STEM CELL BIOLOGY AND REGENERATIVE MEDICINE

Courses offered by the Program in Stem Cell Biology and Regenerative Medicine are listed under the subject code STEMREM on the Stanford Bulletin's Explore Courses web site.

Graduate Program in Stem Cell Biology and Regenerative Medicine

The Stanford Stem Cell Biology and Regenerative Medicine (SCBRM) program is dedicated to doctoral education that translates basic science to clinical applications, typically referred to as Translational Science, and of intense interest internationally in medical schools and universities. Our doctoral program provides exceptional didactic education and research experience in the basic sciences underlying stem cell biology. In addition, program participants will receive specialized training in the development and clinical application of discoveries in the basic sciences to achieve regenerative therapies. Thus, our graduates will be uniquely positioned to develop successful translational careers in Stem Cell Biology and Regenerative Medicine, and will emerge prepared to deliver on their passion to improve the human condition. The core curriculum is combined with unique research and clinical/professional immersion rotations to provide opportunities for doctoral students to specialize in the broad subject of translational medicine and yet focus specifically on fundamentals of SCBRM. The curriculum combines education in genetics and developmental biology with an introductory laboratory-based stem cell course, an advanced course in stem cell biology and regenerative medicine, and a clinical rotation with alternative opportunities in law, business and/or engineering.

The mission of the SCBRM graduate program is to produce future leaders in translational science through a combination of basic science and clinical/professional immersion. The program aims to be innovative and to change the landscape for graduate education in the biomedical sciences by having the immersion tailored to each student's translational goals. The program accommodates students who wish to focus primarily at the basic science level alongside those who wish to focus specifically on innovation such as a new device to solve a clinical problem. In the former case, the student might seek out a primary mentor affiliated with the basic sciences and take electives that reflect the more basic interest. In the latter case, the student might select an elective with an engineering focus and seek out primary mentorship with a more clinically or engineering focused mentor. In this way, graduates from our doctoral program receive exceptional didactic education and research experience and are well positioned to develop successful translational careers in SCBRM by applying their knowledge and passion to improve human health.

Master of Science in Stem Cell Biology and Regenerative Medicine

University requirements for the M.S. degree are described in the "Graduate Degree (http://exploredegrees.stanford.edu/graduatedegrees)s" section of this bulletin.

Students in the Ph.D. program in SCBRM may apply for an M.S. degree in SCBRM, assuming completion of appropriate requirements. The program does not accept applications for a standalone M.S. degree.

To receive an M.S. in Stem Cell Biology and Regenerative Medicine, Students must complete the following:

1. Four full-tuition quarters of residency as a graduate student at Stanford.
2. At least 45 units of academic work, all of which must be in courses at or above the 100 level, 16 units of which must be at or above the 200 level.
3. Four quarters of graduate research, consisting of rotations in the labs of at least three SCBRM faculty members.
4. Course work in Stem Cell Biology and Regenerative Medicine as well as other core requirements:
   a. STEMREM 200 Stem Cell Intensive hands-on immersion to learn basic methods of tissue culture, mouse embryo fibroblast (MEF) preparation, embryonic stem and induced pluripotent stem (ES/iPS) cell culture, differentiation, DNA isolation, polymerase chain reaction (PCR), sequencing, and basic microscopy.
   b. BIOS 200 Foundations in Experimental Biology focuses on the broad themes of Evolution, Energy and Information.
   c. STEMREM 201A Stem Cells and Human Development: From Embryo to Cell Lineage Determination and STEMREM 201B Stem Cells and Human Development Laboratory develop a fundamental understanding of introductory stem cell principles in human development, aging, and disease accompanied by a laboratory-based module with immersion in stem cell-based methods (embryology, embryonic stem cells, reprogramming, adult stem cells).
   d. STEMREM 202 Stem Cells and Translational Medicine, advanced topics related to individual organ systems, cancer stem cells, translational principles of medicine and immunology as related to regenerative medicine, as well as bioengineering and bioinformatics as related to stem cell biology.
   e. STEMREM 203 Stem Cells Immersion: Applications in Medicine, Business and Law, students specialize and choose a clinical immersion, rotation in a biotechnology company or venture firm, or further delve into cutting edge technologies, bioinformatics, materials and/or engineering approaches for stem cell applications in industry, diagnostics and medicine.
   f. STEMREM 250 Regenerative Medicine Seminar Series, a forum for researchers to meet and discuss Stem Cell Biology and Regenerative Medicine and to spark collaborations. 6 units of this course is required.
   g. STEMREM 280 Stem Cell Biology and Regenerative Medicine Journal Club, review and discussion of current literature in both basic and translational medicine as it relates to stem cell biology and/or regenerative medicine.

