I. Course Description

The two-credit CURE Organic Chemistry Laboratory Course serves as an alternative to the Organic Chemistry Laboratory Course (CHEM 0345). One major goal of this course is to offer undergraduate students an opportunity to perform authentic scientific research in the laboratory course. This course engages students in learning approaches towards antibiotic discovery which is essential to address the world’s current antibiotic crisis. This course affords the students the opportunity to develop strategies for antibiotic isolation and purification using chemical separation techniques, and to characterize these unknown antibiotics through spectroscopic techniques commonly used in organic chemistry.

II. Learning Objectives

This course will:

a. Require students to practice, and develop second_nature, safe laboratory practices.

b. Enable students to continue developing scientific skills of observing, reflecting on, questioning, and explaining the natural world.

c. Require students to re_consider their ideas and to justify or refute them with laboratory derived evidence.

d. Require students to devise experiments, write hypotheses, make predictions, change variables, use controls, and create a model that can be tested further.

e. Provide an opportunity for students to collect, organize, analyze and present data.

f. Require students to create, present, and defend, a scientifically accurate and robust poster.
III. Course Expectations & Requirements

A. Assignments and Projects:
   a. Pre lab reading:
      Students are required to complete the pre lab review (material reading and/or videos) and put the experimental plan into their electronic notebook (LabArchive) prior to each lab session. The experimental plan should include but not limited to: Purposes, Materials and Equipment, Procedure and Questions. The plan should be sensible and can serve as a clear guideline for the experiments. A sample plan will be provided in Canvas as a reference. The experimental plans will be graded.

   b. Post lab assignments:
      Students are required to record the experimental data and analysis after each lab session and prior to the next lab session. Every other week, students should organize the data record and analysis in PowerPoint slides before Sunday. A sample data PPT would be provided in Canvas as a reference. The PPT data slides would be graded.

   c. Quizzes:
      Three quizzes will be given throughout the semester. The quizzes have to be completed independently.

   d. Capstone poster:
      Students are required to make a poster (size: 48in × 36in) and present the research to the class.

B. Attendance: Students must attend all laboratory sessions at the time scheduled for their section. Pre and post-lab assignments can only be turned in by those students who attend the appropriate lab session. We encourage you never to miss a single lab session though we do recognize acceptable reasons such as serious illness or personal trauma, or participation if a few University sponsored events. In general, sorority, fraternity, and club activities are NOT recognized as valid reasons to miss a lab.

C. Canvas: Students are responsible for being aware of all materials posted and requirements due, as described on Canvas. Materials will be posted at least three days in advance, and often, long before that. Check the Canvas site often.

IV. Course Evaluation

   Grades will be based on the following four parts:

   a. Electronic Lab Notebook (ELN): Pre and post lab assignments (20% of the final total).
      Pre-lab: records the students experimental planning
      Post-lab: records the experimental results in PowerPoint format (every other week).
      Notebook will be graded periodically.

   b. Quiz grades (30% of the final total).
      Three quizzes will be given in the semester.
c. Participation: Discussion session participation, lab technique/citizenship and research contribution (20% of the final total).

Students are expected to participate in the in-class discussion. Based on the pre-lab readings and planning, students raise questions and answer each other’s questions.

Lab technique/citizenship & Research contribution: As is true for all Organic labs, the technique grade reflects an individual’s attention to cleanliness, safety, and quality of lab work and data analysis. Cleanliness includes a clean and tidy hood and drawer during and after experiments, and proper care for communal areas of the lab space. Lab citizenship reflects awareness and attention to mandatory protocols, lab safety rules, and accommodation of needs of all individuals in the lab space and using shared equipment. Asking questions or making an honest mistake are expected.

d. Poster: the final poster presentation (30% of the final total).

As the final project students present a poster (size: 48in × 36in) to the class. The poster score includes two parts: content and design of the poster, and oral presentation of the poster.

V. Important Dates

- Quiz 1: Sep 27 for MW section, Sep 28 for TTH sections
- Quiz 2: Oct 25 for MW section, Oct 26 for TTH sections
- Quiz 3: Nov 17 for MW section, Nov 18 for TTH sections

The capstone poster (48in × 36in) in PDF is due at 10am on Monday, Dec 6. The poster presentation will be on the last day of class.

VI. Learning Outcomes

**Outcome 1:** Students gain a highly interdisciplinary research experience that integrates required biology and chemistry labs to investigate a scientific challenge of broad interest: discovery of new antibiotics.

**Outcome 2:** Students will learn these chemistry concepts and methods that include: Liquid-liquid extraction; Rotavaping; Freeze-drying; Thin-layer Chromatography (TLC); Normal/Reverse phase Chromatography; High-Performance Liquid Chromatography (HPLC); Mass Spectroscopy; IR; $^1$H NMR; $^{13}$C NMR; Chemical synthesis (oxidation and metal chelating reactions). Students will apply these techniques in their research on antibiotics isolation and spectroscopic characterization.

