NANOMEDICINE ACADEMY

Northeastern University

Fridays 12:00pm – 2:15pm

NNMD 5370: Nanomedicine Research Techniques

Lead Instructors:

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Guiding Questions

- How are new nanomedicines designed, tested, and optimized?
- What are the essential tools and techniques for developing injectable nanomedicines?
- Where can students find resources for selecting and designing interdisciplinary experiments?

Outcomes and Objectives

- Synthesize, characterize, and test three different nanoparticle formulations
- Describe the theory behind different nanomedicine research techniques
- Identify appropriate instrumentation for specific research applications
- Design a cascade of assays for testing and optimizing new nanoparticle designs

COURSE OVERVIEW

This course provides students with an in-depth look at the theory, methods, and instrumentation used for nanomedicine research. Each week, students will: 1) study and review research theory using online modules, 2) read protocols, 3) participate in a live laboratory demonstration with Q&A, and 4) analyze data generated by the demonstration. Students will gain experience in a wide range of laboratory techniques including nanoparticle synthesis, electron microscopy, optical microscopy, magnetic resonance imaging, high-performance liquid chromatography, *in vitro* measurements of nanoparticle bioactivity & cytotoxicity, and *in vivo* measurements of treatment efficacy. To train students at the detail level needed for independence, laboratory demonstrations are led by local experts under the oversight of the course instructors.

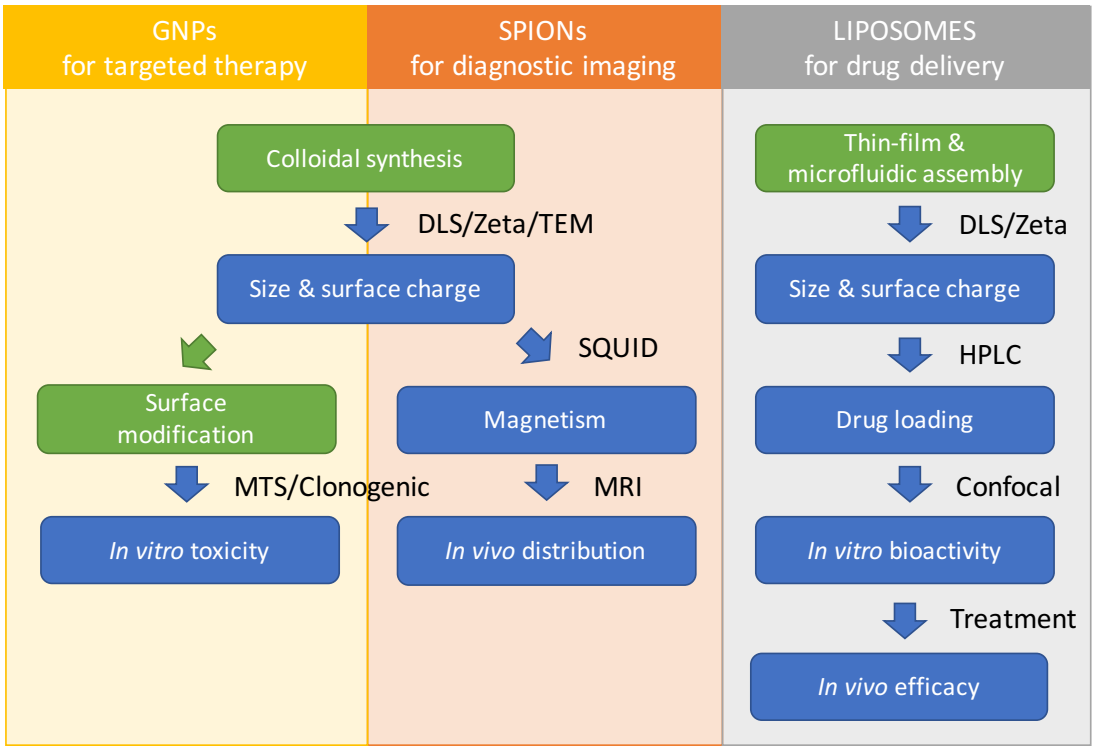
This is one of five courses offered through the Nanomedicine Academy, a joint partnership between Northeastern University, Morgan State University, University of Puerto Rico Mayaguez, Tuskegee University, and Florida International University supported by the National Science Foundation (NSF).