		Units
STEMREM 200	Stem Cell Intensive	1
BIOS 200	Foundations in Experimental Biology	6
STEMREM 201A	Stem Cells and Human Development: From Embryo to Cell Lineage Determination	1-2
STEMREM 201B	Stem Cells and Human Development Laboratory	3
STEMREM 202	Stem Cells and Translational Medicine	3-5
STEMREM 203	Stem Cells Immersion: Applications in Medicine, Business and Law	3
STEMREM 250	Regenerative Medicine Seminar Series	1
STEMREM 280	Stem Cell Biology and Regenerative Medicine Journal Club	2
BIOC 224/BIO 214/ MCP 221	Advanced Cell Biology	4
GENE 205	Advanced Genetics	3
MED 255	The Responsible Conduct of Research	1
DBIO 210	Developmental Biology	4
STEMREM 399	Graduate Research	1-18
Total Units		33-53

h. Students are also required to take 2 electives, totaling a minimum of 6 units.
i. Biochemistry proficiency is required by the end of the second year, as well as a total of 80 units and completed qualifying examinations. Students who do not pass the qualifying examination may retake a full qualifying exam, be retested in a few areas, or be asked to redo their presentation.

5. Participation and attendance at the annual SCBRM Retreat.
6. The qualifying examination process in SCBRM before admission to Ph.D. candidacy has two parts:
   - Part I: a comprehensive written exam in the form of a 5-page NIH grant proposal
   - Part II: a 15-minute oral presentation of the proposal to the thesis committee followed by open questions from the qualifying exam committee on the proposal or encompassing areas of research/academic scholarship that are deemed relevant to the proposal.

Students who do not pass the qualifying exam may retake the full qualifying exam, be retested in a sub-area, or be asked to redo their presentation. Those students who fail the qualifying exam twice may be awarded a master's degree based on completion of course work and rotations. In addition, students who choose to voluntarily leave the program are also awarded a master's degree based on completion of the qualifying exam.

Doctor of Philosophy in Stem Cell Biology and Regenerative Medicine

University requirements for the Ph.D. are discussed in the "Graduate Degrees (http://exploredegrees.stanford.edu/graduatedegrees)" section of this bulletin.

The Stem Cell Biology and Regenerative Medicine curriculum, combined with the research and rotation opportunities, provides a flexible educational opportunity for doctoral students to specialize in the broad subject of translational medicine while being focused more specifically on the fundamentals of Stem Cell Biology and Regenerative Medicine while training in the laboratories of participating SCBRM faculty. The goal of the SCBRM program is to provide an avenue for graduate education to translate the best of basic research into a clinical setting.

Application and Admission

Applications are made through the Graduate Admissions (http://gradadmissions.stanford.edu) web site.

Applicants will be assessed based on their undergraduate transcripts, test scores, research experience, statement of purpose and letters of recommendation that document exceptional potential, ability, or achievements.

Students admitted to the program are offered financial support covering tuition, a living stipend, and insurance coverage. Applicants are urged to apply for independent fellowships such as from the National Science Foundation. Fellowship applications are due in November of the year prior to matriculation in the graduate program, but SCBRM graduate students may continue to apply for outside fellowships after matriculation. Because of the small number of department-funded slots, students who have been awarded an outside fellowship have an improved chance of acceptance into the program. Upon matriculation, each student is assisted in selecting courses and lab rotations in the first year and in choosing a lab for the dissertation research. Once a dissertation adviser has been selected, a dissertation committee is composed to include the dissertation adviser and two additional SCBRM faculty, to guide the student during their dissertation research. The student must meet with the dissertation committee at least once a year.

Degree Requirements

Candidates for Ph.D. degrees at Stanford must satisfactorily complete a program of study that includes 135 units of graduate course work and research.

