RUTGERS HEALTH
Ernest Mario School of Pharmacy

Pharmaceutical Chemistry
30:715:307
2 credits
Fall – 2025

Course Coordinator(s):

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Course Faculty:

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Course Description: The mission of the Pharmaceutical Chemistry course is to introduce students to the structure, properties, and analysis of pharmaceutical agents and metabolites as well as the fundamental techniques used for near patient testing and pharmacokinetic analysis. Topics include some of the basic concepts in medicinal chemistry as well as methods of pharmaceutical and biomedical analysis such as 1) the drug discovery and development process, 2) drug-target interactions, 3) review of organic functional groups found in drug molecules, 4) physicochemical properties related to drug action such as acid-base properties, equilibrium, and stereochemistry, 5) Chemistry of OTC inorganic drugs, 6) Effect of chemical structure on the metabolism of drug molecules, 7) Fundamentals of neurochemistry, and 8) Chromatographic (especially HPLC and LC-MS) analysis and spectroscopic identification of pharmaceutical agents, metabolites, and clinical samples.

Course Meeting Time(s) and Location(s): Tuesday, Thursday 3:40 pm to 4:35 pm, PH-131

Recitations: TBD

Program-Level Educational Outcomes and Course Learning Objectives:

Program Level Educational Outcomes

2025 ACPE Standard 2 : Curricular Outcomes (CO)

Domain	Sub-Domain # Name	One Word Descriptor	Outcome Description	*Bloom's Taxonomy Level
Knowledge	2.1.a Scientific thinking	Learner	The graduate is able to seek, analyze, integrate, and apply foundational knowledge of medications and pharmacy practice (biomedical; pharmaceutical; social, behavioral, and administrative; and clinical sciences; drug classes; and digital health).	Level 1 Level 2
Skills	2.1.b Problem solving process	Problem-Solver	The graduate is able to use problem solving and critical thinking skills, along with an innovative mindset, to address challenges and to promote positive change.	**Level 1** **Level 2**

2025 ACPE Appendix I Categories:

ACPE Appendix 1 Categories	*Bloom's Taxonomy Levels
Medicinal Chemistry	Level 1, Level 2
Clinical Pharmacokinetics	Level 1, Level 2

Course Learning Objectives

At the conclusion of this course learners will be able to:

1. *Develop an appreciation of the drug discovery and development process*
2. *Understand the basis of drug-target interactions*
3. *Understand how OTC inorganic drugs (antacids, oxidizing germicides, etc.) work in the treatment and/or prevention of diseases and conditions*

4. *Identify important organic functional groups found in drug molecules*
5. *Understand the physicochemical properties related to drug action such as acid-base properties, equilibrium, and stereochemistry*
6. *Demonstrate a working knowledge of the chemical structures and functions of several important neurotransmitters*
7. *Identify important metabolic reactions that drug molecules might undergo*
8. *Develop an appreciation of basic analytical separation techniques used in chemistry laboratories and in clinical drug monitoring*
9. *Demonstrate a working knowledge of the various chromatographic techniques (especially HPLC and LC-MS) in analysis and spectroscopic identification of pharmaceutical agents, metabolites, and clinical samples.*

Required and Recommended Texts:

Organic Chemistry Concepts and Applications for Medicinal Chemistry, Joseph E. Rice, Academic Press, 2014, Softcover; ISBN 9780128007396 or eBook; ISBN 9780128008324.

David G. Watson. ***Pharmaceutical Analysis***, *A Textbook for Pharmacy Students and Pharmaceutical Chemists*, 5th Edition, 2020, Elsevier.

