program: **UNC Science in Germany**

Proposed Program Location: **Freiburg, Germany & Basel, Switzerland**

Faculty Program Leaders: **Josh Beavers**

Dear Colleagues:

The UNC Study Abroad Office submits for your approval a proposal for the establishment of a new faculty-led program to be offered beginning **Summer 2021** and continuing annually.

PROGRAM INFORMATION

This proposed faculty-led program would be offered for **6 credits** during the Summer term, tentatively scheduled for **six weeks in late May through June**.

Program Rationale: This proposed program is located in Freiburg, Germany and will hold classes at the University of Freiburg. In working with Lynn Neddo, I have been in contact with administration in the International Office, as well as the Chemistry Department at the University of Freiburg, and the possibility of hosting summer sessions has been met with enthusiasm from our counterparts in Germany. The Study Abroad Office at UNC has already developed a relationship with Freiburg outside of the sciences, and this summer program opens the door to explore additional exchanges and continue to strengthen our relationship with the University of Freiburg.

While Germany is famous for its precision engineering, and environmental sustainability, it also has a rich history of contributions to chemistry. During the introductory chemistry courses at UNC, students learn about the chemical contributions of numerous famous German scientists including Haber, Fischer, Bunsen, Hoffman, and Baeyer. In addition to famous chemists, some of the most important chemical companies in the world, including IG Farben and Baeyer were founded by German scientists. Another famous German chemist is Justus von Liebig who is considered one of the greatest chemistry teachers of all time and is also credited with founding organic chemistry and modernized chemistry education globally.

While CHEM 261 has been offered abroad for the past 5+ summers, including two sections abroad in 2018 and 2019, CHEM 262 has not been offered during that time. Offering CHEM 262 during the summer abroad, provides another opportunity for premedical/preprofessional students and other STEM majors to study abroad and receive graded credit from a UNC professor for a course required for their major or professional aspirations.

During the academic year approximately 1000 students take CHEM 262, and more than 170 students took the course during first and second summer sessions this past summer 2019.

Over the past 5 years, students taking organic chemistry during summer abroad programs have benefited significantly from the small class sizes offered during summer abroad sessions. They also report developing a closer connection with their professor. Because students develop a deeper understanding and appreciation for the course material, they also have opportunities when they return to become peer mentors or undergraduate learning assistants. Acting as peer mentors significantly enhances a student's

undergraduate education and broadens the depth of his/her learning and understanding of science. Since teaching CHEM 261 in Sevilla, Spain in 2017, and in Dublin, Ireland in 2018, eight different students from these programs have been peer mentors in my classroom, many of them serving multiple (upwards of four) times.

While Organic Chemistry II is the targeted class for this proposal, chemistry and biology programs should be able to alternate locations relatively seamlessly between established locations. Other science courses with regional relevance should also be able to rotate through this location. Based on preliminary discussions with faculty members in the Chemistry Department, Southern Germany, with proximity to the Black Forest, Switzerland and Southern France, is an attractive location for faculty teaching abroad.

Target Audience/ Major & Discipline/Student Levels: The primary target class for this proposal is Organic Chemistry II, CHEM 262. This course follows Organic Chemistry I, CHEM 261, and is generally taken during the sophomore or junior year. CHEM 262 is a large enrollment science course because it is a required course for medical and dental schools, as well as the Chemistry and Biology majors at UNC. CHEM 262 is also a prerequisite for Biochemistry, CHEM 430, which is taken by approximately 900 students per year from a variety of majors.

During the academic year approximately 1000 students take CHEM 262, and more than 170 students took the course during first and second summer sessions this past summer 2019.

I am involved in recruiting students for faculty led programs and have had success recruiting for CHEM 261. Since I teach CHEM 261 during the semester, I expect to be able to recruit students from my own classes as well as other sections of the class.

Anticipated Number of Students: Minimum of 10 students; maximum 22

Program Learning Objectives: Chemistry 262 uses organic chemistry to promote a fundamental understanding of concepts in chemistry and science. The material covered in this class expands upon the content covered in CHEM 261 and to introduce reactivity of new functional groups and biomolecules, including the following primary objectives for the course:

- Build critical thinking and problem-solving skills
- Predict mechanisms and products of reactions with various functionalities, including carbonyl groups and carboxylic acid derivatives, as well as classes of molecules, including aromaticity, electrophilic aromatic substitution, reactions of carbohydrates and amines.
- Elucidate chemical structures from NMR spectra and predict NMR chemical signals from organic structures
- Solve multi-step syntheses of organic molecules using known reactions

In addition to learning organic chemistry II concepts, students will expand their world view by living in another country for 5 weeks. Through a 5-week seminar course, students will interact with European scientists as well as German undergraduate students to learn about interdisciplinary research and chemical industries in Germany as well as environmental sustainability and energy production in Germany and central Europe.

PROGRAM ACADEMICS

Proposed Course Name/Number:

CHEM 262 Organic Chemistry Concepts II

Course Description: Chemistry 262 is the second of a two-semester sequence on organic chemistry. Chemistry 262 uses organic chemistry to promote a fundamental understanding of concepts in chemistry and science. The material covered in this class expands upon the content covered in CHEM 261 to introduce reactivity of new

functional groups and biomolecules.

Minimum GPA: 2.5

Course Prerequisites: Yes - CHEM 261 Organic Chemistry Concepts I

Language Prerequisites: None

Degree Requirements: The proposed course can be applied to the following programs:

Major: Chemistry and Biology

Minor: Chemistry

Other: Pre-Medical, Pre-Dental, Nutrition, and others intending to take CHEM 430, Biological Chemistry

Description of Academic Instruction: Course instruction will be founded in the classroom, with additional problem-solving sessions to complement the main course material. As part of the course, we will also take a trip to BASF in Basel, Switzerland, which is a large chemical manufacturing company. We anticipate having a tour of one of the facilities and meeting with scientists. This will be directly related to the course and integrated into the curriculum.

Adaptation of Current UNC Course: I have already taught this course during the summer, here at UNC. Instead of using online homework, I have developed a course pack with Guided Reading Questions, practice problem sets and homework assignments as well as example practice exams and worksheets. I intend to use the course pack as a resource for the students throughout the summer. I also hold longer Q&A type sessions and incorporate more group work to better facilitate active learning within the classroom.

Description of Excursions/Activities:

- BASF Tour
- Winebau on campus
- Optional Excursion: Oldest brewery in Germany

A proposed syllabus is included as an addendum to this proposal.

FACULTY PROGRAM LEADER INFORMATION

Faculty Program Leader Bios: Joshua graduated from Juniata College, a small liberal arts college in the foothills of Pennsylvania, in 2009 with a B.S. in Chemistry with Distinction and Highest Honors. He immediately enrolled in graduate school at the University of North Carolina at Chapel Hill, and received an NSF Graduate Research Fellowship for his studies of molecular recognition of small molecules under the direction of Dr. Marcey Waters. He earned a Ph.D. in Organic Chemistry in 2014 and joined the lab of Dr. Ashutosh Chilkoti at Duke University as a postdoctoral scholar in the Biomedical Engineering Department. Joshua completed his postdoctoral training in 2016 and returned to UNC-Chapel Hill as a visiting lecturer, teaching general chemistry, CHEM 101. Following a successful year of teaching, Joshua was brought onto the faculty at UNC in the Chemistry Department as a Teaching Assistant Professor in 2017. During his first summer at UNC, he led a successful faculty-led program, UNC Science in Sevilla, teaching Organic Chemistry I, CHEM 261, to 23 students in Sevilla, Spain. Joshua's involvement and accomplishments in study abroad were recognized within the department and he has acted as the liaison between the Study Abroad Office and the Chemistry Department since Fall 2017. He also served as the US Co-Director of TASSEP with Lynn Neddo 2018-2019, is coordinating the agreement for a Joint Degree Program in Chemistry between UNC and the National University of Singapore, and is an active member of the Science Working Group in Study Abroad, which is charged with identifying and developing study abroad opportunities and programs for STEM majors and undergraduate students on the pre-medicine path. Joshua led another successful summer program abroad in 2018, Organic Chemistry I in Dublin, Ireland, and has been significantly involved

in recruiting efforts for summer science abroad programs since 2016.

