

CHEM 460 - Scientific and Social Aspects of Drug Development

Instructor: Dr. Dana Lashley

This course constitutes a senior capstone experience and satisfies the COLL 400 requirement.

Course Description:

In this upper-level seminar course students will explore the different drug classes, their medicinal properties, their select organic syntheses and their mechanism of action. Beyond the scientific perspective, students will have a chance to look at drug development through a historical lens as well as investigate the impacts of drugs on society. This course will be interdisciplinary in nature featuring some guest lectures and covering topics in organic chemistry, biochemistry, medicine, pharmacology, toxicology, psychology as well as health policy, patent law, library science and economics.

One of the main focal points of this course is to facilitate student's analytical thinking, synthesis and scientific communication skills practiced through class discussion, individual literature research and presentations to different types of audiences. (Usually there are out-of-class excursions with hands on opportunities which are unfortunately not possible this semester due to the pandemic.)

A major aspect of this class will be the practice of **science communication**. In the context of this class and as part of their assessment students will communicate topics in drug development to both scientific and diverse non-scientific audiences. This will culminate in a final project where students will prepare a lecture to be presented to a large class of students consisting of senior citizens from the Osher Life-long Learning institute as well as freshmen/sophomores (enrolled in Organic Chemistry 1) at W&M.

This course is geared toward students interested in novel, non lab-based career opportunities in chemical education, science journalism, science policy and other communication-oriented scientific careers.

Prerequisites:

The course has a pre-requisite of Biochemistry (CHEM / BIOL 314), as this would facilitate students' understanding of a drug's mechanism of actions.

Objectives:

Students will explore groundbreaking discoveries in the field of Medicinal Chemistry and Drug Development. Different drug classes will be discussed but not necessarily in the chronological order of their discovery. Students will become familiarized with terminology in the field of medicinal chemistry and pharmacology and they will be introduced to important toxicological and pharmacological techniques that are part of modern drug development.

The course will begin by briefly looking at ancient medicines of the antiquity and middle-ages before highlighting the modern-era discovery and development of groundbreaking drugs and medicinal practices. Students will gain an appreciation of both industrial and academic research structure, which facilitates drug discovery. The processes governing modern day pharmaceutical drug development and the different phases of clinical research will also be discussed in this context.

It is envisioned that guest lecturers will teach part of this course underlying the interdisciplinarity of this topic. Guest lectures will be in the realms of patent law and FDA law (in collaboration with the W&M Law School), health-policy (in collaboration with the W&M Government Department), mental health, substance abuse and dependency (in collaboration with W&M Psychology Department) etc.

One of the major assessments in this class will be presenting a class topic to a diverse audience (see under assessments for details). Therefore, a part of the class time will be dedicated to teaching the didactics of relaying scientific topics to a diverse audience.

There will be two types of audiences that students in this class will learn to communicate to. One audience are their peers in the class (senior graduating students in CHEM or related discipline), with whom they will communicate during discussions and whom they will critically analyze after in-class presentations.

For the out of class-presentation students will relay a topic in drug development to students of the Osher Life-long Learning Institute, who are typically senior citizens from the Williamsburg area as well as beginner chemistry students (freshmen/sophomores) who are currently taking organic chemistry 1. Students will learn to answer the immensely important question of how to best "translate" science to the general public without using scientific jargon. Most of this audience will have NO knowledge of biochemistry or advanced chemistry. Relying on their in-class training on communication theory students will relay medicinal drug related topics to non-experts keeping in mind that they may one day depend on a non-expert's funding and publicity. Through careful evaluation of their communication students will learn to help bridge the knowledge and social gap between scientists and the general public, which is more important today than it ever was.

