Spring 2023: RXRS 407: The Discovery, Development and Marketing of Modern Medicines
Updated: 12.19.22

Instructors: Daryl Davies, PhD
Professor, Department of Clinical Pharmacy
University of Southern California
ddavies@usc.edu; (323) 442-1427
HSC Office: PSC 528
UPC Office: Stonier Hall 312
Office Hours by appointment

Hovhannes J. Gukasyan, PhD
Associate Professor, Department of Pharmacology and Pharmaceutical Sciences
University of Southern California
gukasyan@usc.edu; (323) 442-1362
HSC Office: PSC 716
UPC Office: Stonier Hall 312
Office Hours by appointment

Course Weight: 4 Units (two 1.5-hour sessions; plus 1 hour outside activities)

Day/Time/Location: TTH 9:30-10:50 am, Leavey Library (LVL) 13

Introduction

This course introduces the student to the biomedical community as it relates to current strategies undertaken to move research discoveries from the laboratory (bench) into clinical practice (bedside) to diagnose and treat patients. This concept is commonly referred to as Translational Science or Translational Medicine. The tenets of this course will be defined and explained in terms of promoting focused multidisciplinary interactions between science and medicine to enhance disease research and drug development. In addition, the wider inter-relationships with regulatory, ethical and societal sectors will be presented.

Objectives

This course is designed for undergraduates of both scientific and non-scientific majors with an interest in learning about principles and concepts underlying drug discovery and development of medicines. Chapters from the required textbook will be supplemented with a variety of source
materials including articles from scientific journals and public websites. Selected cases studies will be critically reviewed and emerging “hot” topics discussed.

**Upon successful completion of this course, the student should be able to:**

- Describe the importance of a team effort in the drug discovery/drug development process as seen through the eyes of the pharmaceutical industry.
- Describe the many challenges faced by a start-up pharmaceutical company.
- Explain the importance of intellectual property (IP); critical IP issues and timing.
- Summarize the preclinical drug development process from therapeutic target to marketable drug.
- Become fluent with the basic terminology used in characterizing a new drug (e.g. potency, EC\textsubscript{50}, IC\textsubscript{50}, MTD, efficacy, selectivity, ADME, etc…).)
- Explain the importance of a properly designing a scientific experiment (Scientific Method).
- Describe critical components of drug discovery as it relates to genotoxicity, carcinogenicity and reproductive/developmental toxicology issues during the course of a drug discovery campaign and how to test for them.
- Summarize the difference between a small molecule drug and a biopharmaceutical and describe the advantages and disadvantages of each therapy.
- Explain the importance of good laboratory practices (GLP), good manufacturing practices (GMP) and good clinical practices (GCP).
- Discuss the various facets and the role of clinical trials in drug development.
- Deduce why so many experimental compounds fail to ever reach the market.

**Assignments and Grading:**

<table>
<thead>
<tr>
<th>Assignment</th>
<th>Due Date</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 quizzes @ 10 pts each</td>
<td>40 pts</td>
<td>(20%)</td>
</tr>
<tr>
<td>Blackboard Assignment:</td>
<td>30 pts</td>
<td>(15%)</td>
</tr>
<tr>
<td>1 midterm exam</td>
<td>50 pts</td>
<td>(25%)</td>
</tr>
<tr>
<td>1 final exam:</td>
<td>80 pts</td>
<td>(40%)</td>
</tr>
<tr>
<td>Total:</td>
<td></td>
<td>200 pts</td>
</tr>
</tbody>
</table>

**Short Reflections and Attendance:** On a scale of 10, 0-indicating no participation, 10-indicating best participation. You can therefore increase the probability of getting a higher mark by being proactive in terms of asking (relevant) questions in class and/or contributing to discussions. Attendance at all classes is expected as your participation will increase the value of all students participating in the class.

There will be 4 quizzes over the course of the semester that will primarily be based on questions pulled from the textbook and lectures.

