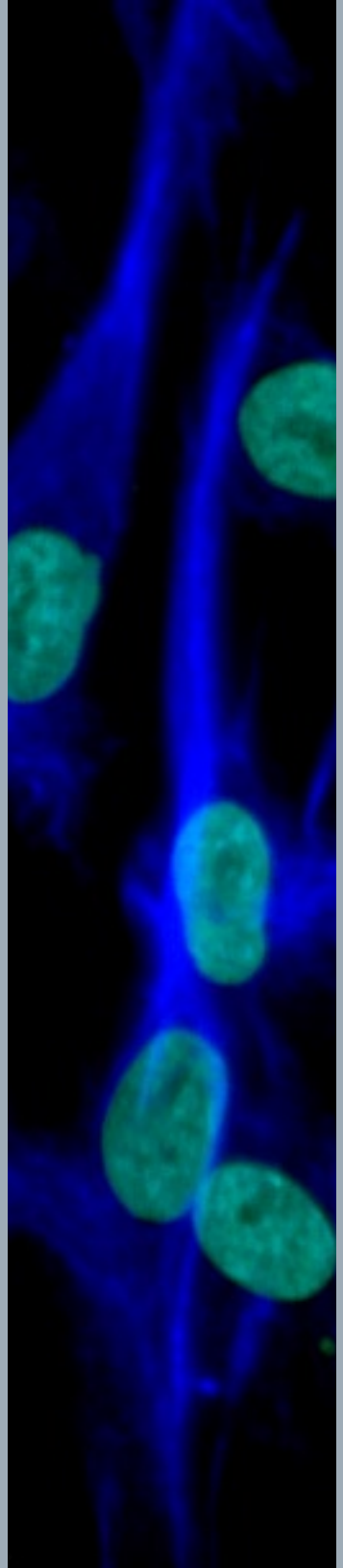
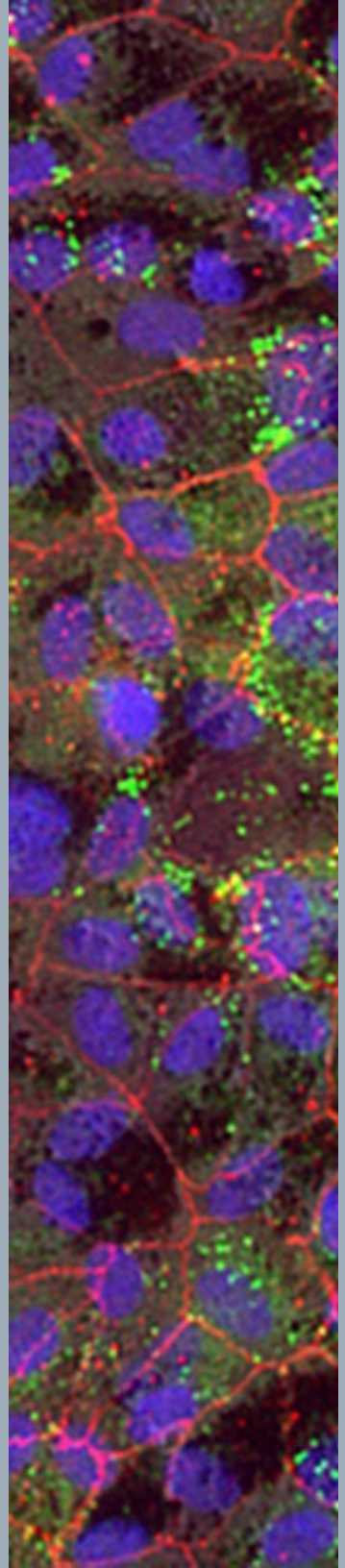
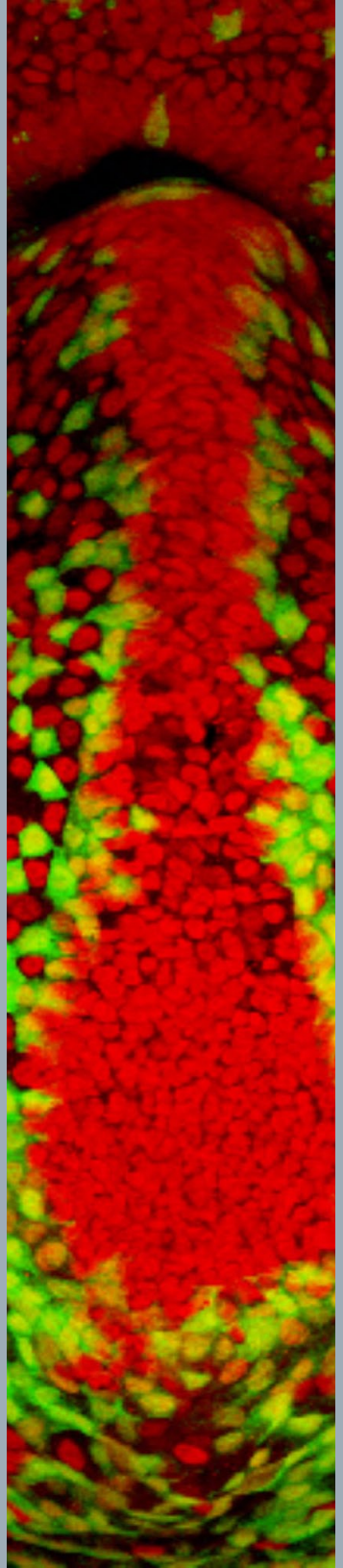






EMPIRE STATE STEM CELL BOARD

Three Pivotal Years

2009-10

2010-11

2011-12

NYSTEM NEW YORK STATE STEM CELL SCIENCE

Wadsworth Center

NEW YORK STATE DEPARTMENT OF HEALTH

The information contained in this report covers the activities of the Empire State Stem Cell Board (ESSCB) and the New York State Stem Cell Science program (NYSTEM) for the period April 1, 2009, through March 31, 2012. For more recent information regarding the ESSCB and the NYSTEM program, please visit the NYSTEM website at www.stemcell.ny.gov.

Contents

MESSAGE FROM THE COMMISSIONER

When I became State Health Commissioner in 2011, I assumed leadership of a wide array of functions and initiatives to safeguard and improve the health of New Yorkers. I also took responsibility for a massive and multi-faceted organization that is as diverse as the state it serves.

I soon recognized that within the New York State Department of Health was the nation's premiere public health laboratory, the research-intensive Wadsworth Center; and that within the Wadsworth Center was the New York Stem Cell Science Program or NYSTEM. I am privileged to serve as chair of the Empire State Stem Cell Board.

I joined the Board in the final year of the three years covered by this Report. Since then I have been deeply impressed by the commitment and dedication of my fellow Board members. They have invigorated and enriched New York's community of stem cell scientists and brought the lessons of stem cell science to the public, all while assuring that the work NYSTEM supports is conducted according to the highest ethical standards – standards the Board has strived to define.

As Commissioner, I have led my team to reassess the health needs of New Yorkers and to chart new courses within the Department. We are now operating under different fiscal circumstances than in 2007, when NYSTEM was created. Despite these changes, the path of NYSTEM remains constant. Governor Cuomo has embraced the mission of NYSTEM, which so closely tracks his own: advancing the well-being of New Yorkers, supporting New York's development as a center of biotechnical excellence, and creating a fertile environment for attracting and retaining the country's finest scientists.

In the pages that follow, evidence of the wisdom of the investment in NYSTEM is on display. During the three-year period described here, NYSTEM has supported the creation of fourteen shared facilities, meeting a primary goal of the Board to build needed infrastructure and expand research capacity. It provided training to scientists, and to the next generation of scientists, through its various educational programs. And it funded first-rate cutting edge research at 37 New York institutions. Advances have been astonishingly rapid and substantial. We are all watching to see what our NYSTEM-funded researchers accomplish next.

Nirav R. Shah, MD, MPH
Commissioner, New York State Department of Health
Chair, Empire State Cell Board

INTRODUCTION

In 2007, the New York State legislature created the Empire State Stem Cell Board (ESSCB or the Board) to administer the newly created Empire State Stem Cell Trust [Appendix 1]. It empowered the Board "to make grants to basic, applied, translational or other research and development activities that will advance scientific discoveries in fields related to stem cell biology." The Board issued its first Request For Applications (RFA) for research projects in its first year and approved 98 awards in its second year [Appendix 2]. But it was in Fiscal Years (FYs) 2009-10 through 2011-12 that the newly funded projects, and New York State Stem Cell Science (NYSTEM) program itself, hit full stride, putting New York scientists at the forefront of the rapidly developing field.

In FYs 2009-10, 2010-11 and 2011-12, the ESSCB issued ten new RFAs and approved 77 new awards to 19 institutions for research, training and educational projects. Of the 55 research awards, 31 involved research on human cells, including 12 on embryonic stem cells (ESCs), nine on induced pluripotent stem cells (iPSCs) and 15 on adult stem cells [Appendix 2]. The program continued to build on the excitement that was sparked when its formation was announced. At the State's great universities and research centers hiring expanded, innovative programs were developed and new collaborations were forged. Scientists were making important discoveries, rapid progress was underway, and New York State was part of it.

Meanwhile, the Board's Ethics Committee debated some of the most difficult bioethics questions in science. Based on their deliberations, the Board passed a resolution allowing researchers to use NYSTEM funds to compensate donors of eggs to research on a par with donors to IVF. The resolution was challenged in state court and the Board prevailed.

Most of the way through its first Strategic Plan, the ESSCB strove to meet the ambitious goals it had set for itself, taking care always to make the optimal choices to advance the development of the science and the welfare of New Yorkers. NYSTEM was moving forward.

STEM CELL RESEARCH: STATE OF THE ART

In the Lab

During FYs 2009-10 through 2011-12, stem cell researchers around the world made dramatic strides. Induced pluripotent stem cell (iPSC) technology yielded rewards for scientists and patients alike, transdifferentiation returned to center stage, and embryonic stem cell research continued to advance towards promised treatments and therapies.

Scientists from around the globe, including here in New York, created new iPSC-based models of some diseases for the first time. Making these models even more powerful, scientists continued to make advances in directing the differentiation of both hESCs and hiPSCs into disease-specific cell types, providing exciting opportunities for testing new drugs.

At the same time, the debate over the equivalence of iPSCs and ESCs continued. Several research teams showed that iPSCs retain functional properties of the cells from which they were derived. If iPSCs are derived from blood, for example, they are more prone to make blood cells than bone cells, and vice versa. Some global analyses of the genome and epigenome of reprogrammed cells have shown consistent differences between iPSC lines and ESCs, but some researchers argued that differences between iPSCs and ESCs simply mirror the variability among different lines of ESCs. Also, while advances in reprogramming technology have continued, the potential of iPSCs to give rise to tumors raised concerns.

