MEDS 380: Stem Cells: Fact and Fiction (2 units)

SPRING 2020: January 16 – April 30
Thursday 4:00 – 5:50 pm, 1 hour 50 minutes contact time per week
Room VKC 155

INSTRUCTOR:
- Gage Crump, Ph.D., Professor and Director of PhD Program in Stem Cell Biology and Regenerative Medicine, Keck School of Medicine of USC
- Office Address: 1425 San Pablo St, BCC 406, Los Angeles, CA 90089-2821
- Office Phone: (323) 442-2693
- Office hours by appointment: please contact Gage Crump at gcrump@usc.edu

Introduction and Purpose

Stem cells have captured the imaginations of scientists, physicians, and the general public for their ability to revolutionize not only how we treat diseases but the foundations of life itself. This course discusses how stem cells and regenerative medicine have been portrayed in culture, the scientific underpinnings of what is currently possible, and visions into the future of this field.

In the timescale of humanity, the biological revolution is very much in its infancy. Yet many concepts that were strictly the realm of scientific fiction have now become, or on the verge of becoming, reality. Driven by genetic engineering and stem cell technology, we have brought extinct animals back to life, conceived embryos from three biological parents, synthesized the genetic blueprint of organisms from scratch, and genetically modified human beings. What might the future hold? Will we find cures for most if not all diseases? Will we live much longer, healthier lives? Are we entering a new stage of self-directed evolution? Are we changing the very essence of what it means to be human?

A special emphasis will be placed on the scientific basis of stem cell biology and regenerative medicine. Interleaved into this will be a discussion of how the reality of stem cell science contrasts with how it has been foretold and portrayed in literature, film, and media.

Upon successful completion of this course, the student should be able to demonstrate a working knowledge of:

- The history of stem cell science
- The biology of stem cells
- The uses of stem cells in regenerative medicine
- Non-medical applications of stem cells in animal conservation and for-profit companies
- The portrayal of stem cells in culture and media

Course Requirements and Grades

- Textbook: Stem Cells: Scientific Facts and Fiction by Mummery, Christine et al. Second Edition (2014). Elsevier Press. ISBN 978-0-12-411551-4

- Course materials include a selection of articles from the peer-reviewed scientific literature, as well as media articles, science fiction literature, and film. These required readings are listed below under Class Sessions.
- The course will consist of one 110 minute meeting each week, which will involve a dynamic combination of lecture, videos, and class discussion.
- Prior to each class meeting, students will receive communication with material to read, listen to, and/or watch in preparation for the session. Students will be expected to be able to discuss the material during class.
- Grading breakdown: Letter Grade
  20% of the grade will be for participation and group presentations of researched material
  20% of the grade will be for short, unannounced quizzes (best 4 out of 5 for grade)
  30% of the grade will be for the mid-term short story
  30% of the grade will be for the final exam

  Grading Scale (curve will likely be applied):

A	94-100
A-	90-93
B+	87-89
B	83-86
B-	80-82
C+	77-79
C	75-76
C-	74-70
D+	69-67
D	66-64
D-	63-60
F	59-0

Examinations:

Final exam and quizzes will be short essay questions. The mid-term exam is an original piece of short fiction.

Class Sessions: 1 hour 50 minutes

Week 1 Introduction
Jan. 16 **What are Stem Cells?**

Viewing of Film "Stem Cell Revolutions: Visions of the Future" – 71 minutes

Required reading:
1. Chapter 3 of StemCells: SFF. "What are Stem Cells?"

Week 2 From Dolly the Sheep to Bringing Back Wooly Mammoths and Dinosaurs
Jan. 23 **Cloning by Somatic Cell Nuclear Transfer**

<u>Class Exercise #1</u>: Groups of 3 students each prepare discussion of how to de-extinct a particular animal. I will assign animals and groups at the end of Week 1 and each group will come prepared to discuss the advantages and challenges of bringing their animal back from extinction.