Each student will also participate in Discussion Board posts during the semester or other deliverable assignments on Blackboard. Further information regarding the Discussion Board assignments will be provided during the first week of class.
The midterm (50 points) will include multiple choice questions T/F questions fill-in the blank questions, and short answers.
Final Exam (70 points): The final exam will include multiple choice and T/F questions as well as a series of questions involving short answers. The final exam will be cumulative but will emphasize material covered after the midterm.

Additional details will be presented during week one of the class and included in the Week 1 PPT slides.

Notes, books, calculators, electronic dictionaries, regular dictionaries, cell phones or any other aids are not allowed during exams.

Students will be asked to complete an anonymous critical evaluation of the course at its completion.

Course Readings

Required Readings

Drug Discovery and Development: Technology in Transition, 2nd Edition

Although not mandatory, it is strongly suggested that the students purchase the textbook for this course as it will greatly improve the students grasp on the Drug Discovery/Development process. The students will be able to use identified chapters in the text to support their learning process throughout the semester.

Other course materials including but not limited to the syllabus, supplemental reading assignments and additional handouts will be posted on http://blackboard.usc.edu/. The students will also be encouraged to use the online discussions among students via Blackboard.

Recommended


- Christine M. Clovis, PhD and Christopher P. Austin, MD. The NIH-Industry New Therapeutic Uses Pilot Program: Demonstrating the Power of Crowdsourcing. Drug Repurposing, Rescue and Repositioning. VOL. 1 NO. 1 (March, 2015)
• Cynthia Fox, Reading Leaves a Dramatic Imprint on the Brain:  
  http://www.biosciencetechnology.com/articles/2014/12/reading-leaves-dramatic-imprint-brain?location=top

• Hepatitis C cure eludes patients as states struggle with costs  

• Dr. Timothy Scott discusses some of the history of the FDA and how it shaped the industry today.  
  https://youtu.be/TXAVCaOSi-s

• Free magazine “Translational Science”  
  https://www.youtube.com/watch?v=9Cw9v-LnrRU&feature=youtu.be
  - Newsletters such as: Drug Discovery Online Newsletter <info@DrugDiscoveryOnline.com>
  - Pharmaceutical Processing: https://www.rdmag.com/topics/pharmaceutical-processing

Online learning Etiquette

  o If it is not possible to have you webcam on during the entire class, do you best to have it on when speaking
  o Turn off your microphone when not speaking
  o If you need to step away from your computer during class (e.g. get a drink of water, use the bathroom, attend to a family member/pet) please do so quietly and without disturbing your classmates. Return to the class when you can.
  o Be aware the contents of conversations typed into the chat box, even private conversations, are visible by the instructors

Course Content Distribution and Synchronous Session Recordings Policies

USC has policies that prohibit recording and distribution of any synchronous and asynchronous course content outside of the learning environment. Recording a university class without the express permission of the instructor and announcement to the class, or unless conducted pursuant to an Office of Student Accessibility Services (OSAS) accommodation. Recording can inhibit free discussion in the future, and thus infringe on the academic freedom of other students as well as the instructor. (Living our Unifying Values: The USC Student Handbook, page 13).

Distribution or use of notes, recordings, exams, or other intellectual property, based on university classes or lectures without the express permission of the instructor for purposes other than individual or group study. This includes but is not limited to providing materials for distribution by services publishing course materials. This restriction on unauthorized use also applies to all information, which had been distributed to students or in any way had been displayed for use in
relationship to the class, whether obtained in class, via email, on the internet, or via any other media. (Living our Unifying Values: The USC Student Handbook, page 13).

