

PHRD 456 Biopharmaceutics and Pharmacokinetics

I. Contact Information

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II. Course Prerequisites/Corequisites

PHRD 404 Pharmaceutical calculations and credit or registration in 470.

III. Course Description

The study of the interrelationship between formulation factors and pharmacokinetic aspects of drug absorption, distribution, metabolism, and excretion.

IV. Curricular Objectives and Outcomes

Professional Practice-Based Outcomes

- 1.A.2. Collect accurate and comprehensive information to be used in monitoring therapeutic outcomes.
- 1.B.3.D. Recommend revisions of therapeutic plans based upon changes in patient status.
- 1.C.3. Evaluate laboratory test results and pharmacokinetics data.
- 1.C.4. Evaluate information obtained from the patient's history and physical assessment.
- 1.C.5. Evaluate research studies.
- 1.C.9. Make reasonable assumptions and/or draw reasonable conclusions when data are incomplete.
- 1.D.2. Recommend appropriate drug therapy.
- 1.D.5.A. Apply knowledge of the pathophysiology of a specific disease to prevent medication-related problems.
- 1.D.8.A. Integrate patient and drug information with drug dosing methods to calculate appropriate dosage adjustments.
- 1.D.8.B. Explain dosage recommendations and associated rationale to other health care team members.

General Ability-Based Outcomes

- 1.A.3. Synthesize information in order to draw conclusions, hypothesize, conjecture alternatives, or decide a course of action.
- 1.A.4. Evaluate conclusions and solutions according to appropriate criteria, and revise as necessary.
- 1.A.5. Provide support for arguments, solutions, and results.
- 1.B.1. Interpret problems within appropriate contexts.
- 1.B.3. Apply systematic and intuitive problem-solving strategies.
- 1.B.4. Articulate and implement a defensible solution.
- 1.B.5. Apply appropriate criteria to monitor solution outcomes.
- 1.B.6. Implement solution modifications based on monitoring data.
- 7.A.1. Identify personal learning style and preferences.
- 7.A.3. Regularly self-assess learning needs for ongoing personal and professional growth.
- 7.B.2. Engage in instructional activities to achieve desired learning goals.

7.B.3. Evaluate the efficacy of completed instructional activities for the achievement of desired learning goals.

Content Specific Abilities-Based Outcomes

1. Recommend initial drug dosing for agents with a narrow therapeutic index.
2. Assess concurrent disease state and drug therapy effects on drug disposition.
3. Recommend appropriate dosage adjustment based on patient specific information.
4. Monitor for efficacy, adverse effects, and toxicity with regard to drugs with narrow therapeutic indices.

V. Course Specific Objectives and Outcomes

- The major objective of the course is to provide the student with a basic understanding of the principles of biopharmaceutics and pharmacokinetics that can be applied to drug therapy and dispensing. *Biopharmaceutics* is the science that examines the interrelationship of the physicochemical properties of the drug, the dosage form in which it is given, and the route of administration on the rate and extent of drug absorption into the systemic circulation. *Pharmacokinetics* is the science of the kinetics (*motion*) of drug absorption, distribution and elimination in an *in vivo* system.

At the end of this course, the student should be able to:

- Understand and analyze drug information literature (e.g. package inserts, physician's desk reference (PDR), and relevant professional information) with regard to kinetics and dynamics of drugs
- Collaborate with physicians, health care professionals, and patients to formulate effective therapeutic regimens
- Predict the effects of routes of drug administration on the plasma-concentration time profiles
- Predict alterations in drugs' kinetics in a body because of drug-drug interactions, pre-existing medical conditions, and/or special population groups
- Apply knowledge of pharmacokinetics in formulating dosage regimens for individualized drug therapy

VI. Course Topics

1. Introduction to course and review of basic algebra and calculus

Understand the following terms: pharmacokinetics, pharmacodynamics, and biopharmaceutics. Review of math: laws of exponents and logarithms, slope and intercept of a linear regression, linear and semi logarithmic plots.

2. Rates, rate constants, and orders of reactions

Know the difference between rate and rate constants, first-order and zero-order kinetic processes, rate constant and half-life calculations from both first- and zero-order processes.

3. Pharmacokinetics of intravenous (i.v.) bolus dosing

Understand one compartmental model and its assumptions, estimate maximum plasma drug concentration (C_0) or at any give time after drug administration, rate constant, half-life, area under the curve, volume of distribution, clearance.

4. Pharmacokinetics of oral (p.o.) dosing

Know the difference b/w i.v. and p.o. dosing, shapes of drug concentration-time profiles, estimate maximum plasma drug concentration (C_{max}), time to reach C_{max} (t_{max}), half-life, area under the curve, volume of distribution, clearance.

