INTRODUCTION TO NANOMEDICINE AND NANOTECHNOLOGY (3 Cr.)

Winter 2013

Co-listed course numbers: CHE5995, MSE7995, PHY6991, PSC8660, and IM7450

4:30–7:10 PM Tuesdays
Welcome Center Auditorium

Instructors: Dr. Alan P. Hudson, Department of Immunology & Microbiology, School of Medicine
Dr.Gavin Lawes, Department of Physics, College of Liberal Arts & Science
Dr. Guangzhao Mao, Department of Chemical Engineering and Materials Science, College of Engineering
Dr. Hitesh Handa, Department of Surgery, University of Michigan

Office Hours: By appointment

Prereq.: It is recommended that students possess the same background knowledge required for the Medical College Admission Test (MCAT). The MCAT has four sections: physical sciences, verbal reasoning, writing sample, and biological sciences. At least one year of each of the following subjects is highly recommended before taking this course: calculus, general or inorganic chemistry, organic chemistry, and biology with lab.

Objectives: Upon completion of this course, students will be able to:

1) Know basic techniques to synthesize and characterize nanoparticles.
2) Present the unique physical properties of nanoparticles that are relevant for biomedical applications.
3) Describe basic types of interactions between nanoparticles and cell membranes.
4) Describe the cell uptake mechanisms as a function of nanoparticle size.
5) Select appropriate methods to measure nanoparticle size.
6) Have an appreciation of the uses of nanotechnological approaches to medicine and basic biology.
7) Have some understanding of aspects of nanotoxicity and current and future regulatory issues relating to use of nanotechnology in medicine.
8) Understand the unique pharmacokinetics and biodistribution properties of nanoparticles.
9) Understand basic principles of nanoparticle drug loading and release.

Responsibilities: Students are responsible for completion of reading assignments in advance of class, lecture materials, class participation, homework assignments, and all exams.

Homework: Assigned weekly. These problems will be discussed during the first 15 minutes of the following lecture. Students will be called on randomly to

answer problems, and their answers will form the basis of the homework grade. There will be no written homework to turn in.

Textbook: Understanding Nanomedicine An Introductory Textbook, Rob Burgess, Pan Stanford Publishing, 2012.

Exams: Final exam. The final exam may consist of a mixture of multiple choice questions and both short and long answer problems. You may also be required to perform some calculations that have been discussed in the lectures.

Presentation Students will conduct literature research and present the literature reviewsin class.Topics will be selected by the instructors at the beginning of the semester. The presentation will be graded based on clarity and relevance. In the clarity category, students are expected to convey the research results in their own words to the classroom audience. The presentation should contain sufficient detail and background information. In the relevance category, students are expected to address the particular application and its relevance to lecture materials and assigned topical areas. The oral presentation should include title and outline, introduction and background, results, discussion of relevance, conclusions and future directions.

Extra Credit: No extra credit projects will be allowed.

Deferred Grades: Deferred grades are allowed only if: 1) the student is not failing the course, and 2) the student can complete the required materials without retaking the course or requiring faculty supervision.

Dropping: Students who wish to drop the class must initiate the request in Pipeline before the deadline. Failing the course is not an acceptable reason for withdrawal.

Grading:

Final exam	50%
Presentation	30%
Homework& attendance	20%
Total	100%

Course Outline:

Week	Instructor	Topics	Content
1/8	Lawes	Introduction to nanomaterials (Chap.1)	Co-precipitation, microemulsion, hydrothermal synthesis, self-assembly, colloidal synthesis, ball-milling
1/15	Lawes	Characterization I (Chap.1, 8)	X-ray diffraction, MRI, Raman, optical methods
1/22	Lawes	Quantum dots and magnetic nanoparticles (Chap.2)	Band gap and quantum confinement, fluorescence, magnetic relaxation, MRI contrast agent, hyperthermia
1/29	Mao	Characterization II(Chap.1,8)	AFM, TEM, zetasizer
2/5	Mao	Engineering and manufacturing (Chap.1)	Self-assembly, colloidal chemistry, polymer engineering, nanolithography
2/12	Mao	Nanoparticle/cell interactions (Chap.6)	Intermolecular forces, cell culture, cell uptake mechanisms, surface and charge effect on cell uptake
2/19	Handa	Nano scaffolds and tissue engineering (Chap.3)	Nanofibers, applications in tissue engineering and drug delivery
2/26	Handa	Biocompatibility(Chap.3,5)	Biomedical devices, blood compatibility, infection
3/5	Handa	Surgery (Chap.5)	Implant and surgical design, wound healing, intracellular nano-surgery
3/19 (classroom change)	Hudson	Nanotechnology and neuroscience (Chap.4)	Delivery of DNA/RNA for modulation of cellular processes, alteration of specific protein-protein and protein-DNA interactions, nanocarriers for clinical neuroscience
3/26	Hudson	Drug/gene delivery (Chap.7)	Use of nanodevices for delivery of drugs, vaccines, other therapeutics
4/2	Hudson	Nanotechnology in medical imaging (Chap.8)	*In vitro* and *in vivo* imaging and nanodiagnostics
4/9		Presentations	
4/16		Presentations	
4/30		Final exam	