

Principles of Drug Action-1
PHRD 4002
CRN# 41556

I. Contact Information

Course Coordinators:

Dr. Seetharama D. Jois (**Course Coordinator, Instructor of record**)
Professor of Medicinal Chemistry
Office: Bienville 316
Office hours: M-Th 10 am to 1 pm, Friday by appointment only
Phone: (318) 342-1993
Email: jois@ulm.edu
Preferred method of Communication: e-mail

Dr. Khalid El Sayed (**Co-coordinator**)
Professor of Medicinal Chemistry
Office: Bienville 324
Office hours: M-Th 10 am to 1 pm, Friday by appointment only
Phone: (318)-342-1725
Email: elsayed@ulm.edu
Preferred method of Communication: e-mail

Course Instructors:

Dr. Ronald A. Hill, Ph.D.
Associate Professor of Medicinal Chemistry
Office: Bienville 310
Hours: M: 3:30-5:30p
 Tu - Th: 11:00-12:00, 4:00-5:30p
 W: 3:30-5:30p
 F: 12:30-1:30p
Phone: 318-342-1706
Email: rhill@ulm.edu
Preferred method of Communication: in-person/E-mail/office phone

II. Course Pre-requisites/Co-requisites

Pre-requisites - Credit or registration in PHRD 4020

III. Course Description

PRINCIPLES OF DRUG ACTION I. 4 cr. This course focuses on molecular-level function and processes as relates to rational and successful therapeutic intervention with medicinal substances.

IV. Curricular Objectives and Outcomes

CAPE

Domain 1 – Foundational Knowledge

1.1. Learner (Learner) - Develop, integrate, and apply knowledge from the foundational sciences (i.e., *pharmaceutical, social/behavioral/administrative*, and *clinical sciences*) to evaluate the scientific literature, explain drug action, solve therapeutic problems, and advance population health and *patient-centered care*.

3.2. Educator (Educator) – Educate all audiences by determining the most effective and enduring ways to impart information and assess understanding.

ACPE APPENDIX 1 (Refer to Appendix at www.examssoft.com/ulmcp)

V. Course Specific Objectives and Outcomes

ACPE Appendix 1 required element

Biochemistry

Structure, properties, biological functions, applicable kinetics. Application of these concepts to identify endogenous targets for drug therapy and rational drug design strategies.

Medicinal Chemistry

Chemical basis of drug action and behavior in vivo and in vitro, with an emphasis on pharmacophore recognition and the application of physicochemical properties, structure-activity relationships, intermolecular drug-receptor interactions and metabolism to therapeutic decision-making.

Pharmaceutics/Biopharmaceutics

Physicochemical properties of drugs, routes of administration, bioavailability, and biodistribution, excretion.

Pharmacogenomics/genetics

Genetic basis for disease and individual differences in metabolizing enzymes

Pharmacology

Pharmacodynamics, mechanisms of therapeutic and adverse drug actions and interactions

At the conclusion of this course, students should be able to:

Describe selected structural and functional characteristics of some of the important types of molecular targets of drug action: (1) enzymes and (2) selected receptor types.

Describe structural and functional characteristics of important macromolecular assemblages and tissue microstructures as affects drug absorption, distribution, biotransformation, and excretion: (1) cellular and intracellular lipid membranes; (2) transporters; (3) enzymes catalyzing biotransformation.

Given a molecular structure of a drug molecule, demonstrate rudimentary abilities to rationalize and make reasonable structure-based predictions concerning ...

- aqueous solubility and relative hydrophilicity/lipophilicity;
- useful routes of administration;
- ease of access to various tissues.

With respect to acidic and basic properties of structural moieties incorporated within drug molecules and macromolecular drug targets, demonstrate a knowledge of approximate pK_as for common

ionizable structural moieties, and the corresponding molecular species distribution as a function of pH (i.e., approximate proportions of ionized, un-ionized, and—if applicable—amphoteric forms). Given a molecular structure of a drug molecule, describe its stereochemical attributes, and potential pharmacological and biopharmaceutical significances thereof.