Transdifferentiation, the conversion of one cell type directly into another without reprogramming, made enormous strides. Transdifferentiation is not new, but only within the past few years has its widespread applicability been appreciated. Based on the iPSC reprogramming technique initially developed by Shinya Yamanaka, researchers have applied their knowledge of developmental biology to cell type conversion. By expressing select sets of transcription factors -- the proteins that activate genes -- scientists have learned to convert skin cells into very different cell types, such as neurons. Transdifferentiation holds promise for the production of cells for therapies and drug discovery.

STEM CELL RESEARCH: STATE OF THE ART

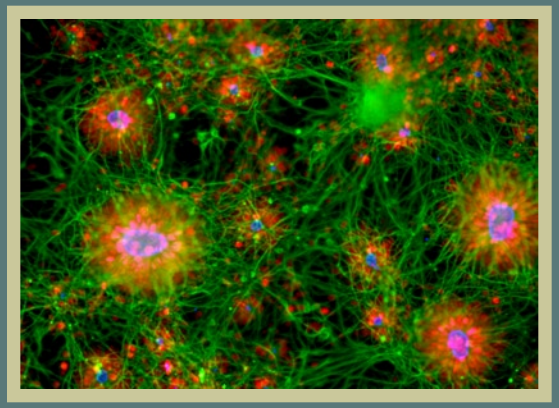
Clinical Trials

Several companies received approval for clinical trials using novel stem cell-based therapies in 2010. Early that year, in Europe, ReNeuron Group, Plc, received approval to begin testing its fetal-derived stem cells for treatment of stroke victims. ReNeuron's goals were to determine the safety of the injection method, the side effects of the cell injections, and efficacy.

Also, two significant advances in the use of hESC-derived cell therapies occurred in 2010. First, Geron Corporation initiated a Phase I trial of its hESC-derived oligodendrocytes to treat spinal cord injury, the first trial of an hESC-based cell therapy. In late 2010, Advanced Cell Technology, Inc. (ACT), received FDA approvals to begin Phase I/II testing of its hESC-derived retinal pigment epithelium (RPE) for treatment of two eye diseases: Stargardt's Macular Dystrophy and Dry Age-related Macular Degeneration, both of which cause vision loss. The eye is a promising test site for cell therapy as it is immune-privileged, thereby reducing the chance that the patient's immune system would reject the transplanted cells. Geron's trial was designed only to test safety of the cell injections, but ACT's trials were designed to test both safety and tolerability of the injected cells.

In addition to these first in kind clinical trials, new uses have been found for bone marrow-derived stem cells. Bone marrow has been used clinically since the first successful transplant in 1956, although it was years before stem cells were identified as the critical ingredient. Two types of stem cells comprise bone marrow: hematopoietic, which produce blood and immune cells, and mesenchymal, which produce bone, cartilage and fat. Hematopoietic stem cells have long been used to treat blood and immune system diseases, including some cancers. Isolated and purified mesenchymal stem cells have been developed in a number of forms. New trials using both hematopoietic and mesenchymal stem cells have been initiated in the past few years.

Despite these advances, less than two years after receiving FDA approval, and barely a year after treating the first patient in October, 2010, Geron discontinued its trial in November 2011because of financial considerations.



NYSTEM-funded iPSC-based disease models

Familial Dysautonomia
Studer Lab,
Memorial Sloan-Kettering

Charcot-Marie Tooth Disease
Studer Lab,
Memorial Sloan-Kettering

Noonan Syndrome
Lemishcka and Gelb Labs,
Mount Sinai

LEOPARD Syndrome
Lemishcka and Gelb Labs,
Mount Sinai

Long QT Syndrome types 3 and 7
Lu and Kass Lab,
Columbia University

Parkinson's Disease
Feng Lab,
University at Buffalo

Parkinson's Disease
Abeliovich Lab,
Columbia University

Alzheimer's Disease
Abeliovich Lab,
Columbia University

Recessive Dystrophic Epidermolysis Bullosa
Christiano Lab,
Columbia University

Angela Christiano, Ph.D., at Columbia University uses allogeneic (immune-matched) stem cells from bone marrow and donated cord blood to treat patients with a form of epidermolysis bullosa (EB). EB is a skin disease that causes severe blistering in response to the slightest injury. After transplant, the stem cells circulate through the body and home in on the sites of injury. Preliminary results in several patients show a reduction in both the number and the severity of blisters after this novel treatment.

NYSTEM FUNDING OVERVIEW

In its first Strategic Plan, the ESSCB identified four categories of spending support to advance its mission: Research; Scientific Training; Infrastructure Development; and Ethical, Legal, and Social Issues and Education (ELSIE). It allocated 65–80% of NYSTEM dollars to Research, 4–10% to Scientific Training, 10–15% to Infrastructure Development, and 3–5% to ELSIE.

In FYs 2009-10 through 2011-12, the ESSCB awarded 53 research grants totaling $37.7 million, and the state contracted an additional 98 research awards, committed previously, for $69.7 million [Appendix 3]. It supported two rounds of awards for infrastructure development through Shared Facilities awards, with nine awards for $32.4 million and of seven more for an additional $27.3 million.

The ESSCB supported the training of scientists in stem cell research through several avenues. These include three Empire State Stem Cell Scholars Fellow to Faculty awards for $3.2 million and four Institutional Training Program awards, to train graduate students and postdoctoral fellows, for $7.4 million. In support of education, the ESSCB gave three awards to undergraduate internship programs for students to conduct summer research, and five awards for the development of undergraduate curricula to include both stem cell science and ELSIE components. Combining the awards to date with new RFAs and additional mechanisms currently in development, the ESSCB is on track to meet the goals of the Strategic Plan.

NYSTEM Support for Scientific Advances

Investigator Initiated Research Awards

NYSTEM has delivered most of its research support in the form of Investigator-Initiated Research Projects (IIRP awards) and Innovative, Developmental or Exploratory Activities (IDEA awards), which are the main drivers of novel discovery. The scope of research supported is broad, and has ranged from basic developmental biology in model organisms such as the nematode worm, C. elegans, fruit flies and mice, up through drug discovery and even development and testing of stem cell therapies for disease and injury. IIRP awards support three-year projects with up to $300,000 a year in direct costs and go to well-developed, basic, applied, translational and pre-clinical research. IDEA awards are smaller, two-year grants of up to $150,000 a year in direct costs, to fund preliminary testing of novel or high-risk projects with potential to lead to larger, IIRP-style research projects. NYSTEM issued its third RFA for IIRP and IDEA awards in August 2011, with awards scheduled to start December 1, 2012.

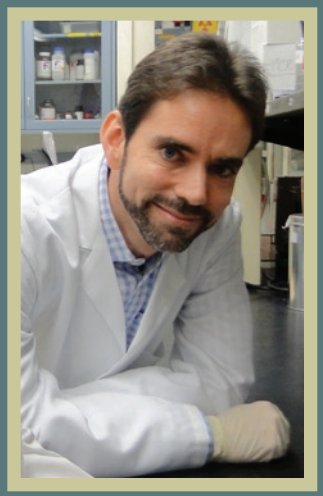
Targeted Research Awards

In addition to soliciting original ideas directly from the scientists, the ESSCB chose to direct funds to specific emerging technologies and neglected or underfunded research areas. With its first round of targeted awards, NYSTEM supported the development and study of iPSC lines for use as disease models and potential therapeutics. Its second round funded three awards for the derivation and characterization of new human embryonic stem cell (hESC) lines. These latter projects aimed to devise novel and improved derivation methods, increase efficiency in the production of new cell lines, to standardize protocols to improve comparisons between hESCs and iPSCs, and to enhance the potential of hESCs for clinical application.

Consortia

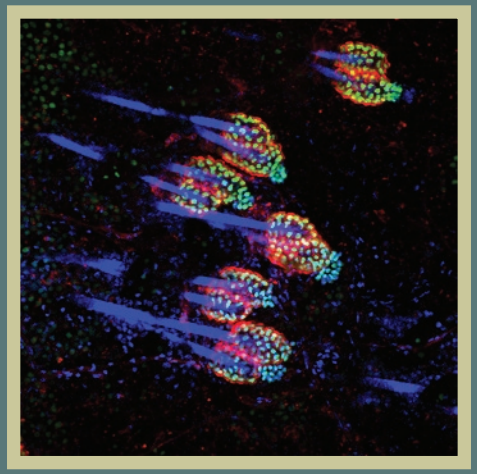
In 2008, the ESSCB recommended eighteen awards to applicants for Planning Grants for Emerging Opportunities and Consortia Development for Stem Cell Research. These one-year awards were designed to assist New York State research institutions in developing ideas for consortia in stem cell research. In September of 2009, NYSTEM convened the awardees to discuss their plans for consortia. Zach Hall, Ph.D., former president of the California Institute of Regenerative Medicine (CIRM), was invited to make opening remarks and lead a discussion. Speakers described consortia covering topics that included the study of specific diseases, high throughput screening, clinical translation of stem cell research, and a New York Institute for Ethical Stem Cell Research. The program agenda is attached as Appendix 4.

The planning meeting was of tremendous value to the Board in developing the *Consortia to Accelerate Therapeutic Applications of Stem Cells*, NYSTEM's largest funding opportunity. This RFA, issued on August 31, 2011, made available up to $80 million to support awards of up to $15.96 million each for specific disease-focused, health outcome-based, multi-disciplinary collaborative research projects that demonstrate the feasibility of proceeding to clinical application during the period of funding. 14 applications were received and are under review with contracts scheduled to start on March 1, 2013.



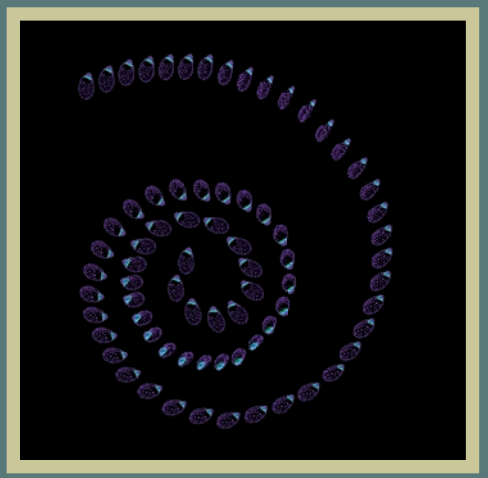
NYSTEM Award Leads to New Funding from NIH

Benjamin Ortiz, Ph.D., of the Center for Study of Gene Structure and Function at Hunter College, CUNY, received an IDEA award in the first round of funding. He used this starter project, *"TCRα Locus Control Region Activity During in vitro Stem Cell Differentiation: Application Towards Improving Lentiviral Gene Therapy Vectors,"* to develop preliminary data, which he then converted into a successful grant application to NIH worth almost $1 million.



