Cell-Biomaterial Interactions

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Course Description
A broad introduction to basic cell biology, interfacial science, surface spectroscopy techniques, the cascade of events in vivo immediately after implantation, cell responses to physical and chemical modifications of biomaterial surfaces, cell signaling and feedback mechanisms between the extracellular matrix or implant surfaces and cell surface expression of biomolecules, cell responses to mechanical forces, stem cells and their differentiation, examples of responses of specific cell types to implant properties including, mesenchymal stem cells, osteoblasts, osteoclasts, chondrocytes and neural cells, and bacterial biofilm infections at implant surfaces in vivo.

The course is targeted to senior undergraduate and graduate students.

Course Goals
To understand the chemical-physical forces controlling interactions at the biomolecule/cell/water/biomaterial interface, the feedback mechanisms between cells and biomaterials, and implant design and tissue engineering applications.

To develop skills in critically evaluating the scientific literature and identifying unsolved research problems, to propose fruitful approaches towards solving these problems, and to improve both oral presentation and writing skills.

Grading
Written Proposal 50%
Presentation of Proposal 40%
Classroom Participation 10%

Reading References


Deadlines
Topic of the proposal will be selected by the end of week 6 and brought to WL or NS for approval.
Written proposal to be submitted by April 30, 2012.
Proposal Content
Proposal to include Introduction (hypothesis, significance, results of previous work, limitations in the state-of-the-art or open questions), Specific aims, Methods and expected results, Preliminary results if any, Summary of conclusions if any, Potential pitfalls and alternate approaches, References, Figures and Tables with legends.

Proposal Format
5 pages length, excluding references, figures with captions and tables with legends
1.5 line spacing, 1 inch margins on all sides of the page
Insert page numbers at bottom of right page
Font size 12 and sans serif
Color permitted

Presentation Criteria
Slide content and clarity
Voice clarity (projection, speed, enunciation)
Physical presentation of self to the audience
Technical understanding and response to audience questions
20 minutes time including questions
COURSE SCHEDULE

Lecture 1: Overview of Cell – Biomaterial Surface interactions. NS
Lecture 2: Interfacial Thermodynamics. NS
Lecture 3: Cell Structure and Function. WL
Lecture 4: Structure of Nucleic Acids and DNA Synthesis and Repair. WL
Lecture 5: Transcription of DNA to RNA. WL
Lecture 6: Translation of RNA to Protein. WL
Lecture 7: Introduction to Extracellular Matrix. WL
Lecture 8: Bioinspired adhesive materials. Prof. Ali Dhinojwala
Lecture 9: Lipid and Protein Interactions with Biomaterials; Surface Probe Apparatus.  Dr. Younjin Min
Lecture 10: X-Ray Spectroscopy Methods. Prof. Mark Foster
Lecture 11: Hemostasis and the Blood Clotting Cascade after Implantation. WL

President’s Day – No Classes

Lecture 12: Peptide-Functionalized Polymers – Correlating Structure to Function. Prof. Matthew Becker
Lecture 13: Inflammatory Response. WL
Lecture 14: Cell Responses to Functionalized Scaffolds in Tissue Engineering. WL
Lecture 15: Nanofibers that Modulate Bone Growth. Dr. Todd Ritzman
Lecture 16: Carbon Nanosphere-Biomaterial Interactions. Prof. Nic Leipzig
Lecture 17: Cell Responses to Chemically Modified Biomaterial Surfaces. NS
Lecture 18: Cell Responses to Mechanical Properties of Biomaterials. NS
Lecture 19: Soluble Bioceramics and Osteogenic Differentiation of Mesenchymal Stem Cells. NS
Lecture 20: Stem Cells and Techniques to Study Their Differentiation. Prof. Fayez Safadi
Term Paper Topics Due

SPRING BREAK – NO CLASSES

Lecture 21: Blood-Biomaterials Interactions. Prof. Anirban Sen Gupta
Lecture 22: Microbial Biofilms on Implant Surfaces. NS
Lecture 23: Neural Cell Response to Stiffness and Laminin Coatings. Prof. Rebecca Willits
Lecture 24: Engineered Hydrogels for Controlling Cell Behavior. Dr. Eben Alsberg
Lecture 25: Supramolecular Nanoparticles for Cell Imaging, Cell Tracking and Biosensing. Dr. Guillermo Bracamonte
Lecture 26: Supramolecular Nanoparticles for Drug Delivery. Dr. Guillermo Bracamonte
Student Presentations
Student Presentations
Student Presentations
Student Presentations

Final Exam Week – No Examination
Final Grades Due