Instructor
Dr. Carolina Salvador Morales
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Office: 255 Krasnow Institute
Office hours (Tuesday) 5:00-7:00pm or by appointment
Office Phone number: 703-993-5895

Class Time and Location:
Monday: 4:30-7:10 pm
Innovation Hall 209, Fairfax Campus

1. COURSE NUMBER AND TITLE:
BENG 441-001: Nanotechnology in Health (3:3:0)
BENG 590-001: Nanotechnology in Health (3:3:0)

Course Prerequisites:
BIOL 213, PHYS 160, either CHEM 251 or CHEM 212

Catalog Description:
This course covers the state-of-the-art of nanotechnology ranging from basic to applied science. This course is divided in two main sections: physical sciences and life sciences. The physical science section includes analysis, process and design at a molecular scale of materials used in contact with biological systems. Also, this section includes the study of molecular interaction between bio-and synthetic molecules and surfaces. The physico-chemical fundamental principles of key drug delivery nanovehicles such as liposomes, nanoparticles and hydrogels are also studied in this course. The life science section of this course describes the application of different biomaterials in medicine showing the advantages and disadvantages of nanotechnology. This course includes lectures, teamwork activities during the class meetings, a visit to the NIST Center for Nanoscale Science and Technology and a guest lecture.

2. COURSE OBJECTIVES:
The objective of this course is to cover a wide range of aspects central to the interface of nanotechnology and nanomedicine. At the end of the class, students should be able to:

• explain the physico-chemical fundamentals involved in the synthesis of different biomaterials
• explain the interactions between biomaterials and biological entities (e.g., cells, tissues, etc)
• explain the fundamentals of different microscopy techniques used to characterize a wide range of biomaterials
• create an innovative nanoengineering approach to solve a medical problem
• discuss advantages and disadvantages of nanotechnology.
3. RECOMMENDED REFERENCES:
The lectures of this course are partially prepared on a course package, which includes a series of peer-reviewed papers. The titles of these scientific papers are listed below. The pdf of these scientific papers will be posted on blackboard. Also, please note that the lectures are prepared on the following book.

1. Introduction to Biomaterials: Basic Theory with Engineering Applications. C. Mauli Agrawal, Joo L. Ong, Mark R. Appleford, and Gopinath Mani, Cambridge Texts in Biomedical Engineering.

4. HOMEWORK ASSIGNMENTS
The homework assignments will include one-page summary of the topics covered in class, problem sets and analysis of peer-reviewed papers. The short summary and problem sets should be submitted at the beginning of each class. Students will be asked to read a peer-reviewed paper before the beginning of next class.

5. MID AND FINAL EXAM
The mid-term and final exam will take place on March 14, 2016 and May 9, 2016, respectively. The mid-term will consist of a combination of several open-ended questions, problem sets, and multiple choice questions.

6. TEAM PROJECT
Students will be asked to form a team of 4 people and work on a scientific project related to nanomedicine. At the end of the semester students will submit an electronic and hard copy of their project reports. Also, they will provide an oral presentation on this report. The format of the scientific project and oral presentation will be provided during the first day of class and instructions will be posted on blackboard.

7. GRADING POLICY
Class attendance and participation and 10%
Summary and Problem sets 10%
Written report 20%
Oral presentation 20%
Mid-term exam (1) 20%
Final exam 20%

8. ADVICES FOR SUCCESS
1. Attend the class every time. Attendance is very important to perform well in this course for several reasons. First, there is only one class meeting per week and one topic will be completely covered. Second, during the class I discuss and complement the information that is included in the course package and reference books. Third, my class is very dynamic. If you miss the class you will miss important discussion about the class material.
2. Read the reading materials indicated in the syllabus before each class so that you can participate in class.
3. Make an effort to write the summaries and solve the problem sets, and submit them on time. The summaries are a great exercise to learn the concepts taught in class and allow me to correct your misconceptions. Also, by writing the summary you will improve your writing skills and exercise your critical thinking skills.
4. Get to know your classmates since the first class. Your team should be formed by Mid Feb and
5. Start brainstorming on a nanomedicine topic before the spring break. Plan in advance the development of your scientific project according to your academic schedule.
6. Ask questions in class and during the office hours.