Course Delivery:

Live (synchronous) in-person lectures on

Tuesdays & Thursdays from 3.30pm – 4.50pm in ISC 2018 (CHEM Department Seminar room on 2nd floor)

Also **Wednesdays from 4.00pm – 5.50pm in ISC 1127**

(only occasionally as scheduled probably no more than 5 times this semester)

Occasionally, the lectures may be via zoom:

<https://cwm.zoom.us/j/92953709986?pwd=WWc1WjJtNXNGTkNmMEUrWE9ObDBsUT09>

Meeting ID: 929 5370 9986

Passcode: [Drugs](#)

NOTE: This is a seminar. **It is expected that your camera is turned on** and that you participate in class discussions and contribute by asking and answering questions.

Readings:

Readings from textbooks may be assigned to reinforce understanding of lecture topics.

- *The Organic Chemistry of Drug Design and Drug action.*
Third edition / Richard B. Silverman, Mark W. Holladay.. San Diego, CA : Academic Press 2014

The textbook is available at no cost electronically through the W&M library.
Available as free e-book under (have to login to WM account for access):

<https://tinyurl.com/y8eqbu5d>

- *Social Aspects of Drug Discovery, Development and Commercialization: From Laboratory to Clinic.*
First edition / Odilia Osakwe, Syed A. A. Rizvi, Academic Press 2015

Available as free e-book under (have to login to WM account for access):

<https://tinyurl.com/y8nwsuzm>

- Other readings or media will be handed out or posted on Blackboard. This will include journal articles, book excerpts as well as podcasts or videos.

Planned lessons: (order is subject to change & we may not be able to cover all topics)

1. Introduction to Medicinal Chemistry: What are Drugs and Natural Products?
2. The drugs of Antiquity: Ancient natural pharmaceuticals from herbs, plants, roots, vines and fungi used in traditional Egyptian, Greek, Roman, Indian and Chinese Medicine (~3000 BC - 19th century)
3. Alkaloids with emphasis on Morphine, Heroin, Cocaine and Atropine. Substance abuse and treatment.
4. The rise of the Pharmaceutical Chemistry and Pharmacology and the first synthetic drugs (1869 onward). Chloroform, chloral hydrate, bromide salts, paraldehyde and urethanes
5. Introduction to literature research and data bases (by Librarians at Swem library)
6. Introduction to FDA law and Patent law: Controlled substance laws for Narcotics and other drugs as well as patent law, copy right and intellectual property (Guest lecture by WM Law School)
7. Introduction to pharmacology and toxicology. Determination of the median lethal dose LD₅₀ and the median effective dose ED₅₀
8. Science Communication
9. Discovery of the Structure of DNA (Watson, Crick and Franklin 1953). Nucleoside and Nucleotide nomenclature.
10. Viruses, Vaccines and Nucleosidic Anti-Viral Drugs (spotlight on Coronavirus and Ebola virus)
11. Barbiturates (1903 onward) with focus on Veronal, Luminal, Vesparax and Thiopental. Use as sedatives, hypnotics, sleeping aids, anesthesia and use in capital punishment.
12. The first Analgesics and Antipyretics and the role of synthetic dyes such as mauveine by British chemist Henry Perkin (1838-1907). Emphasis on Acetaminophen (Tylenol) and Aspirin
13. Discovery of Penicillin (Alexander Fleming 1929) and other classes of Antibiotics
14. Depression and other Mental Health Disorders (potential Guest lecture by WM Psychology)
15. Psychoactive Drugs (e.g. Stimulants, Hallucinogens, Anti-Depressants, Anti-Psychotics)
16. Steroids and the development of the Contraceptive Pill (1950s Carl Djerassi)
17. Women's Health policy (contraception law, abortion law) (Guest Lecture by WM Government)
18. Peptide drugs with focus on Oxytocin and Insulin. Intro to Bioengineering.
19. Ethics of Animal testing
20. Blockbuster drugs and Pharmaceutical companies

Guest lecture details:

- Workshop: Introduction to literature research and data bases by Alexandra Flores and Paul Showalter from Swem library on **TBA**
- Introduction to Patent law by Prof. Sarah Rajec and introduction to FDA law by Prof. Stacy Kern-Scheerer from WM Law School **date TBA**
- Substance Abuse and dependency by Prof. Pamela Hunt from WM Psychology **date TBA**
- Women's Health policy (contraception law, abortion law) by Prof. Claire McKinney from WM Government **date TBA**

Please be aware that other guest lectures may be added.

