DPMP 864 Syllabus
Advances in Drug Delivery
Fall 2024 Semester
UNC Eshelman School of Pharmacy

Name	Email	Phone	Office	CH Office Hrs
Course Director				
Shawn Hingtgen, PhD Professor, Division of Pharmacoengineering and Molecular Pharmaceutics	hingtgen@email.unc.edu	919-537-3827	Marsico 4212	By appointment
Additional UNC Instructors				
Kristy Ainslie, PhD Professor, Chair, Division of Pharmacoengineering and Molecular Pharmaceutics	ainsliek@email.unc.edu	919-962-4556	Marsico 4012	By appointment
Yevgeny Brudno, PhD Associate Professor, Division of Pharmacoengineering and Molecular Pharmaceutics	ybrudno@email.unc.edu	TBD	LCCC 31-321/Marsico 2234	By appointment
Sam Lai, PhD Professor, Division of Pharmacoengineering and Molecular Pharmaceutics	lai@email.unc.edu	919-966-3024	Marsico 4213	By appointment
Juliane Nguyen, PhD Professor, Vice Chair, Division of Pharmacoengineering and Molecular Pharmaceutics	julianen@email.unc.edu	919-962-0146	Marsico 4205	By appointment
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Paul A. Dayton, PhD William R. Kenan Jr. Distinguished Professor Joint Department of Biomedical Engineering	padayton@email.unc.edu	919-843-9521	Mary Ellen Jones 9018A	By appointment
Jillian Perry, PhD Research Assistant Professor Division of Pharmacoengineering and Molecular Pharmaceutics	perryjl@email.unc.edu	919-843-6995	Marsico 2110	By appointment
Wubin Bai, PhD Assistant Professor Department of Applied Physical Sciences	wbai@unc.edu	617-949-9089	Kenan A700	By appointment
Guest Instructors				
Scott Floyd, MD, PhD Gary Hock and Lyn Proctor Associate Professor of Radiation Oncology Duke University	scott.floyd@duke.edu	919-668-7342	n/a	Via email

Class Meeting Time and Location
Monday and Wednesday 9:00am-10:20am; room Marsico 4004

Zoom Link
https://unc.zoom.us/j/91558845886?pwd=WHJTNldNZU8xRlppUy9BTkZJSUlxdz09

Textbook(s)

Description
Students will learn the basic concept of biological barriers for drug delivery, various formulation strategies to overcome barriers, and concepts relevant to specific routes of delivery.

Desired Course Outcomes
The students are expected to develop essential presentation skills, acquire a breadth of knowledge in drug delivery as it relates to disease state, and gain an appreciation for research topics outside their specific field of study. This course will contribute to the student's fundamental understanding of the current trends in drug delivery and other scientific disciplines that may be synergistic with their research efforts, and will facilitate their development of professional skills and knowledge required of an effective, independent research scientist.

Expectations for Student Decorum
Students are expected to actively engage in in-class discussions. Students' contributions and participation will contribute to their final grade. Students should arrive on time and be in their seats at the start of each class, and be respectful of their fellow colleagues by not engaging in work, texting, or computer activities during class. Student preparedness, self-motivation and initiative, and timeliness to follow-up on critical feedback are critical elements for successful in this course.

Class Recordings
Classes will be recorded. The recorded lectures will be provided only for excused absence.

Attendance
Students are expected to be present at each class meeting unless arrangements are made with the course coordinator. Make up time is not permitted for unexcused absences and students providing a doctor's note stating they were sick during this time will be exempt from this rule. Other acceptable excuses include, but are not limited to: conference attendance, interviews, family tragedy, or illness; however adequate proof will be required for each of these excuses for absence as well as advance notice to the course instructor. Unacceptable excuses include, but are not limited to: laboratory experiments, forgetfulness, or course study.

If a student wishes to drop the course after a semester begins, the student must complete a Withdrawal Form and obtain the permission of both the course director and Divisional Director of Graduate Studies. If at the time of withdrawal the student is failing, then a grade of F will be assigned to the student's permanent record and the student will become ineligible to continue in The Graduate School.

Description of Teaching / Learning Methods
This course will be taught with 2 different formats. Certain lectures will require students to watch videos and lecture material prior to meeting. Class time will consist of the opportunity to raise questions on the assigned content and further discussions. The second format of lectures will consist of traditional style teaching, where content will be presented during class time.

Review Article
Each student will be required to write a review article. Specific dates are dedicated to introducing the concept, selecting topics, review of an initial draft, and submission of final drafts.

