Instructor
Dr. Carolina Salvador Morales
Email: csalvado@gmu.edu
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: 3:00-4:15pm
Innovation Hall 336, Fairfax Campus

1. COURSE NUMBER AND TITLE:
BENG 441-001: 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 and a visit to the NIST Center for Nanoscale Science and Technology.

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 reference books.

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. This book is the main reference book used in this course. It is recommended to purchase this book but it is not mandatory.

2. Molecular Biology of the Cell, Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, and Peter Walter, any edition. This book will be used as a reference only for the section titled “fundamentals of biological systems”.

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 in hard copy and electronically. Students will be asked to read a peer-reviewed paper before the beginning of next class as indicated in the calendar. Students will take a quiz on the peer-reviewed papers.

5. MID AND FINAL EXAM
The mid-term and final exam will take place on March 8, 2017 at class time and classroom. The final exam will take place on May 15, 2017 from 1:30 pm to 3:00 pm as indicated in the registrar calendar. The mid-term and final exam 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 in class and instructions will be posted on blackboard.

7. GRADING POLICY

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<thead>
<tr>
<th>Grade</th>
<th>Score Range</th>
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<tr>
<td>A+</td>
<td>&gt; 97</td>
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<td>A</td>
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<td>C</td>
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Content of the summaries: Write down in your own words your understanding of the key concepts discussed in class. Relate the concepts to each other. Do not write bullet points. Also write down the importance of those concepts in medicine. The summary should be written in one page as maximum, single space, 12 Font size and 1” margin.

Team Work Evaluation. The Final project written report and oral presentation will be conducted in teams. Students will be evaluated based on their team and individual contributions. To obtain 20% in the written report and final presentation, students should get at least B+ in these two activities. To obtain B+ the written report should contain original ideas, comprehensive content and good presentation. To assess student individual contribution to the team I will meet once a week with each team during my office hours and I will ask questions to every team member.

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 will be two meeting class per week and one topic will be covered per class. 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 start brainstorming on a nanomedicine topic before the spring break. Plan in advance the development of your scientific project according to your academic schedule. Work actively with your team members.

5. Ask questions in class and during the office hours.

9. CALENDAR:

<table>
<thead>
<tr>
<th>Topic</th>
<th>Date</th>
<th>Reference Material</th>
<th>Assignments</th>
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<tr>
<td>Introduction to Nanotechnology and biomaterials.</td>
<td>Week 1 (Jan 23)</td>
<td>Chapter 1-18</td>
<td>Problem sets in chemistry (review)</td>
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Course objectives, brief historical background of nanotechnology and nanomedicine, review of basic chemistry concepts and
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<tr>
<th>Topic</th>
<th>Week</th>
<th>Assignments</th>
<th>Problems sets in chemistry, biomaterials and material science</th>
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| Characterization techniques for biomaterials.          | Week 2 (Jan 30) | 1. Selected material will be provided in class.  
2. Chapter 2, 19-45  
3. Chapter 4, page 94, 98, 100. |                                                                |
2. Degradable polymer microspheres for controlled drug delivery.  
3. Selected material will be provided in class. | Problem sets in chemistry                                      |
2. Degradable polymer microspheres for controlled drug delivery. | Problem sets in chemistry                                      |
| Controlled release devices                             | Week 5 (Feb 20) | 1. Chapter 12, 321-340.  
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. | Problem sets in chemistry                                      |
**Fundamentals of Biological systems.** Specifically we will review key concepts on cell biology such as cell chemistry, structure and function of DNA, the cell cycle and programmed cell death and mechanics of cell division, the adaptive immune system.

| Week 6 (Feb 27) | 1. Chapter 3, page 48-73  
| | 2. Selected material will be provided. |
| Read the paper titled “Cells on trial”. |

**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 6) | 1. Long-circulating and target-specific nanoparticles: Theory to Practice.  
| | 3. Selected material will be provided in class. |
| Read the paper titled “Importance of Physicochemical characterization prior to immunological studies”. |

**Nanomedicine: Concepts and examples).** Cancer therapy, diagnostics, clinical studies, pharmacokinetics, toxicity of biomaterials.