9. CALENDAR:

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<tr>
<th>Topic</th>
<th>Date</th>
<th>Reading Material</th>
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<tr>
<td><strong>Introduction to Nanotechnology and biomaterials.</strong> Course objectives, brief historical background of nanotechnology and nanomedicine, review of basic chemistry concepts and chapter 1.</td>
<td>Week 1 (Jan 25)</td>
<td>Closing the gap accelerating the translational process in nanomedicine by proposing standardized characterization techniques (Introduction section). Chapter 1</td>
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| **Characterization techniques for biomaterials.** Definition and performance of biomaterials, fundamentals of Transmission Electron Microscopy, Scanning Electron Microscopy, Scanning Tunneling Microscopy, Atomic Force Microscopy, Energy Dispersive X-Ray spectroscopy. | Week 2 (Feb 1) | 1. Selected material will be provided in class.
2. Chapter 2, 19-45
3. Chapter 4, page 94, 98, 100. |
| **Biodegradable polymeric solids.** Chemistry and physical chemistry of hydrolysis, links between materials structure and hydrolysis mechanisms. | Week 3 (Feb 8) | 1. Chapter 6, page 134-154.
2. Degradable polymer microspheres for controlled drug delivery.
3. Selected material will be provided in class. |
2. Degradable polymer microspheres for controlled drug delivery. |
| **Controlled release devices**  
2. Degradable polymer microspheres for controlled drug delivery.  
3. Optimisation of treatment by applying programmable rate-controlled drug delivery technology.  
4. Selected material will be provided in class. |
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| **Nanoparticle and microparticle biomolecule drug carriers.**  
Pro-drugs, micelles, liposomes, polymerosomes, nanoparticles, and microparticles delivery of drugs to tissues via systemic circulation. | Week 6 (Feb 29) | 1. Nanotechnology in drug delivery and tissue engineering: from discovery to applications.  
2. Recent developments in multifunctional hybrid nanoparticles: opportunities and challenges in cancer therapy.  
4. Selected material will be provided in class. |
| **Nanoparticle and microparticle biomolecule drug carriers (cont.)**  
Barriers to systemic, delivery of molecules to tissues 'stealth' particles, theory of protein-resistant particles, experimental function of long-circulating carriers and pegylated compounds. | Week 7 (March 7) | 1. Long-circulating and target-specific nanoparticles: Theory to Practice.  
| **Nanomedicine: Concepts and examples).**  
Cancer therapy, diagnostics, clinical studies, pharmacokinetics, toxicity of biomaterials. | Week 8 (March 14) | 1. Nanocarriers as an emerging platform for cancer therapy.  
2. Long-circulating and target-specific nanoparticles: Theory to Practice.  
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<th>Topic</th>
<th>Week</th>
<th>Reading/Activity</th>
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<tr>
<td>Biological recognition <em>in Vivo</em>, protein-resistant and cell-resistant surfaces.</td>
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<tr>
<td><strong>Engineering biological recognition of biomaterials cont.</strong></td>
<td>Week 10 (March 28)</td>
<td>Long-circulating and target-specific nanoparticles: Theory to Practice.</td>
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<td>Mimicking cell-cell contacts with surfaces.</td>
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<td><strong>Hydrogels as biomaterials.</strong></td>
<td>Week 11 (April 4)</td>
<td>1. Chapter 6, page 159-163.</td>
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<td>Hydrogel structure and physical chemistry, methods of polymerization.</td>
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<td>2. Biomedical applications of hydrogels: A review of patents and commercial products.</td>
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<td><strong>Hydrogels as biomaterials (cont.) and tissue engineering</strong></td>
<td>Week 12 (April 11)</td>
<td>1. Chapter 6, page 159-163.</td>
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<td>2. Biomedical applications of hydrogels: A review of patents and commercial products.</td>
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<td><strong>Molecular switches via proteins and “smart” polymers.</strong></td>
<td>Week 13 (April 18)</td>
<td>pH-responsive polymer microspheres: Rapid release of encapsulated material within the range of intracellular pH).</td>
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<td>Temperature, pH, and light-sensitive switches.</td>
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<td><strong>Recent developments on siRNA delivery, Nanotechnology approaches for HIV, fundamentals and applications of carbon nanotubes, and immunoengineering</strong></td>
<td>Week 14 (April 25)</td>
<td>1. Knocking down barriers: advances in siRNA delivery.</td>
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<td>2. Emerging nanotechnology approaches for HIV/AIDS treatment and prevention</td>
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<td><strong>Course review and final exam</strong></td>
<td>Week 15 (May 9)</td>
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10. COURSE PACKAGE (Please find attached pdf for each scientific paper)

Bioinspired pH-Responsive polymers for the intracellular delivery of biomolecular drugs
Block copolymer micelles for delivery of gene and related compounds
Comparative properties and methods of preparation of lipid vesicles (liposomes)
Degradable Polymer Microspheres for controlled drug delivery
Drug Delivery Systems: Entering the Mainstream
Developments in liposomal drug delivery systems
Endosome escape pathways for delivery of biologicals
Emerging nanotechnology approaches for HIV/AIDS treatment and prevention
Materials for protein delivery in tissue engineering
Nanocarriers as an emerging platform for cancer therapy
Nanomedicine-Challenges and perspectives
Optimisation of treatment by applying programmable rate-controlled drug delivery technology
pH-responsive polymer microspheres: rapid release of encapsulated material within the range of intracellular pH
Knocking down barriers: advances in siRNA delivery
Structure and Morphology changes in absorbable poly(glycolide) and poly (glycolide-co-lactide) during in vitro degradation
Why degradable polymers undergo surface erosion or bulk erosion
Mechanisms of polymer degradation and erosion
Multifunctional nanoparticles properties and prospects
Long-circulation and target-specification nanoparticles
Common pitfalls in nanotechnology: lessons learned from NCI’s Nanotechnology Characterization Laboratory.
Alginate/polyoxyethylene and alginate/gelatin hydrogels: preparation, characterization and application in tissue engineering.
Closing the gap: accelerating the translational process in nanomedicine by proposing standardized characterization techniques.