Assessment and Grading
The grading distribution will be as follows:

- 5% Attendance and participation
- 30% Exam 1
- 15% Exam 2
- 15% Exam 3
- 35% Review article (2% topic submission, 5% first draft, 8% first draft, 20% final draft)
    - Topic submission: Students are expected to provide an 8-10 minute oral presentation accompanied by slides introducing their selected topic. This will provide background on the selected topic, relevance to drug delivery, general areas to be covered in the final review article, and raise any potential challenges associated with the topic that could limit completing the review article.
    - First draft: The students should have approximately 30% of the review article complete. Students are expected to present a 5-7 minute discussion on the status of their review article during class time. It is

expected that students have complete outlines of the proposal with close to 30% of the text complete, as well as several of the figures or tables drafted.

o Second draft: The students should have 70% of the review article complete. Students are again expected to present a 5-7 minute discussion on the status of their review article during class time. It is expected that students text fully drafted for all sections of the article, although some may still be in draft form. The majority of tables and figures should be completed.

o Final draft: The completed article is expected to contain appropriate references, figures, and text. It will be graded based on the following rubric.

Guidelines for Grading of Final Review Article					
Criteria	90-100	80-90	70-80	60-70	0-59
Scope and choice of question	Paper achieves an original synthesis addressing a novel idea.	Question chosen is interesting; narrow enough for in depth discussion.	Paper focuses on a well-defined topic with reasonable choice of scope.	Topic is evident but possibly not well defined; may be too narrow or broad to achieve goals.	Topic not defined, no question addressed.
Literature search	Judicious choices of sources allows ideas to be integrated in an original way; may go beyond an obvious collection of materials on similar topic.	Sources chosen create a coherent story with clear connections.	Sources center on topic, creating a reasonably complete and picture; no extraneous material.	Sources are interrelated but may not be sufficient to clearly or fully address a question; some attempt to connect sources, but integration may be weak.	Sources chosen do not allow paper to focus on a specific idea or problem.
Appropriate details	Judicious choice of details maximizes interest and understanding.	All relevant details presented, but details not critical to understanding omitted.	Enough critical details presented for understanding, unnecessary details generally omitted.	Most important details included but may include too much or too little detail for easy understanding.	Some critical details missing, unnecessary details may be present.
Overall organization	Develops persuasive arguments and explanations; effortless and seamless logical flow. Excellent and original synthesis of sources.	Well chosen arguments and explanations; logical flow and connections always easy to follow. Sources used to prove points not just summaries.	Relevant arguments and explanations presented; builds case with mostly logically connected arguments, material from sources mostly integrated.	Some arguments and explanations presented, possibly incomplete, or awkwardness in logical flow. Sources somewhat but not fully integrated.	Major sections missing or lack of logical flow; sources summarized but not connected.
Clarity of explanations	Sophisticated use of language maximizes interest, enjoyment and comprehension; explanations very clear, factually correct.	All explanations clear and easy to understand, factually correct.	Most explanations clear and easy to understand, mostly factually correct.	Overall meaning is understandable; possibly some areas of slight confusion or minor factual errors.	Serious difficulty explaining ideas, major factual errors; lack of comprehensibility.
Use of terminology	Correct use of all terminology,	All technical terms used	Few errors in use of terminology;	Most terms used correctly,	Jargon terms used incorrectly,

	attention to nuances of meaning, judicious use of clearly defined jargon.	correctly and defined clearly, including terms with different common meanings; overuse of jargon avoided.	definitions provided for technical terms, overuse of jargon avoided.	possibly some incorrect usage or use of unnecessary or undefined jargon.	without definition; attempting to sound "scientific" without understanding meaning of terms.
Writing style	Sophisticated, elegant style, complex yet lucid sentence structure, flawless grammar.	Error-free, easy to read writing style, well practiced and polished use of language.	Good basic writing style, easy to read, few errors, almost entirely in author's own words, little paraphrasing or unnecessary quotation.	Mostly basic, correct writing style, relatively few errors and little awkwardness, minimal use of unnecessary quotation or paraphrasing.	Serious errors and awkwardness, excessive use of quotation in place of author's own words, excessive paraphrasing.

Pharmaceutical Sciences Guidelines for the Assignment of Letter Grades	Letter Grade	Numerical Scale
The H grade clearly indicates the student has shown such outstanding promise in all aspects of the assigned work. Demonstrates frequent engagement in class, mastery of assigned homework and/or examinations; superior knowledge in terms of breadth and depth, and clear evidence of creative thought.	**H**	90 - 100
The P grade indicates the student has shown solid promise in the aspect of the discipline under study. Demonstrates occasional engagement in class in a manner that demonstrates good but not outstanding mastery of breadth and depth of knowledge of the subject matter; an appropriate level of ability to synthesize and extend understanding beyond knowledge base; some evidence of creative thought.	**P**	70 - 89
The L grade states that, while not yet showing unusual promise, the student may continue to study in the discipline with reasonable hope of intellectual development. Demonstrates engagement class topics rarely, and where such engagement reflects a limited breadth or depth of knowledge; evidence of minimal competency; limited ability to synthesize and extend understanding beyond knowledge base; little evidence of creative thought.	**L**	60 - 69
A grade of F should warrant an advisor's questioning of whether the student may suitably register for further study in the discipline. No understanding of subject matter; evidence of major deficiencies in subject matter; insufficient breadth and depth of knowledge; absence of ability to synthesize and extend.	**F**	0 – 59

Course policy related to adjusting grades
Students who have questions regarding their semester grade must contact the course director within two business days after the grade has been posted on ConnectCarolina.