As pertains to molecular recognition (including drug-target interactions), describe the significances of conformation changes involved in binding events, the types and strengths of intermolecular forces that occur between a ligand (drug or other) and its macromolecular binding site, the enthalpic and entropic gains and penalties involved in molecular recognition and the relationship of these to binding affinity, rate constants associated with binding interactions and significances thereof with respect to molecular pharmacodynamics, and the basis of hydrophobic interactions.

Define and differentiate affinity and intrinsic activity (molecular-level efficacy), describe how these concepts relate to the associated concepts of agonism, antagonism, partial agonism, and inverse agonism, and further describe in general how these concepts are related to the patient-level actions (observed clinical pharmacology) of drugs.

Define the concept of pharmacological selectivity, describe the molecular bases for selectivity from both the drug and target aspects, and describe the general clinical significance of selectivity.

Define the concept of equilibrium, and how equilibria are affected by Gibbs free energy changes for biochemical transformations.

Define the basic mathematical terms commonly encountered in descriptions of the kinetic characteristics of enzymes, and their meaning from a biochemical, drug action, and drug biotransformation (drug metabolism) perspective.

Demonstrate an understanding of the distinct types of enzyme inhibitors, and the consequences of these differences in terms of the biochemical pharmacology of drugs that modulate enzymes.

Define allosteric cooperativity, and describe the significance of such cooperativity to molecular cellular physiology and the biochemical pharmacology of drug action.

Provide a list of drug-associated and tissue-associated factors affecting access by drugs to particular organs of the body, including access *to* the body (i.e., bioavailability).

Describe the general physiological purposes of drug biotransformation (“drug metabolism”), and define and differentiate Phase I and Phase II biotransformation, including the nature of the chemical transformations involved with each.

Given a molecular structure of a drug molecule, be able to predict likely routes of biotransformation.

Describe, in general terms, the significance of drug biotransformation with respect to pharmacokinetics.

List major sources of individual variation and drug-drug interactions that may arise as a result of effects on drug biotransformation, and outline the practical significance of each of these sources.

VI. Course Topics

See a listing in the Course Schedule (Section X below).

VII. Instructional Methods and Activities

Instructional methods will include: traditional and technology-based content presentations, generally aiming to be highly interactive in nature, and various formative exercises designed to invoke active learning, including outside homework/study assignments that in most cases will not be collected for a grade. Molecular modeling software such as PyMol will be used for visualization of three-dimensional structure of protein and drug molecules. Microsoft Excel will be used for plotting graphs and for active learning exercises. Zoom or Microsoft Team may be used for distant learning.

VIII. Evaluation and Grade Assignment

Test 1	50 points	(Hill)
Test 2	50 points	(Hill/)
Test 3	50 points	(El Sayed)
Quizzes/active learning	50 points	(Hill, El Sayed, Jois)
Final Exam	50 points	(Jois ~80%, Hill/El Sayed ~20%)
Total	250 points	

According to university guidelines (as given in *The University of Louisiana at Monroe 2017-2018 Graduate Catalog*, wherein the Pharm.D. program is currently listed as a professional degree program), grades should reflect the following:

A - EXCELLENT B - AVERAGE C - BELOW AVERAGE

D - POOR F- FAIL

Grading will be straight-scale:

>89.5% = A 79.5%–89.4% = B 69.5%–79.4% = C

59.5%–69.4% = D <59.5% = F

Mid-term grades will be posted online for students to view via Banner. *Mid-term grades indicate a student's status at mid-semester only.*

**Quizzes/assignments will be given as deemed necessary by each faculty member. The points available from these quizzes and assignments will be added into the denominator for the total number of points available from the course, and course grade determined accordingly. Quiz grades will generally be available within 1-2 days. Preliminary exam grades will generally be posted within 2-4 days of exam administration, and will be finalized and updated if applicable after student review opportunities have been provided (see below), and challenges or appeals are resolved.*

- **Exams.** Four examinations will be administered during the course. The three hourly exams (Tests 1, 2, & 3) will emphasize topics as mentioned in the class schedule, but beginning with Test 2, will have some degree of comprehensive coverage, the nature of which will be communicated to you soon enough for any needed review. The final exam will include a significant comprehensive component.