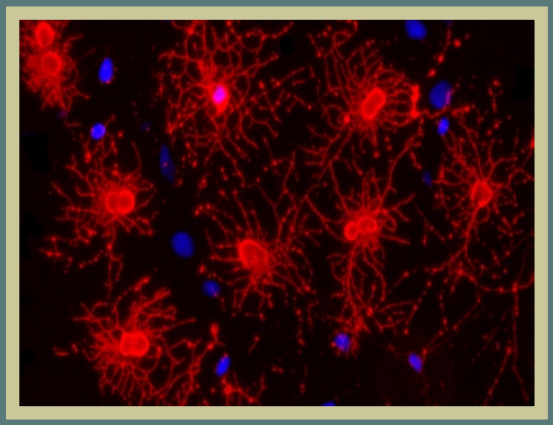
Understanding the Dynamics Between Hair Follicle Stem Cells and the Niche Microenvironment

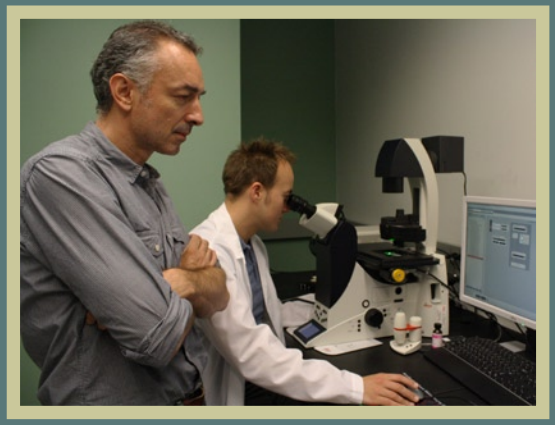
Researchers from the lab of Elaine Fuchs, Ph.D., at Rockefeller University, identified a novel concept in stem cell biology: stem cell descendants that regulate their own progenitors. Dr. Fuchs found that early descendants of hair follicle stem cells retain "stemness" and return to their niche when hair growth, which is cyclical, stops. In contrast, once the descendants commit to differentiation, they signal to the stem cells to stop dividing in a negative feedback loop. This loop regulates stem cell growth and prevents overgrowth. These data were published in *Cell*.

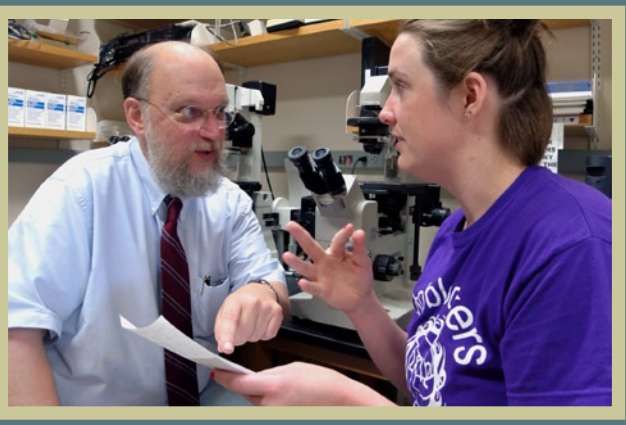


Stem Cells Divide Symmetrically, Differently Than Previously Thought

Tudorita Tumbar, Ph.D., and colleagues at Cornell University reported in *Cell Stem Cell* that a population of stem cells in the mouse hair follicle divides symmetrically, giving rise to two identical daughter cells. This contrasts with the popular model of asymmetric somatic stem cell division, wherein the daughter cells of a stem cell are not equal; one is equivalent to and replaces the stem cell while the other will differentiate. However, whether this is specific to mouse hair cells or a more general paradigm remains an open question.







Cancer Stem Cells Produce Their Own Support Network

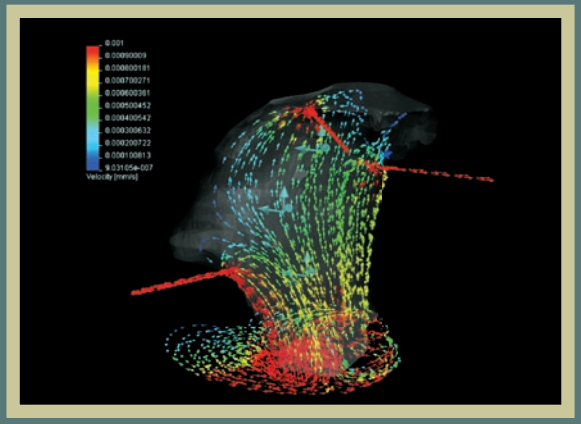
Work published in *Nature* by Viviane Tabar, M.D., and colleagues at Memorial Sloan-Kettering Cancer Center, found that some cancer stem cells in glioblastomas (malignant brain tumors) become blood vessel-forming endothelial cells. These tumor-derived blood vessels do not respond to current anti-angiogenesis drugs such as Avastin. In this way, the tumors evade destruction by contributing to their own support system. This expands the known roles of cancer stem cells and identifies a novel target for therapeutic development.

Producing Endoderm by Directing the Differentiation of Pluripotent Stem Cells

Hans Snoeck, M.D., Ph.D., and colleagues at the Mount Sinai School of Medicine reported in *Nature Biotechnology* the ability to produce anterior foregut endoderm from hESCs and hiPSCs. Anterior foregut endoderm, or AFE, gives rise to organs such as the thymus, thyroid and parathyroid glands, trachea and lungs. Dr. Snoeck collaborated with NYSTEM-funded scientists Ihor Lemischka, Ph.D., and Christoph Schaniel, Ph.D. This first report of hESC and hiPSC-derived AFE takes us one step closer to reconstructing the thymus, which is critically important for immune cell function, and other organs both *in vitro* and for cell therapies.

A New Source of Blood for Transfusions Identified

James Palis, M.D., and colleagues at the University of Rochester identified a new population of primitive blood cells in the mouse embryo. This work, published in *Blood*, distinguishes a population of cells that can multiply repeatedly in the lab, yet still retain the ability to produce erythrocytes, red blood cells. What is most surprising is that these cells are differentiated beyond the stem cell stage, yet have much greater proliferative capacity. If the same cells can be identified in humans, they could serve as a plentiful source of red blood cells for transfusions.



Growing Joints Through Stem Cell Homing

Research findings published in *The Lancet* by a team led by Jeremy Mao, Ph.D., of Columbia University Medical Center, laid the groundwork for possible future joint replacement. The regenerated joints consist of biodegradable materials shaped into anatomically correct scaffolds with a bioprinter. These are the world's first fully regenerated biological joint, combining an anatomically correct scaffold infused with growth factors to recruit endogenous stem cells. Such joints, regenerated by the body's own cells, will hopefully replace metal and plastic joints.

Identification of Safe Harbors for use in Cell Therapies

Michel Sadelain, M.D., Ph.D., and colleagues at Memorial Sloan-Kettering Cancer Center, identified "safe harbors" in which to insert genes. This work, published in *Nature Biotechnology*, involved collaborations with NYSTEM-funded investigators Lorenz Studer, M.D., and Gabsang Lee, Ph.D., D.V.M. Using stem cells from patients with the blood disease β-thalessemia major, Dr. Sadelain's team identified safe locations to insert functional copies of disease-causing mutant genes, which produced near normal levels of functional protein upon differentiation. This method provides a potential stem cell-based cure for this and other genetic diseases.

Pluripotent Stem Cells Used to Create Lens Progenitors

A collaboration between Ales Cvekl, Ph.D., and Eric Bouhassira, Ph.D., at the Albert Einstein College of Medicine resulted in production of eye lens progenitor cells from hESCs. Lens dysfunction can lead to age-related cataracts, and these data will allow researchers to study the mechanisms by which lenses develop and cataracts arise. This publication, in *The FASEB Journal*, presents a recipe for producing lens progenitor cells using chemically defined conditions, making it amenable for production of cells for transplant into humans.

Training Scientists

Fellow to Faculty Awards – the Empire State Stem Cell Scholars

The two-stage Fellow to Faculty Awards advanced multiple ESSCB goals. The first stage provided two years of support to three gifted postdoctoral fellows at New York institutions. The second stage will follow with three additional years of funding for independent stem cell research -- but only if the fellow obtains a faculty position here in New York State. This is but one way in which NYSTEM has supported the state's larger economy as well as its stem cell community. By training its most promising young scientists, and providing incentives to live and work in the state, NYSTEM is striving to give New Yorkers the rewards of their investment in stem cell research.

As evidence of the promise of these young scientists, one of the Scholars, Lan Wang at Memorial Sloan-Kettering, published a first author paper in *Science* in August 2011. Another Scholar, Ting Chen at The Rockefeller University, has a first author paper in press at *Nature* due to be published early in the next fiscal year.

Institutional Training Awards

NYSTEM granted four Institutional Training Awards, which fund any combination of pre-doctoral and postdoctoral training for up to five years. The flexible structure allows the host institutions to provide sustained support to researchers who show the potential to make significant contributions to stem cell research. The awards encouraged the creation of permanent stem cell training programs at the recipient institutions, ensuring a steady population of biomedical researchers here in New York. NYSTEM received almost four times more applications than they could fund and hopes to reissue this RFA soon.

Training Programs for Medical, Dental and Veterinary Students

To encourage the translation of stem cell research into clinical practice and provide research training to the next generation of clinicians, NYSTEM developed an RFA to invite medical, dental and veterinary schools across the state to implement programs each giving two students the chance to spend an academic year conducting research in stem cell labs anywhere in the world. By providing a taste of research to these students, the ESSCB hopes to encourage them to pursue careers as clinician scientists, bringing their unique expertise and experiences to bear in order to speed the translation of research findings to therapies. The RFA was issued in August 2011.

EMPIRE STATE STEM CELL SCHOLARS

Ting Chen, Ph.D.

The Rockefeller University

"Regulation of Hair Follicle Stem Cell Maintenance and Activation"

under Elaine Fuchs, Ph.D.

Dr. Chen is interested in understanding the mechanisms that establish, maintain and activate hair follicle stem cells during development to create treatments for diseases including cancer. Stem cells of the hair follicle are responsible for hair growth and work with epidermal stem cells to repair damaged skin. Dr. Chen will compare two different populations of cells from hair follicles, cells of the hair germ, which fuel the initial hair regrowth, and cells from the bulge, which maintain the process. In this way, she will determine the molecular signature that controls stem cell self-renewal versus differentiation, thus better understanding how skin stem cells maintain their proliferative and regenerative potential until called upon to generate new tissue.

Donald Freytes, Ph.D.

Columbia University

"Optimizing Dynamic Interactions Between hESC-Derived Cardiac Patch and Inflammatory Cells"

under Gordana Vunjak-Novakovic, Ph.D.