Course policies for remediation and resolution of IN grades
o   A course policy of no remediation for a final course F grade is in accordance with Graduate School policy.
o   By University policy, IN grades must be resolved by the first day of the next semester before the student may progress to any course for which this course is a prerequisite; All other IN grades must be resolved as specified to the student in writing, by the course director, but in no circumstance later than the first day of class when the course is next offered.
o   A temporary grade converts to F* unless the grade is replaced with a permanent grade by the last day of classes for the same term one year later.
o   Students assigned a temporary grade of "IN" cannot receive a grade above "L".

Academic Honor Code

The principles of academic honesty, integrity, and responsible citizenship govern the performance of all academic work and student conduct at the University as they have during the long life of this institution. Your acceptance of enrollment in the University presupposes a commitment to the principles embodied in the Code of Student Conduct and a respect for this most significant Carolina tradition. Your participation in this course comes with the expectation that your work will be completed in full observance of the Honor Code. Academic dishonesty in any form is unacceptable. If a violation is suspected, it may be reported to the Student Attorney General's Office. If you have any questions about your responsibility or the responsibility of faculty members under the Honor Code, please visit the Office of Student Conduct web site (http://studentconduct.unc.edu), consult the Graduate and Professional Student Attorney General (gpsag@unc.edu), or contact a representative within the UNC Eshelman School of Pharmacy.

Plagiarism and Referencing

You are encouraged to use a variety of information resources to support your assignments, but you must give credit for any and all ideas that are not originally your own. In addition to citing published works, you must also reference any ideas derived from the Internet, lectures or seminars, or personal correspondence. You can check your work for plagiarism using iThenticate.

Generative AI Use

Generative AI (e.g., ChatGPT) can produce text, images, and other media. These tools can assist with brainstorming, finding information, and even creating materials. However, these tools must be used appropriately and ethically. Ultimately, you the student are responsible for the final product. The unauthorized use of AI to complete any School assignments is a violation of the academic dishonesty policy. For appropriate use of AI at the School, please refer to the Student AI guidance. Each course may have course specific AI policies which supersedes the broader School guidance.

Students with Disabilities Statement

The UNC Eshelman School of Pharmacy is committed to providing reasonable accommodations for all persons with documented disabilities or accessibility concerns in accordance with Section 504 of the Rehabilitation Act of 1973 and the Americans with Disabilities Act of 1990. If you have a medical condition, disability, or accessibility concern that may impact your ability to meet the academic demands or requirements of the course, please contact the appropriate office on your campus. Students are required to self-identify for disability/accessibility support. Students can contact Accessibility Resources and Services in person at the Student and Academic Services Building (SASB) Suite 2126, by email at accessibility@unc.edu or via the web site at http://accessibility.unc.edu.

Course policy on student evaluations of instructor and course effectiveness

Student feedback is essential and highly valued in the School's efforts to continually improve the quality of courses and the effectiveness of our faculty as educators. As a faculty, we can assure you that your feedback is reviewed in detail. The evaluations are taken very seriously by course directors, individual instructors, and the School. In 2011, the School implemented new policies and procedures for course evaluations, which include specific guidance on how the findings are used by the School as a means of continued quality improvement. More information about the policy and insight into how we use your feedback can be found here: http://pharmacy.unc.edu/about-us/school-organization/office-of-strategic-planning-and-assessment/course-evaluations.

Unless otherwise requested. Online graduate course evaluations will be available to students during the last 2 weeks of the Graduate Program. Those not completing the evaluation will receive an "incomplete" grade for the course. All course evaluations are confidential and anonymous.

Syllabus Changes Statement

The course director reserves the right to make changes to the syllabus, including project due dates and test dates, when unforeseen circumstances occur. These changes will be announced as early as possible so that students can adjust their schedules.