Assessments

Students final grades will be determined according to the below assessments:

- 20% Individual Presentation on Select Drug Development Topic (geared toward peers in class)
- 30% Individual Presentation on Select Drug Development Topic (geared toward general audience)
- 20% Literature Review Paper on select Natural Product
- 20% Final Exam
- 10% Participation

Individual Presentation geared toward peers in class.

Students are expected to generate a **30-minute** individual presentation to be presented in front of the rest of the class. The presentation should capture both the scientific importance (if the topic is a certain drug class then organic synthesis and mechanism of action should be discussed in depth) as well as the historical and cultural context of the topic. This presentation should be geared toward an audience who is knowledgeable in chemistry. Topic choices should be discussed with instructor at the latest by March 1st!

Dates: **March 22***, **March 24**, **March 29** and **March 31** (two students present on each date. Three students will present on one of the dates – we may go a little over on that date – apologies in advance if you have to leave that's ok). The order will be decided by luck of the draw.

*attention: right after Spring Break!

Individual Presentation geared toward general audience.

Prepare a **30-minute** presentation on a select Drug Development topic. Topic choices must be made by **March 1st** and the selected topics must be approved by the instructor. **You may use the same topic that you already selected for the peer presentation.** But you have to communicate differently to this general, non-science audience!

This presentation will take place in front of a diverse audience (some senior citizens from the Osher Institute as well as a number of Organic Chem 1 students at W&M). Be sure to gear your presentation towards a general audience and do not expect prior knowledge of chemistry or any other topic beyond a high school education.

The presentations will take place outside of class time on **Wednesdays between 4-6pm** on the dates indicated below.

The presentation should capture both the scientific importance as well as the historical and cultural context of the topic while keeping in mind the audience that is not expert in chemistry.

It is expected that students confer and work closely with the instructor over the course of several weeks to develop a high-quality presentation.

Students will present on WEDNESDAY 4/06/, 4/13 or on 4/20.

THREE students will present on each date.

*this is one of the Spring break days so try to attend one of the earlier ones if you like

Literature Review Paper on select Natural Product. Students will select a Natural Product of choice and write a literature review through researching and critically evaluating of primary literature. Detailed criteria and instructions for the paper will be posted on BB. This paper is due by the last day of classes by **May 6th by 23.59pm** (electronic). You may turn the paper in at any time during the semester and do not have to wait until the deadline.

Final Exam. The final will assess the students understanding of lecture and reading topics. Exams will include drug structure, nomenclature, mechanism of action and pharmacological calculations. The historical and cultural contexts of drug discovery as highlighted in lecture will also be subject to the exam.

Topics from guest lectures will be part of this exam.

You will be provided a study guide toward the end of the semester.

Firm date: Monday, May 17th 2-5pm IN PERSON (Room TBA).

This exam can't be taken online. Please plan to be on campus – this is not a remote class.

Participation. Students are expected to attend class and actively participate by engaging in discussions. Moreover, students are expected to apply their critical thinking skills when presented information and ask questions to seek clarification. This goes both for lectures as well as after student presentations. During presentations students will be asked to assess their peers' presentations based on a set of given criteria on a handed-out form. Attendance at the general audience lectures on Wednesdays when you are not presenting yourself will also count toward the participation grade. Missing class or being constantly tardy can also count against your participation grade.

Note: we may have conversations (for example around equity and race) that may make you feel uncomfortable. I expect you to be respectful of others as we have these important conversations.