Experience in Proposed Location(s): I visited Germany once and one of my closest friends lived in Germany for 4 years. I unfortunately canceled a visit to Freiburg and the University at the end of September because of illness, so I have not been to Freiburg yet. I am working with the Study Abroad Office to coordinate a visit in April or May 2020.

Lynn Neddo mentioned off hand to me that UNC was building its relationship with the University of Freiburg and that they had expressed interest in our summer programs. I was aware that a number of Chemistry Faculty at UNC speak German, and after speaking with Lynn and other faculty, felt that this was an appropriate location to explore the possibility for a summer program.

Experience Leading Student Groups: I have led two UNC faculty-led summer programs; Sevilla, Spain in 2017 and Dublin, Ireland in 2018. Both of these programs were for CHEM 261, Organic Chemistry I.

I was also recently one of six adult leaders for a mission trip to Puerto Rico with UNC Lutheran Campus Ministry and Holy Trinity Lutheran Church. I led a group of 6 students while we performed hurricane relief work on houses and a community center in rural PR.

PROGRAM LOCATIONS

Proposed Locations:

- Freiburg, Germany and the University of Freiburg in Freiburg
- Basel, Switzerland, including a tour of a BASF facility

Location Rationale: Germany has a rich history of contributions to chemistry. During the introductory chemistry courses at UNC, students learn about the chemical contributions of numerous famous German scientists including Haber, Fischer, Bunsen, Hoffman, and Baeyer. In addition to famous chemists, some of the most important chemical companies in the world, including IG Farben and Baeyer were founded by German scientists. Another famous German chemist is Justus von Liebig who is considered one of the greatest chemistry teachers of all time and is also credited with founding organic chemistry and modernized chemistry education globally.

Involving the University of Freiburg with this summer program provides unique opportunities for students that they would not experience elsewhere. Through connections at the University of Freiburg, we are coordinating a tour for students to see a BASF facility in Switzerland. BASF is one of the largest chemical producing companies in the world.

Students will also have an opportunity to visit a wine-making laboratory at the University of Freiburg and we will have an opportunity to incorporate some of the chemistry of wine making into our curriculum. In conjunction with faculty at the University of Freiburg, we are also assembling a 1-credit seminar series course that will involve both UNC and German students. This series will explore environmental sustainability, energy production, and chemistry research in Germany.

PROGRAM LOGISTICS

Once the program is approved, the Study Abroad Office will coordinate all program services with a host organization or university, following the [Standards of Good Practice](#) developed by the Forum on Education Abroad.

The Study Abroad Office will work to secure accommodations for students and faculty leaders and assistance coordinating excursions, meal arrangements (individual and group), transportation, and any other services required to support the program on the ground. Information below represents initial discussions that have taken place between the Study Abroad Office and the anticipated host organization.

Anticipated Program Host Organization/University: I have been in contact with faculty and administration at the University of Freiburg and have begun coordinating the program with them. They are interested in having us and building a stronger connection between our universities. Faculty within the University of Freiburg have connections with local business owners, as well as scientists and representatives in large industrial companies, including BASF. We will capitalize on this connection to coordinate a visit to BASF for the UNC, and potentially some German students.

Host Organization/University Website:

[The University of Freiburg](#) and most specifically the Faculty of Chemistry and Pharmacy will be hosting our program. The colleagues in the Office of International Relations, with whom we work closely for our exchange program, have been instrumental in putting us in contact with the professors in the Faculty of Chemistry and Pharmacy.

Services Provided:

Both of the Departments mentioned above will help to secure a classroom for our class; they have also offered to make the initial contact with some of the local appropriate facilities and organizations, and then connect us with them. They will help us put together the Seminar, are willing to give lectures and to attract other lecturers as well as market this opportunity to their local students. They will also help us organize our field trips and excursions.

Anticipated Accommodations:

During a site visit last September, the Program Director met with some colleagues who run the Goethe Institute in Freiburg and visited their housing. They have student lodgings that are available during the time when our program will take place. Students will have the option to either share a room or have a single room in a housing complex specifically for students. Each floor has a large living area with a kitchen and dining area. The residence buildings are locked at all times and students must have a card key to get in. It is located in a residential area of Freiburg, within a 15-20 minute walk to campus but there are also trams that run frequently.

HEALTH & SAFETY INFORMATION

Health Insurance: The Study Abroad Office coordinates with the Office of Risk Management Services to enroll student and faculty participants in international accident and health insurance through GeoBlue for the duration of the program.

Safety & Risk Information: Germany is currently under a US State Department Travel Advisory level 2.

Health Information: Possible health risks are minimal. There are no listed health risks for travel to Germany beyond what would be expected in most developed countries. The global measles outbreak is relevant to Germany, which is at Watch Level 1, Practice Usual Precautions.

Required Vaccinations (if applicable): Travelers should be up to date on routine vaccinations.

Health, safety, and security information will be presented to students during the required pre-departure orientation.

CONCLUSION

A letter of support from the home academic department is included in as an addendum to this proposal.

We are happy to provide any additional information necessary for your review of this program. Thank you for your time and your support of global opportunities for Carolina students.

Sincerely,

Heather Ward
Associate Dean of Study Abroad & Exchanges

October 25, 2019

RE: Faculty-Led Program (Summer) Proposal

Dear Colleagues,

This letter outlines my support for the proposal of Professor J. Beaver for a summer program at the University of Freiburg. My support is based on the following facts:

- CHEM 262 is a core chemistry course that fulfills requirements for the chemistry and biology majors and is taken by more than 900 students each academic year
- Last summer 188 students registered to take CHEM 262 during summer sessions 1 and 2, 159 students enrolled and 154 students completed the course.
- Prof. Beaver taught CHEM 262 last summer and intends to teach it again
- UNC does not currently offer a summer program for science in Germany
- University of Freiburg is a potential strategic partner on the research front and establishing this program will help build this relationship

Please contact me with any questions.