Dr. Freytes's research examines the regeneration of heart muscle by human embryonic stem cell (hESC) derived cardiac muscle cells. His project builds upon recent work showing that human stem cells are both aided and impeded in repairing damaged cardiac tissue by inflammation caused by the immune system. Using a high-throughput platform, he will initially examine the recruitment of two different immune cells, monocytes and macrophages, by hESC-derived cardiomyocytes. He will use this knowledge to test different 3D "biomimetic" environments to select conditions that enhance the positive effects of the immune system and dampen the negative effects. Finally, he hopes to optimize the delivery of the repair cells to the damaged heart, which has little innate ability to repair itself after heart attack.

Lan Wang, Ph.D.

Sloan-Kettering Institute

"Determining the Effects and Mechanisms of Id1 on Leukemia Stem Cells"

under Stephen Nimer, M.D.

Dr. Wang's research focuses on what happens when the behavior of hematopoietic stem cells (HSCs), which produce blood and immune cells, goes awry and leads to leukemia. Her prior research showed that a transcription factor called Id1 maintains HSC self-renewal. Her hypothesis is that Id1 also maintains the population of leukemia stem cells, the cells that give rise to the leukemia. Using mouse models of leukemia, Dr. Wang seeks to understand the role of Id1 in leukemia stem cells and then use a variety of methods to inactivate it specifically in leukemia stem cells. If accurate and successful, this could eliminate the progenitor cells of the leukemia. Developing a method to inactivate Id1 in the leukemia stem cell population could provide a useful therapeutic in human patients.

INSTITUTIONAL TRAINING PROGRAM HEADS

Ruth Lehmann, Ph.D.

New York University School of Medicine

Training Program in Stem Cell Biology

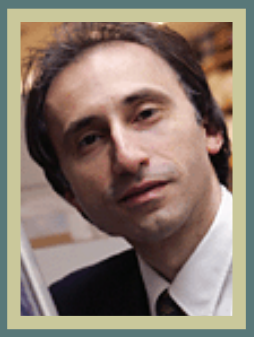
$1,884,320

Mark Noble, Ph.D.

University of Rochester

Stem Cell Training Programs at the University of Rochester

$1,781,977

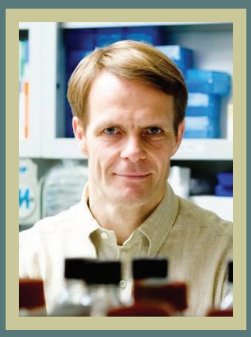


Shahin Rafii, M.D.

Weill Cornell Medical College, Cornell University

Weill Cornell Training Program in Stem Cell Biology and Regenerative Medicine

$1,869,721



Lorenz Studer, M.D.

Memorial Sloan-Kettering Cancer Center, Established 1884

Research Training in Stem Cell Biology

$1,863,000

Growing the Community

At the close of Fiscal Year 2008-09, NYSTEM had funded awards to 33 New York institutions. Early investments focused primarily on infrastructure development and individual stem cell research projects. In the following three years, new awards for Undergraduate Curriculum Development and Undergraduate Summer Internships added several new institutions, mostly undergraduate schools, to the list of NYSTEM recipients. In 2010, NYSTEM funded research at the Masonic Medical Research Laboratory for the first time. By the close of the period, NYSTEM had funded 37 institutions across the state to advance stem cell research and knowledge.

New York's Stem Cell Community

While NYSTEM and the ESSCB were funding stem cell work around the state, many research institutions were creating their own multi-departmental stem cell initiatives to enhance collaboration and access to resources. Together, these efforts have ignited New York's stem cell community, helping its scientists to leverage a continually increasing amount of support from other sources. Based on the survey responses NYSTEM received to shape the next five-year strategic plan, NYSTEM awards lead to more than $16 million further new funding.

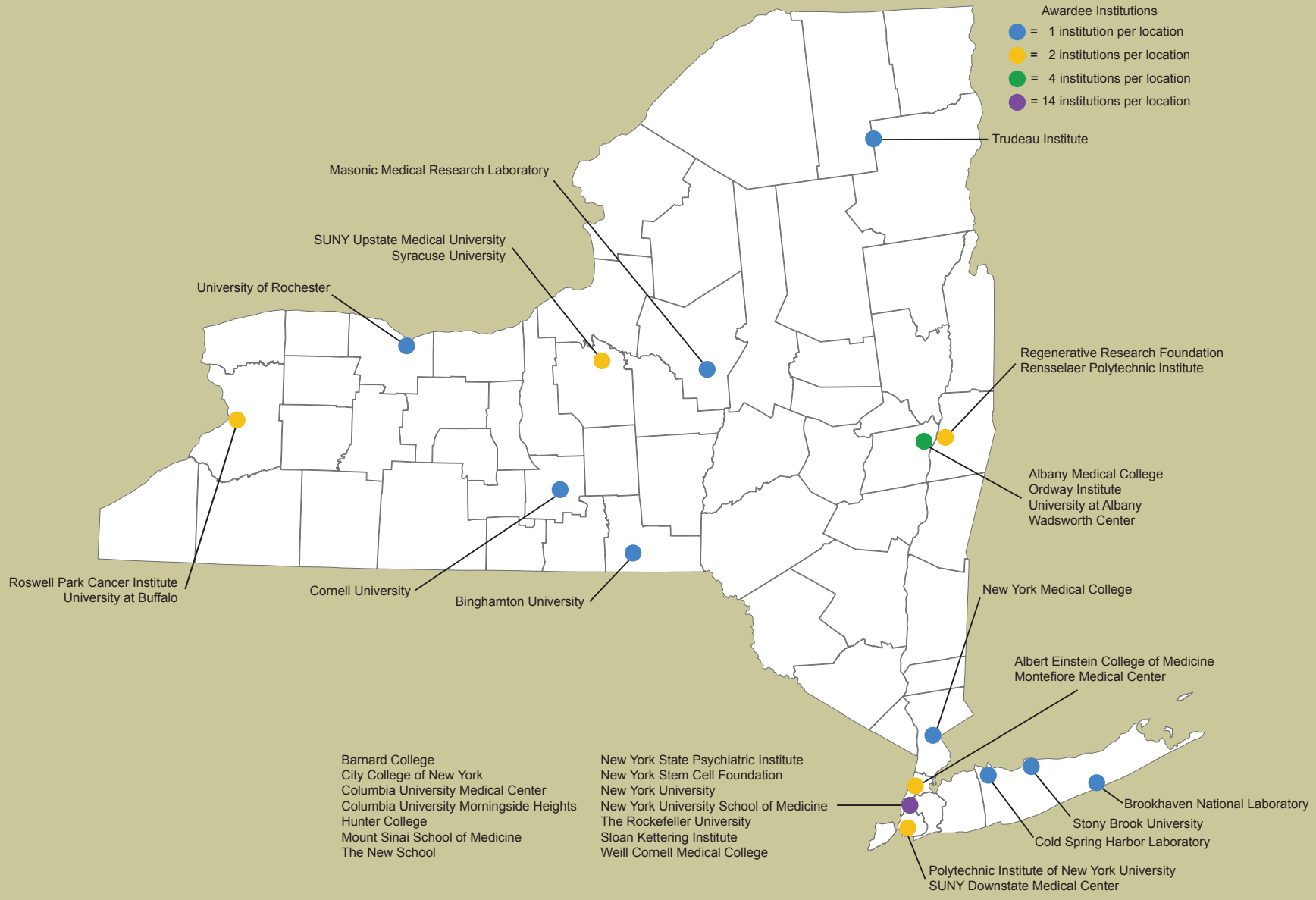
Support for Shared Facilities and Resources

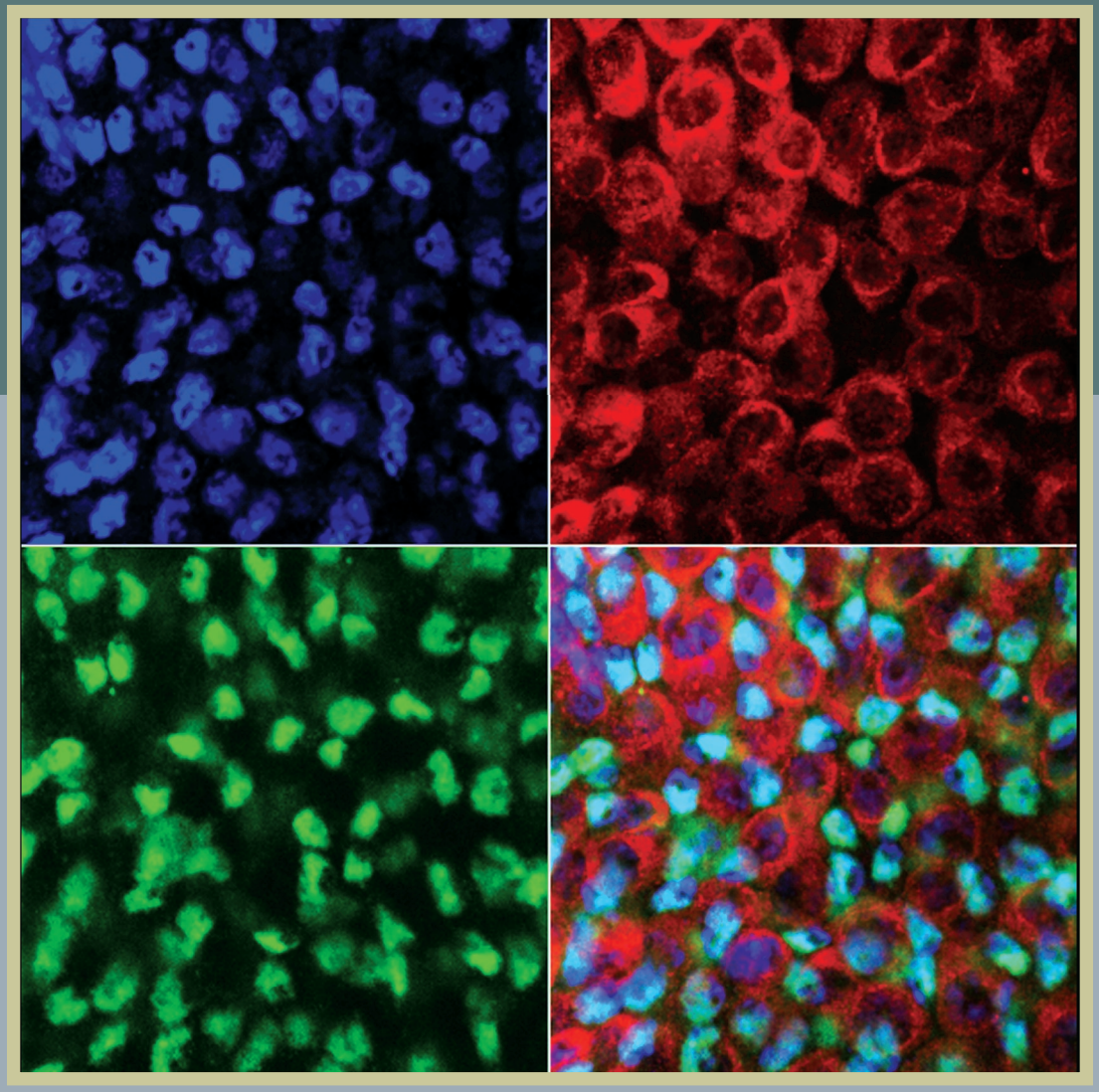
Since the development of its first five-year strategic plan, the ESSCB has made the expansion of stem cell research capacity in New York State a top priority. Through its Shared Facilities awards, NYSTEM has supported the creation of state-of-the-art facilities and made them available to stem cell researchers from across the state, fostering inter-institutional collaboration and promoting progress.