Exam dates are scheduled in the course syllabus and will only be changed in the event of University closure.

- *Exams may be multiple-choice, fill-in-the-blank, short-answer, case- or scenario-based discussion, essay, or any other format deemed necessary by the faculty members and Course Coordinators. The final exam will be exclusively multiple-choice.*
- *Normal laboratory values will be provided for all questions, unless otherwise specified during class. Lab values that are specific to a disease state will generally not be provided.*
- *Information acquired from previous portions of the course and from other courses in the professional pharmacy curriculum may be needed in preparing for these examinations.*
- *Exams may cover material (readings, outside assignments) not covered in class.*
- *Exams will NOT be returned to the student. All instructors will have copies of the exam and students' results, and students may view their exam results (inc. right/wrong) in instructors' offices, at times convenient for all involved. At this time, they may also discuss exam questions with the instructors who wrote them; however, any official "challenges" of questions must be done in writing. (See below)*
- *Exams will be issued using Exam Soft; all students are required to download the exams prior to the date of the scheduled exam. If a student cannot take the exam on the scheduled date the student must reverse download the exam to Exam Soft. Under no circumstances should a student open an examination, except during the scheduled time and at the scheduled location. Scratch paper will be issued on the day of the exam and all students are required to sign the scratch paper and return it to the exam proctor prior to leaving the room. No other paper items will be allowed during the exam*

unless supplied by the faculty administering the exam. All exams must be uploaded before leaving the classroom; in the event of a power outage or loss of Wi-Fi connection all students are required to upload the exam at the earliest possible reconnection time, however proof of exam closeout will be required prior to leaving the classroom.

- Students wishing to review their exams with the course coordinators or with a specific faculty member must do so within 2 weeks of when the exam scores are posted, or within 1 week of the time that the score for the final exam is posted.
- Problems or issues with a question should be first directed, via e-mail, to the person who wrote it. The course coordinator(s) should be copied on this email, but it is the responsibility of the question's author to address the concern(s). If the student is unsure which faculty member wrote a specific question, then he or she may ask the course coordinator. In the written challenge, the student is expected to include references or rationale to support their challenge of the question. The challenge will be reviewed by the faculty member, and his or her decision will be shared with the course coordinator(s). Discussion of a dispute will occur only after the written query is submitted. Challenges of test questions for the first 4 exams will only be considered within 2 weeks of when the test scores are posted. For the final examination, challenges of test questions will only be considered within 1 week of the time that the scores are posted.
- In the event that there is an issue with a particular test question, adjustments to scores will be made based on discussions between the test question writer and the course coordinator.
- The use of programmable calculators and electronic devices capable of storing, receiving or transmitting data are prohibited during an exam or quiz unless expressly authorized by the course instructor. Such devices must be turned off and left with your belongings in the front of the room.
- Mid-term grades will be posted on-line for students to view via Banner. Mid-term grades indicate a student's status at mid-semester only and do not indicate the final performance outcome of a student.
- **Dropped Test Questions.** When, due to faculty concerns regarding a question appearing on an administered examination, or as the result of a student-generated appeal or challenge that is judged to be valid and of merit by course faculty, the question will generally be omitted from the grade calculation for all students—the total points for the course will be reduced, without altering the percentages required to earn a particular course grade given above in section VIII. Course faculty reserve the right to deviate from this general guideline, however, according to their professional judgement as pertains to the specifics of the issue with the question deemed to be flawed.
- As noted above, Exams will be conducted using ExamSoft/Examplify on your portable computer. All students will be required to download the testing file prior (amply so!) to the time of the scheduled exam. In the event that a student cannot take an exam that has already been downloaded on the scheduled date and at the scheduled time, the student must reverse-download the exam, without having opened it, at earliest pragmatically possible opportunity (i.e., you are with your computer and an internet connection is available to you). Under no circumstances should a student open an examination, except during the scheduled time and at the scheduled location. Please anticipate the likely use of seating charts for examinations, and screen privacy covers must be used during exams and during any other activity during which computers are used as part of a grade-generating exercise. For examinations and some quizzes, official scratch paper will be issued, and all students will be required to print and sign their name on the scratch paper and return it to the proctor, **even if otherwise unused**, prior to leaving the room. For exams and some quizzes, when turning in this sheet, students will also be required to show a proctor that the exam/quiz has been irreversibly closed, and also uploaded, before leaving the room; in the event of a power outage or loss of Wi-Fi connection, students are required to upload the exam/quiz at the earliest possible reconnection time, however proof of exam closeout will be required prior to leaving the classroom. No other paper items will be allowed during the exam unless supplied by the faculty administering the exam.
- During exams as well as during any grade-generating activities, the use of programmable calculators and electronic devices capable of storing, receiving or transmitting data are prohibited unless expressly authorized by the course instructor. Such devices must be turned off and placed in a location that is not readily accessible to you during the activity.
- Assignments should be turned in according to the coordinator or instructor's set deadline. Late assignment