Sincerely,



Jeffrey Johnson

*A. Ronald Gallant Distinguished Professor
Chairperson, Department of Chemistry*

ORGANIC CHEMISTRY CONCEPTS II (CHEM 262)

Instructor: Dr. Joshua Beaver (jebeaver@email.unc.edu)

Office: TBD

Course Website: sakai.unc.edu

Class Location: TBD

Class meetings: TBD Mon-Thurs or Mon-Fri

Prerequisite: CHEM 261, 261H or equiv. (grade of C- or better)

COURSE DESCRIPTION

Welcome to Chemistry 262, which is the second of a two-semester sequence on organic chemistry! Chemistry 262 uses organic chemistry to promote a fundamental understanding of concepts in chemistry and science. The material covered in this class expands upon the content covered in CHEM 261 and to introduce reactivity of new functional groups and biomolecules. More specifically during this course, you will:

- Build critical thinking and problem-solving skills
 - Predict mechanisms and products of reactions with various functionalities, including carbonyl groups and carboxylic acid derivatives, as well as classes of molecules, including aromaticity, electrophilic aromatic substitution, reactions of carbohydrates and amines.
 - Elucidate chemical structures from NMR spectra and predict NMR chemical signals from organic structures
 - Solve multi-step syntheses of organic molecules using known reactions
-

COURSE COPYRIGHT INFORMATION:

All materials used in this course including notes, tests and assignments are covered by copyrights, which forbid you from sharing class materials with any group not affiliated with this class. This includes sharing in-class activities or group work questions with others.

University Copyright Policy, found at <http://policies.unc.edu/files/2013/05/Copyright.pdf> indicates "STUDENT WORKS THAT CONSTITUTE NOTES OF CLASSROOM AND LABORATORY LECTURES AND EXERCISES SHALL NOT BE USED FOR COMMERCIAL PURPOSES BY THE STUDENT GENERATING SUCH NOTES." What this means is that you are in violation of the law (and the Honor Code) if you post any course materials for use by others. Sharing your notes directly with other individuals in the class is fine.

HOW TO CONTACT YOUR PROFESSOR

I am here to help you succeed, which means that I need to hear from you if you need help understanding what is going on in this class or are having other difficulties.

Problem-Solving Sessions are an ideal setting for working through organic chemistry concepts and reviewing core concepts with a professor. Problem-sessions are open to all students taking CHEM 262 and you can attend as many as you wish. Problem sessions are typically the most efficient opportunity for you to ask me chemistry content questions. Problem sessions are not held on days of exams.

Problem-Solving Sessions: Location TBD

- Mondays: TBD
 - Tuesdays: TBD
 - Thursdays: TBD
-

Individual or Small Group Office Hours are a great way to discuss challenges and issues you're facing while taking the class abroad. Individual office hours are scheduled on a need by need basis in increments of 10 or 15 minutes to provide individual assistance to students seeking help. Office hour time is best used to discuss study habits or techniques. Because this is a small class and there are ample opportunities for content discussion in groups in class and in group problem solving sessions, we should not discuss chemistry content during individual sessions. Office hours are not held on days of exams.

To request an Individual Office Hour session, you must email Dr. Beaver. Location: TBD

- Monday – Thursday: TBD

Sakai Course Website (sakai.unc.edu)

Sakai will be an invaluable resource this semester. Use this site as a supplement to the syllabus and your textbook. I often post announcements to the entire class using Sakai as a means of communication. I also post annotated class slides, additional practice problems, and other study resources under the Resources tab.

Email

Many in-person opportunities for help will be provided for chemistry content questions as well as other discussions. I am generally available before and after class, and can be easily reached by ways described previously in this syllabus. As a department, we do not answer Chemistry Content questions via email. This policy is upheld during summer sessions as well. Content questions are better answered in person in group settings so everyone can benefit from the question. If you must email me (jebeaver@email.unc.edu):

1. Check the syllabus for an answer to your question.
2. Please be as concise and to the point as possible.
3. Note that I do not discuss grading policies or grades via email in accordance with FERPA policy.

*****If you are having difficulty with the course, get help as soon as possible. Waiting until half way through the semester (or longer) is too late.*****

Review the following from CHEM 261 as soon as possible, preferably before we leave for Germany:

- a. bonding (Bruice Chapter 1)
- b. formula writing (Bruice Chapter 1)
- c. structures and names of functional groups (Bruice Chapter 3)
- d. basic nomenclature rules (Chapters 3, Bruice pgs 97-108)
- e. arrow pushing electron movement
- f. acid-base theory (Bruice Chapter 2)
- g. stereochemistry (Bruice Chapter 4)
- h. fundamental processes for basic mechanisms (Bruice Chapter 5)
- i. nucleophilic substitution (Bruice Chapter 9)

COURSE MATERIALS

- **Required text:**
 - *Organic Chemistry, Paula Bruice, 8th Edition*
 - Available online or in hard copy in the bookstore
 - *UNC Organic Chemistry Course Pack Part II, Beaver and Zurcher*
 - Available from the bookstore
- **Required/shared text:**
 - Organic Chemistry Student Study Guide and Solution Manual, Paula Bruice
 - This may be purchased/rented from any online book retailer
 - You must have access to a solutions manual for this class – however, I encourage you to share a manual with at least one of your peers to help reduce the cost burden.

Organic Chemistry, Paula Bruice, 8th Edition: You have the option to purchase access the E-Text or a hard copy of the text. Unlike semester courses, Mastering Chemistry provides limited benefit during summer courses, so we will not use Mastering this summer. Instead, textbook problems will be assigned and additional practice problems will be provided periodically throughout the summer session.

COURSE FORMAT

This course is designed to help students actively participate in the learning experience. One of the most effective methods of instruction is the High Structure Active Learning classroom. This is not traditional lecture, and instead combines in-class problem-solving activities with post-class practice activities and learning assessments. This style of teaching imparts responsibility upon students to read, practice and study outside of class. During class, the instructor acts as a facilitator to guide you through your learning and exploration. This is a proven and effective learning method and is ultimately a rewarding experience for students.

Student responsibilities

1. **Before Class:** Reading assignment, videos (*optional*), warm-up practice problems (assigned in-text problems and/or problems from the course pack). Because class participation is a primary mode of learning, it is crucial that you complete the preparatory assignments, and show up to class on time.
2. **During Class:** Participate, individually and in groups, to complete practice problems, ask questions and clear up any misunderstandings.
3. **After Class:** Practice and test your learning using assigned problems from the textbook and course pack as well as any other instructor-provided resources.

Online Videos: You can use this library of videos to learn each of the new concepts in organic chemistry. Dr. Beaver supplements these videos with his own explanations in class. When watching these videos, take notes and follow along as if you were in a lecture. The benefit of a video is that you can pause, read the book, and replay parts of the video as many times as you need.

GRADING POLICIES

Your final grade will be determined by your performance on assignments from the Course Pack, semi-daily quizzes and 3 midterm examinations. This ensures that you are consistently working on chemistry throughout the session and rewards learning concepts as the summer session proceeds.

Scoring and Grade Scale

Your letter grade for the course will be based on your overall weighted percent score from the following list of graded work this semester. Of your three midterm exams, the lowest score will contribute to 10% of your final grade, while the two higher midterm scores will contribute 20% each. The final exam is worth 30% of the final grade and Semi-Daily Quizzes will contribute to 20% of the final grade.

Two Highest Midterm Exams	50%
Lowest Midterm Exam	10%
Final Exam	25%
Quizzes & Homework	15%
Total	100%

Grade scale:

Final letter grades will be assigned in accord with the 2000 Educational Policy Committee Report, which describes the meaning of grades as follows:

- "A": Outstanding mastery of course material
- "B": Superior mastery of course material
- "C": Adequate mastery of course material
- "D": Mastery of course material that is unsatisfactory
- "F": Unsatisfactory mastery of course material

Grade Cutoffs: The exact cutoffs will vary term to term based on exam averages, but the historical ranges tend to be what is listed in the table. Grades round to the nearest whole number. XX.50 rounds up; XX.49 rounds down.