**Outcome 3:** Students take the lead and gain a full experience of authentic research. Students learn how to raise a question/project, how to design experimental strategies for a project, how to analyze experimental results and perform trouble-shooting, and how to summarize and present their research projects.

**Outcome 4:** Students become familiar with reading the primary scientific literature through background research, designing experimental strategies, seeking for troubleshooting ideas and discussing research discovery.

VII. Student Opinion of Teaching Surveys
Students in this class will be asked to complete a Student Opinion of Teaching Survey. Surveys will be sent via Pitt email and appear on your CourseWeb landing page during the last three weeks of class meeting days. Your responses are anonymous. Please take time to thoughtfully respond, your feedback is important to me. Read more about Student Opinion of Teaching Surveys

VIII. University Policies

**Academic Integrity**

Students in this course will be expected to comply with the University of Pittsburgh's Policy on Academic Integrity. Any student suspected of violating this obligation for any reason during the semester will be required to participate in the procedural process, initiated at the instructor level, as outlined in the University Guidelines on Academic Integrity. This may include, but is not limited to, the confiscation of the examination of any individual suspected of violating University Policy. Furthermore, no student may bring any unauthorized materials to an exam, including dictionaries and programmable calculators.

**Disability Services**

If you have a disability for which you are or may be requesting an accommodation, you are encouraged to contact both your instructor and Disability Resources and Services (DRS), 140 William Pitt Union, (412) 648-7890, drsrecep@pitt.edu, (412) 228-5347 for P3 ASL users, as early as possible in the term. DRS will verify your disability and determine reasonable accommodations for this course.

**Copyright Notice**

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IX. Diversity and Inclusion

I strongly believe in the importance of diversity, equity and inclusion (DEI). It is my goal that students from all backgrounds and identities feel welcomed and well-served by this course. If you experience or observe anything within this course that deviates from DEI, please bring them to my attention as soon as possible so that we may take steps to address them.

Additionally, please remember that the University of Pittsburgh does not tolerate any form of discrimination, harassment, or retaliation based on disability, race, color,
religion, national origin, ancestry, genetic information, marital status, familial status, sex, age, sexual orientation, veteran status or gender identity or other factors as stated in the University’s Title IX policy. The University is committed to taking prompt action to end a hostile environment that interferes with the University’s mission. For more information about policies, procedures, and practices, see: https://www.diversity.pitt.edu/civil-rights-title-ix-compliance/policies-procedures-and-practices.
Chem 0745_Tentative Schedule

1. The content for each session may **very likely** change for your team because it depends on the research progress of your team and also the availability of instrument.
2. This schedule is mostly for you to see what you will work on in the lab to reach your research goal. Materials for each lab session will be in Modules.
3. For each session, first date is MW lab, second date is TTH lab.

