

## **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, economics and English literature.

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, presentations and finally out-of-class excursions with hands on opportunities. 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 at the Christopher Wren Association.

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 generally in 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 (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), socio-economics (in collaboration with W&M Economics Department) and English literature (in collaboration with the W&M English Department).

Several field trips to Washington D.C. (and other nearby destinations) will complement the course through hands-on learning. In collaboration with the W&M D.C. office we will travel to D.C. and be able to tour sites of interest. Moreover, the D.C. office has kindly offered to coordinate talks for this course by alumni in our fields of interest for which we can utilize the classroom in the D.C. office.

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, 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 Christopher Wren Association (CWA), who are typically senior citizens from the Williamsburg area. Students will learn to answer the immensely important question of how to best "translate" science to the general public without using scientific jargon. 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 an 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.

### **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 will be handed out or posted on Blackboard. This will include journal articles, as well as book excerpts.

**Planned lessons:** (subject to change)

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 - 19<sup>th</sup> century)
3. Alkaloids with emphasis on Morphine, Heroin, Cocaine and Atropine
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 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**)
6. Barbiturates (1903 onward) with focus on Veronal, Luminal, Vesparax and Thiopental. Use as sedatives, hypnotics, sleeping aids, anesthesia and use in capital punishment.
7. Drug influences on literature and poetry (**Guest lecture by WM English Dept.**)
8. 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
9. Discovery of Penicillin (Alexander Fleming 1929) and other classes of Antibiotics
10. Introduction to pharmacology and toxicology. Determination of the median lethal dose LD<sub>50</sub> and the median effective dose ED<sub>50</sub>
11. Depression and other Mental Health Disorders (**Guest lecture by WM Psychology**)
12. Substance abuse (**Guest Lecture by WM Psychology**)
13. Psychoactive Drugs (e.g. Stimulants, Hallucinogens, Anti-Depressants, Anti-Psychotics)
14. Drugs for the treatment of substance abuse
15. Career highlight: Science Librarian (**guest lecture by Kristy Borda, science librarian at the Swem library**)
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. Introduction to literature research and data bases (**by Kristy Borda in Swem library**)
19. Topic Excursion: Relaying Topics of interest in Chemistry to Diverse Audiences (**possible guest lecture by WM School of Education**)
20. Discovery of the Structure of DNA (Watson, Crick and Franklin 1953). Nucleoside and Nucleotide nomenclature.
21. Viruses and Nucleosidic Anti-Viral Drugs
22. Peptide drugs with focus on Oxytocin and Insulin. Intro to Bioengineering.
23. **Methods in Bioengineering (possible guest lecture WM Applied Science)**
24. Modern rationale design drug development and clinical trials
25. Ethics of Animal testing
26. Blockbuster drugs and Pharmaceutical companies
27. Student presentations on select topics

### **Guest lecture details:**

- Introduction to FDA law and Patent law by Prof. Stacy Kern-Scheerer and Prof. Sarah Rajec from WM Law School **on February 5.**
- Drug influences on literature and poetry by Prof. Tom Heacox from WM English Department. **Date TBA**
- Treatment of Mental Health Patients by Prof. Chris Conway from WM Psychology. **Date TBA**
- Substance Abuse and dependency by Prof. Pamela Hunt from WM Psychology. **Date TBA**
- Career highlight: Science Librarian by Kristy Borda, science librarian at the Swem library **on February 28.**
- Women's Health policy (contraception law, abortion law) by Prof. Claire McKinney from WM Government **on March 12.**
- Workshop: Introduction to literature research and data bases by Kristy Borda in Swem library in the Ford Classroom **on March 14.**

### **The Daily Work of Justice:**

The Daily Work of Justice is a conversation series that invites people directly involved in an issue to share their lived experience, as a way of providing space for others to engage with empathy, understanding, and action. It was created collaboratively by people from diverse units across William & Mary.

