Principles and Practice of Tissue Engineering

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COURSE OVERVIEW

DESCRIPTION
The principles and practice of tissue engineering (and regenerative medicine) are taught by faculty of the Harvard-MIT Division of Health Sciences and Technology, and faculty of affiliated and other institutions. The subject will be Webcast to the world.

The principles underlying strategies for employing selected cells, biomaterial scaffolds, soluble regulators or their genes, and mechanical loading and culture conditions, for the regeneration of tissues and organs in vitro and in vivo are addressed. Natural and synthetic scaffolds, and undifferentiated (viz., stem cells) and differentiated cell types, are compared and contrasted for various applications. Methodology for the preparation of cells and scaffolds in practice is described. The rationale for employing selected growth factors is covered and the techniques for incorporating their genes into the scaffolds are examined. Discussion also addresses the influence of environmental factors including mechanical loading and culture conditions (e.g., static versus dynamic). Methods for fabricating tissue-engineered products and devices for implantation are taught. Examples of tissue engineering-based procedures currently employed clinically are analyzed as case studies.

“Take Home Messages”
Students will have learned how to apply tissue engineering principles to the solution of medical problems requiring the regeneration of tissue, and the methods for the fabrication of tissue-engineered products. They will have exercised this knowledge in a Term Report requiring them to select certain cells, scaffolds, cytokines, and culture conditions individually or in combination to address a specific clinical problem.

RATIONALE
By presenting these topics in one subject, students will have the opportunity of learning details of certain aspects of tissue engineering and be able to place them in the broader context of the overall strategic approach used to solve a clinical problem. By presenting the practice as well as the principles, students will come to appreciate the real-world challenges encountered in translational research.

The impact of a subject which is Webcast to the world relates to the very demonstration of the universality of tissue engineering principles and practice. The benefits include the exposure to questions and comments that will come from individuals from many countries (by e-mail) which, in part, will reflect the similarities and differences in the way in which tissue
engineering may be implemented for the solution of clinical problems (e.g., affected by available resources, health care philosophies, economic issues, and other cultural factors).

CLASS SESSIONS
Students at MIT/Harvard will attend the same 90-min. lecture each week, Wednesday mornings from 8:00-9:30 AM (Boston time). Prior to the class session all students will be given a reading assignment and access to the presenters’ PowerPoint slide presentation on a Harvard Web site that has been established. All classes will be held at MIT in Rm. 9-152.

GRADING
The final grade will be determined by the following:
- 30% Quiz #1
- 30% Quiz #2
- 30% Term Report
- 10% Homework (10 homework assignments)

Quizzes
Each quiz will be 90 minutes in length and cover the information presented and discussed in class and in the homework sets. Any notes can be used during the quiz. Quiz #2 will focus on material presented and discussed during the second half of the subject but some reference may be made to material discussed in the first half of the course.

Term Report
The term report, which will be prepared individually by each student, will be 12 pages (US letter size, 8 1/2 x 11 inches with a 1 in border all around), 1 1/2 line spacing, Times Roman font or equivalent with a minimum font size of 12 pts. The Report should be written in English. The 12-page limit includes all text, images and references. The Report will describe a tissue engineering approach for the production of a tissue or organ (i.e., a structure comprising 2 or more tissues) of the student’s selection. The Report will include discussion of the following: rationale for the production of the tissue in vitro or the preparation of an implant for the regeneration in vivo; scaffold material and characteristics to be used; cells to be employed; and regulators to be implemented. Additional details dealing with the preparation of the Report will be discussed in class. The Report will be due as a Microsoft Word document sent as an attachment to an e-mail message to Professor Spector by 5:00 PM (Boston time) on Wednesday, November 28.

CREDIT FOR SUBJECT
The subject is allocated 8 assigned units, reflecting the minimum number of hours per week that the students will be engaged in class-related activities: 1 ½ hours in class and 6 ½ hours out of class studying the materials presented in class and posted on the Web site, working on homework sets, and working on the Term Report.

PREREQUISITES
The subject is taught as a first-year graduate level course for students with engineering and science backgrounds, and students enrolled in medical school. As prerequisites students should have had subjects covering concepts of cellular biology and surveying the composition
and properties of materials. The course directors can assist in determining if such prerequisites are met by individual subjects at the respective institutions.

READING MATERIALS

Readings for the subject will comprise lecture notes, PowerPoint slides, journal articles, and selections from textbooks. All of the reading materials will be posted on the Web site as “pdf” files which can be downloaded.

OTHER MIT SUBJECTS ADDRESSING TISSUE ENGINEERING

Tissue engineering is such a broad field encompassing principles from so many disciplines that no one subject can deal with all of its aspects in meaningful depth. There is some overlap of certain tissue engineering concepts presented in HST.535 with topics presented in other subjects offered at MIT. However, HST.535 will address several topics not dealt with in other subjects and other topics will be discussed in greater depth in HST.535. Moreover, some topics will benefit from their inclusion in a subject exclusively focused on tissue engineering.

Following are other MIT subjects addressing tissue engineering in their curriculum:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Subject Title</th>
<th>Instructor(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.449/20.360</td>
<td>Cell and Tissue Engineering</td>
<td>L. Griffith/H. Lodish</td>
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<tr>
<td>HST.521</td>
<td>Biomaterials and Tissue Engineering in Medical Devices and Artificial Organs</td>
<td>F. Schoen</td>
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ACKNOWLEDGMENT

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