| Week 8 (March 20) | 1. Nanocarriers as an emerging platform for cancer therapy.  
| | 2. Video on pharmacokinetics  
| | 4. Selected material will be provided in class. |
| Read the paper titled “Taming vessels to treat cancer”. |

**Nanoparticle and microparticle biomolecule drug carriers.** Pro-drug, micelles, liposomes, polymerosomes, nanoparticle, and microparticle delivery of drugs to tissues via systemic circulation

| Week 9 (March 27) | 1. Chapter 12, page 321-336  
<p>| | 2. Selected material will be provided in class |
| Read the paper titled “Polymer conjugates as anticancer nanomedicines”. |</p>
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<tr>
<th>Nanomedicine: Engineering biological recognition of biomaterials</th>
<th>Week 10 (April 3)</th>
<th>Long-circulating and target-specific nanoparticles: Theory to Practice. Protein binding case study 1: Understanding relationship between protein corona and nanoparticle toxicity</th>
<th>Read the paper titled “Nanoparticle interaction with plasma proteins as it relates to biodistribution.”</th>
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<td>Hydrogels as biomaterials. Hydrogel structure and physical chemistry, methods of polymerization.</td>
<td>Week 11 (April 10)</td>
<td>1. Chapter 6, page 159-163. 2. Selected material will be provided</td>
<td>Read the paper titled “Recent developments in hydrogels”</td>
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<td>Cell transplantation and immunoisolation</td>
<td>Week 12 (April 17)</td>
<td>Cell Transplantation for endocrine disorders and immunoisolation</td>
<td>Read the paper entitled “Immunoisolation”</td>
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<td>Molecular switches via proteins and “smart” polymers. Temperature, pH, and light-sensitive switches.</td>
<td>Week 13 (April 24)</td>
<td>pH-responsive polymer microspheres: Rapid release of encapsulated material within the range of intracellular pH).</td>
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<td>Project presentation</td>
<td>Week 15 (May 8)</td>
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<td>Final exam</td>
<td>Week 16 (May 15)</td>
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10. COURSE PACKAGE (Please find attached pdf for each scientific paper). This course package is divided in three sections. The first section contains the papers that should be read by the students as class assignments. The second section contains papers that further explain the information presented in class. The third section contains papers that can be read by students for further knowledge in the field of nanomedicine.
First section
1. Cells on trial
2. Importance of physicochemical characterization prior to immunological studies
3. Taming vessels to treat cancer
4. Polymer conjugates as anticancer nanomedicines
5. Nanoparticle interaction with plasma proteins as it relates to biodistribution
6. Cell transplantation for endocrine disorders
7. Immunoisolation

Second section
1. Degradable Polymer Microspheres for controlled drug delivery.
2. Structure and Morphology Changes in Absorbable Poly(glycolide) and Poly(glycolide-co-lactide) during in Viro Degradation.
3. Optimisation of treatment by applying programmable rate controlled drug delivery technology.
4. Nanotechnology in drug delivery and tissue engineering: from discovery to applications.
5. Long circulating and target specific nanoparticles: Theory to Practice.
6. Nanocarriers as emerging platform for cancer therapy.
10. pH-responsive polymer microspheres: Rapid release of encapsulated material within the range of intracellular pH.
11. Common pitfalls in nanotechnology: lessons learned from NCI’s Nanotechnology Characterization Laboratory.

Third section
1. Nanocarriers as an emerging platform for cancer therapy
2. Comparative properties and methods of preparation of lipid vesicles (liposomes)
3. Drug Delivery Systems: Entering the Mainstream
4. Endosome escape pathways for delivery of biologicals
5. Why degradable polymers undergo surface erosion or bulk erosion
6. Mechanisms of polymer degradation and erosion
7. Multifunctional nanoparticles properties and prospects
8. Closing the gap: accelerating the translational process in nanomedicine by proposing standardized characterization techniques.
9. Shape-adaptable polymeric particles
10. pH responsive gels
11. Hydrogels and tissue engineering

11. CELL PHONE, LAPTOP, FOOD POLICY

The use of cell phone, audio devices, laptop and eating in class 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.
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. For assistance during non-office hours, call the free after-hours nurse (703) 993-2831, a hospital emergency room, an urgent care facility, or call 911.

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