WHY A NANOMEDICINE RESEARCH TECHNIQUES COURSE?

Advances in our ability to assemble and manipulate structures on the nanoscale has led to many new applications of nanotechnology in medicine. This interdisciplinary field, known as nanomedicine, is made possible by collaboration, knowledge sharing, and creation of a research culture across a range of disciplines including physics, chemistry, biology, health sciences, and engineering.

Students performing nanomedicine research are generally educated and trained along traditional disciplinary boundaries, which can create difficulties in the identification and mastery of interdisciplinary research techniques. The goal of this course is to lower barriers to trying new research techniques and giving students a broader range of research options for their thesis work.

Students will have the opportunity to synthesize, characterize, and test different formulations of nanoparticles for multiple applications as shown below. At the end of the course, students will integrate this knowledge by designing their own cascade of assays for a composite nanoparticle.



TEXTBOOKS AND REFERENCES

There is no textbook for this course. Weekly lecture content and reading materials will be provided within Blackboard. Additionally, you may be asked to search library resources and the web as part of your assignments.

HOW THE COURSE IS STRUCTURED

This course features a variety of interactive online and classroom activities that will allow you to engage with classmates and faculty at multiple institutions. These include:

Online Video Lectures and Activities: All lecture content is posted is posted online. Each week you will start with one or more online lecture modules, supplemented with a variety of tasks and readings. These activities will help you engage with the course materials in a variety of ways to enhance your learning. These activities should be considered as part of the lecture materials and are mandatory. **It is important that each week's online instructional materials be completed before the corresponding live laboratory session! Timely completion of the online lectures is worth 30% of your grade.**

Live Laboratory Demonstrations: You will gain first-hand exposure to a wide range of laboratory techniques and instrumentation via live, interactive demonstrations. Remote participants will be kept engaged through the use of a live videographer with the capability to pan and zoom a web-based camera as needed. Remote students can use their laptops and mobile devices to ask questions and interact with the demonstration in real-time. **Participation in the live laboratory and Q&A is worth 30% of your grade.**

Individual Data Analysis: Each week, you will be provided with actual experimental data, generated from the demonstrations or produced using the same tools and techniques that you will be learning in the course. You will work to individually analyze the data in specially designed activities and then post your results to the Course Blog on Blackboard. These blogs are not open to the public but can be viewed by your classmates and instructors. **The assignments make up 20% of your grade.**

Virtual Laboratory Team Project: In the second half of the semester, you will work as part of a group to design a cascade of laboratory assays with appropriate controls for a mock nanoparticle formulation currently under development. Teams will present their proposed assays in a 10 to 12-minute narrated multimedia presentation during the last week of class. All instructions may be found on BB. **This group project is 20% of your grade.**

Burning Questions: Many of you probably have a burning question about some aspect of nanomedicine. As part of your first assignment, we ask that you to post a question on the Burning Questions Discussion Forum. The course instructors and TAs will work to see that all these questions are answered by the end of the semester, either in the course materials or discussion forum.

COURSE CONTENT AND ACTIVITIES

Below is a list of topics that will covered in the course. After the first week, each online lecture topic will be followed by an interactive laboratory demonstration led by local experts. Demonstrations will be held at different sites across campus, so please check BB each week for the appropriate class meeting location. After each demonstration, you will be provided with the opportunity to perform experiments and/or analyze actual experimental data.

Week	Online Lecture Topic	Interactive Demonstration	Activity
1		Overview of experimental techniques	Practice course tools on BB
2	Colloidal metal synthesis	Gold and iron oxide NP synthesis	Synthesize GNPs & SPIONs
3	Liposome synthesis	Thin-film & microfluidic assembly	Synthesize PARPi liposomes
4	Liposome drug loading	High-pressure liquid chromatography	Measure drug loading efficiency
5	NP characterization	Dynamic light scattering tools	Measure NP size & surface charge
6	Electron microscopy	Transmission electron microscopy	Measure NP size from images
7	NP surface modification	Dye and antibody labeling	Label & test GNP modifications