NYSTEM made the first round of Shared Facilities awards in 2008 to give investigators access to the most advanced available technology. Seven thriving facilities were created.

In May 2010, a second round of awards culminated in an additional seven equipment. Several feature highly specialized services to catalyze the transformation of stem cell inventions into therapeutic innovations. And by late FY 2011-12, planning for a third round was underway.

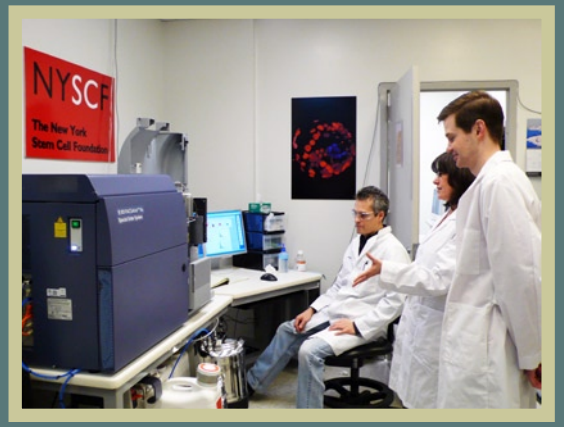
LOCATIONS OF NYSTEM FUNDED INSTITUTIONS: ALL MECHANISMS





Human Embryonic Stem Cell (hESC) Core at Mount Sinai School of Medicine

The hESC/iPSC Shared Resource Facility at the Mount Sinai School of Medicine was funded in the first round of awards. It now provides scientists with hematopoietic stem cells, cardiac progenitors, and NIH-approved hESC lines to use in their own research. The facility offers the latest techniques to derive patient-specific iPSC lines, performs quality control and provides tested media and reagents necessary for the maintenance and differentiation of hESCs and iPSCs. It also offers training to the next generation of researchers: postdoctoral fellows and graduate students.



Shared Facility for Derivation, Distribution and Translational Research with Human Pluripotent Stem Cells

NYSCF's goal in establishing a laboratory was in response to needs in the research community for a specialized and dedicated stem cell facility to enable researchers to generate quality-controlled, fully characterized pluripotent stem cell lines for their research. They are now embarking on small molecule high throughput screening projects, which represent the next phase of utilizing stem cell lines for modeling diseases, including diabetes, Alzheimer's, Parkinson's, MS, cardiac disease, and bone replacement. This will represent a huge advancement in utilizing stem cells as robust and meaningful tools to study and find cures for intractable diseases.

Neural Stem Cell Bank

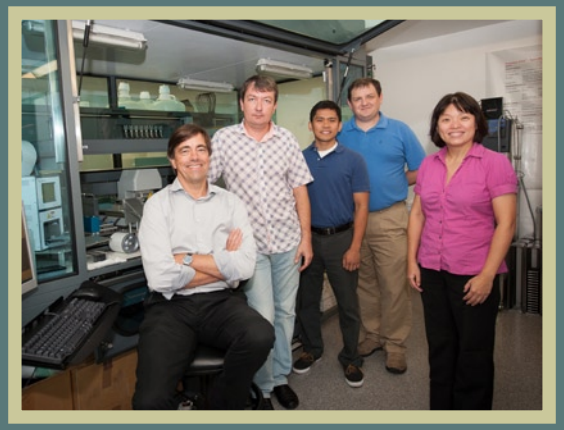
NeuraCell at Regenerative Research Foundation, located in the Capital District, provides specialized expertise in isolating and growing neural stem cells and retinal epithelial cells. Neural stem cells are a basic research tool for understanding the nervous system and a possible cell source for cell replacement therapies. During 2009-2011, the facility isolated multiple neural stem cell lines from brain/eye tissues of humans and mice. These cells are available to any researcher interested in neuroscience.

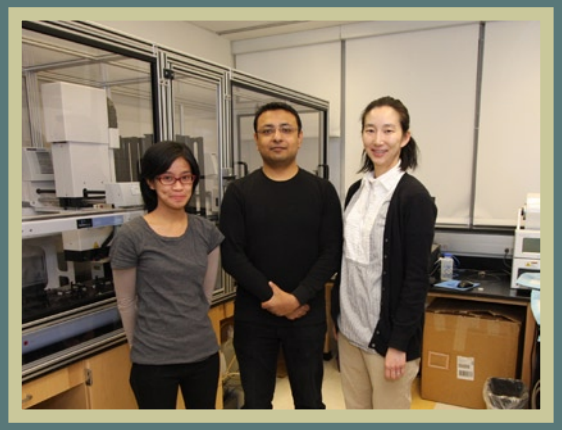
Shared Facilities Awards

Both sets of shared facilities awards provided funding for institutions to develop specialized laboratories to advance stem cell research. These facilities have multiple functions: they provide services and reagents to users, they act as hubs of collaboration among investigators, they provide stem cells and stem cell derivatives for disease modeling, and, perhaps most importantly, they train scientists to work with stem cells.

Shared Facilities Awards: Round 2

Institution	Principal Investigator	Title	Amount
Columbia University Medical Center	Christopher Henderson	High-Throughput Screening and Chemistry Shared Facility	$5,874,675
Cornell University	Andrew Yen	Flow Cytometry Core Laboratory to Support Stem Cell Research	$1,102,829
New York University School of Medicine	Ramanuj DasGupta	Developing an Integrated Platform for siRNA and shRNA-Based Genome-Scale Screens in Eukaryotic Stem Cells	$5,436,929
Rensselaer Polytechnic Institute	Glenn Monastersky	An Upstate New York Shared Facility for Basic Stem Cell Research	$2,450,561
SUNY - Stony Brook University	Wadie Bahou	Shared Facilities for the Stony Brook Stem Cell Center	$5,503,554
SUNY - University at Buffalo	Richard Gronostajski	Western New York Stem Cell Culture and Anaysis Center	$3,564,599
University of Rochester	Stephen Dewhurst	Upstate Stem Cell cGMP Facility	$3,331,362





High-Throughput Screening and Chemistry Shared Facility

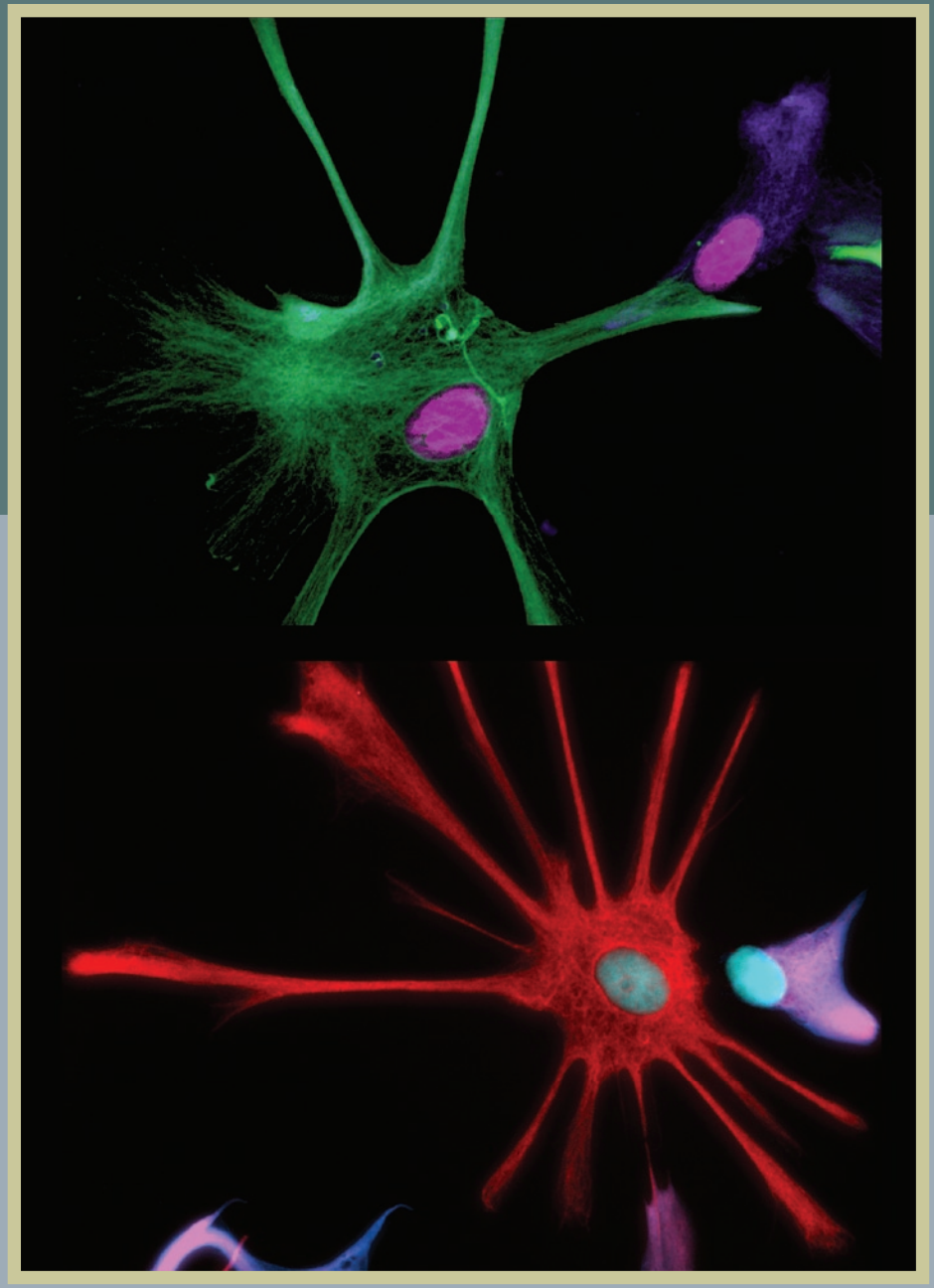
Using stem cells and their derivatives, scientists can model in culture the abnormal processes that lead to disease in humans. In "high-throughput screening" (HTS), chemical compounds can be tested for their ability to ameliorate the defects. Columbia University Medical Center's new HTS facility will provide access to its collection of over 100,000 chemical compounds and gene libraries, as well as all the specialized equipment and expertise to support pilot projects focused on therapeutic development of stem cells.