Final Average	Letter Grade
93 – 100	A
90 – 92	A-
87 – 89	B+
83 – 86	B
80 – 82	B-
77 – 79	C+
73 – 76	C
67 – 72	C-
59 – 66	D
< 58	F

Quizzes & Homework (15%):

Problems from the textbook and course pack will be assigned to accompany pre-class readings and videos. Between 2 and 3 days per week, your homework may be collected, or you will be quizzed on the assigned problems with a short 10-minute quiz at the beginning of class. Homework will be checked for thorough completion. If you completed the problems before class, you should be able to complete the problems on the quiz. These quizzes will be graded for correctness via Gradescope. **You will receive full credit for the quiz & homework grade component of the course if you score a 90% average or higher on the quizzes and homework.**

For example: if there are 15 assignments for a total of 150 points, and you earn 135 points, you will earn full credit for the quiz component of the final grade (100% of 15%). Less than 135 points would earn a proportional score (for example 108 points would earn a final quiz score of 80% of 15%, or 12%). Note that the total number of points available will not be determined until the end of the course.

Because we will cover the material in quizzes & homework during class, students will not be able to “make up” quizzes missed for any reason. If a class is missed for an excused reason, the total number of points will be adjusted for that individual. If a class is missed for an unexcused reason, the student will receive a 0 if a quiz is given.

Exams (75%):

- Three midterm exams will be given during the semester. Each exam is designed to take 75 minutes, but you will have the entire class period to complete it. Each exam will take place during our scheduled class time. The final exam is cumulative and will include a section on new material. The final exam will be designed to take 2 hours, but you will have 3 hours to complete it.
 - Midterm I:
 - Midterm II:
 - Midterm III:
 - Final Exam:
- If scanning is available, exams will be scanned, graded and returned to students as quickly as possible using Gradescope. You will be given a course code and required to enlist in our course using your ONYEN and UNC email address. Further information will be provided prior to the first exam.
- If scanning is not available, I will grade the exams as quickly as possible and return them to you within 48 hours.

EXAM MAKE-UP REQUESTS:

Course expectations are that you will be in attendance for every exam; however, in the case of a family emergency or religious holiday, a make-up opportunity will be provided. In the case of critical illness, accident, or family emergency, please reach out to the Dean of Students; they keep instructors informed your behalf. If you are a student-athlete, please share your travel letter with your instructor within the first two weeks of the semester.

- ***Note that club sports, organizational meetings, non-University travel, and club activities do not qualify for a Make-up Exam.***

Requests to take an exam during the make-up exam time for any other reason should be submitted to Dr. Beaver by email and these requests will be handled on a case-by-case basis. Please make sure to state “Chem 262 Make-up request” in the subject line; in your message, include your full name, onyen, and an explanation of the circumstances.

COURSE SCHEDULE

To ensure that you are prepared for each class meeting please **check Sakai for the most updated information**. A detailed course calendar with assignment dates, exams, and daily content can be found on the course website (Sakai) under the “google calendar” tab.

DISCLAIMER

I reserve the right to adjust any portion of this syllabus at any time before or during the semester if I deem necessary. This includes the lecture schedule, exam dates, and grading scale. In the event that something is adjusted, I will notify students at the earliest possible time.

COURSE POLICIES

ELECTRONIC DEVICES IN CLASS:

Internet-connected electronic devices (laptops, tablets, cell phones) are NOT PERMITTED during class. If you violate this policy you will first be warned, and 5 pts/incidence will be deducted from your next exam score thereafter. This is a serious policy and will not be taken lightly. Classroom disruptions are not tolerated.

ACADEMIC HONESTY AND THE UNC HONOR CODE:

While this course heavily encourages collaborations, you must **only collaborate when explicitly instructed to do so**. The student-led Honor System is responsible for adjudicating any suspected violations of the Honor Code and all suspected instances of **academic dishonesty will be reported to the honor system**. Information, including your responsibilities as a student is outlined in the Instrument of Student Judicial Governance. Your full participation and observance of the Honor Code is expected. You may work together on practice problems and study together. You are not permitted to work on Mastering Chemistry together if it is counted as any portion of your grade.

It is a violation of the Honor Code to fail to comply with exam procedures. Exam procedures will be provided for each exam. These will include when you are allowed to begin the exam, when you should stop working on the exam and how to maintain the integrity of individual performance on the exam. It is a violation of exam procedure to look at another student's exam during the exam period whether you use that information or not. It is also a violation of exam procedure to "allow" another student to look at your exam during the exam period. Each student is responsible for maintaining the integrity of the exam by protecting his or her answers.

Violations of the Honor Code and/or Exam Procedures will be vigorously pursued through the Honor System.

STUDY TIPS & KEYS TO SUCCESS

Organic chemistry is a two-semester sequence, which throughout builds sequentially on material presented earlier in the course. **It is essential that you do not fall behind.** It becomes extremely difficult to catch up. The best approach to mastering the material in this course is to keep up daily. Read the assigned sections and view assigned videos before class. **It is significantly better to invest shorter amounts of time every day for seven days than to sit down and spend a large block of time one day a week on this course.** Repetition is extremely important. It takes time to master some of the difficult concepts and going back over certain ideas will make them much easier to comprehend. In addition, new ideas that you learn later in a chapter will often make earlier concepts more understandable. This is why repetitive studying and working every day is so important. If you are having difficulty with the course, get help as soon as possible.

- ***Stay Organized.*** A three-ring binder will be a very helpful tool in this class. You will receive notes and exercises in many different forms (GRQ's, online videos, lecture notes, in-class activities, etc.).
- ***Come to class prepared.*** Complete all preparatory assignments (reading, videos, GRQs, etc.) *before* coming to class. Come to class ready to engage in group discussions and complete in-class activities.
- ***Do your homework.*** Complete all pre-class assignments and utilize other preparatory items such as GRQs to hone the new things you learned to do in class. This will likely make studying for exams a breeze. Complete practice problems from the book. **Only check your answers after trying to complete them all yourself.** A good study session feels like a hard workout; expect to be tired afterward.
- ***Form a study group.*** Working with a study group outside of class will help you learn the material deeply. You should take turns explaining the answers to questions so that every person in the group has a chance

to “teach” the others the material, which is a great way to improve each members’ understanding. Your in-class working group is a great place to form these connections.

- **Use electronic resources.** You will get plenty of homework problems from the textbook. Google can provide a wealth of extra practice problems *once you have exhausted those in your textbook*.

Counseling and Psychological Services:

- CAPS is strongly committed to addressing the mental health needs of a diverse student body through timely access to consultation and connection to clinically appropriate services, whether for short or long-term needs. Go to their website: <https://caps.unc.edu> or visit their facilities on the third floor of the Campus Health Services building for a walk-in evaluation to learn more.

Accessibility Resources & Service:

- UNC-Chapel Hill facilitates the implementation of reasonable accommodations for students with learning disabilities, physical disabilities, mental health struggles, chronic medical conditions, temporary disability, or pregnancy complications, all of which can impair student success. See the ARS website for contact and registration information: <https://ars.unc.edu/about-ars/contact-us>

Course Calendar (example from a previous summer session)

- The course schedule is included below. Note, that we may deviate from the anticipated schedule and Dr. Beaver will inform you in advance of any changes.