Our focus for spring 2019 is addiction. Over the course of three weeks, we will examine the topic from three perspectives:

- **February 5:** People who have experienced addiction first-hand
- **February 12:** People who work within treatment, recovery, medical, legal, and other systems that address addiction and support those affected
- **February 19:** People who work to make change to systems and communities, including prevention specialists, advocates, legislators, philanthropists, journalists, and others

Participants will gather around tables, and after a brief introduction, will participate in small group conversations. A guest speaker with personal experience in the issue (as described above) and a facilitator will be at each table. Events time is **6.30pm - 8.00pm.**

## Field Experiences and Trips

Several field trips will bring the students to discussed historical and modern sites within reach of Williamsburg. [Dates TBA soon.](#)

<b>Trip</b>		<b>Location</b>	<b>Relevance</b>
Williamsburg and/or Richmond Botanical Gardens <a href="https://www.lewisginter.org">https://www.lewisginter.org</a>		Williamsburg / Richmond	<u>Plants from all over the world - including many with medicinal properties.</u>
National Institutes of Health		Washington D.C.	Tour of facilities; possible guest lecture in D.C. office.
Outreach		Williamsburg	Presenting topics of this class to a diverse audience at the Christopher Wren Association

**Table 1: Field Trips related to this course**

### Assessments

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

- 30% Group Outreach Presentation
- 20% Individual Presentation on Select Drug Development Topic
- 20% Midterm Exam
- 20% Literature Review Paper on select Natural Product
- 10% Participation

**Group Outreach Presentation.** Students will work in groups of two and prepare a 45 minute presentation on a select Drug Development topic. Topic choices must be made within one month of the start of semester ([by February 22<sup>nd</sup>](#)) and the selected topics must be approved by the instructor.

This presentation will take place in front of a diverse audience as part of a course taught at the Christopher Wren Association geared toward senior citizens. The presentation will take place outside of class time in the late afternoon.

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.

The community course has the same title as this class and meets on 6 consecutive Wednesdays on the dates listed below. You need to be present on those 6 Wednesdays. I will teach the first 3 sessions and after that you will teach the class.

### ***Scientific and Social Aspects of Drug Discovery and Drug Development***

**Wed 5:00 PM - 7:00 PM**, 6 sessions on [3/20/2019 - 4/24/2019](#)

W&M Integrated Science Center III, Room 1221 180 seats available

<https://www.wm.edu/offices/auxiliary/osher/coursecatalog.pdf> (page 47)

## Individual Presentation.

Students are expected to generate a 30 minute individual presentation to be presented in the last 2 weeks of classes 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 right after Spring Break!  
Dates: **March 19, 21, 26 and 28** (two students present on each date)

**Midterm Exam.** The midterm will assess the students understanding of lecture and reading topics. This includes topics of the guest lectures. 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.  
**Tentative date: Tuesday, April 2 in class.**

**Literature Review Paper on select Natural Product.** After a visit to the Botanical Gardens 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 end of the semester on **May 2 by 23.59pm** (electronic). Hard copy must be provided by **May 3<sup>rd</sup> 5pm to my office.**

**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 group presentations students will be asked to assess their peers' presentations based on a set of given criteria on a handed out form. Attendance at out of class events such as excursions/field trips and the "Daily works of Justice" series also counts toward the participation grade.

### 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.

**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.

**Blackboard:** Course related materials such as lecture templates/notes, exam keys and announcements will be posted on Blackboard ([www.blackboard.wm.edu](http://www.blackboard.wm.edu)).

**General information for exams:** All examinations are to be taken in ink. No pencil!!! There will be a deduction of 2 points for use of pencil and no regrades.

**Grading concerns/re-grades:** All grading concerns need to be discussed with me within 3 class days upon receiving your graded exam. 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.

**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 few days prior to the test date.

**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](https://www.wm.edu/offices/deanofstudents/services/communityvalues/documents/18_19hbcompletefinal.pdf)