submission will have a penalty or receive zero points. Students should contact the instructor or coordinator if there are any special circumstances that hinder the submission of assignments.

Student Success Policy: <http://www.ulm.edu/pharmacy/currents.html>

Remediation Policy: <http://www.ulm.edu/pharmacy/currents.html>

IX. Class Policies and Procedures

At a minimum, all policies stated in the current ULM *Student Policy Manual & Organizational Handbook* should be followed (see <http://www.ulm.edu/studentpolicy/>). Additional class policies include:

a. Textbook(s) and Materials:

In addition to the required textbooks listed below, various materials will be provided online via the Moodle portal.

Required textbook (online edition available via AccessPharmacy): Goodman & Gilman's *The Pharmacological Basis of Therapeutics*, 13th Edition (2018). Laurence L. Brunton, Bruce A. Chabner, Björn C. Knollmann, eds. McGraw-Hill Professional; ISBN 978-1-25-958473-2.

Required textbook: Graham L. Patrick. *An Introduction to Medicinal Chemistry*, 6th edition (2017). Oxford University Press; ISBN: 978-0198749691 (Paperback)

Required textbook: Marc W. Harrold, Robin M. Zavod. *Basic Concepts in Medicinal Chemistry* (2018). American Society of Health-Systems Pharmacists (Bethesda, Maryland). ISBN: 978-1-58528-6010-1 (paperback)

Reference textbook: Lemke TL, Williams DA, eds. Foye's Principles of Medicinal Chemistry, 8th ed., Lippincott Williams & Wilkins, 2019. ISBN 9781496385024 8th ed. Baltimore, MD: Lippincott Williams and Wilkins; 2013. Electronic version available at <http://pharmacy.lwwhealthlibrary.com>

Reference Textbook: Wilson & Gisvold's *Textbook of Organic Medicinal and Pharmaceutical Chemistry*, 12th Edition, Baltimore, MD: Lippincott Williams and Wilkins 2011. ISBN 978-0-7817-7929-6.

Reference textbook (online edition available via AccessPharmacy): *Harper's Illustrated Biochemistry*, 31 Edition (2018). Michael Weitz and Regina Y. Brown, eds. McGraw-Hill Education; ISBN 978-1-259-83793-7.

Purchase of the Examsoft Examplify® software is also required.

b. Attendance Policy: Class attendance is regarded as an obligation as well as a privilege, and students are expected to know attendance regulations and to attend regularly and punctually at classes in which they are enrolled. Failure to do so may: (1) prevent access to the classroom during regularly scheduled times; (2) jeopardize a student's scholastic standing; and (3) lead to suspension from the School or University. Students must submit excuses for class absences to course coordinators within three class days after returning to classes.