	Date	Section	Pages	Video	Pre-Class Book Problems
1	Wed, May 15	14.1 14.3 14.4 14.15	620-622 623-624 624-626 650-651	14.1.NMR.Basic.Theory 14.2 Equivalence of Hydrogens	3, 4, 5, 6 33, 34
2	Thurs, May 16	14.5-14.8 14.10-14.11 14.13-14.14 14.9	626-632 634-639 644-649 632-634	14.3.chemical.shifts 14.4.splitting.patterns 14.7.complex.splitting.patterns 14.5.integration	11, 12, 13, 14 19, 20, 21, 22 30 16, 18
3	Fri, May 17	14.12 8.14-8.15	639-644 355-362	14.6.interpreting.NMR.examples 8.4.diels.alder	23, 25, 26, 27, 28 39, 42, 43, 44, 46
4	Mon, May 20	8.1-8.2 8.16-8.18 8.20 8.19	318-322 362-367 368-370 367	8.1.structure.of.benzene 8.2.aromaticity 8.3.MO.Frost.Diagram	48, 49, (52), 54 56, 57, (58), 59 55

5	Tues, May 21	18.1	868-870	18.1.nomenclature.benzene.derivs	1
		18.2	871-872	18.2.electrophilic.aromatic.subst	
		18.3	872-874	18.3.halogenation.benzene	4
		18.4-18.5	874-876	18.4.nitration.sulfonation	
6	Wed, May 22	18.6-18.8	876-881	18.5.Friedel.crafts.alkylation	5, 6
				18.6.Friedel.crafts.acylation	
		18.11-18.12	884-890	18.7.Reactivity.substituted.benzenes	14, 15, 16, 17
		18.13-18.17	890-899	18.8.Directing.groups.EAS	23, 24, 25, 26
7	Thurs, May 23	Catch up and review			
8	Fri, May 24	Midterm Exam 1			
9	Tues, May 28	11.1	508-511	11.1.organometallic.reagents	(Ch. 11) 1
		16.1	739-743	16.1.aldehyde.ketone.nomenclature	(Ch. 16) 1
		16.2	743-744	16.2.reactivity.aldehydes.ketones	4
		16.3	744-745	16.3.general.aldehyde.ketones.rxns	5, 6, 7, 13
		16.4	745-747	16.4.Grignard.addition (skip 4:30-6:30)	
10	Wed, May 29	16.5	752-753	16.5.hydride.reagents (0-1:58)	20
		16.4	751	16.7.cyanohydrins	15
		16.9	766-769	16.8.hydrates	36, 37, 38
		16.9-16.10	769-774	16.9.acetals	39, 40, 43, 46c
		10.5	474	16.6.alcohol.oxidations (do not need to know mechanisms)	
11	Thurs, May 30	16.8	760-765	16.10.imines.enamines	32-34
		16.13	776-778	16.11.Wittig.reaction	49
		16.15	781 -784	16.12.direct.vs.conjugate.addition	51
		16.14	779-781	(synthesis)	50 (b, c, d, e)
12	Fri, May 31	20.1-20.4	950-955	20.1.carbohydrates.classific.struct.	1, 2, 3, 4, 5, 6, 7, 8, 9
		20.5	956-957		
13	Mon, June 3	20.5	956-957	20.5.enediol.rearrangement	

		20.10-20.11	962-967	20.2.cyclic.structures.carbohydrates	19, 20, 21, 22	
		20.12-20.14	967-969	20.3.mutarotation.anomeric.effect 20.4.glycosides.disaccharides	23, 24 25, 26, 28	
14	Tues, June 4	Midterm Exam 2				
15	Wed, June 5	15.1-15.3	686-694	15.1.nomenclature.carbox.acids	2, 3a, 3d, 3h, 4	
		15.4-15.5	694-698	15.2.rel.react.CAD 15.3.paths.Nuc.Acyl.Subst	7, 10, 18	
		15.18	723-724	15.4.Interconv.CAD	47	
		15.6	698-700	15.5.Rxns.acyl.chlorides	12, 13	
16	Thurs, June 6	15.16	719-721	15.6.Rxns.anhydrides	43, 44	
		15.7	701-702	15.10.Rxns.esters	17	
		15.8	702-706	15.8.acid.cat.ester.hydrolysis	22, 23, 26	
		15.9	706-709	15.9.base.cat.ester.hydrolysis	28-30	
		15.10	709-711	15.7.Fischer.esterification	31	
		16.4	747-750	16.4.Grignard.addition (4:30-6:32)	(Ch. 16) 7, 9, 10, 11, 12	
17	Fri, June 7	16.5	753-758	16.5.hydrate.reagents (1:56-7:56)	(Ch. 16) 21	
		16.8	764-765	19.6.amides.LiAlH4		
		15.11-15.13	711-716	15.11.hydrolysis.amides	(Ch. 15) 34, 36	
		15.15	764-765	15.12.nitriles.hydrolysis Practice; Review; Synthesis	(Ch. 15) 41	
18	Mon, June 10	17.1-17.4	801-808	17.1.acidity.carbonyl.alpha.H 17.2.keto-enol.tautomerization 17.3.alpha.halogenation	(Ch. 17) 4, 5, 7, 8, 10	
		17.6-17.7	810-814	17.4.LDA.enolate.alkylation	12, 14, 15, 16	
19	Tues, June 11	17.10-17.11	817-820	17.5.aldol.reaction	20, 21, 22	
		17.12	821-823	17.6.crossed.aldol	25, 27	
		17.13-17.15	824-829	17.7.Claisen.condensation 17.8.crossed.Claisen	28-35	

20	Wed, June 12	17.9 17.17-17.19 17.16	815-817 831-836 830-831	17.10.Michael.Reaction 17.12.Decarboxylation.malonic.ester 17.13.Robinson.Annulation	18, 19 38-41 36, 37
21	Thurs, June 13			Catch up, synthesis, review 17.14.synthesis.problems (suggested)	
22	Fri, June 14	Midterm Exam 3			
23	Mon, June 17	19.1-19.3 21.1-21.4 9.5 21.6	924-929 986-996 410 1000-1002	19.1.amine.structure.properties 19.2.basicity.amines 21.1.amino.acids.structure.class 21.2.amino.acids.acid.base.prop. 19.3.amine.alkylation 19.5.primary.amine.reduction 19.7.reductive.amination	3 (Ch. 21) 2, 5, 6, 7, 8, 10, 11 (Ch. 19) 22, 23 (Ch. 21) 21, 22, 23, 24
	Tues, June 18	Reading Day – No Class			
	Wed, June 19				
24	Thurs, June 20	Final Exam			

Course Learning Objectives

- The course learning objectives are listed below. We will do our best to cover all of these learning objectives, but may deviate from semester to semester.

CHEM 262: All learning objectives. After taking this course, you should be able to...

Chapter 14

- Explain, in simple terms, the basic theoretical premise for NMR
 - Effect of field strength on resonance frequency
 - What is meant by resonance
- Predict whether protons are equivalent (homotopic, enantiotopic) or nonequivalent (chemically nonequivalent or diastereotopic).
- Explain how adjacent hydrogens cause splitting of proton resonance signals
- Predict splitting patterns for proton signals
 - Simple splitting: doublet, triplet, quartet, etc.
 - Complex splitting: doublet of doublets (dd), dt, ddt.
- Predict and explain the relative chemical shift of protons in different magnetic environments

- Interpret NMR spectra using equivalence, non-equivalence, relative integration, chemical shift, and splitting patterns to predict a chemical structure if provided with an NMR spectrum and a molecular formula.

