

## Biomaterials-Tissue Interactions

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### SYLLABUS

Principles of materials science, chemical and mechanical engineering, and cell biology underlying the use of materials for the development of implantable devices. Including permanent biomaterials for prosthetic devices (*e.g.*, joint replacement prostheses), and absorbable (biodegradable) biomaterials as scaffolds for tissue engineering and regenerative medicine (figure). Employs a conceptual model, the "unit cell process," for systematic analysis of the mechanisms underlying wound healing and tissue remodeling following implantation of biomaterials/devices in various organs. Unit cell processes will also include those dealing with: the action of biomaterial scaffolds on cells; tissue and biomaterial degradation; and wound contraction. Design principles of implants based on control of biomaterials-tissue interactions. Comparative analysis of permanent and absorbable implants by reference to clinical case studies. Criteria for restoration of physiological function for tissues and organs.

#### Course Materials

The course materials will be posted on the class Stellar website, as will be the homework sets. Selected readings will be in the book, *Tissue and Organ Regeneration in Adults*, by I.V. Yannas, which will be on reserve at the MIT library.

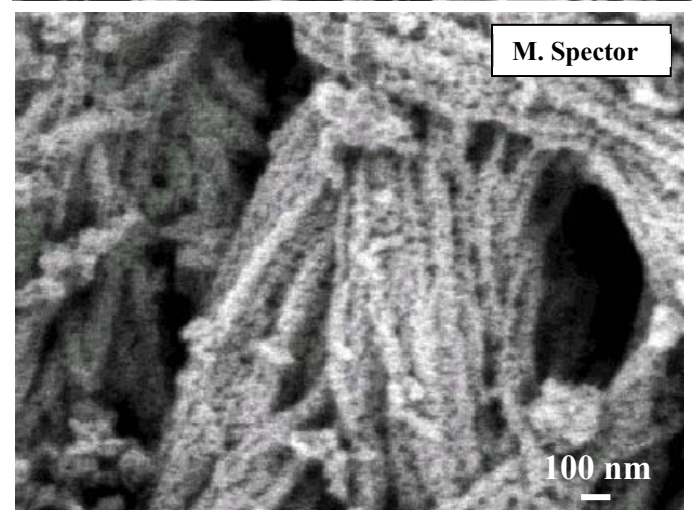
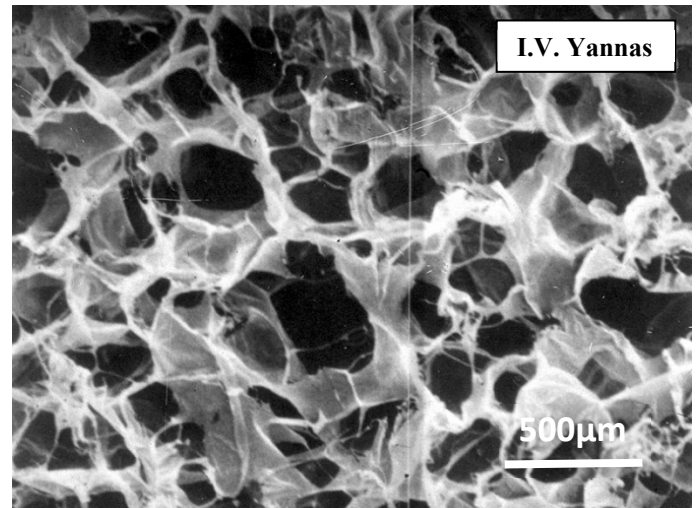
#### Grading

The final grade will be based on 3 quizzes (open notes/website access). No final exam. The quiz questions will be principally based on material discussed in class.

#### Homework Sets

Assigned homework sets will not be graded. Most of the homework questions are quiz questions from prior years. Examples of how quiz answers will be graded will be provided during the class presentation of the homework solutions.

**No collaboration is permitted on the homework sets and quizzes.**



Scanning electron micrographs of absorbable biomaterial scaffolds for organ regeneration. (Top) A collagen-GAG scaffold with regenerative activity employed in the clinic as a dermal regeneration template. The micrograph shows the physical structure but not the surface chemistry (specific ligands for cells). (Bottom) A natural bone mineral scaffold produced by removing the organic matter from bovine bone; the native collagen fiber structure is reflected in the calcium-phosphate (apatite) crystallite structure. The scaffold is used in the clinic to facilitate bone regeneration in defects at various locations.

**Massachusetts Institute of Technology 2.79J/HST.522J Fall 2021**  
**Tuesdays and Thursdays; 2:30-4:00 PM**  
**Stellar Website: <http://stellar.mit.edu/S/course/2/fa21/2.79/>**

**BIOMATERIALS - TISSUE INTERACTIONS**

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Lec #	Date	Readings		Lecturer
<b>I. TISSUE ENVIRONMENT OF THE IMPLANTED BIOMATERIAL: UNIT CELL PROCESSES</b>				
1	Sept 9	1	Survey of Clinical Cases of Biomaterials-Tissue Interactions	Spector/Yannas
2	14	2,4	Tissue Structures and Unit Cell Processes	Spector
3	16	3	Biological Function of Extracellular Matrices (ECM)	Yannas
4	21	5	Unit Cell Processes Comprising the Healing Response	Spector
5	23	8	Unit Cell Processes Underlying Tiss Engr/Regen Med	Spector
6	28	<b><u>1,2,3,4</u></b>	Quantitative Analysis of Wound Closure	Yannas
7	30		Injectable Biomaterials	Love
8	Oct 5	21	Multifunctional Drug Delivery Devices	Mendez
9	7		<b>QUIZ #1</b>	
<b>II. TISSUE/ORGAN RESPONSE TO IMPLANTS</b>				
10	12	13	Chronic Response to Implants	Spector
11	14	13	Tissue Response to Particles; Review	Spector
12	19	8	Biomaterial Scaffolds for TERM	Spector
13	21	<b><u>6</u></b> (pp. 167-172)	Degradation of Biomaterials	Yannas
14	26	<b><u>8</u></b>	Scar Formation around Biomaterials	Yannas
15	28	<b><u>7</u></b>	Selection of Biomaterials for Regeneration	Yannas
16	Nov 2	<b><u>9</u></b>	Mechanism of Organ Regeneration	Yannas
17	4		<b>QUIZ #2</b>	
<b>III. IN VIVO AND CLINICAL CASE STUDIES</b>				
18	9	<b><u>Appendix</u></b>	Manufacturing Errors that Doom Biomaterials	Yannas
	11		<i>No Class; Veterans Day</i>	
19	16	18	Biomat for TERM of Musculoskeletal/Oral Tissue: Bone	Spector
20	18	18, 19	Bone Response to Long Term Implants: Orthopaedic and Dental Prostheses	Spector
21	23	18	The Roles of Biomaterials in Cartilage Repair	Spector
	25		<i>No Class; Thanksgiving Day Holiday</i>	
22	30	20	Biomaterial Applications in the CNS: Brain and Spinal Cord	Love/Spector
23	Dec 2	20	Biomaterial Applications in the CNS: Retina	Dromel
24	7	15, 22	Databases for Biomaterials Search: Nerves; Startups; Review	Yannas/Spector
25	9		<b>QUIZ 3</b>	

\* Readings: Numbers in plain text refer to chapters on the Web site; numbers in bold, italics, and underlined refer to chapters in Tissue and Organ Regeneration in Adults, I.V. Yannas, 2<sup>nd</sup> edition, 2015. MIT Library reserve.