Professors shall accept an official University excuse. With the following exceptions, professors are to determine whether absences are excused or unexcused: 1) Absences arising from authorized trips away from the University or from special duties at the University shall be excused. 2) Absences arising from a student's confinement in a hospital or other in-patient facility or doctor's excused absences shall be excused. Students are responsible for verifying providing documentation to the faculty, which will be verified. 3) Absences arising from a death in the immediate family shall be excused. The immediate family is defined as spouse, child, step-child, mother, father, sister, brother, grandmother, grandfather, step-mother, step-father, step-brother, step-sister, aunt, uncle, mother-in-law or father-in-law.

- c. **Make-up Policy:** Each student is expected to attend each exam at the date and time specified. If a student cannot attend an exam due to valid University excuse, he/she must speak directly with the course coordinator, as soon as possible. The course coordinator must be notified **prior** to an examination if a student misses an exam. The ULM SOP Excused Absence Policy must be followed. Please refer to the official document for details. In case of emergency, the course coordinator must be notified within 48 hours of the emergency. Failure to do so will result in a zero (0) grade for that exam. Make-up exams will be prepared at the same or higher level than the original exam. The format of the make-up exam may be written or oral. Failure to attend a scheduled make-up exam will result in a zero (0) grade for that exam. Students missing an exam due to a University approved excuse will take the make-up exam during the week of finals, or as determined by the course coordinator. <http://www.ulm.edu/pharmacy/currents.html>
- d. **Academic Integrity:** Faculty and students must observe the ULM published policy on Academic Dishonesty (see Page 4 of the ULM *Student Policy Manual* - <http://www.ulm.edu/studentpolicy/>). All professional students will adhere to the standards set forth in the College of Pharmacy's Code of Conduct (<http://www.ulm.edu/pharmacy/currents.html>).

Censures (Penalties)

Academic dishonesty will result in a referral to the Committee on Ethical and Professional Standards with a recommendation for a grade of "F" for the course and expulsion from the College of Pharmacy. Academic dishonesty includes, but is not limited to, the use of information taken from others' work or ideas, the provision of help to others on non-collaborative evaluations (tests, quizzes, etc.), collaboration on take home exams, or the use of unapproved information or electronic devices to assist in obtaining an answer to the question

- e. **Course Evaluation Policy:** At a minimum, students are expected to complete the online course evaluation.
- f. **Student Services:** Information concerning student services in the College of Pharmacy can be found in the College of Pharmacy Student Handbook. In particular, students should pay special attention to the University's technical standards and policies concerning students with special needs (<http://www.ulm.edu/studentpolicy/studentpolicy.pdf>). ULM student services, such as the Student Success Center (<http://ulm.edu/cass/>), Counseling Center (<http://ulm.edu/counselingcenter/>), and Student Health Services, is available at the following Student Services web site <http://ulm.edu/studentaffairs/>. Students with special needs requiring accommodations MUST follow the process described at <http://rxweb.ulm.edu/pharmacy/student/specialneeds.pdf>.

Mental Wellness on the ULM Campus

If you are having problems with emotional, social, and/or behavioral issues please call any of the mental health clinics on the ULM campus to make an appointment. All services are free to ULM students, staff, and faculty, and are strictly confidential.

- COP Office of Student and Professional Affairs: 342-3800
- ULM Counseling Center: 342-5220
- Marriage and Family Therapy Clinic: 342-5678

- Community Counseling Center: 342-1263
- ULM HELPS (Helping Educators and Learners Prevent Suicide) Project Office: 342-1335

The University of Louisiana at Monroe strives to serve students with special needs through compliance with Sections 504 of the Rehabilitation Act of 1973 and the Americans with Disabilities Act. These laws mandate that postsecondary institutions provide equal access to programs and services for students with disabilities without creating changes to the essential elements of the curriculum. While students with special needs are expected to meet our institution's academic standards, they are given the opportunity to fulfill learner outcomes in alternative ways. Examples of accommodations may include, but are not limited to, testing accommodations (oral testing, extended time for exams), interpreters, relocation of inaccessible classrooms, permission to audiotape lectures, note-taking assistance, and course substitutions.