8	Cell uptake & cytotoxicity	Colorimetric assays & SARRP visit	Quantify IC_{50} & clonogenic data
9	Drug efficacy & bioactivity	Immunocytochemistry	Immunolabeling of treated cells
10	Optical microscopy	Confocal microscopy	Quantify biomarker expression
11	Magnetism & magnetometry	Superconducting quantum interference	Measure magnetism of SPIONs
12	In vivo biodistribution	Magnetic resonance imaging	Measure relaxivity of SPIONs
13	In vivo therapeutic efficacy	Tumor measurements & DLAM visit	Plot tumor growth curves

TIMELINE AND GRADING

You will be assessed on the basis of individual assignments, a group presentation, and active participation in class activities.

Activity	Description	Due Date	Grade
Online Instruction	Completion of online lectures & instructional activities	Weekly	30%
Live Laboratory	Participation in laboratory demonstrations and Q&A	Weekly	30%
Data analysis	Individual data analysis assignments	Weekly	20%
Virtual Laboratory	In-class group presentation of mock research proposal	TBD	20%

COMMUNICATION WITH YOUR PEERS

The students who attend this course with you come from universities in 5 different states and territories across the U.S. Each of you brings a unique background, area of expertise, and perspective to the course. We are providing you with the opportunity to interact with each other in a variety of ways so that you can benefit from each other's experiences.

Course Blog: You will have several opportunities to post your work to a shared blog so that the entire class can benefit and learn from your research. You are also asked to provide a short biography and introduction so that the other class members can get to know you. You are also encouraged to comment on the work of other individuals!

Group Presentation: You will be provided with all the software needed to perform group brainstorming sessions and create a presentation. The great thing about all this online software means

it is no longer necessary to be in same room all the time to do a group project! You will have the opportunity to pitch your research proposal and answer questions in front of the entire multi-institutional student body on the last day of class.

"Burning Questions" Discussion Forum: As you attend lectures and work on your assignments, you might come across new topics on which you have questions. You are encouraged to post these questions in this discussion forum. The course instructors and TAs will work to see that all these questions are answered by the end of the semester, either in the course materials or discussion forum. You are also free to answer questions that pop up here! General questions about assignments can also be posted here. Tip: The discussion "subscribe" option forwards messages directly to your email, making it easier to monitor.

COMMUNICATION WITH THE INSTRUCTORS

Instructor Participation in Blog Posts: The weekly blog posts and peer-to-peer commenting are intended to create a conversation among students, not a back-and-forth between the professor and students. We believe in your capacity for taking the discussion in interesting and productive directions. The course instructors will occasionally provide expert advice and personalized help to challenge and motivate you. Even though we may not respond to every blog post, please know we are "listening" intently.

Messages and Announcements: We will regularly post announcements with observations and questions designed to spur, focus, or deepen the whole group's discussion. We will also send logistical updates as needed. These announcements will typically be posted to a Blackboard announcement that is also forwarded to your email address. This redundancy ensures that everyone in the course sees the communication.

Face-time with a Course Instructor: Face-time with a Course Instructor: We have designated a local Faculty Facilitator at each institution. The role of this faculty is to host the classroom space, act as a local point of contact for any questions you have, and provide mentoring for group projects. Feel free to contact your local Faculty Facilitator as needed.

Technical Questions and Concerns

Please visit Blackboard's Online Support Center at http://nuonlinebbsupport.neu.edu to access tutorials and live chat support, or call the Center at (855) 836-3520. **This 24/7 hotline is available to ALL nanomedicine students; no matter what institution you attend.**

Getting Help: The best place to go for help depends on the specifics of your concern or question.

COURSE POLICIES

1. Class attendance is mandatory. You are encouraged to also actively participate in this course by engaging local and remote instructors in discussion of course content and asking questions during lab demostrations.
2. You are expected to check Blackboard regularly. All required lectures, assignments, protocols, readings, and course communications will be posted on Blackboard.
3. You are expected to follow guidelines stated in the NEU Academic Integrity Policy (http://www.northeastern.edu/osccr/academichonesty.html)
4. The use of mobile devices and laptops during laboratory demonstrations is not allowed.