Chapter 8

- Predict whether a structure is aromatic, anti aromatic or non-aromatic based on the criteria for aromaticity and anti-aromaticity
- Predict whether unshared electrons are included in the pi electron count for aromaticity
- Use Frost diagrams to construct molecular orbital diagrams and predict whether compounds are aromatic, antiaromatic or non-aromatic
- Predict the relative acidity of a structure based on whether its conjugate base is aromatic, antiaromatic or non-aromatic
- Draw resonance contributors to various aromatic systems to predict their reactivity
- Predict the products of the reaction (including the product stereochemistry) of dienes with dienophiles in a Diels Alder reaction
- Predict the relative rates of reactivity of various dienes in the Diels Alder reaction based on their conformation
- Predict the relative rates of reactivity of various dienophiles in the Diels Alder reaction based on their electronic character
- Provide the appropriate starting materials needed to complete a synthetic transformation involving a Diels-Alder reaction
- Draw reaction mechanisms (including transition states as needed and the product stereochemistry) for reactions of dienes with dienophiles in a Diels Alder reaction using intermediates and arrows to show the movement of electrons.
- Use the reactions you have learned to plan a synthesis of a product from a given starting material or choose an appropriate starting material to plan a synthesis.

Chapter 18

- Predict the products of the electrophilic aromatic substitution of aromatic compounds with various electrophiles including Br^+ , Cl^+ , I^+ , NO_2^+ , SO_3H^+ , R^+ , RCO^+ .
 - Bromination, chlorination, iodination
 - Nitration
 - Sulfonation
 - Friedel Crafts alkylation (from alkyl halides, alkenes and alcohols)
 - Friedel Crafts acylation (from acid halides and acid anhydrides)
- Draw reaction mechanisms (including transition states as needed) for the formation of the electrophiles and the electrophilic aromatic substitution reactions using intermediates and arrows to show the movement of electrons for each of the reactions above.
- Draw the resonance contributors to the intermediate arenium ions in various electrophilic aromatic substitution reactions.
- Provide the appropriate reagents needed to complete a synthetic transformation, particularly, the reaction of various electrophiles in halogenation, nitration, sulfonation, alkylation and acylation with aromatic compounds
- Predict the relative rates of reactivity of various substituted aromatic compounds based on the type of substituent on the ring.
- Draw reaction coordinate diagrams for the reaction of various substituted benzene derivatives in electrophilic aromatic substitution reactions.
- Predict whether substitutions of aromatic rings will be ortho-para or meta directed products.

- Use the reactions you have learned to plan a synthesis of a product from a given starting material or choose an appropriate starting material to plan a synthesis.
- Exploit the difference in reactivity of various aromatic compounds in planning a synthesis of a product from a given starting material.

Chapter 11

- Provide reagents to prepare organolithium reagents (including acetylides), and Grignard reagents
- Predict the compatibility of organometallic reagents with various acidic compounds
- Predict the products of the reaction of organolithium reagents (including acetylides), and Grignard reagents with epoxides, aldehydes, and ketones
- Predict the relative reactivity of various organometallic reagents

Chapter 16

- Predict the relative reactivity of aldehydes and ketones based on steric and electronic effects
- Predict the products of the reaction of each of the following with aldehydes and ketones
 - RMgX, RLi, RCCLi (addition of Grignard, alkyllithium and acetylides)
 - NaBH₄, LiAlH₄ (reduction with hydrides)
 - NaCN, H⁺, (cyanohydrin formation)
 - H₂O, H⁺, ROH, H⁺ (hydrate and acetal formation)
 - RNH₂, H⁺, R₂NH, H⁺ (formation of imines, enamines, hydrazones)
 - Ylides (Wittig reaction)
- Predict the products of the reaction of alcohols with H₂CrO₄, PCC, and CrO₃-2pyr
- Predict the degree of hydration of various aldehydes and ketones in water
- Predict whether the reaction of each of the following with α,β -unsaturated aldehydes and ketones (that is, enones) will lead to 1,2- or 1,4-addition
 - RMgX, RLi, RCCLi
 - NaBH₄, LiAlH₄
 - NaCN, H⁺,
 - H₂O, H⁺, ROH, H⁺
 - RNH₂, H⁺, R₂NH, H⁺
- Draw reaction mechanisms (including transition states as needed) for reactions of aldehydes and ketones with nucleophiles/bases using intermediates and arrows to show the movement of electrons.
 - Specific mechanisms: formation of...
 - cyanohydrins
 - hydrates
 - acetals
 - imines
 - enamines
 - and addition of...
 - Grignard reagents
 - alkyl lithium reagents
 - hydride reagents
- Draw reaction mechanisms for reactions of α,β -unsaturated aldehydes and ketones (that is, enones) nucleophiles/bases in both 1,2- or 1,4-additions using intermediates and arrows to show the movement of electrons.
- Use the reactions you have learned to plan a synthesis of a product from a given starting material or choose an appropriate starting material to plan a synthesis.

- Exploit the difference in reactivity of various aldehydes and ketones and use protecting groups (acetals) in planning a synthesis of a product from a given starting material.

Chapter 20

- Classify a carbohydrate as
 - monosaccharide, disaccharide, polysaccharide
 - aldose, ketose
 - triose, tetrose, pentose, hexose
 - D or L sugar
 - Alpha or beta anomer
 - Reducing (hemiacetal) or non reducing (acetal)
- Draw the cyclic hemiacetal structure of monosaccharides including the stereochemistry at the anomeric carbon (alpha or beta).
- Predict the most stable cyclic structure of monosaccharides
- Explain the change in optical rotation of carbohydrates when they are dissolved in water (mutarotation)
- Draw the mechanism of interconversion of alpha and beta anomers in the mutarotation process
- Draw the reaction mechanism (including transition states as needed), using intermediates and arrows to show the movement of electrons, for the formation of cyclic hemiacetals of carbohydrates and for the formation or hydrolysis of glycosides of carbohydrates: monosaccharides and disaccharides.
- Explain the anomeric effect.
- Predict the products of the reaction of carbohydrates with alcohol and acid and the product of various glycosides with alcohol or water and acid.

Chapter 15

- Identify the structure of carboxylic acids, acid chlorides, acid anhydrides, esters and amides if provided with an IUPAC name.
- Provide methods and reagents for the preparation of carboxylic acids, acid chlorides, acid anhydrides, esters amides, and nitriles.
- Describe the reactivity of a carboxylic acid derivative with a nucleophile based on the electronic nature of the C=O double bond
- Predict the relative reactivity of carboxylic acids, acid chlorides, acid anhydrides, esters and amides in nucleophilic acyl substitution reactions based on steric and electronic effects, and strength of leaving group bonded to the carbonyl group.
- Predict the products of the reaction of carboxylic acids, acid chlorides, acid anhydrides, esters and amides with various nucleophiles
 - Nucleophiles such as alcohols, water, amines, carboxylate ions, Grignard reagents, hydride reagents
- Provide the appropriate reagents needed to complete a synthetic transformation, particularly, the interconversion of various carboxylic acid derivatives (carboxylic acids, acid chlorides, acid anhydrides, esters and amides)
- Draw reaction mechanisms (including transition states as needed) for reactions of carboxylic acids, acid chlorides, acid anhydrides, esters and amides with nucleophiles/bases using intermediates and arrows to show the movement of electrons.
 - Specifically for the interconversion of carboxylic acids, acid chlorides, acid anhydrides, esters and amides
 - Familiarity with both acid catalyzed and base mediated processes will be important
 - Reaction of esters with hydride reagents and Grignard reagents.