Title IX of the Education Amendments of 1972 prohibits sex discrimination against any participant in an educational program or activity that receives federal funds, including federal loans and grants. Furthermore, Title IX prohibits sex discrimination to include sexual misconduct, sexual violence, sexual harassment and retaliation. If you encounter unlawful sexual harassment or gender-based discrimination, please contact Student Services at 318-342-5230 or to file a complaint, visit www.ulm.edu/titleix.

- g. Emergency Procedures:** Please review the emergency escape plan in the classrooms and hallways of the Bienville building. Move quickly and in an orderly manner to the appropriate stairwell and exit the building. The meeting place for this class will be the far end of the north parking lot between the Bienville building and Broadmoor Blvd. Under no circumstances is the elevator to be used for emergency evacuation. Any student needing assistance should notify the professor immediately. For emergencies, to contact University Police, call 1-911 from landlines and **342-5350 from cell phones. The course coordinators reserve the right to adjust the syllabus or schedule, in accordance with University and School policies and procedures.**
- h.** Federal Regulations require determination and verification of every students' physical location while enrolled in classes (where they are physically located while taking classes), regardless of the delivery method (on campus, online). At the beginning of every semester and whenever physical location changes, students must update or verify their current location through banner <https://ssb-prod.ec.ulm.edu/PROD/bwgkogad.P.SelectAtypUpdate>. Students should do this by the end of the first week of classes.
- i.** This course is a major requirement for the Doctor of Pharmacy degree. Completion of degree requirements leads to eligibility for professional licensure and/or certification in Louisiana upon graduation. Federal Regulations require universities to provide information to students about the alignment between Louisiana's requirements and those of other states. ULM has created a web page with discipline-specific information containing hyperlinks to Licensure Boards in the United States <https://www.ulm.edu/professional-licensure-disclosures/index.html>. Program Directors and/or faculty will discuss this information with you during advising or other program meetings but is also available to answer questions and address any concerns you might have. It is also important to note that licensure or certification requirements are subject to change. Although ULM Program Directors annually review and update licensure information for every state, the faculty recommends that before enrolling in a program and throughout enrollment, students communicate with the applicable state board to confirm understanding and whether upon completion of ULM's program, they will meet requirements.
- o Preparation for class.** For each class period, you will typically be held responsible for varying degrees of **prior preparation**, involving: (1) viewing any e-presentations as may be assigned in advance; (2) completing one or more advance readings if assigned as preparation for a particular

class; (3) answering or attempting to answer any assigned pre-class study questions. Pre-class and post-class study assignments will be constrained to a modest length, and will serve to illustrate and elaborate key concepts, emphasizing application, in accord with specific content objectives provided. **You should plan for a minimum of 7-8 hours per week of outside study time in support of your learning in this class; some students may find that they need more time than this in some topic areas, depending in part on strength of pertinent prior academic preparation.** Assignments and any needed materials (notes, handouts, study questions) will typically be posted on Moodle at least several days in advance. You should, however, habitually check the Moodle page the evening before class for any possible corrections or clarifications.

- **Portable Computers and Clickers.** Exercises conducted on portable computers (“laptops” or equivalent) may occur on any given day to generate grades for certain activities (such as a quiz). Therefore, please bring your computer to every class period; if you do not have it, you may not be afforded an alternative means to provide responses (i.e., you may earn a ‘0’ on the graded activity).

X.