Developing an Integrated Platform for siRNA and shRNA-Based Genome-Scale Screens in Eukaryotic Stem Cells

RNA interference (RNAi) provides a quick and simple method to knockdown or inactivate a gene of interest. The multi-institutional facility established through a collaboration by New York University and the Mount Sinai School of Medicine will couple RNAi with high-throughput screening, allowing scientists to query gene function systematically and comprehensively in a variety of stem cells. A major mandate of the facility is to share the data generated. The creation of a public screen-database will generate awareness of post-genomic screening technologies and encourage academic researchers in New York State to utilize this unique resource.

Upstate Stem Cell cGMP Facility

The FDA requires companies to follow current Good Manufacturing Practices (cGMP) to ensure that products, including stem cell-based therapies, meet established standards. Meeting these standards requires highly specialized, dedicated facilities. The University of Rochester is creating a GMP facility to support stem cell research in upstate New York. The facility will accelerate stem cell clinical trial activity by producing cGMP grade products for human use. It will also facilitate collaboration among stem cell researchers throughout the state and provide them with expert guidance on regulatory compliance.



Shared Facilities for the Stony Brook Stem Cell Center

Stony Brook University has been devoted to operationalization of the 3,500 SF state-of-the-art space to support 3 key Stem Cell Cores, (1) Stem Cell Processing and Education, (2) Stem Cell Gene Transfer, and (3) Stem Cell Analysis, that will provide culturing, processing, imaging and analysis of stem cells. The Stem Cell Center has partnered with the state-supported Advanced Energy Research and Technology Center (AERTC) at Stony Brook Technology Park, thereby providing unique synergisms linking biomaterials and nanoenginerring principles to stem cell research. Both the AERTC and the NYSTEM-funded stem cell center share the same mission of partnership with industry for the purpose of job creation, completing cutting edge research, and fostering economic growth and development in New York State.

Annual Meetings

In May of 2009, NYSTEM held its first annual meeting of awardees, entitled "Stem Cell Science in New York State: Emerging Opportunities," in Albany, New York. The meeting featured opening remarks from Dr. Richard F. Daines, New York State Commissioner of Health, a Keynote Address by Susan Solomon of the New York Stem Cell Foundation, three plenary sessions featuring ten of New York's most prominent stem cell scientists, and ended with a panel discussion on the opportunities and challenges of translational stem cell research. The meeting agenda is attached as Appendix 4.

NYSTEM held its second annual meeting, "NYSTEM 2010: Building the New York Stem Cell Community," at the CUNY Graduate Center in New York City. This two-day meeting hosted 175 New York State-based scientists for six plenary sessions, a workshop on shared facilities and a poster session. NYSTEM-funded scientists presented over 75 abstracts detailing their NYSTEM-funded research. The agenda is attached as Appendix 4.

Stem cell science has continued to progress at a remarkable pace, with important advances both in our understanding of stem cells and translation of that knowledge to clinical applications. The third annual meeting, "NYSTEM 2011: Science Accelerating Therapies," included two new gatherings: an Education Workshop showcasing the Curriculum Development and Summer Internship awardees; and a Translation Panel featuring participants from academia, the FDA and industry. Meeting attendees represented more than thirty New York institutions, from Long Island to Buffalo. The Agenda is attached as Appendix 4.

New York State Commissioner of Health

Richard F. Daines, M.D., served as Chair of the ESSCB from its inception in 2007 through the end of 2010. He led 41 board meetings during his tenure.

Education: Future Scientists and an Enlightened Public

Taking Stem Cells Beyond the Stem Cell Community

Continued progress in stem cell science requires a steady influx of stem cell scientists. The Empire State Stem Cell Board has created programs to attract newcomers to the field, including the very youngest.

In addition to training future scientists, the ESSCB made a commitment to promote awareness of stem cell science -- its promises and its challenges -- among all New Yorkers. An understanding of its fundamentals, as well as the difficult social issues it raises, is critical to sustaining progress. As stem cell research moves from bench to bedside, the social and policy issues become ever more complex. One aim of the program has been to provide the public with the tools needed to address these questions. NYSTEM has employed several different tactics to achieve this goal.

Summer Undergraduate Experience in Stem Cell Research

There is no better way to test a career than through an immersive internship. NYSTEM developed the Summer Undergraduate Experience in Stem Cell Research RFA and made three awards in May 2010, to Columbia University, Cornell University, and Stony Brook University. In their first two summers, these ten-week programs gave 48 promising students the chance to conduct research under experienced stem cell investigators and exposed them to the cultural, historical, clinical and ethical issues surrounding the field through seminars, discussion groups and field trips. As testament to the quality and value of these experiences, several students have co-authored journal publications reporting their findings (see insert on page 25).

Development and Implementation of Undergraduate Curricula

In July 2010, five New York universities received awards to develop and implement undergraduate level courses on stem cell science and its ethical, legal and social implications. To broaden the impact of these courses, the RFA required that the new curricula be made available free of charge to any interested institution.

Each awardee conceived the curriculum in its own way. Columbia University developed two separate curricula: one for traditional biomedical science students, who will likely go on to medical or scientific careers, and a second online tool to be made available to any interested user. A multi-departmental team at the New School designed a program for non-science students, teaching the fundamentals of stem cell science as well as its broader ethical, social and policy implications. Binghamton University aimed its course at entrepreneurs by focusing on biotechnology and the commercialization of stem cell research, including a visit to a local biotech startup company.

Going Straight to the Public

Several efforts under development during fiscal years 2009-10 through 2011-12 will be aimed at the public at large. First, by teaming journalists-in-training, established journalists and stem cell scientists, the ESSCB hopes to support increased public knowledge of stem cell research. Second, the ESSCB will support opportunities for primary and secondary school science teachers to conduct research in stem cell labs so that they can better convey the science of stem cells and spark an interest in young students. Other programs are under development that will be designed specifically to attract high school students. And after considerable research and discussion with experts, the Board advanced the concept of stem cell educational programs to be designed by science museums and offered both in the museums and online, where they can reach the largest and broadest possible audience.

Awards for Summer Undergraduate Experience in Stem Cell Research

Institution	Principal Investigator	Amount	Title
Columbia University	Alice Heicklen	$243,000	Summer Undergraduate Research Experience in Stem Cell Science
Cornell University	Laurel Southard	$234,576	Cornell Undergraduate Stem Cell Science Program
SUNY - Stony Brook University	David Bynum	$229,471	Summer Undergraduate Experience in Stem Cell Research

Awards for Development and Implementation of College and University Curricula Concerning Stem Cell Science and Related Ethical, Legal and Societal Implications

Institution	Principal Investigator	Amount	Title
The New School	Katayoun Chamany	$212,914	The Development, Implementation, and Assessment of an Interdisciplinary Stem Cell Curriculum for Non-Majors
Columbia University	Daniel Kalderon	$291,061	Implementation of a New Undergraduate Course, "Stem Cells: Biology, Applications and Ethics" at Columbia University
University of Rochester	Dina Markowitz	$272,448	The Science and Ethics of Stem Cells: a Case Study-Based Course for Undergraduates
Syracuse University	John Russell	$324,000	Development of an Interdisciplinary Portable Course on Stem Cells
SUNY - Binghamton University	Robert Van Buskirk	$287,823	The Business and Biology of Stem Cells in Cell Therapy

Summer Undergraduate Research Trainees Publish Three Papers

In 2009, NYSTEM sponsored summer undergraduate research programs at three institutions in New York. Now, three of the students in these programs have coauthored publications with their colleagues. From Columbia University, Grace Taylor, working with Professor Gordana Vunjak-Novakovic in the Department of Biomedical Engineering, coauthored a paper in *Proceedings of the National Academy of Sciences*. From Cornell University, Dian Yang, working with Professor John Schimenti in the Department of Biomedical Sciences, coauthored a paper in *Nucleic Acids Research*. Also from Cornell, Jimmy Wang, working with Professor Claudia Fischbach in the Department of Biomedical Engineering, coauthored a paper in *Proceedings of the National Academy of Sciences*.

Stem Cells for the Liberal Arts Student

Dr. Katayoun Chamany at the New School for Liberal Arts in New York City heads a team of eight faculty and five students that has created a module-based interdisciplinary course on stem cells. After first identifying the learning outcomes, they developed modules designed to illustrate each one. Several modules were piloted individually in advance of the complete course. Two were offered at the New School -- one as part of a course for incoming freshmen and another in the introductory course, "Feminist Thought and Action." A third was introduced at the San Francisco State University campus. The modules were then revised based on student and faculty evaluation and were incorporated into a full course at the New School in the spring semester of 2011.

Stem Cells for Non-Biology Majors

Dr. Dina Markowitz brought together a team of faculty from the University of Rochester and from Monroe Community College to develop an undergraduate stem cell course for non-biology majors. The multi-disciplinary team includes a stem cell scientist, a biology curriculum expert, and a philosopher with expertise in ELSI and medical and research ethics. The course, which provides both an overview of stem cell science and an opportunity to explore the related ethical, legal and social implications of the research using real-life case studies, was offered at both institutions, and the project modules will also be provided to other undergraduate institutions.

Stem Cells, Ethics and the Media

Faculty from Syracuse University and SUNY Upstate Medical University have teamed up to develop a course to cover the science of stem cells and the ethical, religious and social issues it raises. A unique aspect of the curriculum is its examination of the role of the news media and the ways interested groups use it to advocate for their positions. An interdisciplinary faculty team teaches the course, bringing their diversity of expertise.

STEM CELL RESEARCH: THE ETHICAL DIMENSIONS

The Board's Ethics Committee tackled several important issues during the period covered by this report. To help frame its own discussions, the Ethics committee considered the policies of other organizations on key ethics issues, including the permissibility of Somatic Cell Nuclear Transfer (SCNT), chimera research, creation of embryos for research, and compensation for oocyte and embryo donation. The committee reviewed the literature and heard presentations from leaders in the field. Over the course of nine meetings, members deliberated the ethical, legal, and social implications of stem cell research and developed groundbreaking new guidelines affecting hESC research by NYSTEM-funded researchers.