- Use the reactions you have learned to plan a synthesis of a product from a given starting material or choose an appropriate starting material to plan a synthesis.
- Exploit the difference in reactivity of various carboxylic acids, acid chlorides, acid anhydrides, esters and amides in planning a synthesis of a product from a given starting material.

Chapter 17

- Predict the relative acidity of alpha protons of various carbonyl-containing compounds based on electronic (electron withdrawing and electron donating) effects and resonance stabilization.
- Predict the position of the equilibrium of acid base reactions between various carbonyl containing compounds and bases
- Predict the relative amount of enol content of various carbonyl containing compounds
- Predict the products of the reaction of enolates and enols with various electrophiles including aldehydes, ketones, esters, α,β -unsaturated ketones, alkyl halides and proton sources.
 - Aldol reaction
 - Claisen condensation
 - Michael reaction
 - Aceto acetic ester and malonic ester synthesis
 - Robinson annulation
- Identify carboxylic acids that can undergo loss of CO₂ (decarboxylation) when heated
- Provide the appropriate reagents needed to complete a synthetic transformation, particularly, the reaction of various carbonyl containing compounds and enamines with electrophiles in alkylation, nucleophilic addition, and nucleophilic acyl substitution reactions
- Draw reaction mechanisms (including transition states as needed) for reactions of enolates, enols, and enamines with nucleophiles/bases using intermediates and arrows to show the movement of electrons. Specifically
 - Aldol reaction
 - Claisen condensation
 - Michael reaction
 - Aceto acetic ester and malonic ester synthesis
 - Robinson annulation
- Use the reactions you have learned to plan a synthesis of a product from a given starting material or choose an appropriate starting material to plan a synthesis.
- Exploit the difference in reactivity of various enols and enolates in planning a synthesis of a product from a given starting material.

Chapter 19

- Recognize whether amines are 1°, 2° or 3°.
- Predict the relative strength of various amine bases using your understanding of inductive effects, resonance effects and hybridization of the basic atom.
- Predict the relative strength of various amine bases using the pK_a of their conjugate acids or the pK_b of the free base.
- Predict the products of various reactions that are used to prepare amines
 - Nucleophilic substitution of alkyl halides by ammonia, 1° amines, 2° amines or 3° amines.
 - Reductive amination of aldehydes and ketones
 - Reduction of amides by LiAlH₄
 - Reduction of nitriles, azides, nitro compounds

Chapter 21

- Classify an amino acid as
 - D or L amino acid
- Predict the principle form of the amino acid present in solutions at pH 7
- Predict the products of various reactions that are used to prepare amino acids
 - Nucleophilic substitution of alpha halo acids by ammonia
 - Reductive amination of alpha keto acids
 - Strecker reaction
 - Modified malonic ester synthesis
- Use the reactions you have learned to plan a synthesis of an amine or amino acid from a given starting material or choose an appropriate starting material to plan a synthesis.

Study Abroad Course Itinerary

Program Name		UNC Science in Germany		
Course Name and Number		Organic Chemistry II, CHEM 262		
Credit Hours		3		
Day <i>(or specific date)</i>	Location <i>(classroom or other venue)</i>	Topic/Activity	Assignment/Reading: List does not include assigned problems or links to videos - these are viewable in my syllabus.	Contact Hours
Monday	Classroom	NMR basic theory	14.1, 14.3, 14.4, 14.15	1.5
Tuesday Day	Classroom	NMR and spectra patterns	14.5-14.8, 14.10-14.11, 14.13-14.14, 14.9	1.5
Tuesday Evening	Active Learning Room	Review and problem solving session		1
Wednesday	Classroom	NMR Interpretation and the Diels Alder Reaction	14.12, 8.14-8.15	1.5
Thursday	Classroom	Aromaticity and benzene	8.1-8.2, 8.16-8.20	1.5
Monday	Classroom	Electrophilic aromatic substitution part 1	18.1-18.5	1.5
Tuesday Day	Classroom	Electrophilic aromatic substitution part 2	18.6-18.6, 18.11-18.17	1.5
Tuesday Evening	Active Learning Room	Problem solving session		1
Wednesday	Classroom	Review		1.5
Thursday	Classroom	Midterm Exam I		1
Friday	BASF	Tour of BASF Facility in Basel	TBD	3
Monday	Classroom	Aldehydes part I	11.1, 16.1-16.4	1.5
Tuesday Day	Classroom	Aldehydes part II	16.5, 16.4 (part 2), 16.9-16.10, 10.5	1.5
Tuesday Evening	Active Learning Room	Problem solving session		1
Wednesday	Classroom	Aldehydes part III	16.8, 16.13-16.15	1.5
Thursday	Classroom	Carbohydrates part I	20.1-20.5	1.5
Friday	Classroom	Carbohydrates part II	20.5 (cont), 20.10-20.14	1.5
Monday	Classroom	Midterm Exam II		1
Tuesday Day	Classroom	Carboxylic Acid Derivatives Part I	15.1-15.6, 15.18	1.5
Wednesday	Classroom	Carboxylic Acid Derivatives Part II	15.7-15.10, 15.16, 16.4	1.5
Thursday	Classroom	Carboxylic Acid Derivatives Part III	15.11-15.13, 15.15, 16.5, 16.8	1.5
Monday	Classroom	Ketones Part I	17.1-17.4, 17.6-17.7	1.5
Tuesday Day	Classroom	Ketones Part II	17.10-17.15	1.5
Tuesday Evening	Active Learning Room	Problem solving session		1
Wednesday	Classroom	Ketones Part III	17.9, 17.16-17.19	1.5
Thursday	Classroom	Review		1.5
Monday	Classroom	Midterm Exam III		1
Tuesday Day	Classroom	Amines	19.1-19.3, 21.1-21.6, 9.5	1.5
Tuesday Evening	Active Learning Room	Review		2
Wednesday		"Reading Day"		
Thursday	Classroom	Final Exam		3
			Total Contact Hours	45

Joshua E. Beaver, Ph.D.

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Education

Ph.D. Organic Chemistry | University of North Carolina at Chapel Hill | 2014

- NSF Graduate Research Fellowship

B.S. Chemistry | Juniata College | 2009

- *magna cum laude*, Honors and Distinction in Chemistry

Teaching Experience & Training

Teaching Assistant Professor | University of North Carolina at Chapel Hill | 2017 – Present

- Use active learning and online homework learning systems to teach large enrollment chemistry classes. Act as faculty advisor for peer mentors to teach current pedagogy and teaching practices.
 - Fall 2019, CHEM 261, Organic Chemistry I, 197 students
 - Fall 2019, CHEM 261, Organic Chemistry I, 222 students
 - Summer 2019, CHEM 262, Organic Chemistry II, 88 students
 - Spring 2019, CHEM 261, Organic Chemistry I, 215 students
 - Spring 2019, CHEM 261, Organic Chemistry I, 220 students
 - Fall 2018, CHEM 261, Organic Chemistry I, 212 students
 - Fall 2018, CHEM 101L, General Chemistry I Lab, 40 sections, 960 students
 - Summer 2018, CHEM 261, Organic Chemistry I, UNC Science Abroad in Dublin, Ireland, 19 students
 - Spring 2018, CHEM 101, General Chemistry I, 404 students
 - Spring 2018, CHEM 101, General Chemistry I, 236 students
 - Fall 2017, CHEM 101, General Chemistry I, 398 students
 - Fall 2017, CHEM 101, General Chemistry I, 225 students
 - Summer 2017, CHEM 261, Organic Chemistry I, UNC Science Abroad in Sevilla, Spain, 23 students
- Description: Guide student learning of fundamental concepts in chemistry, such as atomic and molecular structure, stoichiometry, and conservation of mass and energy, through active learning and flipped classroom techniques. Evaluate student understanding in real time using in-class survey and critical thinking questions to guide the pace of class activities. Lead open office hour problem solving sessions to further students' grasp of the material. Provide short (5-10 minute) video resources as additional learning tools for students.
- Curriculum Development: Work directly with a team of teaching and research faculty to implement a new common General and Organic Chemistry curriculum that emphasizes the development of critical thinking skills and an understanding of core concepts in chemistry

