

## **BME 4440/6440 – Biomaterials**

### **Course Description**

Classifications of biomaterials, typical structures, and properties for biomedical applications. Introduction to basic human anatomy, cell and biomolecule structure and function, and cellular fate processes as they relate to biocompatibility as part of the design of medical devices and their biomaterials. Fundamentals of cell-biomaterial interactions and the response of living tissues to implanted biomaterials, including inflammatory responses and blood compatibility. Assessment of biocompatibility of biomaterials, sterilization procedures and an introduction to ethical and regulatory issues with medical devices.

Undergraduate/Graduate level - 4 credit hours.

BME 4440L/6440L corequisite

\*Homework and exams are specific for the graduate students. In them concepts are explored at a deeper level than for undergraduates.

### **Course Learning Objectives**

Students enrolled in BME 4440 /6440 will learn to:

Provide foundational knowledge in the fields of materials science and engineering, applied to materials used in biomedical applications, specifically polymeric, metallic, ceramic, and composite biomaterials, and the relationship between their properties and performance.

1. Overview of current challenges and successes with implantable medical devices, biomaterials properties, clinical requirements, clinical applications and cases, and in vivo behavior of different classes of natural and synthetic materials.
2. Analysis of biological response and biocompatibility, degradation, and failure processes of implantable biomaterials/devices.

### **Course Learning Outcomes**

On successful completion of this course, the student can:

Understand how the characteristics of the four types of biomaterials (metallic, polymeric, ceramic and composite) affect their properties and interactions with the body and how these relate to their application in medical devices.

1. Understand methods to modify biomaterials to obtain the desired biological response.
2. Discuss potential applications of biomaterials in treating human diseases, including biomaterial selection requirements.
3. Apply knowledge of basic human anatomy, cell and biomolecule structure and function, to evaluate how biomaterial properties influence their interaction with the body.
4. Appreciate the ethical responsibilities and regulatory processes involved in the process of developing biomaterials and translating medical devices.

### **Tentative Weekly Schedule**

Week 1	Orientation and Introduction to Biomaterials; Material Properties, Surface Characterization
Week 2	Polymers; Polyurethane, Silicones, Fluorinated Biomaterials (HW 1 due)
Week 3	Restorative Composites and Adhesives; Hydrogels
Week 4	Smart Polymers, Medical Fibers and Biotextiles; Biodegradable materials, Natural materials (HW 2 due)
Week 5	Natural materials, Surface Modification (Read 1.3.6B); Surface Patterning, Metals

Week 6	Titanium Alloys, Stainless Steels; CoCr alloys, Biodegradable metals (HW 3 due)
Week 7	Ceramics and Glasses, Hydroxyapatite; Composites
Week 8	Midterm Review; Composites, Carbon Biomaterials
Week 9	MIDTERM; Carbon Biomaterials, Porous materials
Week 10	Cells, Stem Cells, Cell injury response (HW 4 due); Adsorbed proteins
Week 11	Nonfouling Surfaces; Cells and surfaces, Cell/tissue biomaterial interactions
Week 12	Biological response, Inflammation and immunity (HW 5 due); Innate immunity
Week 13	Adaptive immunity; Systemic and immune toxicity, Tumorigenesis
Week 14	Blood coagulation, Blood-material interactions, Biofilms, Pathological calcification (HW 6 due); Review for Final
Week 15	FINAL EXAM