Compensation for Oocyte Donation

On June 11, 2009, the Board adopted a resolution, crafted and recommended by the Ethics Committee, allowing NYSTEM contractors to compensate women who donate their oocytes directly and solely to stem cell research for the expense, time, burden, and discomfort associated with the donation process. The Board's policy allows the use of NYSTEM funds to compensate donors of oocytes for research in amounts equal to those allowed by the State for donors of oocytes for *in vitro* fertilization. In reaching its conclusions, the Board considered the policies of other states and nations on donor payment, both in research and clinical contexts, as well as the views of experts on all sides of the issue. A majority of the Board voted to revise the language of the NYSTEM contract to permit the payments but required a rigorous review by an Embryonic Stem Cell Research Oversight (ESCRO) Committee and an IRB to ensure that the amounts do not constitute an undue inducement to donate. It prohibited compensation based on the number or quality of the oocytes donated. See Roxland, B.E. New York State's landmark policies on oversight and compensation for egg donation to stem cell research. Regen. Med. 2012 May; 7(3):397-408. Epub 2012 Mar 29, DOI 10.2217/rme.12.20.

Later that year, in New York State Supreme Court, an advocacy group opposed to hESC research filed *Feminists Choosing Life of New York, Inc., et al.* v. Empire State Stem Cell Board, et al., claiming that the policy violated the law that created the Board. First, it claimed that funding hESC research was unlawful because it "directly or indirectly fund[ed] research involving human reproductive cloning" by producing knowledge that could advance human reproductive cloning. Second, it argued that the prospect of monetary compensation for the donors' time, inconvenience and burden would overbear their ability to give informed consent. The trial court dismissed the complaint and the dismissal was upheld by the appellate court. Plaintiff appealed to the Court of Appeals, New York's highest court, which in late 2011 declined to review the lower court's decision.

ESSCB Comment on the NIH's Draft Guidelines for Human Stem Cell Research

In March 2009, President Obama issued Executive Order 13505, removing certain limitations on federal funding of hESC research. In response, NIH proposed Draft Guidelines to implement the order and opened a period of public comment. In May 2009, the Board submitted official comments to the NIH's Draft Guidelines urging it to:

- Allow funding for stem cell lines derived from embryos created for research purposes;
- Revise its draft guidelines to align them with the Common Rule's principles related to voluntary informed consent, independent oversight of the informed consent process, and undue inducements;
- Adhere more closely to the standards of the National Academy of Sciences (NAS) and ISSCR;
- Endorse the use of ESCROs;
- Allow use of cell lines imported from another jurisdiction or institution, or created prior to the effective date of the guidelines, so long as they were "acceptably derived;" and
- Continue to fund research on the hESC lines that were previously approved for use in federally-funded research according to the Bush Administration's policy.

In July 2009, NIH published final guidelines, clarifying its current policy.

Informed Consent

In FY 2009-10, the Board revised the NYSTEM contract to conform to the newly issued NIH guidelines, making it easier for researchers to comply with both standards. Among others, modifications included: (1) informing donors that their decision whether or not to donate to research will not affect the quality of care they receive; (2) informing donors of alternatives to donation for research purposes; (3) giving donors the right to withdraw consent up until the moment their oocytes are used in research; and (4) providing that NYSTEM awardees can utilize cell lines registered in the NIH registry, subject to ESCRO review. Provisions were also added requiring re-consent for the donation of excess embryos to research that had been initially created for reproductive purposes. Collectively, these revisions imposed stringent informed consent standards exceeding the legal requirements for participation in human subjects research.

Model Consent Forms

During this reporting period, the Ethics Committee continued the prodigious task of creating model informed consent forms for the following kinds of tissue donations:

- Eggs Provided Directly and Solely for Stem Cell Research;
- Eggs Collected During the Course of Fertility Treatment and in Excess of Clinical Need;
- Sperm Provided Directly and Solely for Stem Cell Research and Sperm in Excess of Clinical Need;
- Embryos Created for Fertility Purposes and in Excess of Clinical Need; and
- Somatic Cell Donation for Human Embryonic Stem Cell Research.

It completed its work in 2011 and the Funding Committee approved the model forms on November 14, 2011. They are posted on the NYSTEM website at stemcell.ny.gov/esscb-forms.

Respect for the Embryo

The Ethics Committee also continued to debate the philosophical and ethical dimensions of using human embryos in stem cell research. After thoughtful and respectful discussion, the Committee recommended that NYSTEM-funded protocols utilize the fewest number of embryos necessary, have sufficient scientific justification, undergo peer review, and halt experiments before or at 14 days of development, before formation of the primitive streak.

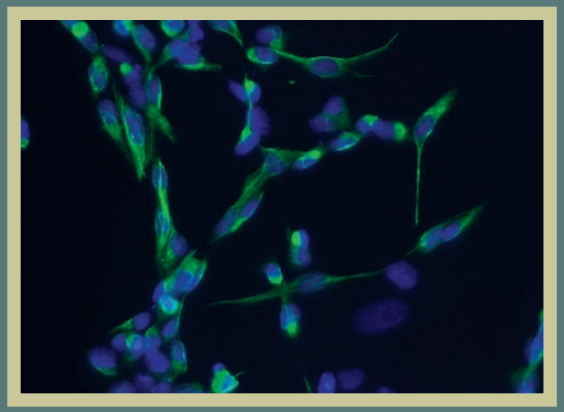
Human-Animal Chimera Research

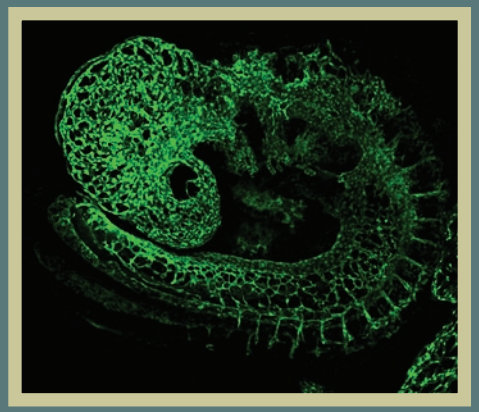
In FY 2010-11, the Ethics Committee completed its guidelines for chimera research, the combination of certain types of human cells with animals, their cells or embryos, and submitted them to the Funding Committee for final approval. The Ethics Committee deliberated extensively about the value of human-chimeras as an experimental tool and the prevailing ethical concerns. Ultimately, the Ethics Committee recommended that NYSTEM grantees adhere to the guidelines of the NAS or ISSCR when conducting chimera research involving human pluripotent stem cells, while highlighting key ethical issues for researchers and institutional bodies to consider when reviewing research protocols involving chimeras.

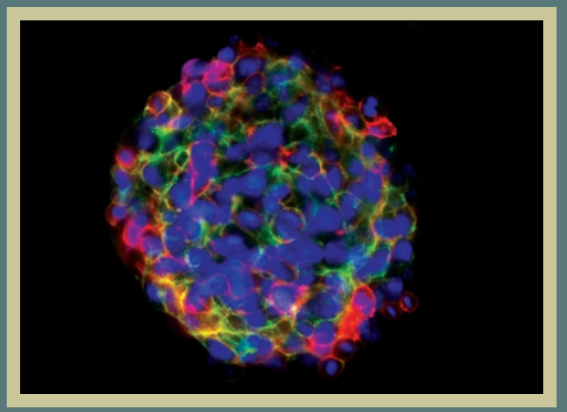
FUTURE DIRECTIONS

In support of scientific research, NYSTEM planned a fourth RFA for Investigator-Initiated Research awards to be issued in the fall of 2012. The Consortia will mark the beginning of an exciting new phase for the program by focusing on advancing breakthroughs in stem cell research toward clinical treatments and therapies. These and similar translational efforts are expected to be a major focus of NYSTEM for the duration of the program, even as NYSTEM and the ESSCB continue to work on new mechanisms to support research, training, infrastructure and education in stem cells.

The close of the period brought change to the Board. Dr. Nirav R. Shah, who was appointed Commissioner of Health by Governor Cuomo, became the new Chair of the Empire State Stem Cell Board, bringing fresh insights and a new approach. The Board passed a resolution to recognize its first chair, Commissioner Richard F. Daines, with an expression of its gratitude and affection. Following Dr. Daines's premature death in February 2011, the Board presented a formal statement to his widow, Linda Skidmore Daines. It is attached hereto as Appendix 5.







Mechanisms of Inherited Parkinson's Disease Discovered

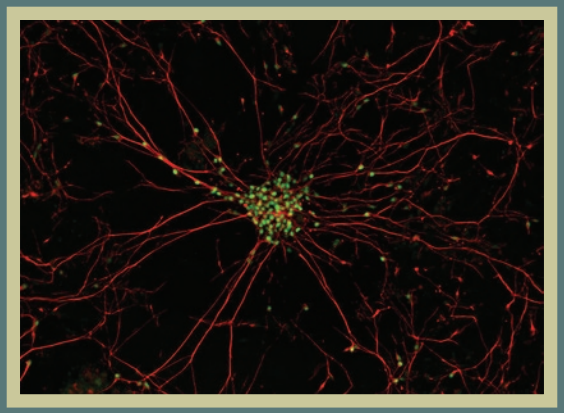
Jian Feng, Ph.D., at the University at Buffalo, reported in *Nature Communications* the generation of live human neurons from skin cells of patients with inherited Parkinson's Disease (PD). Although these neurons carry mutations in a gene accounting for only a subset of PD patients, the cells allow Dr. Feng and his colleagues to understand the molecular underpinnings of the disease. PD affects the very type of neuron Dr. Feng generated and will provide potential new targets for therapies to treat both the inherited and more common sporadic forms of PD.

Blood Vessels are Key to Liver Regeneration

Data from the lab of Shahin Rafii, M.D., at Weill Cornell Medical College, published in *Nature*, shows that blood vessel-lining endothelial cells secrete growth factors that spur the liver's stem cells, hepatocytes, to proliferate and regenerate liver in mice. Combining the two cell types together might help regenerate and heal damaged livers, helping the more than 60,000 people who die from liver disease each year. Dr. Rafii has additional data that endothelial cells may also contribute to tissue regeneration in other tissues.