<u>Required reading:</u>
1. Chapter 6 of StemCells: SFF. "Cloning: History and Future Applications"

Week 3 The Clone Wars
Jan. 30 **Human Cloning**

<u>Novel #1 Discussion:</u> <u>Boys from Brazil</u> by Ira Levin

<u>Required reading:</u>
1. "Yes to Human Cloning" by Rael.

Week 4 Growing Embryos Outside the Mother
Feb. 6 **Embryonic Stem Cells and Embryoid Bodies**

<u>Required reading:</u>
1. Chapter 4.1-4.5 (pp. 69-89) of StemCells: SFF. "Of Mice and Men: The History of Embryonic Stem Cells"

2. "Human embryos grown in lab for longest time ever". Commentary in *Nature*.

Week 5 Designer People
Feb. 13 **Genetic Engineering of Stem Cells and Human Embryos**

Movie Viewing Before Class: *GATTACA (1997) – 106 minutes*

<u>Class Exercise #2</u>: Groups of 3 students each prepare discussion of an application of genetic engineering in humans, such as curing a disease or introducing a new ability.

<u>Required reading:</u>
1. CRISPR editing of human babies in China
<u>https://www.npr.org/sections/health-shots/2018/11/26/670752865/chinese-scientist-says-hes-first-to-genetically-edit-babies</u>
<u>https://www.youtube.com/watch?v=th0vnOmFltc</u>
<u>http://www.sciencemag.org/news/2018/11/i-feel-obligation-be-balanced-noted-biologist-comes-defense-gene-editing-babies</u>

2. "Scientists reveal proposal to build human genome from scratch".

http://www.sciencemag.org/news/2016/06/scientists-reveal-proposal-build-human-genome-scratch

Week 6 Mermaids and Cenotaurs
Feb. 20 **Human-Animal Chimeras**

Novel #2 Discussion: Heart of a Dog by Mikhail Bulgakov

Required reading:
1. Solter, D. (2010). Viable rat-mouse chimeras: where do we go from here? Cell *142*, 676-678.

No Class
Feb. 27

Week 7 Modern Alchemy
March 5 **Cellular Reprogramming and Transdifferentiation**

Class Exercise #3: Groups of 3 students research and discuss therapeutic applications of cellular reprogramming and transdifferentiation in specific organ systems.

Required reading:
1. Chapter 4.6-4.9 (pp. 93-100) of StemCells: SFF. "Of Mice and Men: The History of Embryonic Stem Cells"

2. Have iPS cells diffused ethical debates regarding stem cells?
http://www.vox.com/2014/12/15/7384457/stem-cell

Week 8 Beyond Mommy and Daddy
March 12 **Altering Heredity with Germline Stem Cells and SCNT**

Class Exercise #4: Groups of 3 students research and discuss potential uses of germline stem cells in changing the concept of heredity and addressing issues of parents unable to conceive by natural processes.

Movie Viewing and Discussion: "Ethics of three-parent babies"
http://www.closeupresearch.com/mitochondria_replacement_ethical_considerations.html

Required reading:
1. Check, E. (2005). Gene study raises fears for three-parent babies. Nature *438*, 12.

2. Human eggs and sperm made from stem cells
http://www.nature.com/news/rudimentary-egg-and-sperm-cells-made-from-stem-cells-1.16636

******* ***Mid-Term Essay - Due March 14, 11:59pm***

Fictional Short Story on Future Impact of Stem Cells and Regenerative Medicine on Society (5 pages, single-spaced, Arial 11pt, 1-inch margins)

Spring Recess
March 15-22

Week 9 Mind without a Body
March 26 **Neuronal Differentiation in a Dish**

Required reading:
1. Miniature Human Brains In a Dish
http://www.nature.com/nature/journal/v501/n7467/full/nature12552.html

2. Modeling Neurodegenerative Diseases In a Dish
http://www.nature.com/nbt/journal/v32/n8/full/nbt.2977.html

3. "Did grief give him Parkinson's"
http://nautil.us/issue/21/information/did-grief-give-him-parkinsons

Week 10 Growing New Arms and Legs
April 2 **Epimorphic Regeneration**

Class Exercise #5: Groups of 3 students research the regenerative abilities of a particular animal and come prepared to discuss how this knowledge could be applied to humans.

