

ENGN 1510: Nanoengineering and Nanomedicine

Professor:

Anita Shukla, Ph.D.

Assistant Professor of Engineering

[email], [phone]

Barus & Holley 749

Office Hours: By appointment

***Note:** Put 'ENGN 1510' somewhere in the subject of any email sent to Prof. Shukla regarding class.

Course Description: Students in this course will develop a fundamental understanding of nanoengineering and its applications in medicine. We will discuss nanomaterials synthesis, fabrication, and characterization. Applications of nanoengineered materials in medicine, including nanotechnology-based drug delivery systems, nano-based imaging and diagnostics, and nanotechnology-based tissue engineering approaches will be explored in depth. Host response to nanomaterials and nanotoxicology will also be discussed. Research methods in nanoengineering and nanomedicine will be emphasized (i.e. critical analysis of scientific literature, effective oral and written communication).

Prerequisites:

This course is meant for engineering and science graduate students and advanced upper level engineering undergraduates. The following courses are recommended prerequisites (and/or permission of the Professor): ENGN 1490 (Biomaterials) and ENGN 1110 (Transport & Biotransport Processes).

Course Outcomes:

Students completing ENGN 1510 should:

1. Understand the state-of-the-art in terms of nanoengineered materials research for applications in medicine, as demonstrated through exams, assignments, and in-class contributions.
2. Be able to critically read, analyze, and interpret the scientific literature in nanoengineering and nanomedicine.
3. Apply knowledge of engineering and biology to think critically about and propose solutions for current applications in medicine based on understanding of nanoscience fundamentals.
4. Be able to clearly represent ideas in written reports and oral presentations.

Course Website: All assignments unless otherwise specified should be submitted on the course Canvas website (canvas.brown.edu). Course announcements, readings, etc. will be posted on the website.

Textbook(s):

There is no required textbook for this course. Articles and other reading materials will be provided throughout the semester.

Additional Resources:

Available Online (see 'E-Reserves' on Canvas):

-x'', editors: C.T. Laurencin and L.S. Nair, CRC Press, 2008.

-*Biomaterials Science: An Introduction to Materials in Medicine* (3rd Edition), B.D. Ratner et al., Academic Press, 2013.

On Reserve at the Sciences Library:

-*Fundamentals of Microfabrication and Nanotechnology, Vol. 3* (3rd Edition), M.J. Madou, CRC Press, 2012.

-*Molecular Biology of the Cell*, B. Alberts, et al., Garland Science, 2002.

Tentative Class Schedule:

Week	Topic(s) Covered
1	-Course introduction -Fundamentals of nanoengineering and nanoscience -Reading scientific literature
2	-Synthesis and fabrication of nanoengineered materials -Journal club 0 (example)
3	-Nanoengineered materials characterization and analysis tools -Journal club 1
4	-Journal club 2 -Special topics in nanoengineering guest lecture (Prof. I. Wong) -Special topics in nanoengineering guest lecture (Prof. A. Tripathi)
5	-Nanoengineered materials in drug delivery and development -Journal club 3
6	-MIDTERM EXAM 1 -Nanoengineered materials in drug delivery and drug development -Journal club 4
7	-Nanoengineered biosensors -Journal club 5
8	-Nanobased materials for studying cell behavior -Journal club 6
9	-Nanoengineered materials in tissue engineering and regenerative medicine -Journal club 7
10	-Biomimetic nanomaterials -Journal club 8
11	-Nanotoxicology

	-Journal club 9
12	-Special topics in nanoengineering guest lecture (Dr. P. Katwa) -Nanomaterials for medical imaging and diagnostics -Journal club 10
13	-MIDTERM EXAM 2
14	-Journal club 11 -Wrap-up -Journal club 12
15	-Journal club 13 -Journal club 14
16	-Final project due -Final proposal review panel

Tentative Grading Scheme:

Attendance and participation – 15%
 Journal club presentation – 25%
 Journal club article analysis/critique documents – 10%
 Mid-term exam 1 – 10%
 Mid-term exam 2 – 10%
 Final project – 30%

Time Allocation

Over the 15 weeks of this course, students will spend three hours in class each week (45 hours total). Although specific out-of-class time investments may vary for individual students, a reasonable estimate to support this course's learning outcomes is 135 hours total, or on average, 9 hours weekly over a 15-week term. Out-of-class preparation will regularly include about three hours per week for reading (45 hours total). In addition to this ongoing preparation time, each of the midterms will require about 15 hours of studying, preparation of the journal club presentation will take about 10 hours, and students are expected to allocate about 50 hours to the final project and mock review.

-Attendance and Participation: Attendance is mandatory and will be taken in class. Students are expected to actively participate in class; participation will be assessed heavily during journal club. To achieve full credit for attendance and participation, students must:

1. Attend, be prepared for, and actively and respectfully participate in each class
2. Ask and answer questions and contribute critiques and analysis of the articles presented in each journal club
3. Give written feedback to classmates on their journal club presentations in the form of an evaluation to be completed in class

-Journal Club: Each student will give a 15-20 minute slide-based presentation in class describing a current nanoengineering/nanomedicine related journal article. The presentation should provide a clear and concise summary of the introduction, methods, results, discussion, and conclusions of the article. An example of what is expected for the journal club presentation will be presented in class. Following the presentation, the journal club presenter will lead a

class discussion of the article in which the class will analyze and critique the research (refer to 'Attendance and Participation').