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<thead>
<tr>
<th>Date</th>
<th>Topic</th>
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| Aug 30/31| **Course Introduction; Safety Discussion & Design of Antibiotics Discovery**  
Discussion: Global planning: How to discover antibiotics from bacteria  
Wet-lab: Start antibiotics production from *Lysobactor Antibioticus* |
| Sep 1/2  | **Making an overall plan for studying antibiotics from Lysobactor antibioticus**  
Discussion: design your plan based on the reference paper |
| Sep 6/7  | **No lab**                                                             |
| Sep 8/9  | **How to make experimental plans and data summary slides**  
Discussion: examples and how to make your own  
Wet-lab: Start antibiotics production from *Lysobactor Antibioticus* |
| Sep 13/14| **Chemical Extraction of Antibiotics**  
Discussion: extraction and purification of antibiotic compounds from bacteria  
Wet-lab: Centrifugation / Liquid-liquid extraction of antibiotics from *Lysobactor antibioticus* culture / Rotavaping |
| Sep 15/16| **Continuance of liquid-liquid extraction**  
**Antibiotics Activity Assay of the Crude Extract (can be skipped for L. antibioticus)**  
Discussion: Tester strains and the antibiotic activity assay  
Wet-lab: Test the crude extract’s antibiotic activity against tester strains |
| Sep 20/21| **Isolation of Antibiotics: Normal-phase Chromatography**  
Discussion: Molecular polarity/Dielectric Constant/Normal phase chromatography  
Wet-lab: Separation of the crude extract using silica column |
| Sep 22/23| **Antibiotics Activity Assay of the Fractions from Silica Column**  
Discussion: How to optimize conditions for silica column separation  
Wet-lab: Test the antibiotic activity of all fractions separated from silica column |
| Sep 27/28| **Quiz 1**                                                             |
| Sep 29/30| **Purification of Antibiotics: HPLC**  
Discussion: Chemical polarity / Reverse phase chromatography/HPLC  
Wet-lab: Purify the antibiotic compounds using HPLC |
| Sep 27/28| **Continuance of HPLC**  
**Structural Characterization: Mass Spectrometry**  
Discussion: The principle of Mass Spectrometry  
Wet-lab: Run the purified compounds on LC-MS |
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<tr>
<th>Date</th>
<th>Topic</th>
<th>Details</th>
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<tbody>
<tr>
<td>Oct 4/5</td>
<td><strong>Structural Characterization: $^1$H NMR</strong></td>
<td>Discussion: The principle of $^1$H NMR / How to analyze $^1$H NMR spectrum</td>
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<td>Wet-lab: Obtain $^1$H NMR of the purified compounds</td>
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<tr>
<td>Oct 6/7</td>
<td><strong>Structural Characterization: $^{13}$C NMR</strong></td>
<td>Discussion: The principle of $^{13}$C NMR / How to analyze $^{13}$C NMR spectrum</td>
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<td>Wet-lab: Obtain $^{13}$C NMR of the purified compounds</td>
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<tr>
<td>Oct 11/12</td>
<td><strong>Structural Characterization: IR</strong></td>
<td>Discussion: Principle of IR / How to analyze IR spectrum</td>
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<td>Wet-lab: Obtain IR of the purified compounds</td>
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<tr>
<td>Oct 13/14</td>
<td><strong>Structural Analysis of the Purified Compounds &amp; Plan for the Unknown Strain</strong></td>
<td>Discussion: Derive the chemical structure of the compounds based on the spectroscopy data / Summary of the research on the <em>Lysobacter Antibioticus</em> strain / Literature research to plan for the unknown strain</td>
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<tr>
<td>Oct 18/19</td>
<td><strong>Chemical Extraction of the Antibiotics from the Unknown Bacteria Strain</strong></td>
<td>Discussion: extraction and purification of antibiotic compounds from the unknown strain / potential problems and alternative strategies</td>
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<tr>
<td>Oct 20/21</td>
<td><strong>Antibiotics Activity Assay of the Crude Extract from the Unknown Strain</strong></td>
<td>Discussion: Tester strains and the antibiotic activity assay</td>
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<td>Oct 25/26</td>
<td><strong>Quiz 2</strong></td>
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<td><strong>Isolation of Antibiotics from the Unknown Strain: Normal-phase Chromatography</strong></td>
<td>Discussion: Molecular polarity/Dielectric Constant/Normal phase chromatography</td>
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<tr>
<td>Nov 1/2</td>
<td><strong>Antibiotics Activity Assay of the Fractions from Silica Column</strong></td>
<td>Discussion: How to optimize conditions for silica column separation</td>
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<tr>
<td>Nov 3/4</td>
<td><strong>Purification of Antibiotics from the Unknown Strain: HPLC with Optimizations</strong></td>
<td>Discussion: How to optimize HPLC conditions for purification with higher resolution</td>
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<td>Nov 8/9</td>
<td><strong>Structural Characterization: $^1$H NMR II</strong></td>
<td>Discussion: How to obtain high quality $^1$H NMR data / How to analyze $^1$H NMR spectrum</td>
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<tr>
<td>Nov 10/11</td>
<td><strong>Structural Characterization: $^{13}$C-NMR II</strong></td>
<td>Discussion: How to obtain high quality $^{13}$C NMR data / How to analyze $^{13}$C NMR spectrum</td>
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<td>Nov 15/16</td>
<td><strong>Quiz 3</strong></td>
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<td></td>
<td><strong>Structural Characterization: IR</strong></td>
<td>Discussion: Principle of IR / How to analyze IR spectrum</td>
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<td>Nov 29/30</td>
<td>Wet-lab: Obtain IR of the purified compounds from the unknown strain</td>
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<td><strong>Quantifying the Antibiotic’s Activity Against Multiple Pathogens</strong></td>
<td>Discussion: Antibiotic activity profiling</td>
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<td>Wet-lab: Quantitatively test the activity of the purified compounds against multiple pathogenic tester strains</td>
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<tr>
<td>Dec 1/2</td>
<td><strong>Structural Analysis of the Antibiotics from the Unknown Strain</strong></td>
<td>Discussion: Derive chemical structure of the antibiotics</td>
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<td>Practice: using ChemDraw to draw the structure of the antibiotics</td>
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<tr>
<td>Dec 6/7</td>
<td><strong>Research Summary &amp; Poster practice</strong></td>
<td>Discussion: Literature research on the antibiotic compounds isolated from the unknown strain / How to use SciFinder</td>
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