5. Bioavailability and Bioequivalence

Understand bioavailability, absolute & relative bioavailability, bioequivalence and generic substitution; assess bioavailability from plasma and urine data.

6. Pharmacokinetics of continuous & intermittent i.v. infusion

Applications of i.v. infusion, estimation of steady state plasma drug concentration (C_{ss}), what determines the rate and magnitude of C_{ss} , estimation of C_{max} and C_{min} , half-life, volume of distribution, clearance.

7. Pharmacokinetics of multiple dosing

Applications of multiple dosing, estimation of average steady state plasma drug concentration (C_{av}^{∞}), what determines the rate and magnitude of C_{av}^{∞} , estimation of accumulation factor, half-life, volume of distribution, clearance.

8. Dose dependent (Non-linear) pharmacokinetics

Know the difference b/w linear and non-linear kinetics, sources of non-linearity in kinetic data, understand Michaelis-Menten equation, estimate V_{max} (max. velocity of metabolism) and K_M (M-M constant).

9. Multi-compartment (MC) model

Know the difference b/w one, two and multi compartment models, applications of MC kinetics, significance of pseudo equilibrium, different volume terms in MC models, estimation of plasma drug concentration, terminal half-life, volume in central compartment and during terminal phase, clearance.

10. Protein binding

Effects of changes in plasma protein binding of drug's kinetics; recommend appropriate modifications in dosage regimens because of protein binding.

11. Clearance concepts

Relationships among individual organ clearance, hepatic, renal and total systemic clearance and drug half life; understand changes in drug clearance and recommend appropriate modifications in dosage regimens.

12. Therapeutic drug monitoring (TDM)

Understand drug therapeutic range, goals of TDM, variability in pharmacokinetics among individuals based on sex, genetic build, ethnic background; drugs for which TDM is required; how to individualize doses.

13. Specific cases

Estimate pharmacokinetics and dose adjustments for specific drugs.

VII. Instructional Methods and Activities

Instructional methods may include: traditional and technology-driven lectures with in-class discussion, quizzes and exams, and outside of class assignments.

VIII. Evaluation and Grade Assignment

- Quizzes and class participation 10%
- Completed assignments 30%
- 4 Exams (*including comprehensive final*) 60% (15% each exam)

An overall class grade of $\geq 70\%$ is required to pass the course. Students scoring $\geq 90\%$ will receive an "A" grade, those scoring $\geq 80\%$ but $< 90\%$ will receive a "B" grade, and those scoring $\geq 70\%$ but $< 80\%$ will receive a "C" grade.

Undergraduate mid-term grades will be posted on-line for students to view via Arrow. Mid-term grades indicate a student's status at mid-semester only and do not indicate the final performance outcome of a student.

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:

○ **Preparation for class:** For each class there will be lecture notes posted online at least 3 days before the class day. For each lecture notes, there will be *Expected Outcomes* mentioned in the outline which should be met at the conclusion of the topic. The notes may also contain few problems which should be worked out by the student before attending the class. These problems will be the basis of discussion in the class. Therefore, it is mandatory that you come prepared to discuss the scheduled topic and problems.

○ **In-Class quizzes:** For each class period, there will be a quiz administered either at the beginning, during or at end of the class. The quizzes will contain multiple choice, true/false, and/or fill in the blank type questions. As there could be unexpected emergencies, a student is allowed to miss up to 2 quizzes during the course period. There is no need to submit proof of medical condition or the situation you were involved in. As you have the convenience to miss two quizzes, there will be no make-up quizzes administered. Students, who are able to take all the quizzes, will have the option to drop their two lowest grades from consideration.

○ **Take-home assignments:** Assignments for each lecture will be available simultaneously with the class notes and are due on the date mentioned in the *class schedule*. There will also be a few sets of practice problems with answers posted which will be similar to the actual assignment. The students should work on these practice problems before working on the assignments. The grades of these assignments will be added to the final grade. As you will have ample time to work on and submit each of the assignments online before the due date, there are no make-up assignments available.

○ **Exams:** Four examinations will be administered during the course. The dates of exams are mentioned in the *class schedule*. While the first three exams (*Exam 1, 2 & 3*) will be progress exams covering only selected lecture topics mentioned in the *class schedule*, the final exam (*Exam 4*) will be comprehensive in nature covering ALL the topics covered in the course. Additionally, as your knowledge of the course builds up based on proper understanding of preceding lecture topics, it shouldn't be surprising to expect occasionally some overlapping material, belonging to preceding lecture topics, asked in later progress exams.