Topics for the presentations are listed below in the 'Tentative Journal Club Schedule.' The schedule of presentations will be set during the first week of class. A selection of approved journal articles for each topic will be provided on the Canvas website. The presentation will be evaluated based on the rubric posted on the Canvas website (note: presentation skills/slide structure/etc. will be evaluated!).

Note that exams may include questions based on journal club articles/discussions.

Journal Club Presenter:

-At least 9 days prior to the journal club date (by 10 AM):

Select a paper from the list of approved journal club articles corresponding to your topic and email Prof. Shukla your selection.

You may choose a current paper of your choice within the topic specified and email this to Prof. Shukla instead, along with a brief explanation of why this is a good choice for the journal club. This explanation should be included in the body of your email in less than 100 words. Do not send multiple papers/explanations. Prof. Shukla will decide whether or not to approve your selection. If your selection is not approved, you must immediately select an article from the approved journal club articles list.

-Day of journal club (by 10 AM):

Submit a PDF copy of your journal club presentation slides on Canvas (ensure that the content of each slide is visible). These will be made available to the class after journal club.

Rest of the Class:

-At least 7 days prior to the journal club date (by 10 AM):

Prof. Shukla will post the selected journal club article on the course website. Students must read this article.

-Day of journal club (before 10 AM):

Upload a brief analysis on the Canvas website in **.doc, .docx, or .pdf format** (maximum 300 words – not including student name, title, heading, etc.) of the journal club article. Students should think of these documents as a basis for the in-class discussion portion of journal club (a component of your attendance and participation grade). Rather than summarizing the entire article, the brief analysis document should focus more thoroughly on posing questions and critique of the research presented in the article.

-Day of journal club (end of class):

Submit completed evaluation form (provided in class) of the journal club presentation. Scanned, anonymous copies of feedback will be provided to the presenter. Note: submitting these evaluations makes up part of your attendance and participation grade.

Note: the journal club presenter does not need to submit an evaluation or an analysis document.

Tentative Journal Club Schedule:

Journal Club #	Topic
0 (Example)*	Nanomaterials synthesis and fabrication
1	Nanomaterials synthesis and fabrication
2	Nanomaterials characterization and analysis
3	Nanoengineered materials in drug delivery/drug development
4	Nanoengineered materials in drug delivery/drug development
5	Nanobiosensors
6	Nanobased materials for studying cell behavior
7	Nanoengineered materials for tissue engineering/regenerative medicine
8	Biomimetic nanomaterials
9	Nanotoxicology
10	Nanomaterials for imaging/diagnostics
11	Nanomaterials for imaging/diagnostics
12	Nanomaterials for translational medicine
13	Nanomaterials for translational medicine
14	Nanomaterials for translational medicine

*All students must submit analysis document for this example journal club article

-Final Project:

Research Proposal and Mock Review Panel: Students will work in groups of 2 to formulate a grant proposal based on a novel nanoengineering/nanomedicine research topic (exact format will be specified). Prof. Shukla must approve the topic. Students will receive proposals from their classmates to critique and evaluate based on the knowledge gained in the class. A mock review panel will be conducted during the final exam period in which all students are expected to participate and discuss the proposals (specific details regarding the format of the review panel will be provided). Rubric and grading details will be specified on DATE TBD.

Important Final Project Dates

- October 15 (by 5 PM): Final project description provided
- October 31 (by 5 PM): Final project groups and topics due
- November 5: Notification of approval of final project groups/topics
- December 15 (by 10 AM): Research proposal due
- December 20: Mock review panel during final exam period

Course Late Policy:

1. Any assignment submitted late, deadline not met, or directions not followed (**including submitting assignment after the date and time due, not meeting a deadline by the date and time specified, not following directions for an assignment**) will lose credit at a rate of **20% per day** until the assignment has been submitted or the directions have been followed. This includes all deadlines associated with journal clubs.
2. Final project: Late research proposal submission or absence from mock review session will lead to no credit for the final project.
3. Requests for extensions on assignments and exams will be considered only if accompanied by a written memo from a Dean or from Health Services.

Other considerations: Please notify the professor if you have a disability or other condition that might require some modification of any of these course procedures. For more information contact Student and Employee Accessibility Services at 401-863-9588 or SEAS@brown.edu.

Students in need of short-term academic advice or support can contact one of the deans in the Dean of the College office.

Please review the Brown University Academic Code:

<http://www.brown.edu/academics/college/degree/sites/brown.edu/academics/college/degree/files/uploads/Academic-Code.pdf>

Violations of the Academic Code will lead to strict disciplinary action as outlined in the Code. Misunderstanding of the Code will not be accepted as an excuse for dishonest work.