Summer Institute for College Teaching | University of North Carolina at Chapel Hill | 2019

- Summer fellowship training to incorporate current leading pedagogy into the classroom to foster teaching excellence

Visiting Chemistry Lecturer | University of North Carolina at Chapel Hill | 2016 – 2017

- Spring 2017, CHEM 101, General Chemistry I, 100 students
- Spring 2017, CHEM 101, General Chemistry I, 230 students
- Fall 2016, CHEM 101, General Chemistry I, 228 students
- Fall 2016, CHEM 101, General Chemistry I, 341 students

Graduate Research Consultant | University of North Carolina at Chapel Hill | 2011 – 2013

- Teaching mentor: Prof. Paul Kropp
- Course: Honors Intermediate Organic Chemistry (CHEM 460H, three semesters, 5 students each)
- Description: Co-taught the Honors section for 3 semesters, during which I devised lesson plans, led classes, and individually mentored students in literature research and presentation content as well as public speaking strategies. Employed Bloom's Cognitive Taxonomy, reflective questioning, and critical thinking exercises to encourage students to think critically about research topics and generate their own ideas about the subjects discussed in class.

- Curriculum Development: Developed an innovative curriculum for the honors section that strengthened students' public speaking abilities, garnered interest in chemistry and emphasized hot topics in organic chemistry research.

UNC TIBBS Teaching Certification | University of North Carolina at Chapel Hill | 2012

- Course: UNC Training Initiatives in Biomedical & Biological Sciences (TIBBS): Summer Series Teaching Certification
- Description: Participated in a 6-week seminar series to learn how to apply current teaching pedagogy to undergraduate science education. Specifically learned how to integrate Bloom's Cognitive Taxonomy in course design, and apply teaching methods that encourage critical thinking and active learning in large classrooms.

Teaching Assistant | University of North Carolina at Chapel Hill | 2009 – 2010

- Courses: General Chemistry Lab I & II (CHEM 101L & 102L, two semesters, 20-25 students)
- Description: Prepared lesson plans and taught the lab for CHEM 101 & 102 and held office hours and problem solving sessions. Engaged students by asking questions that encouraged critical thinking and problem solving. Helped students develop translatable writing and group work skills by critiquing lab reports and encouraging teamwork building activities.

Mentoring Experience

Postdoctoral Mentor | Duke University | 2014 – 2016

- Ph.D. Students: Simone Costa, Imran Ozer
- Description: Mentored and trained two graduate students in organic chemistry and project development.

Mentor for NC Project SEED | University of North Carolina at Chapel Hill | 2011, 2012

- High School Student: Mariah Reese
- Description: During two 8-week programs, mentored a NC URM high school student by guiding her through two research projects to teach her fundamental laboratory concepts, foster excitement for science, chemistry and research, and build presentation and public speaking skills.

Publications

- **Beaver, Joshua E.**, Waters, Marcey, L. "Molecular Recognition of Lys and Arg Methylation." *ACS Chem. Biol.* **2016**, *11*, 643-653. (Co-contributing author)
 - **Beaver, Joshua E.**,* Peacor, Brendan, C.,* Bain, Julianne V., Waters, Marcey L. "Contributions of Pocket Depth and Electrostatic Interactions to Affinity and Selectivity of Receptors for Methylated Lysine in Water." *Org. Biomol. Chem.* **2015**, *13*, 3220-3226.
 - James, Lindsey I.,* **Beaver, Joshua E.**,* Rice, Natalie W., Waters, Marcey L. "A Synthetic Receptor for Asymmetric Dimethyl Arginine." *J. Am. Chem. Soc.* **2013**, *135*, 6450-6455.
- * - Denotes equal contribution

Notable Honors & Awards

University of North Carolina at Chapel Hill

- Global Strategic Partnership Award (2019)
- NSF Graduate Research Fellowship (2010-2013)
- Graduate Travel Award (2013)
- Venable Summer Research Fellowship (2009)

Juniata College

- Brumbaugh Award for Science (2009): Excellence in science courses and research
- Rockwell Chemistry Prize (2008): Excellence in chemistry coursework
- ACS Award in Organic Chemistry (2008): Top student in organic chemistry
- Pentz Premedical Scholarship (2008): Exemplary humanitarian attitude, scholarly excellence, and character
- Service and Peacemaking Scholarship (2005): Humanitarian service scholarship

Relevant Research Experience

Duke University | Postdoctoral Research Associate | Durham, NC 27708 | 2014 – 2016

- Supervisor: Professor Ashutosh Chilkoti, Biomedical Engineering

- Research Description: Investigated the utility of single stranded DNA drug polymers as a backbone for novel nanoparticle architectures for drug delivery in cancer and inflammatory therapies.
- Regularly consulted with graduate students and research scientists as the resident expert in organic chemistry, polymer design, and molecular recognition and mentored students to help troubleshoot and design research projects in surface chemistry and peptide drug delivery.

Juniata College | Undergraduate Research Assistant | Huntingdon, PA 16652 | 2007 – 2009

- Supervisors: Professor Dave Reingold and Professor Paul Ewbank
- Description: Synthesized novel semiconducting polymers and oligomers for organic field-effect transistors.

Carnegie Mellon University | Summer Undergraduate Researcher | Pittsburgh, PA 15289 | Summer 2008

- Supervisor: Professor Richard McCullough
- Description: Synthesized, characterized and analyzed semiconducting organic polymer derivatives for organic solar cells and chemical sensing applications.

Relevant Leadership & Service

- Co-Director for United States | Trans-Atlantic Science Student Exchange Program | 2017-2019
- Liaison to Study Abroad | Chemistry Department, UNC | 2017-Present
- Member, Study Abroad Science Working Group | Study Abroad Office, UNC | 2017-Present
- Member, Education Committee | Chemistry Department, UNC | 2017-Present
- Member, Undergraduate Labs Committee | Chemistry Department, UNC | 2017-Present
- Council Member | Holy Trinity Lutheran Church | 2018-Present
- Faculty Advisor | UNC-CH Wrestling Club | 2017-Present
- Faculty Advisor | UNC Figure Skating Club | 2017-Present
- Faculty Advisor | UNC Global Brigades | 2016-2018
- NSF Graduate Research Fellowship Reviewer and Panelist | National Science Foundation | 2016
- President | Association of Chemistry Graduate Students, UNC | 2012 – 2013
- Vice President | Association of Chemistry Graduate Students, UNC | 2010 – 2012
- Senator | Graduate and Professional Student Federation, UNC | 2010 – 2012
- Diabetes Mentor, faculty assistant mentor | Heels & Hearts UNC | 2010 – Present