An unexcused absence for an exam will result in a grade of zero for that exam. If the absence was unpredictable (e.g. medical emergency), a written notice should be submitted as soon as possible along with the supporting document to the instructor and/or the office of student affairs. If the absence for an exam is predictable (e.g. scheduled surgery), a prior approval should be obtained from the instructor and/or the office of student affairs. When deemed legitimate, a make-up exam similar to the actual exam will be administered to the absentee.

A. Textbook(s) and Materials:

- Lecture handouts (provided online)

- Basic knowledge of Microsoft Office Excel program
- Small ruler and scientific calculator or laptop (In class)
- Access to computer with internet (outside of class)
- Rectilinear and semi logarithmic graph papers (provided online)

The following textbooks and materials were primarily consulted while preparing the class notes

- Leon Shargel, Susanna Wu-pong, Andrew B.C. Yu, *Applied Biopharmaceutics and Pharmacokinetics*, 5th Ed, McGraw Hill, ISBN: 0071375503
- Joseph T. Dipiro, William J. Spruill, William E. Wade, Robert A. Blouin, Jane M. Pruemer, *Concepts in Clinical Pharmacokinetics*, ASHP, ISBN: 1585281247
- Leon Shargel, Alan H. Mutnick, Paul F. Souney, Larry N. Swanson. *Comprehensive Pharmacy Review*, 5th Ed, Lippincott Williams & Wilkins, ISBN: 0781744865

B. Attendance Policy:

Class attendance is required. 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: (1) may prevent access to the classroom during regularly scheduled times; (2) may jeopardize a student's scholastic standing; and (3) may lead to suspension from the college or University. Students shall submit excuses for all class absences to professor 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 this information to the faculty. 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:

Excused make-ups will be within one week of the student's return to class at the convenience of the instructor. Excused absences will be determined using the guidelines stated in the University Catalog.

D. Academic Integrity: Faculty and students must observe the ULM published policy on Academic Dishonesty (see Page 4 in ULM *Student Policy Manual* - <http://www.ulm.edu/studentpolicy/>).

Cheating, plagiarism, or other inappropriate conduct will not be tolerated. Academic cheating includes but is not limited to the accomplishment or attempted accomplishment of the following:

1. Copying or obtaining information from another student's test paper.*
2. Using, during a test, materials not authorized by the person giving the test.**
3. Collaborating, conspiring, or cooperating during an in-class or take-home test with any other person by giving or receiving information without authority.
4. Stealing, buying, or otherwise obtaining all or part of an unadministered test.
5. Selling or giving away all or part of an unadministered test or any information concerning specific questions and items on an unadministered test.
6. Requesting, bribing, blackmailing, or in any other way causing any other person to obtain an unadministered test or information about an unadministered test or a test in the process of being administered.

7. Substituting for another student, or permitting any other person to substitute for oneself to take a test.
8. Submitting as one's own, in fulfillment of academic requirements, any work prepared totally or in part by another person.
9. Any selling, giving, or otherwise supplying to another student for use in fulfilling academic requirement any work.
10. Submitting artificially produced data or information in the place of descriptive, experimental, or survey results.
11. Any other devious means of securing an unearned grade in a non-credit course or in a course offered for credit.
12. Using, during a test, any electronic storage device, wireless and/or internet-based technology, or any other means that provides information not authorized for use during the testing period.

*A student looking on another student's paper is considered cheating.

**The presence on one's person (or in close proximity thereto) of a condensation of test information which could be regarded as a "cheat sheet" will be considered adequate evidence to establish cheating.

Plagiarism is the use of any other person's work (such work need not be copyrighted) and the unacknowledged incorporation of that work in one's own work offered for credit.

Censures (Penalties)

Academic dishonesty will result in a referral to Committee on Ethical and Professional Standards with a recommendation for a grade of "F" for the course and expulsion from the College. 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: Students are expected to complete the on-line course evaluation. It is requested that they also complete the College of Pharmacy course and instructor evaluations, including providing comments. In addition, individual feedback is encouraged throughout the course.

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 Colleges technical standards and policies concerning students with special needs (<http://www.ulm.edu/studentpolicy/studentpolicy.pdf>, pages 21-22). ULM student services, such as 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/>

G. Emergency Procedures: (Include appropriate emergency information)

Please review the emergency escape plan in the classrooms and hallways of the Bienville building. Move quickly and orderly 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 Bienville 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.

H. Discipline/Course Specific Policies: Students are responsible for all course information on Moodle and/or instructor websites. They are expected to check these sources regularly to

access class materials, required readings, assignments, and other information necessary to excel in this course.

X. Tentative Course Schedule

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