BIOL 1150 – Stem Cell Engineering
Prof. Eric Darling

BIOL1150 - Stem Cell Engineering, Fall 2013

Course description
Stem cell engineering is a relatively young field of research that focuses on using adult, embryonic, and induced stem cells to repair damaged or diseased tissues. This course will examine the role of stem cells in development, tissue homeostasis, and wound healing, as well as how they have been used for tissue engineering and cell-based regeneration therapies. As such, the course is divided into two major topic areas: stem cell biology and biomedical applications. The first third of the course will focus on the biological aspects of stem cells, while the remaining portions will highlight the practical use of these cells for improving health and well being. We will also discuss the ethical, legal, and regulatory issues that accompany current and emerging stem cell engineering endeavors. The course will use a lecture and discussion format to effectively present relevant information. As an additional part of this course, students will receive hands-on training in how to isolate, culture, and differentiate adult stem cells in a laboratory setting.

Prerequisites
This course is for graduate students and upper-level undergraduate concentrators in biology, engineering, or other scientific fields. Prerequisites are CHEM 0330 and BIOL 0500 or an equivalent course in cell biology or physiology. Enrollment is limited to 20 students to facilitate in-class discussions of current literature and beneficial laboratory participation. Preference will be given to graduate students and seniors.

Course goals
This course is designed for students interested in the field of stem cell engineering and will provide an introduction to the role of stem cells in tissue growth and development, the theory behind the design and in vitro construction of tissue and organ replacements, and the applications of biomedical engineering principles to the treatment of tissue-specific diseases. Upon completion of the course, students will be well equipped for several burgeoning areas of biomedical engineering and its integration with stem cell science and regenerative medicine. Information will be learned through textbook and journal article readings as well as class discussions of the latest research developments in the field. Development of writing, oral communication, and critical thinking skills will be emphasized through joint projects and presentations.

Grading
10% Assignment 1: 8-12 slide summary of scientific article in PowerPoint format (i.e. journal club)
30% Take-home examination
15% Assignment 2: Oral presentation
20% Assignment 3: 10-page paper
10% Class participation
15% Lab performance and write-up

Readings
Readings will be from Essentials of Stem Cell Biology (Lanza), Stem Cell Engineering (Altmann, Minger, Hescheler), and scientific journal articles on stem cell engineering (to be posted on My Courses).

Assignment Descriptions
1. Review of scientific journal article: 8-12 slide summary of scientific article in PowerPoint format (i.e. journal club). Journal article choice must be approved by noon on TBD. Summary due by noon on TBD.
Select a recent paper related to Stem Cell Engineering that is of interest to you. The paper’s publication date must be 2005 or later. Have Prof. Darling approve your selection by TBD. Incorporate summary of introduction, methods, results, and discussion into a clear, concise, slide-based presentation. For detailed suggestions of what information to include, see example on MyCourses.

2. **Individual oral presentation**. To be scheduled for three class periods near the end of the semester.

   Give a PowerPoint presentation to the class on a Stem Cell Engineering Application*. This presentation should be 12-15 minutes and appropriate for a lay person audience (see example below). You should assume that each of your reviewers has a general college education but do not assume any are an expert in stem cells or regeneration therapies. The goal of the presentation is to clearly explain your subject matter and application to persuade the audience that your proposed approach is feasible and well thought out.

   **Example:** The Alzheimer’s Foundation of America review board is composed of educated individuals in business, law, science, and medicine. The foundation’s mission is to provide optimal care and services to individuals, caregivers, and families confronting dementia. What cutting-edge, stem cell options currently exist, and which strategy should they fund? Why? Make the argument for choosing your proposed approach or the approach that you have found to be the best in current literature.

3. **Technical research proposal**, 10 pages (plus additional pages as needed for bibliography). Due TBD.

   Write a paper on the same Stem Cell Engineering Application* that you presented for Assignment 2. In contrast to the oral presentation in Assignment 2, write this paper at a high scientific and technical level, as if it is for a reviewer from the National Institutes of Health or the National Science Foundation who is an expert in the field of stem cell science, though not necessarily an expert in your chosen sub-field. Address directly your scientific reasons for choosing a particular strategy over other strategies, including its potential for clinical success.

*Topic for Assignments 2 and 3: Stem Cell Engineering Applications
Using information from class, labs, and current research literature, compare multiple stem cell engineering strategies for a specific therapeutic application. Alternatively, you may develop an original experimental strategy that addresses a specific application in the area of stem cell, regeneration therapy. In either case, you must present both orally (Assignment 2) and in writing (Assignment 3) the strengths and weaknesses of each strategy, and highlight your reasons for selecting one particular strategy as the best.

Submit your top 3 topic choices by October 12. Topics will be assigned to present the class with a diverse set of stem cell engineering subfields (i.e. musculoskeletal, cardiovascular, drug delivery). Topic assignments will be made in the order of submission; you are advised to consult with Prof. Darling or the TA and submit your choices early in the semester.

**Lab Descriptions**
Five, non-conventional laboratory sessions are included as part of the Stem Cell Engineering course. The class will be divided into four groups to conduct separate laboratory experiments. Discussion and synthesis of results will be carried out with the entire class. Because these experiments involve cell culture, a joint effort will be required my members of each group to maintain cells in a healthy state through a period of 4-5 weeks. Lab sessions will focus on three areas: stem cell isolation, culture, and differentiation. The first session is a brief review of sterile cell culture procedures, followed by students making expansion and lineage-specific media cocktails necessary for later stages. The next week involves isolating adult stem cells from multiple mature tissues from a small animal model (i.e. rat). Each group is responsible for harvesting, cleaning, digesting, and plating stem cells from target tissues (bone marrow, fat, muscle, skin). The subsequent lab session focuses on maintaining cell cultures, monitoring cell density and determining when cells should be passaged, and assessing...
the health of the cultures which includes identifying multiple types of contamination. The third lab session has students differentiate stem cell cultures down three target lineages (bone, fat, cartilage) to determine whether their cells can be considered “multipotent.” This portion of the lab lasts three weeks to allow complete differentiation. The final session involves assessment of the differentiated samples. Protein staining and biochemical assays are used to quantitatively assess the degree of differentiation for each sample. Lab sessions will be monitored by Dr. Darling and/or the TA to provide initial guidance and oversee lab safety procedures. Additional lab use (e.g. changing culture media) should be scheduled during Multidisciplinary Lab (MDL) operating hours. Protocols and instructions will be distributed a week before each lab session, and results/experiences will be discussed the following class period.

**Class participation**

10% of your grade will be based on class participation. To achieve full credit, you must:

1. Attend, be prepared for, and actively and respectfully participate in each class and lab.
2. Prepare 2 questions per article on assigned journal articles and submit them by email to the TA by Monday 5pm for TBD-TBD classes.
3. Give written feedback to classmates on their individual oral presentations of Assignments 1 and 2.

**Resources**

- Journals with articles of interest to Stem Cell Engineering
  - ASAIO Journal
  - Cell (Stem Cell)
  - Cell and Molecular Bioengineering
  - Cytotherapy
  - FASEB Journal
  - Journal of Cell Science
  - Nature (Biotechnology, Materials, Medicine)
  - Proceedings of the National Academy of Sciences USA
  - Science
  - Stem Cells and Development
  - Tissue Engineering A, B, C

**Course policy on courtesy**

Everyone is expected to respect the deadlines of the course. Requests for extensions on assignments and exams will be considered only if accompanied by a written memo from a dean or from Health Services.