Method of Instruction:

- *Lectures will be given in person only.*
- *All lecture material including notes, powerpoint slides, extra problems, etc. will be posted on Canvas.*
- *In-Person Recitation Sessions will be scheduled, and invitations may be extended. Recitations will contain discussions, problem-based learning and further explanations of topics covered in lecture. Attendance at weekly recitation sessions is recommended but are not required. Students may attend any recitation session. Recitation materials will be available to all students to download via the Canvas module.*

Class Schedule:

Date	*Lecture Number*	Topic	Course faculty
9/2	*L1*	**Course Introduction and Importance of Pharmaceutical Chemistry in Understanding Drug Action and Clinical Test Results:** Drug discovery and development process, Sequence of events after drug administration, List of Physico-chemical properties related to drug action, Clinical Chemistry and the importance of fundamental chemistry concepts and analytical techniques	Moschitto

9/4	*L2*	**Review of Organic Functional Groups and Acid-Base Concepts**: Chemical bonding, Functional groups, Electron donating and withdrawing groups; Acids and bases, Henderson-Hasselbach equation; Estimating pKa and pKb; Heterocycles	Totleben
9/9	*L3*		
9/11	*L4*		
9/16	*L5*		
9/18	*L6*		
9/23	*L7*		
9/25	*L8*	**Review of Stereochemistry and Physico-Chemical Properties Related to Drug Action:** Stereoisomers, Stereochemistry of unsaturated compounds, Enantiomers, Diastereomers, Partition coefficients	Totleben
9/30	*L9*		
10/2	*L10*	**Drug-Target Interactions:** Structural Effects on Biological Action, Role and types of chemical bonding interactions between drug and target, Binding of neurotransmitters to their receptors, Thalidomide: Lessons as related to chirality of drugs	Hu
10/7	*E1*	**Exam #1 (covers lectures 1 - 9)**	
10/9	*L11*	**Chemistry of Over-the-Counter (OTC) Inorganic Drugs:** Structures, chemical properties and mechanisms of action of antacids (Tums®, Pepto-Bismol, Milk of Magnesia), inorganic germicides, imaging agents, and platinum anticancer agents	Hu
10/14	*L12*	**Chemical Aspects of Drug Metabolism:** Introduction, Effects of chemical structure on Phase I oxidative, reductive, and hydrolytic reactions,	Nargund
10/16	*L13*	**Chemical Aspects of Drug Metabolism:** effects of chemical structure on Phase II conjugative reactions (COMT and PNMT-catalyzed methylation, acetylation, sulfation, glucuronidation, amino acid conjugation, mercapturic acid formation), Sites of metabolism; Metabolic pathways of selected common drugs, Metabolites identified for a new anticancer drug, Imatinib	Nargund
10/21	*L14*		
10/23	*L15*	**Fundamentals of Neurochemistry:** Structures, chemical properties, metabolism,	Hu

10/28	*L16*	and actions of select neurochemicals including acetylcholine, epinephrine, norepinephrine, dopamine, serotonin, glutamate, GABA, nitric oxide and nicotine	
10/30	*L17*		
11/4	*L17a*	Open/review	
11/6	*E2*	**Exam #2 (covers lectures 10 – 17)**	
11/11	*L18*	**Introduction to Analytical Separations:** Basic separation techniques in chemistry laboratories and in clinical drug monitoring, Extraction, Effect of pH.	Moschitto
11/13	*L19*	**Chromatographic Theory:** Available formats and types of chromatographic techniques, Classification based on retention mechanisms, Efficiency of separation, particle size, theoretical plates.	Moschitto
11/18	*L20*	**Chromatographic Analysis of Pharmaceutical Agents, Metabolites, and Clinical Samples with HPLC**: HPLC components, Normal vs reversed phases, Isocratic vs gradient elution, Criteria of good separation, Applications of HPLC in quantitative analysis of pharmaceutical agents and metabolites	Moschitto
11/20	*L21*	**Chromatographic Analysis of Pharmaceutical Agents, Metabolites, and Clinical Samples with HPLC:** HPLC components, Normal vs reversed phases, Isocratic vs gradient elution, Criteria of good separation, Applications of HPLC in quantitative analysis of pharmaceutical agents and metabolites Spectroscopic Analysis: GC and MS: Types of GC, GC interpretation, types of masspectrometry, interpreting mass spectrometry patterns.	Moschitto
11/25	*L22*		
12/2	*L23*	**Spectroscopic Analysis:** UV, IR, fluorescence	Moschitto
12/4	*L24*	**Spectroscopic Analysis:** NMR	Moschitto
12/9	*L25*	**PK studies and Applications of Pharmaceutical Analysis/Review**	Moschitto
TBD	*E3*	**Exam #3 (covers lectures 18 – 26)**	
TBD	*Final*	**Comprehensive Final Exam (optional for students w/≥70%)**	

