Department of Materials Science and Engineering
University of Maryland

ENMA425: Introduction to Biomaterials (Elective) – 3 Credits

Class Schedule: 11:00am-12:15pm Tuesday, Thursday

Instructor: Prof. Joonil Seog


References:
1. Introduction to Protein Structure, 2nd Edition, Carl Branden & John Tooze
2. Intermolecular force in biology, Quarterly Reviews of Biophysics 34, 2001, p105; Deborah Leckband & Jacob Israelachivili
3. Introduction to Polymers, 2nd edition, RJ Young and PJ Lovell
4. Biomaterials, the interaction of biology and materials science, Temenoff and Mikos, 2008

Catalog 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.

Course Description: Examine the relationship between structure and function of biomaterials. Study physical properties of synthetic and natural biomaterials. Understand molecular level interactions between biomolecules and biomaterials to design novel biomaterials with desirable characteristics. Application of biomaterials as implants, drug delivery systems, biosensors, and scaffold materials for tissue engineering will be covered.

Pre-requisites: Organic chemistry CHEM231 and CHEM 232. An introductory Materials Science and Engineering class like ENES 220, ENMA 300 or ENME 382 is helpful.
**Student Outcomes covered by the Course:**
ABET A: Ability to apply mathematics, science and engineering principles;
ABET C: Ability to design a system, component, or process to meet desired needs.
ABET H: The broad education necessary to understand the impact of engineering solutions in a global and societal context;
ABET K: Ability to use the techniques, skills and modern engineering tools necessary for engineering practice

**Topics Covered:**

1. History and overview of biomaterials
2. Bulk properties of materials (1.2)
3. Tissues, the extracellular matrix, and cell-biomaterials interactions (3.4)
4. Natural biomaterials I (2.8)
5. Natural biomaterials II (2.8)
6. Synthetic biomaterials: polymers (2.2)
7. Biodegradable and bioerodible materials (2.7)
8. Synthetic biodegradable polymer scaffold (8.4)
9. Hydrogels and smart polymers (2.5, 2.6)
3/3 Exam 1
10. Surface properties of materials (1.4, 2.14)
11. Surface immobilized biomolecules (2.16)
12. Intermolecular forces in biology (van der Waals and electrostatic forces)
13. Intermolecular forces in biology (hydration, hydrophobic, and steric forces)
14. The role of adsorbed proteins in tissue response to biomaterials (3.2)
15. Blood coagulation and blood-materials interactions (4.6)
16. Biofilms, biomaterials, and device related infections (4.8)
17. Nonthrombogenic treatments and strategies (7.2)
4/9 Exam 2
18. Orthopedic applications (7.7) & Dental implantation (7.8)
19. Structural basis for the fracture toughness of the shell
20. Cardiovascular medical devices (7.3)
21. Tissue engineering (Ch 8) & Burn dressings and skin substitutes (7.12)
22. Biomedical sensors and biosensors (7.17)
23. Drug delivery systems (7.14)
24. siRNA-based therapeutics
25. Nanocomposites inspired by the sea cucumber dermis
26. Designing novel biomaterials