Course Outline

This course will be in the format of a directed seminar/lecture under the guidance of the instructor for the specific session. During each weekly session the instructor will engage the students with questions and draw comments or interpretations primarily based on the assigned reading. Students are expected to ask questions and participate in an interactive fashion.
<table>
<thead>
<tr>
<th>Week &amp; Date</th>
<th>Topic</th>
<th>Subtopics to be Included</th>
<th>Assigned and Supplemental Reading</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Introduction and Background</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Week 1</strong></td>
<td>Tues. Jan 10</td>
<td>Introduction: expectations and goals of this class. General overview of drug development process from therapeutic target to marketable drug.</td>
<td>Dr. Daryl Davies</td>
</tr>
<tr>
<td>Thur. Jan 12</td>
<td></td>
<td>Pharmacological principles and definitions: Efficacy (EC\text{50}), potency, MTD, ADME, etc. Drug discovery and development: facts and figures</td>
<td>Additional readings to enrich subject matter will be posted on Blackboard. Hill/Rang, Chapter 22.</td>
</tr>
<tr>
<td><strong>Week 2</strong></td>
<td>Tues. Jan 17</td>
<td>Development of Pharmaceutical Industry- History of the Discovery and Development of Modern Medicines</td>
<td>Quiz 1 Jan 19 DD</td>
</tr>
<tr>
<td>Thur. Jan 19</td>
<td></td>
<td>History of drug development (where and how it all got started). Case studies illustrating why we have the FDA. What is Translational Science? <a href="https://www.youtube.com/watch?v=rAblbUmyQgk">https://www.youtube.com/watch?v=rAblbUmyQgk</a></td>
<td>Hill/Rang, Chapter 2; Hill/Rang, Chapter 3</td>
</tr>
<tr>
<td><strong>Week 3</strong></td>
<td>Tues. Jan 24</td>
<td>Nature of Disease</td>
<td>Dr. Hovik Gukasyan</td>
</tr>
<tr>
<td><strong>Week 4</strong></td>
<td>Tues. Jan 31</td>
<td>The Components of Drug Discovery</td>
<td>Dr. Mary Ellen Cosenza</td>
</tr>
<tr>
<td>Thur. Feb 2</td>
<td></td>
<td>Biopharmaceuticals; Assessing Drug Safety;</td>
<td>Hill/Rang, Chapters 10-12; 13-14</td>
</tr>
<tr>
<td><strong>Week 5</strong></td>
<td>Tues. Feb 7</td>
<td>An Overview of Modern-Day Drug Discovery</td>
<td>Dr. Hovik Gukasyan Quiz 2 Feb 9th</td>
</tr>
<tr>
<td>Thur. Feb 9</td>
<td></td>
<td>General Principles; Case Histories,</td>
<td>Hill/Rang, Chapter 4</td>
</tr>
<tr>
<td><strong>Week 6</strong></td>
<td>Tues. Feb 14</td>
<td>Dr. Ashutosh Kulkarni</td>
<td></td>
</tr>
<tr>
<td>Thur. Feb 16</td>
<td></td>
<td>Understand the role of drug metabolism and pharmacokinetics (DMPK) and early stage toxicology studies as major hurdles in the drug discovery process; Role of pharmacology (specifically confirmation in vitro assays, target selectivity testing and in vivo pharmacological profiling) in the drug discovery process;</td>
<td>Hill/Rang, Chapters 10-11; 13-14</td>
</tr>
<tr>
<td><strong>Week 7</strong></td>
<td>Tues. Feb 21</td>
<td>Dr. Robert Pacifici, CHDI</td>
<td></td>
</tr>
<tr>
<td>Thur. Feb 23</td>
<td></td>
<td>Drug Discovery, where does it all start? Identifying the Project; Identifying the Target Role of CROs in new drug development</td>
<td>Hill/Rang, Chapter 12</td>
</tr>
<tr>
<td>Week 8</td>
<td>Tues. Feb 28</td>
<td>Dr. Hovik Gukasyan</td>
<td>Confidence In Chemical Matter: Drug Discovery Implications</td>
</tr>
<tr>
<td>--------</td>
<td>--------------</td>
<td>-------------------</td>
<td>----------------------------------------------------------</td>
</tr>
<tr>
<td></td>
<td>Thursday Mar 2</td>
<td><strong>Midterm March 2</strong></td>
<td></td>
</tr>
<tr>
<td>Week 9</td>
<td>Tues. Mar 7</td>
<td>Defining a Market Project Management of Drug Dr. Daryl Davies</td>
<td>Defining the Market. Where and how does it start. The role of Project Management in Drug Discovery</td>
</tr>
<tr>
<td>Thurs. Mar 9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Spring Recess: No Class on Tuesday, March 14 or Thursday, March 16</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drug Development</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Week 10</td>
<td>Tues. Mar 21</td>
<td>Dr. Larisa Yedigarova</td>
<td>&quot;Clinical development of novel therapeutics&quot; as described through Clinical Trials <a href="https://www.youtube.com/watch?v=RuzoAjNyJr0">https://www.youtube.com/watch?v=RuzoAjNyJr0</a></td>
</tr>
<tr>
<td>Thurs. Mar 23</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Week 11</td>
<td>Tues. Mar 28</td>
<td>Pharmaceutical Development Dr. Hovik Gukasyan Quiz 3 March 30th</td>
<td>&quot;Drugable&quot; Property Space: Desired properties and qualities of an ideal candidate? Safety, Efficacy, Delivery Development products for clinical testing and comparability</td>
</tr>
<tr>
<td>Thurs. Mar 30</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thurs. Apr 6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Week 13</td>
<td>Tues. Apr 11</td>
<td>Repurposing Patents: Importance of IP in Academia Dr. Daryl Davies</td>
<td>The use of a drug repurposing strategy to accelerate new opportunities for currently approved drugs in the pharmaceutical industry</td>
</tr>
<tr>
<td>Thurs. Apr 13</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Week 14</td>
<td>Tues. Apr 18</td>
<td>Dr. Michael R. Hamrell Quiz 4 April 20th</td>
<td>Regulation of Advertising and Promotion for Prescription Drugs</td>
</tr>
<tr>
<td>Thurs. Apr 20</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Week 15</td>
<td>Apr 25 &amp; 27</td>
<td>Dr. Hovik Gukasyan</td>
<td>Comprehend different drug delivery systems Scale-up /formulation challenges</td>
</tr>
</tbody>
</table>
Academic Integrity:

The University of Southern California is foremost a learning community committed to fostering successful scholars and researchers dedicated to the pursuit of knowledge and the transmission of ideas. Academic misconduct is in contrast to the university’s mission to educate students through a broad array of first-rank academic, professional, and extracurricular programs and includes any act of dishonesty in the submission of academic work (either in draft or final form).

This course will follow the expectations for academic integrity as stated in the USC Student Handbook. All students are expected to submit assignments that are original work and prepared specifically for the course/section in this academic term. You may not submit work written by others or “recycle” work prepared for other courses without obtaining written permission from the instructor(s). Students suspected of engaging in academic misconduct will be reported to the Office of Academic Integrity.

Other violations of academic misconduct include, but are not limited to, cheating, plagiarism, fabrication (e.g., falsifying data), knowingly assisting others in acts of academic dishonesty, and any act that gains or is intended to gain an unfair academic advantage.

The impact of academic dishonesty is far-reaching and is considered a serious offense against the university and could result in outcomes such as failure on the assignment, failure in the course, suspension, or even expulsion from the university.

For more information about academic integrity see the student handbook or the Office of Academic Integrity’s website, and university policies on Research and Scholarship Misconduct.

Statement on Academic Conduct and Support Systems

Academic Integrity:

The University of Southern California is a learning community committed to developing successful scholars and researchers dedicated to the pursuit of knowledge and the dissemination of ideas. Academic misconduct, which includes any act of dishonesty in the production or submission of academic work, comprises the integrity of the person who commits the act and can impugn the perceived integrity of the entire university community. It stands in opposition to the university’s mission to research, educate, and contribute productively to our community and the world.

All students are expected to submit assignments that represent their own original work, and that have been prepared specifically for the course or section for which they have been submitted. You may not submit work written by others or “recycle” work prepared for other courses without obtaining written permission from the instructor(s).