Final Grades:

A-/A	90-100%	Excellent performance and mastery of the material
B-/B/B+	80-89.99%	Very good understanding of the material
C-/C/C+	70-79.99%	Adequate performance
D-/D/D+	60-69.99%	Poor performance
F	below 60%	Unsatisfactory performance

Contact: Students should always feel free and comfortable to contact me with any questions or concerns. Talk to me after class or email me to schedule an appointment.

Inclusion and Diversity: Please know that I value all students regardless of their background, country of origin, race, religion, ethnicity, disability status, sexual orientation or gender identity. I am committed to providing a climate of excellence and inclusiveness within all aspects of this course. If there are aspects of your culture or identity that you would like to share with me as they relate to your success in this class, I am happy to meet to discuss. Likewise, if you have any concerns in this area or facing any special issues or challenges, you are encouraged to discuss the matter with me. You can set up a meeting with me via email with an assurance of full confidentiality (only exception being mandatory reporting of academic integrity/code violations and sexual harassment/misconduct).

Smart phones / tablets: You may use smart phones and tablets in class during lectures. Most of you have this technology available and you can use it to easily access course material. I trust that you will use them responsibly for class-related issues. You may not use them during exams and other assessments. I just ask that you be respectful about it and please do keep your phones on silent.

Please beware that use of a phone can be very distracting especially in any setting (online or in-person) and could cause you to miss some key information that you would be expected to know for the final exam.

Blackboard: Course related materials such as lecture templates/notes, exam keys and announcements will be posted on Blackboard (www.blackboard.wm.edu). Lectures will be recorded and posted on BB as well. For guest lectures I need to obtain permission from the guest lecturers but hopefully that will be fine.

Grading concerns/re-grades: All grading concerns need to be discussed with me within 3 class days upon receiving your graded exam or other assessment. After that there will be no re-grades.

Make-up work: Exams and other graded work cannot be easily made-up. See me in the event of extenuating circumstances.

Class Attendance: In accordance with College policy, class attendance is expected and participation in class discussions will account for a part of your grade.

See undergraduate catalog for more information. Please notify me of any absences by email. Attendance will be recorded daily.

Missing more than 3 lectures (unexcused) will result in a deduction of the participation grade.

Student Accessibility Services: Students with disabilities must contact the Student Accessibility Services in the Dean of Students office to arrange for extra-time during exams. If you are granted special accommodations, such as a quiet testing environment, I will work with you to make arrangements for that. **It is the student's responsibility to make contact with me at least a week prior to the test date and to adhere to their specific accommodations.**

Honor Code: All students are bound to the Honor Code. There will be **zero tolerance for cheating** and all incidences will be reported to the honor system. See the student handbook for more information on the honor code.

https://www.wm.edu/offices/deanofstudents/services/communityvalues/documents/18_19hbcompletefinal.pdf

Mental and Physical Well-Being

William & Mary recognizes that students juggle different responsibilities and can face challenges that make learning difficult. There are many resources available at W&M to help students navigate emotional/psychological, physical/medical, material/accessibility concerns. Asking for help is a sign of courage and strength. If you or someone you know is experiencing any of these challenges, we encourage you to reach out to the following offices:

- For psychological/emotional stress, please consider reaching out to the W&M Counseling Center <https://www.wm.edu/offices/wellness/counselingcenter/>; or (757) 221-3620, 240 Gooch Dr., 2nd floor. Services are free and confidential.
- For physical/medical concerns, please consider reaching out to the W&M Health Center at <https://www.wm.edu/offices/wellness/healthcenter/>; or (757) 221-4386, 240 Gooch Drive.
- For additional support or resources, please contact the Dean of Students by submitting a Care Report at <https://www.wm.edu/offices/deanofstudents/services/caresupportservices/index.php>; or by calling 757-221-2510, or by emailing deanofstudents@wm.edu.
- For a list of many other resources available to students, see [Health and Wellness Resources for Students](#)

As your professor, I also ask you to reach out to me if you are facing challenges inside or outside the classroom; I will guide you to appropriate resources on campus.