Requirements for the Ph.D. degree in SCBRM include:

1. Completion of at least 3 research rotations in the labs of SCBRM faculty members.
2. Completion of the following courses:
   a. STEMREM 200 Stem Cell Intensive hands-on immersion to learn basic methods of tissue culture, mouse embryo fibroblast (MEF) preparation, embryonic stem and induced pluripotent stem (ES/iPS) cell culture, differentiation, DNA isolation, polymerase chain reaction (PCR), sequencing, and basic microscopy.
   b. BIOS 200 Foundations in Experimental Biology focuses on the broad themes of Evolution, Energy and Information.
   c. STEMREM 201A Stem Cells and Human Development: From Embryo to Cell Lineage Determination and STEMREM 201B Stem Cells and Human Development Laboratory develop a fundamental understanding of introductory stem cell principles in human development, aging, and disease accompanied by a laboratory-based module with immersion in stem cell-based methods (embryology, embryonic stem cells, reprogramming, adult stem cells).
   d. STEMREM 202 Stem Cells and Translational Medicine advanced topics related to individual organ systems, cancer stem cells, translational principles of medicine and immunology as related to regenerative medicine, as well as bioengineering and bioinformatics as related to stem cell biology.
   e. STEMREM 203 Stem Cells Immersion: Applications in Medicine, Business and Law students specialize and choose a clinical immersion, rotation in a biotechnology company or venture firm, or further delve into cutting edge technologies, bioinformatics, materials and/or engineering approaches for stem cell applications in industry, diagnostics and medicine.
   f. STEMREM 250 Regenerative Medicine Seminar Series a forum for researchers to meet and discuss Stem Cell Biology and Regenerative Medicine and to spark collaborations. 6 units of this course is required.
   g. STEMREM 280 Stem Cell Biology and Regenerative Medicine Journal Club review and discussion of current literature in both basic and translational medicine as it relates to stem cell biology and/or regenerative medicine.
3. Students have the option to select from the following courses in the first year:

		Units
STEMREM 200	Stem Cell Intensive	1
BIOS 200	Foundations in Experimental Biology (Offered in Autumn and Spring)	5
STEMREM 201A	Stem Cells and Human Development: From Embryo to Cell Lineage Determination	1-2
STEMREM 201B	Stem Cells and Human Development Laboratory	1
STEMREM 202	Stem Cells and Translational Medicine	3-5
STEMREM 203	Stem Cells Immersion: Applications in Medicine, Business and Law	3
STEMREM 250	Regenerative Medicine Seminar Series	1
STEMREM 280	Stem Cell Biology and Regenerative Medicine Journal Club	1
BIOC 224/BIO 214/MCP 221	Advanced Cell Biology	4
GENE 205	Advanced Genetics	3

MED 255	The Responsible Conduct of Research	1
DBIO 210	Developmental Biology	4
STEMREM 399	Graduate Research	1-18
Total Units		29-49

4. Students are also required to take two electives, totaling a minimum of 6 units.
5. Biochemistry proficiency is required by the end of the second year, as well as a total of 80 units and completed qualifying examinations. Students who do not pass the qualifying examination may retake a full qualifying exam, be retested in a few areas, or be asked to redo their presentation.
6. STEMREM 802 TGR Dissertation.

Students unable to meet Ph.D. milestones after remediation are offered a M.S. degree if they have completed all requirements.

Graduate Advising Expectations

The Program in Stem Cell Biology and Regenerative Medicine is committed to providing academic advising in support of graduate student scholarly and professional development. When most effective, this advising relationship entails collaborative and sustained engagement by both the adviser and the advisee. As a best practice, advising expectations should be periodically discussed and reviewed to ensure mutual understanding. Both the adviser and the advisee are expected to maintain professionalism and integrity.

Faculty advisers guide students in key areas such as selecting courses, designing and conducting research, developing of teaching pedagogy, navigating policies and degree requirements, and exploring academic opportunities and professional pathways.

Graduate students are active contributors to the advising relationship, proactively seeking academic and professional guidance and taking responsibility for informing themselves of policies and degree requirements for their graduate program.

For a statement of University policy on graduate advising, see the "Graduate Advising (http://exploredegrees.stanford.edu/graduatedegrees/#advisingandcredentialstext)" section of this bulletin.