Other violations of academic integrity include, but are not limited to, cheating, plagiarism, fabrication (e.g., falsifying data), collusion, knowingly assisting others in acts of academic
dishonesty, and any act that gains or is intended to gain an unfair academic advantage.

The impact of academic dishonesty is far-reaching and is considered a serious offense against the university. All incidences of academic misconduct will be reported to the Office of Academic Integrity and could result in outcomes such as failure on the assignment, failure in the course, suspension, or even expulsion from the university.

For more information about academic integrity see the student handbook or the Office of Academic Integrity’s website, and university policies on Research and Scholarship Misconduct.

Please ask your instructor if you are unsure what constitutes unauthorized assistance on an exam or assignment, or what information requires citation and/or attribution.

Students and Disability Accommodations:

USC welcomes students with disabilities into all of the University’s educational programs. The Office of Student Accessibility Services (OSAS) is responsible for the determination of appropriate accommodations for students who encounter disability-related barriers. Once a student has completed the OSAS process (registration, initial appointment, and submitted documentation) and accommodations are determined to be reasonable and appropriate, a Letter of Accommodation (LOA) will be available to generate for each course. The LOA must be given to each course instructor by the student and followed up with a discussion. This should be done as early in the semester as possible as accommodations are not retroactive. More information can be found at osas.usc.edu. You may contact OSAS at (213) 740-0776 or via email at osasfrontdesk@usc.edu.

Support Systems:

Counseling and Mental Health - (213) 740-9355 – 24/7 on call
Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention.

988 Suicide and Crisis Lifeline - 988 for both calls and text messages – 24/7 on call
The 988 Suicide and Crisis Lifeline (formerly known as the National Suicide Prevention Lifeline) provides free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week, across the United States. The Lifeline is comprised of a national network of over 200 local crisis centers, combining custom local care and resources with national standards and best practices. The new, shorter phone number makes it easier for people to remember and access mental health crisis services (though the previous 1 (800) 273-8255 number will continue to function indefinitely) and represents a continued commitment to those in crisis.

Relationship and Sexual Violence Prevention Services (RSVP) - (213) 740-9355(WELL) – 24/7 on call
Free and confidential therapy services, workshops, and training for situations related to gender-and power-based harm (including sexual assault, intimate partner violence, and stalking).
Office for Equity, Equal Opportunity, and Title IX (EEO-TIX) - (213) 740-5086
Information about how to get help or help someone affected by harassment or discrimination, rights of protected classes, reporting options, and additional resources for students, faculty, staff, visitors, and applicants.

Reporting Incidents of Bias or Harassment - (213) 740-5086 or (213) 821-8298
Avenue to report incidents of bias, hate crimes, and microaggressions to the Office for Equity, Equal Opportunity, and Title for appropriate investigation, supportive measures, and response.

The Office of Student Accessibility Services (OSAS) - (213) 740-0776
OSAS ensures equal access for students with disabilities through providing academic accommodations and auxiliary aids in accordance with federal laws and university policy.

USC Campus Support and Intervention - (213) 740-0411
Assists students and families in resolving complex personal, financial, and academic issues adversely affecting their success as a student.

Diversity, Equity and Inclusion - (213) 740-2101
Information on events, programs and training, the Provost’s Diversity and Inclusion Council, Diversity Liaisons for each academic school, chronology, participation, and various resources for students.

USC Emergency - UPC: (213) 740-4321, HSC: (323) 442-1000 – 24/7 on call
Emergency assistance and avenue to report a crime. Latest updates regarding safety, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible.

USC Department of Public Safety - UPC: (213) 740-6000, HSC: (323) 442-1200 – 24/7 on call
Non-emergency assistance or information.

Office of the Ombuds - (213) 821-9556 (UPC) / (323-442-0382 (HSC)
A safe and confidential place to share your USC-related issues with a University Ombuds who will work with you to explore options or paths to manage your concern.

Occupational Therapy Faculty Practice - (323) 442-2850 or otpf@med.usc.edu
Confidential Lifestyle Redesign services for USC students to support health promoting habits and routines that enhance quality of life and academic performance.