Required reading:
1. Simon, A., and Tanaka, E.M. (2013). Limb regeneration. Wiley interdisciplinary reviews Developmental biology *2*, 291-300.

Week 11 Ship of Theseus and Immortality
April 9 **Stem Cells and Aging**

Novel #3 Discussion: Oryx and Crake by Margaret Atwood

Required reading:
1. Heterochronic Parabiosis
http://onlinelibrary.wiley.com/doi/10.1111/acel.12065/full

2. Young Blood Reverses Aging:
http://www.nytimes.com/2014/05/05/science/young-blood-may-hold-key-to-reversing-aging.html?_r=0

3. In vitro meat
http://www.nytimes.com/2013/05/14/science/engineering-the-325000-in-vitro-burger.html

Week 12 Custom Order Replacement Organs
April 16 **Cultured Organoids, Biological 3-D Printing, and Organs-on-Chips**

Class Exercise #6: Groups of 3 students prepare to discuss how to make a particular organ in vitro from stem cells. What are the advantages and particular challenges to bio-engineering such an organ?

Required reading:
1. Print Thyself
http://www.newyorker.com/magazine/2014/11/24/print-thyself

2. Chapter 13 of StemCells: SFF. "Human Stem Cells for Organs-on-Chips: Clinical Trials without Patients?"

Week 13 Stem Cells in the Clinic
April 23 **Potential and Limitations of Stem Cell Therapy**

Required reading:
1. Chapter 7 of StemCells: SFF. "Regenerative Medicine: Clinical Applications of Stem Cells"

Week 14 Stem Cell Tourism and the New Snake Oil
April 30 **Misinformation and the Media in the Stem Cell Age**

Movie Viewing Before Class: "21st Century Snake Oil" – 2 parts
https://www.youtube.com/watch?v=zupt6RoQgbM
https://www.youtube.com/watch?v=njSMTfPRz9g

Required reading:
1. Chapter 11 of StemCells: SFF. "Stem Cell Tourism"

FINAL EXAM
May 7, 4:30-6:30 PM Series of Short Essay Questions

Statement for Students with Disabilities
Any student requesting academic accommodations based on a disability is required to register with Disability Services and Programs (DSP) each semester. A letter of verification for approved accommodations can be obtained from DSP. Please be sure the letter is delivered to me as early in the semester as possible. DSP is located in STU 301 and is open 8:30 a.m.–5:00 p.m., Monday through Friday. The phone number for DSP is (213) 740-0776.

Statement on Academic Integrity
USC seeks to maintain an optimal learning environment. General principles of academic honesty include the concept of respect for the intellectual property of others, the expectation that individual work will be submitted unless otherwise allowed by an instructor, and the obligations both to protect one's own academic work from misuse by others as well as to avoid using another's work as one's own. All students are expected to understand and abide by these principles. *Scampus,* the Student Guidebook, contains the Student Conduct Code in Section 11.00, while the recommended sanctions are located in Appendix A: http://www.usc.edu/dept/publications/SCAMPUS/gov/. Students will be referred to the Office of Student Judicial Affairs and Community Standards for further review, should there be any suspicion of academic dishonesty. The Review process can be found at: http://www.usc.edu/student-affairs/SJACS/..

Emergency Preparedness/Course Continuity:
In case of emergency, and travel to campus is difficult, USC executive leadership will announce an electronic way for instructors to teach students in their residence halls or homes using a combination of Blackboard, teleconferencing, and other technologies. Instructors should be prepared to assign students a "Plan B" project that can be completed at a distance. For additional information about maintaining your classes in an emergency please access:
http://cst.usc.edu/services/emergencyprep.html