Lecture	Date	Title	Instructor	Topics
1	Monday, August 19, 2024	Intro to course and how to prepare a journal article	Hingtgen	
Drug Delivery Basics (1 credit)				
2	Wednesday, August 21, 2024	Introduction to drug carriers	Ainslie	Drug carriers, encapsulation and controlled release, PK and PD
3	Monday, August 26, 2024	Lipid based formulations	Nguyen	Liposomes, liposome preparation methods, lipid carriers, emulsions
4	Wednesday, August 28, 2024	Polymer based formulations	Brudno	Intro to polymer basics, polymeric micelles, polymersomes. fabrication methods
	Monday, September 2, 2024	Labor Day		No class
5	Wednesday, September 4, 2024	Conjugation Chemistry & Polymer Drug Conjugates	Brudno	Intro to conjugation chemistry, Polymer drug conjugates including PEGylation
6	Monday, September 9, 2024	Endocytosis and endosomal lysis mechanisms	Nguyen	Endocytosis mechanisms, effect of particle shape on uptake, proton sponge effect
7	Wednesday, September 11, 2024	RES Evasion and Tumor Microenvironment	Kabanov	RES clearance, PEGylation of liposomes, tumor microenvironment
8	Monday, September 16, 2024	Blood Brain Barrier	Kabanov	Physiology of BBB, Delivery methods to bypass the BBB
9	Wednesday, September 18, 2024	**Student Presentations on Review Article Topics**	**Hingtgen**	Student Presentations on Review Article Topics
	Monday, September 23, 2024	Wellbeing day		No class
10	Wednesday, September 25, 2024	Lymphatics	Lai	Physiology of lymphatics and lymph nodes, diseases of the lymph, lymph nodes in cancer, lymph node drug delivery
11	Monday, September 30, 2024	Transvascular Transport	Lai	Epi/endothelial cells, cellular junctions, basics of cell transport and cell transporters, methods and types of endocytosis, EPR
12	Wednesday, October 2, 2024	Mucosal Barriers	Lai	Intro to mucus and mucosal physiology (coverage, mucociliary clearance), drug carrier systems for mucosal drug delivery
13	Monday, October 7, 2024	Drug Targeting	Brudno	Local and targeted delivery, classification of delivery, controlled release
14	Wednesday, October 9, 2024	**Exam 1: Drug Delivery Basics**	**Hingtgen**	
Characterization of Nanomaterials (1/2 credit)				
15	Monday, October 14, 2024	**Q&A Discussion of review article draft**	**Hingtgen**	
16	Wednesday, October 16, 2024	Transport mechanisms	Lai	Diffusion, Diffusion constant, Brownian motion, Fick's Law, diffusion in mucus, diffusion through a membrane
17	Monday, October 21, 2024	DLS, zeta potential & methods of NP measurements	Nguyen	Rayleigh scattering, limitations of DLS, intensity, volume, or number-based distributions, colloidal dispersions, interfacial double layer, limitations of zeta-potential
18	Wednesday, October 23, 2024	Basics of Radiation and Radiolabeling of Nanomedicines	Floyd	Isotopes and radionucleotides, radiolabeling, nuclear imaging

Lecture	Date	Title	Instructor	Topics
19	Monday, October 28, 2024	Material characterization	Perry	Surface chemistry characterization, elemental characterizations, AFM, SEM, TEM
20	Wednesday, October 30, 2024	Ultrasound triggered DD	Dayton	Introduction to ultrasound, ultrasounds use in drug delivery
21	Monday, November 4, 2024	MRI, CT and Optical Imaging	Hingtgen	Fluorescence, Bioluminescence, CT, MRI
22	Wednesday, November 6, 2024	Lipid and polymer physiochemical characterization methods	Nguyen	TLC, HPLC/RP-HPLC, LC-MS, GPC/SEC, MALDI-TOF, DSC, Lipid extraction methods, Phosphorus assay to quantify phospholipids, NMR
Injectable and Oral Drug Delivery (1/2 credit)				
23	Monday, November 11, 2024	**Exam 2: Characterization of nanomaterials**	**Hingtgen**	
24	Wednesday, November 13, 2024	Injectable Dosage Forms	Brudno	SubQ delivery, foreign body response, Intradermal, intramuscular, intrathecal and other formulations
25	Monday, November 18, 2024	Drug Delivery Devices	Bai	Basics for sensors, drug delivery devices
	Wednesday, November 20, 2024	Thanksgiving Recess		No class
26	Monday, November 25, 2024	Oral Drug Formulations	Nguyen	Background and physiology of GI tract, experimental methods for studies, clinical formulations
27	Wednesday, November 27, 2024	Mechanisms of Absorption and Barriers to Systemic Drug Delivery	Nguyen	Permeation enhancers, asymmetric delivery
28	Monday, December 2, 2024	Bioequivalence and Modified-Release Oral Formulations	Nguyen	Introduction to Bioavailability and Bioequivalence, Delayed, sustained, and modified release dosage forms
29	Wednesday, December 4, 2024	**Final Review Article Due: Email to Dr. Hingtgen by 5:00pm**	**Hingtgen**	
30	Monday, December 9, 2024	**Exam 3: Oral and Injectable Drug Delivery**	**Hingtgen**	