NCI strategic plan 2015

Taming vessels to treat cancer
Cell transplantation for endocrine disorders
11. CELL PHONE AND LAPTOP POLICY

The use of cell phone, audio devices and laptop are not allowed during this class.

12. ACADEMIC INTEGRITY CODE DISHONESTY IN EXAMINATION AND HOMEWORK

Dishonesty or cheating in examinations is the use of inappropriate or unauthorized materials, information, or study aids in a test. Unless the instructor directs otherwise, an examination is assumed to be solely a student’s own work. No communication is allowed among students either through voice, written, electronic, or any other form of transmission, nor are students permitted to consult books, papers, study aids or notes without explicit permission. Dishonesty in examination includes but is not confined to copying from another’s paper, giving or receiving unauthorized assistance, failing to hand in the exam at the end of the class period, using electronic devices and/or modified clothing/personal items to obtain unauthorized assistance, obtaining unauthorized advance knowledge of questions on an examination, and using mechanical or marking devices or procedures on scratch paper or machine-graded examinations. Dishonesty or cheating on homework includes but is not confined to plagiarism from another’s paper or from an outside source. Dishonesty or cheating on an examination or homework assignment may result in disciplinary actions including grade reduction and/or a formal complaint with the honor committee.

The complete policy of academic integrity for George Mason University can be found at the Office for Academic Integrity website: http://academicintegrity.gmu.edu/

13. STUDENTS WITH DISABILITIES

If you qualify for accommodations because of a disability, please notify me with a letter from the Office of Disability Services so that I can make arrangements to address your needs.

14. WAVES: WELLNESS, ALCOHOL AND VIOLENCE EDUCATION AND SERVICES

WAVES promotes wellness within the Mason community through health education, alcohol/drug assessment and education, and violence awareness, prevention and sexual assault response. We help students make healthy, safe choices and encourage lifelong, thoughtful healthy decision-making through individualized support, creative programming, and evidence-based education and outreach.

WAVES office 703-993-9999
SUB I, Suite 3200
24-Hour Sexual and Intimate Partner Violence Crisis Line 703-380-1434
waves.gmu.edu

- 703-360-7273 (Fairfax County Office for Women and Domestic and Sexual Violence Services 25 hotline)
- 703- 228-4848 (Arlington County Domestic Violence Services Hotline)703-368-4141 (Prince William County Sexual Assault Victims Advocacy Services)
- (SAVAS) hotline
  1-800-838-8238 (Virginia Family Violence and Sexual Assault Hotline) o 1-800-656-HOPE
  (Rape, Abuse and Incest National Network)
15. CAPS: COUNSELING AND PSYCHOLOGICAL SERVICES

Counseling and Psychological Services (CAPS) provides a wide range of free confidential services to students, faculty, and staff. Services are provided by a staff of professional clinical psychologists, social workers, counselors, learning specialists, and psychiatric providers. CAPS individual and group counseling, workshops, and outreach programs are designed to enhance students’ personal experience and academic performance.

Visit us at caps.gmu.edu for additional resources. For consultation or emergency assistance during office hours call 703-993-2380. For assistance during non-office hours, call University Police at 703-993-4357. 703-527-4077 (CrisisLink) 1-800-273-8255 (National Suicide Prevention Lifeline) 1-877-838-2838 (Veterans' Crisis Hotline)

16. STUDENT HEALTH SERVICES (SHS)— Provides confidential health care to enrolled students in emergency and non-emergency circumstances on the Fairfax, Arlington and Prince William campuses. If there is a medical emergency and Student Health Services (SHS) is closed, please contact the free after-hours nurse ((703) 993-2831), a hospital emergency room, an urgent care facility, or call 911.

SUB 1, Suite 2300 703-993-2831

17. UNIVERSITY POLICE

Emergency: 911 Non-Emergency: (703) 993-2810 Reporting a Crime (Crime Solvers Anonymous Tip Hot-Line): (703) 993-4111 Mason Police Website: http://police.gmu.edu/ Eric Heath, Chief of Police Phone: (703) 993-3840 E-mail: ehealth2@gmu.edu