Changes in lecture scheduling may need to be made at the discretion of the course coordinator. Please see canvas for updated course schedule

Attendance and Participation Policy
Students are expected to attend all lectures; if you expect to miss one or more lectures, please use the University absence reporting website ***https://sims.rutgers.edu/ssra/*** *to indicate the date and reason for your absence. An email is automatically sent to the faculty coordinator. If you will need to miss a quiz, please contact Dr. Moschitto (m.moschitto@rutgers.edu) or Dr. Hu (longhu@rutgers.edu).*

Details of special Educational Technology use:

- *A reliable laptop with keyboard, mouse*
- *High speed internet connection*
- *Canvas with Lockdown Browser installed*
- *Access to Poll Everywhere via phone or computer*

Assessment and Grading:

- *There will be approximately ten quizzes, three "hourly" exams and one cumulative final examination. Quizzes are worth 10% combined, each hourly exam is worth 20%, and the final exam is worth 30% of total course score.*
- ***The cumulative final exam is optional for students with ≥70% average after the third "hourly" exam.***
- *There will be no lecture on the three scheduled hourly exam days.*
- Each lecture will have poll everywhere questions which take into account participation and correctness. To participate in these activities, students are expected to have electronic access during class (via laptop, tablet, or phone). Make sure you use your official name, as it appears in the Rutgers registrar's system, and your Rutgers email address for registration; otherwise, you will not get credit for your participation. If your Canvas and Poll Everywhere accounts are not communicating with each other, reach out to https://support.polleverywhere.com/hc/en-us for support.
- **Bonus Poll Everywhere Points:** Each student will receive automatic bonus points towards their Poll Everywhere grade. These bonus points are intended to accommodate occasional poor performance or missed classes due to emergencies, illness, traffic, conference presentations, interviews, or similar conflicts. Typically, these bonus points will be equivalent to approximately three days' worth of Poll Everywhere points. You may utilize these bonus points as needed.

Missed exam and quiz policy:

- *No makeup quizzes are offered. Students must have contacted Drs. Moschitto or Hu PRIOR (unless it is an emergency) to the quiz or exam to request to be excused. To be excused from a quiz, an hourly exam, or the final exam you must produce a legal or medical excuse that has been approved by the course coordinator.*

- *Additionally, please log any absence in the University reporting website: https://sims.rutgers.edu/ssra/.*
- *In the event of a missed exam, students will be required to take the final, and all exams will be weighted higher. No makeup exams will be offered. You cannot be excused from two exams.*
- *If you are excused from a quiz, your quiz score will be calculated based on the remaining quizzes.*
- *If you are excused from the final exam, your course grade will be an "incomplete" grade. You will have until the end of the following semester to complete a make-up for the final exam. Due to the extended period of time that the student has available to study for the make-up final, the make-up final exam is more rigorous.*

Examination policies:

- *Students must complete all quizzes and exams during the specified times using Lockdown Browser on Canvas to ensure the integrity of the course and the success of the students. Students must take the quiz in their assigned classroom with proctors. Accessing an active quiz or exam at any time outside of their assigned classroom is considered academic misconduct.*
- *There are NO makeup quizzes!*
- *Weekly timed quizzes (10 questions, 10 points total, 15 minutes) will be given in-person **between 3:10 pm and 3:40 pm on Tuesdays** per the course schedule posted on Canvas. Students must be in the room and logged into the quiz and have started by 3:15 pm.*
- *Students must have their student ID or photo driver's license with them for verification at each quiz or exam. Textbooks, notes, handouts, multiple monitors, PDAs, cell phones, pagers, portable radios, etc. may NOT be used during exams!*
- *Once you have clicked on the quiz through Quizzes in Canvas, you will be prompted that Lockdown Browser will begin and you will be asked for an access code which the instructor will provide to you. After entering the access code, you will be taken to the quiz/exam to begin and your time will start at question #1.*
- *Once in the quiz or exam, after you hit the "next" button on each question, you may **not** go back to a previous question so please be sure to carefully consider the question and your answer before moving forward. The time remaining will be displayed on the screen and once the allotted time has expired or the portal closes, your quiz or exam will be submitted as complete.*
- *You must checkout with a proctor after submission of an exam. Failure to checkout is considered academic misconduct and may result in a zero for the exam.*
- *When it is announced in Canvas that your quizzes/exams may be viewed, you will have 5 calendar days from the date of posting to submit any issues. You must send a detailed email to the lecture instructor specifying which questions need to be reviewed and why. The instructor reserves the right to regrade the entire exam/quiz.* ***No regrading of any exam for any reason will be done after 5 days.***

Poll Everywhere: Each class will have anywhere between 2-4 poll everywhere questions during class. Students will receive 1 point for attendance and 1 point for each correct answer. Students must be present in the lecture hall to answer questions. Answering questions outside of the lecture hall will be considered for academic integrity violations.
Bonus Poll Everywhere Points: Each student will receive automatic bonus points towards their Poll Everywhere grade. These bonus points are intended to accommodate occasional poor performance or missed classes due to emergencies, illness, traffic, conference presentations, interviews, or similar conflicts. Typically, these bonus points will be equivalent to approximately three days' worth of Poll Everywhere points. You may utilize these bonus points as needed.

	Grade % Taking the final exam	*Grade %, Not taking the final exam*
Quizzes	*10*	*13.3*
Poll Everywhere	*5*	*6.6*
Exam 1	*20*	*26.6*
Exam 2	*20*	*26.6*
Exam 3	*20*	*26.6*
Final Exam	*25*	*--*

Assessment Mapping Table

Assessment	Mapping COs	ACPE Appendix 1	*Bloom's Levels
Exam 1	*2.1a, 2.1b*	*Medicinal Chemistry*	*1,2*
Exam 2	*2.1a, 2.1b*	*Medicinal Chemistry* *Clinical Pharmacokinetics*	*1,2*
Exam 3	*2.1a, 2.1b*	*Medicinal Chemistry* *Clinical Pharmacokinetics*	*1,2*
Final Exam	*2.1a, 2.1b*	*Medicinal Chemistry* *Pharmacokinetics*	*1,2*

Grading Policy:

Students will be informed of their current grade prior to the final exam in canvas. Course scores will not be curved, and scores cannot be rounded beyond the grading scheme posted below. Please DO NOT email your instructor about final grade changes.

Grading Scale:

A = 89.45-100 (4.0)
B+ = 84.45-89.44 (3.5)
B = 79.45-84.44 (3.0)
C+ = 74.45-79.44 (2.5)
C = 69.45-74.44 (2.0)
D = 59.45-69.44 (1.0)
F = 0-59.44 (0.0)

In the event of course failure: *After a student receives an F as the final grade for this course, the sole remediation option is to repeat the course when next offered, subject to approval of the School's Scholastic Standing Committee.*

Remediation Policy: *Course faculty is committed to academic success for all students and use a system to identify students with academic deficiency early in the semester and encourage them to attend weekly recitation sessions and utilize Students-Assisting-Students (SAS) program throughout the semester.*

Accessibility:

Rutgers University is committed to the creation of an inclusive and safe learning environment for all students and welcomes students with disabilities into all the University's educational programs. The Office of Disability Services (ODS) is responsible for the determination of appropriate accommodations for students.