Program Director: Theo D. Palmer

Program Co-Director: Vittorio Sebastiano

Teaching Faculty:

- Arash A. Alizadeh (Assistant Professor, Medicine/Oncology and Member of Bio-X, Child Health Research Institute and Stanford Cancer Institute)
- Philip A. Beachy (Professor, Institute for Stem Cell Biology and Regenerative Medicine, Department of Biochemistry and Developmental Biology and Member of Bio-X and Stanford Cancer Institute)
- Michael F. Clarke (Professor, Institute for Stem Cell Biology and Regenerative Medicine and Department of Medicine/Oncology and Member of Bio-X and Stanford Cancer Institute)
- Tushar Desai (Assistant Professor, Medicine/Pulmonary & Critical Care Medicine and Member of Bio-X, Child Health Research Institute and Stanford Cancer Institute)
- Maximilian Diehn (Assistant Professor, Radiation Oncology/Radiation Therapy and Member of Bio-X and Stanford Cancer Institute)
- Margaret T. Fuller (Professor, Developmental Biology, Genetics and Obstetrics & Gynecology/Reproductive Biology and Member of Bio-X, Child Health Research Institute and Stanford Cancer Institute)
- Sarah C. Heilshorn (Associate Professor, Materials Science and Engineering and (by courtesy) Chemical Engineering and Member of Bio-X, Child Health Research Institute and Stanford Neurosciences Institute)
- Stefan Heller (Professor, Otolaryngology/Head and Neck Surgery and Member of Bio-X, Stanford Cancer Institute and Stanford Neurosciences Institute)
- Kyle Loh (Assistant Professor, Developmental Biology and Member of Bio-X, Institute for Stem Cell Biology and Regenerative Medicine, Stanford Neurosciences Institute, and Faculty Fellow, Stanford ChEM-H)
- Michael T. Longaker (Professor, Surgery/Plastic and Reconstructive Surgery, and (by courtesy) Bioengineering and Materials Science and Engineering and Member of Bio-X, Child Health Research Institute and Stanford Cancer Institute)
- Ravindra Majeti (Associate Professor, Medicine/Hematology and Member of Bio-X and Stanford Cancer Institute)
- Michelle Monje-Deisseroth (Assistant Professor, Neurology & Neurological Sciences and Member of Bio-X, Child Health Research Institute, Stanford Cancer Institute and Stanford Neurosciences Institute)
- Hiromitsu Nakauchi (Professor, Institute for Stem Cell Biology and Regenerative Medicine and Department of Genetics and Member of Bio-X)
- Aaron Newman (Assistant Professor, Department of Biomedical Data Science, Member of Bio-X and Institute for Stem Cell Biology and Regenerative Medicine)
- Roeland Nusse (Professor, Developmental Biology and Member of Bio-X and Stanford Cancer Institute)
- Anthony Oro (Professor, Dermatology and Member of Bio-X, Child Health Research Institute and Stanford Cancer Institute)
- Theo D. Palmer (Associate Professor, Neurosurgery and Member of Bio-X, Child Health Research Institute, Stanford Cancer Institute and Stanford Neurosciences Institute)
- Sergiu Pasca (Assistant Professor, Psychiatry & Behavioral Sciences/Stanford Center for Sleep Sciences & Medicine and Member of Bio-X, Child Health Research Institute and Stanford Neurosciences Institute)
- Matthew Porteus (Associate Professor, Pediatrics/Stem Cell Transplantation and Member of Bio-X, Cardiovascular Institute, Child Health Research Institute and Stanford Cancer Institute)
- Maria Grazia Roncarolo (Professor, Pediatrics/Stem Cell Transplantation and Medicine/Blood & Marrow Transplantation and Member of Bio-X, Child Health Research Institute and Stanford Cancer Institute)
- Vittorio Sebastiano (Assistant Professor, Obstetrics & Gynecology/Reproductive Biology and Member of Bio-X and Child Health Research Institute)
- Judith Shizuru (Professor, Medicine/Blood & Marrow Transplantation and Member Stanford Cancer Institute)
- Irving L. Weissman (Professor, Institute for Stem Cell Biology and Regenerative Medicine, Department of Pathology and Developmental Biology and (by courtesy) Department of Biology and Member of Bio-X and Stanford Cancer Institute)
- Marius Wernig (Associate Professor, Institute for Stem Cell Biology and Regenerative Medicine and Department of Pathology and (by courtesy) Chemical & Systems Biology and Member of Bio-X, Child Health Research Institute, Stanford Cancer Institute and Stanford Neurosciences Institute)
- Joseph C. Wu (Professor, Medicine/Cardiovascular Medicine and Radiology and Director, Cardiovascular Institute and Member of Bio-X, Child Health Research Institute and Stanford Cancer Institute)
- Sean M. Wu (Associate Professor, Medicine/Cardiovascular Medicine and (by courtesy) Pediatrics and Member of Bio-X, Cardiovascular Institute and Child Health Research Institute)

- Joanna Wysocka (Professor, Chemical & Systems Biology and Developmental Biology and Member Bio-X and Stanford Cancer Institute)