

**Department of Materials Science and Engineering
University of Maryland, College Park, Maryland**

ENMA 425- Introduction to Biomaterials

Course Description: Examination of materials used in humans and other biological systems in terms of the relationships between structure, fundamental properties and functional behavior. Replacement materials such as implants, assistive devices such as insulin pumps and pacemakers, drug delivery systems, biosensors, engineered materials such as artificial skin and bone growth scaffolds, and biocompatibility will be covered.

Pre-requisites: None, but an introductory Materials Science and Engineering class like ENES 230 is helpful

Textbook:

Biomaterials Science – An Introduction to Materials in Medicine, edited by (Buddy Radner et al.) Academic Press 1996

Supplemental text: Biomaterials Science and Engineering, Joon Bu Park (1984, 1992)

Course Objectives: The objective of this course is to explore the relationships between structure, properties and function in biomedical applications and how this can be used in materials and system selection and design. Students satisfactorily completing the class will:

1. Gain a historical perspective on the use of materials to remedy medical problems along with current perspectives.
2. Will understand the role of materials structure/property/function relationships in the design of improved biomaterials. This will be accomplished through lectures, case studies, and a team design project in which students will analyze and redesign biomaterials and biomaterials systems for improved function using materials selection criteria.

Course Goals to meet ABET 2005 Criteria:

1. Students are familiar with the relationships between material type and properties and function in biomedical systems
2. Students understand how to choose materials for the design of biomedical systems

Class Schedule: Tuesday, Thursday 3:30-4:45 p.m.

Grading:

35%	Term Team Project (includes a presentation)
20%	Midterm
25%	Final Exam (date as given in the Schedule of Classes)
20%	Homework, reading, class participation

University Code of Ethics: <http://www.inform.umd.edu/CampusInfo/Departments/JPO/>

Topics Covered:

- I. Introduction, Historical Perspectives of Biomaterials
- II. Design Principles in Nature: Biomimetics
 - a) Natural systems – collagen, bone, nacre, spider silk
 - b) Biomineralization – biocolloids, magnetotactic bacteria
 - c) Spin-off technologies (biomaterials development, controlled release, bioreactors, tissue engineering)
- III. Structure/Property/Function Relations for Biomaterials
 - a) Mechanical, Structural, Thermodynamic, Sensing Properties of Materials for Biological Applications
 1. Bulk Properties
 2. Surface Properties
 3. Characterization Techniques
 - b) Classes of Biomaterials
 1. Metallic Implants
 2. Polymer Implants
 3. Ceramic Implants
 4. Composite Implants
 - c) Degradation of Materials in the Biological Environment
- IV. Biological Aspects of Biomaterials Implants
 - a) Basics of Cells and Cellular Function
 - b) Tissue Organization and Function
- V. Biocompatibility Issues for Materials in the Body- In *Vivo* Response
 - a) Host Reactions
 - b) Immunology and System Toxicity
 - c) Blood-Materials Interactions
 - d) Tumorigenesis and Biomaterials
 - e) Infection – Implant Associated
 - f) Biomaterials Testing (in *vivo*, in *vitro*)
- VI. Materials Applications in Medicine and Dentistry
 - a) Cardiovascular
 - 1) Heart Valves
 - 2) Assist Devices
 - 3) Total Artificial Heart
 - b) Dialysis and Insulin Pumps for Enhancement of Kidney and Pancreas Function
 - c) Dental Implants and Restorations
 - 1) Adhesives and Sealants
 - 2) Restorations (Crowns and Bridges)
 - d) Ophthalmologic Implants (eye)
 - e) Drug Delivery Systems
 - f) Biosensors

VII. Tissue Engineering

- a) Methodology
 - 1) Cell Line Establishment
 - 2) Scaffold Materials (Polymer, Ceramic)
- b) Hard Tissue (Bone, Teeth)
- c) Soft Tissue (Cartilage, Skin, Organs)

VIII. Future Developments

Instructor: Dr. Isabel Lloyd
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Office hours: Weds. 1:00-3:00 pm, Fri. 12-1 pm and by appointment (tentative)

Prepared by Prof. Lloyd, August 2004