Course Schedule - Tentative Course Schedule *subject to change at the discretion of the Course Coordinator
Class will meet in Bienville 340 Monday, Wednesday at 8:00-9:50am

	Day, Date		Topic	Hrs	Faculty Contrib.	Pts/Questions Due date
1	08/16/21	M	Drug creation Active learning	2	Hill	
2	08/18/21	W	Molecular structure as relates to acidity, basicity, and solution ionization of organic molecules; review of ionic equilibria of biochemically and medicinally common structural moieties	2	Hill	
3	08/23/21	M	Drug discovery and molecular therapeutics invention/creation (focus on small molecules/non-biologics, with illustrative examples, and embedded introduction to selected pharmacology and biopharmaceutics concepts	2	Hill	
4	08/25/21	W	Solution ionization—drug action and disposition aspects	2	Hill	
5	08/30/21	M	Class Exercise 1* Active learning Stereochemistry as pertains to drug action and biohandling	2	Hill	10
6	09/01/21	W	Conformational equilibria (of drugs and drug targets) as pertains to drug action Molecular recognition (ligand-target interactions)	2		

	09/6/21	M	HOLIDAY -labor day			
7	09/8/21	W	Molecular recognition (ligand-target interactions), contd Class Exercise 2** Active learning	2	Hill	10
8	09/13/21	M	Response vs. concentration relationships	2	Hill	
9	09/15/21	W	Response vs. concentration relationships Review for the test	2	Hill	
10	09/20/21	M	Test 1 (Topics covered from 08/16 to 09/15)	2	Jois/Hill/El Sayed	Questions due by 09/16/21 50 pt
11	09/22/21	W	Amino acids and Proteins: Brief review/overview of their various biological functions as pertains to drug targets and drug action	2	Hill	
12	09/27/21	M	Multimeric protein assemblies; allosteric cooperativity and regulation	2	Hill	
13	9/29/21	W	Enzyme Kinetics	2	Hill	
14	10/04/21	M	Enzyme kinetics	2	Hill	
15	10/06/21	W	Physicochemical properties: molecular determinants of membrane transport (passive diffusion emphasis; see transporters coverage below) and other biopharmaceutics-related attributes	2	Hill	
16	10/11/21	M	Physicochemical properties: molecular determinants of membrane transport	2	Hill	
17	10/13/21	W	Biotransformation of xenobiotics (including drugs) Phase I metabolism, including some enzymology Phase II metabolism, including some enzymology Biotransformation (continued.)	2	El Sayed	
18	10/18/21	M	Test 2 (Topics covered from 09/22 to 10/11)	2	Jois/Hill/El Sayed	Questions due by 10/15/21 50 pt

19	10/20/21	W	Biotransformation of xenobiotics (including drugs) Phase I metabolism, including some enzymology Phase II metabolism, including some enzymology Biotransformation (continued)	2	El Sayed	
20	10/25/21	M	Biotransformation (continued)	2	El Sayed	
21	10/27/21	W	Biotransformation (continued) Active learning	2	El Sayed	
	11/01/21	M	Fall Break			
22	11/03/21	W	Quiz 1 Review of biotransformation	2	El Sayed	10
23	11/08/21	M	Enzyme based drug design	2	Jois	
24	11/10/21	W	Enzyme-targeted drug design.	2	Jois	
25	11/15/21	M	Test 3 (Topics covered from 10/13 to 11/03)	2	Jois/Hill/El Sayed/	Questions due by 11/09/21 50 pt
26	11/17/21	W	Enzyme-targeted drug design with examples Active learning	2	Jois	10
27	11/22/21	M	Quiz 2 Enzyme-targeted drug design with examples. Enzyme-targeted drug design with examples	2	Jois	
28	11/24/21	W	Enzyme-targeted drug design with examples. Active learning Thanksgiving holiday starts at Noon.	2	Jois	10
29	11/29/21	M	Review Q & A	2	Jois	
30	12/03/20 21	M	Final Examination, 9-11 a.m. (covers topics 11/08–11/24 + comprehensive)		Jois/Hill/El Sayed	Questions due by 11/24/21 50 pts

**practice tests will be posted on Examsoft before each test.

**NOTE: TEST DATES REMAIN SUBJECT TO CHANGE UNTIL
FINALIZED BY THE BEGINNING-OF-THE-SEMESTER REVIEW
PROCESS, AND SUCH CHANGES, IF ANY, WOULD REQUIRE
FURTHER ADJUSTMENTS TO THE OVERALL COURSE SCHEDULE**