Once a student has completed the ODS process (registration, initial appointment, and submitted documentation) and reasonable accommodations are determined a Letter of Accommodation (LOA) can be requested and will be sent to the student and instructor. This should be done as early in the semester as possible as accommodations are not retroactive, and a discussion should occur about how the accommodations will be implemented.

More information can be found at https://ods.rutgers.edu/.
To begin this process, please complete the registration form (https://webapps.rutgers.edu/student-ods/forms/registration).
You can contact ODS at 848-202-3111 or via email at dsoffice@echo.rutgers.edu for any questions.

Academic Integrity Policy:

Pharmacy students are subject to the University academic integrity policy, which is provided to new students at orientation and is also available online from https://academicintegrity.rutgers.edu at:
https://academicintegrity.rutgers.edu/sites/default/files/pdfs/current.pdf

This policy was updated in the summer of 2020.

The School of Pharmacy has also established an ad hoc committee on academic integrity. The committee has membership from both the faculty and student body. Given the serious nature of the work health care workers provide, academic integrity and honesty are of the utmost importance in pharmacy school. The faculty of the Ernest Mario School of Pharmacy approved the following statements for both students and faculty which were developed by the committee in conjunction with student leadership.

In the new policy, violations of academic integrity are generally divided into three categories: Level 1, Level 2, and Level 3.

- Level 1 violations may occur as a result of inexperience or lack of malicious intent by the person committing the violation.
- Level 2 violations include misconduct of a more serious character or misconduct that affects a major, significant, or essential portion of work done to meet course requirements. These violations demonstrate premeditation or may have posed harm to others. The student alleged to have committed the violation may have one or more previous violations.
- Level 3 violations represent the most serious breaches of conduct. They may involve a serious violation of a professional code of conduct; may include extreme cases of dishonesty and maliciousness or violations of law; and/or are likely to cause direct harm to others.

The procedures for adjudicating alleged violations of academic integrity are different for Level 1, Level 2, and Level 3 violations. Students are referred to the full policy at the link above for examples of violations and potential sanctions. When a student is accused of one or more Level 3 violations that include alleged violations of law or a professional code of conduct, or when it is reasonable to believe that the student is likely to cause direct harm to others, they may be removed from a course, clinical, or internship setting on an interim basis, with the approval of the dean of the school.

The profession of pharmacy is one that demands adherence to a set of ethical principles. These high ideals are necessary to ensure the quality of care extended to patients. Students at Ernest Mario School of Pharmacy are responsible for upholding the principles of the Policy on Academic Integrity for Undergraduate and Graduate Students. At Ernest Mario School of Pharmacy all students are held accountable for their actions. Each student should review the entire Academic Integrity Policy as well as the Student Code of Conduct.

The following are some general examples of the responsibilities of students:

- To understand the definition of scholastic dishonesty.
- To understand the instructions for each assignment, quiz, or examination.
- To refrain from committing any acts of scholastic dishonesty.
- To take appropriate action when acts of scholastic dishonesty are observed.

- To understand the importance of confidentiality in pharmacy practice and the ramifications of breaching patient trust.
- To engage in appropriate classroom and laboratory conduct.

As noted, this list serves only as an example. The entire Academic Integrity Policy should be reviewed, downloaded and printed from the link above. It is the student's responsibility to review the entire policy for more specific information regarding specific infractions and penalties. Violations of any of these principles will result in prosecution by Ernest Mario School of Pharmacy and the Student Judicial Affairs department. Being students enrolled in a school of health professions, severe penalties may be levied which may include expulsion from Ernest Mario School of Pharmacy as well as from the entire Rutgers University

Class recordings:

*Audio and video recordings may only be made with **consent of the instructor**; each instructor has different approaches. In the case that audio and video recordings are approved, they may not be shared or posted in any online forum or site.*