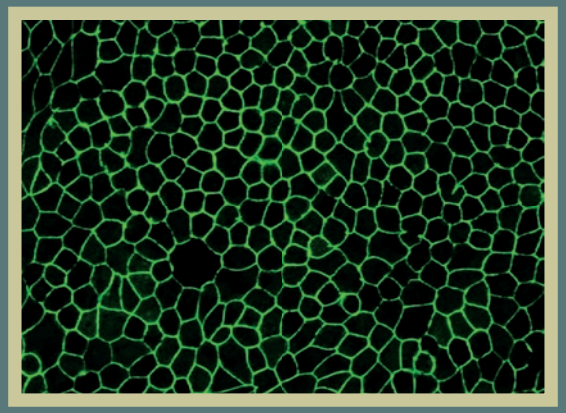
A Link Between Epigenetics and Transcription in Pluripotent Stem Cells–

A team of NYSTEM scientists at the Mount Sinai School of Medicine identified a link between epigenetics and the core pluripotency transcription network. The NYSTEM-supported group, headed by Ihor Lemischka, Ph.D., included Emily Bernstein, PhD., Michael Rendl, M.D., Christoph Schaniel, Ph.D., Jianlong Wang, Ph,D., with additional colleagues, collaborated to show that a component of the Trithorax complex, Wdr5, interacts with the pluripotency transcription factor Oct4 demonstrating for the first time a link between the epigenetic state and the pluripotency network in ES and iPS cells. This research was published in *Cell*.



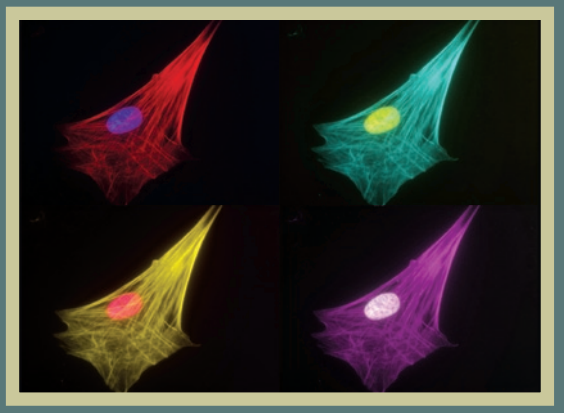
Conversion of Skin Cells From Alzheimer's Patients Into Functional Neurons

New research, published in *Cell*, from the lab of Dr. Asa Abeliovich, M.D., Ph.D., at Columbia University Medical Center, shows that cells from Alzheimer's disease (AD) patients can be converted directly into functional neurons, the cells damaged and lost in the disease. Dr. Abeliovich and his colleagues generated human induced neurons (hiNs) from patients with inherited and sporadic forms of AD. These cells are already providing insights into how AD develops, and with their ability to integrate normally, may prove useful for cell-based therapies.



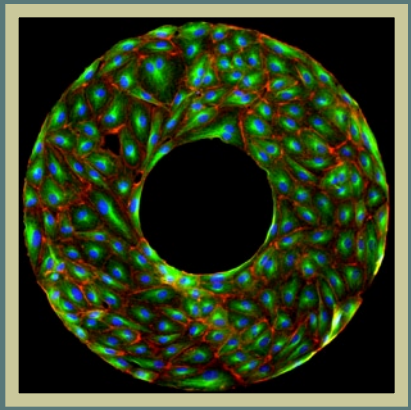
Multipotent Stem Cells Discovered in Human Eyes

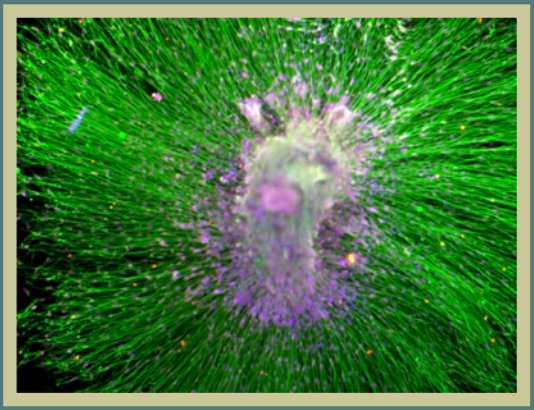
Drs. Sally Temple, Enrique Salero, and colleagues from the Neural Stem Cell Institute in Rensselaer, identified a population of adult stem cells that is readily accessible in the eye. The cells are found in the retinal pigment epithelium (RPE) and termed RPESCs, lie dormant throughout life, but when removed from the eye in a simple procedure, from patients as old as 99 and even from cadavers, begin to multiply. The data, published in *Cell Stem Cell*, show RPESCs are good source candidates for cell replacement therapies in diseases such as age-related macular degeneration.



Conversion of Human Embryonic Stem Cells Into Endothelial Cells

NYSTEM supported scientists discovered an efficient method to convert human embryonic stem cells (hESCs) into blood vessel-forming endothelial cells, with the potential to heal damaged tissues and organs. Dr. Shahin Rafii's group at Weill Cornell Medical College published in *Nature Biotechnology* identification of factors promoting commitment of hESCs to vascular lineages, yielding a 36-fold expansion of endothelial cells. Importantly, their methodology is amenable to clinical manufacturing processes, paving the way toward therapies.





Modification of Fusion Protein Causes Blood Cancers

Lan Wang, Ph.D., an Empire State Stem Cell Scholar at Memorial Sloan-Kettering Cancer Center, published new data in *Science* identifying the mechanism behind the uncontrolled cell proliferation leading to certain blood cancers. Dr. Wang and her mentor, Stephen Nimer, M.D., study the blood cancer acute myelogenous leukemia (AML). Their new research identified the mechanism by which one of the most common mutations leading to AML can cause uncontrolled cell growth, and presents an attractive target for development of new therapeutics for AML and possibly other cancers.

NYSTEM Scientists Report a Stem Cell Source for Parkinson's Disease Therapy

A new method, published in *Nature* from the lab of Lorenz Studer, M.D, produced dopamine (DA) neurons from human embryonic stem cells (hESCs) that could engraft into animal models of Parkinson's disease (PD). Scientists have been able to produce DA neurons from stem cells for years, but these cells never engrafted well and hence failed to allay symptoms in the animal models. Using a new approach, Dr. Studer's team derived midbrain DA neurons, the cell type affected in PD, that engrafted and improved disease symptoms in animals. This research provides a potential avenue for stem cell-based therapy to treat PD in humans.

APPENDIX 1
Roster of the Empire State Stem Cell Board

Nirav R. Shah, M.D., M.P.H. (Chair), is the fifteenth New York State Commissioner of Health. His nomination by Governor Andrew M. Cuomo was confirmed by the State Senate on January 24, 2011, making him the first Indian-American to serve as State Commissioner of Health as well as the youngest person named to the post. An expert in the use of systems-based methods to improve patient outcomes, Dr. Shah has been a leading researcher in the use of large-scale clinical laboratories and electronic health records to improve the effectiveness and efficiency of care. He is a nationally recognized thought leader in the methods needed to transition to lower-cost, patient-centered health care for the 21st century. Before his government service, Dr. Shah was attending physician at Bellevue Hospital Center in Manhattan, associate investigator at the Geisinger Center for Health Research in central Pennsylvania, and assistant professor at the New York University School of Medicine in value and comparative effectiveness. Dr. Shah also has conducted research into advancing preventive care for patients with cardiovascular disease and improving cardiovascular disease surveillance and public health. A native of Buffalo, Dr. Shah is an honors graduate of Harvard College and received his medical degree and master's degree in public health from the Yale School of Medicine. He was a Robert Wood Johnson Clinical Scholar at UCLA and a National Research Service Award Fellow at New York University. Dr. Shah is a fellow of American College of Physicians and the New York Academy of Medicine. He has served on the editorial boards of medical journals, has published more than 90 peer-reviewed articles, and has received more than $4.5 million in research funding. He is certified in internal medicine by the American Board of Internal Medicine.

Richard F. Daines, M.D.
New York State Health Department Commissioner
2007 – 2010

Funding Committee

Bradford C. Berk, M.D., Ph.D.
CEO of the Medical Center and Strong Health,
University of Rochester
2007- Present

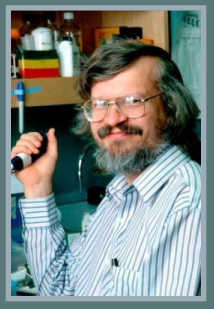
Robin Anthony Elliott, M.A.
Executive Director, Parkinson's Disease Foundation
2007 – Present

Kenneth Adams, M.B.A.
President & CEO, Empire State Development Corporation
2007-2011

Richard W. Dutton, Ph.D.
Trudeau Institute
2007 – 2010

Gerald D. Fischbach, M.D.
Scientific Director, The Simons Foundation
2007 – 2011

David C. Hohn, M.D.
President Emeritus and Executive Director of Health Policy, Roswell Park Cancer Institute
2007 – Present



Richard M. Gronostajski, Ph.D.
Director of the Western New York Stem Cell Culture and Analysis Center, University of Buffalo
2011 – Present

Bruce Holm, Ph.D.
Executive Director,
New York State Center of Excellence in Bioinformatics and Life Sciences, University of Buffalo
2007 – 2011

Hilda Hutcherson, M.D., FACOG

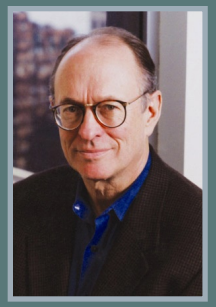
Associate Dean in the Office of Diversity &
Clinical Professor of Obstetrics and Gynecology,
Columbia University College of Physicians and Surgeons

2007 – 2012

Mario G. Loomis, M.D., F.A.C.S.

Vice Chairman of Surgery, Orange Regional Medical Center

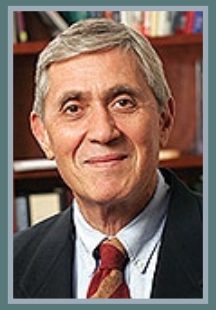
2010 – Present



Michael A. Stocker, M.D., M.P.H.

Chairman of the Board,
New York City Health and Hospitals Corporation

2007 – Present



Allen M. Spiegel, M.D.

Dean, Albert Einstein College of Medicine
of Yeshiva University

2009 – Present

Madelyn Wils

President and CEO, Hudson River Park Trust

2007 – Present

Ethics Committee

Jann K. Armantrout

Diocesan Life Issues Coordinator,
Roman Catholic Diocese of Rochester, New York

2010 - Present

Nancy Neveloff Dubler, LL.B.

Ethics Consultant,
Health and Hospitals Corporation of New York City

2007 – Present

Thomas Berg, Ph.D.

Roman Catholic Priest in the Archdiocese of New York
Professor of Moral Theology at Saint Joseph's Seminary

2007 - 2012

Brooke Ellison, Ph.D.

Director of Education and Ethics,
Stony Brook University Stem Cell
Research Facility Center
Founder and President, Brooke Ellison Project

2007 - Present

Samuel Gorovitz, Ph.D.

Professor of Philosophy, Syracuse University

2007 - Present

Vivian S. Lee, M.D., Ph.D., M.B.A.

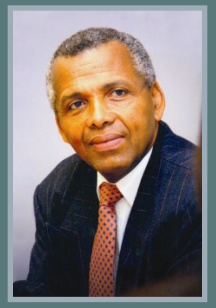
Senior Vice President and Chief Scientific Officer,
New York University (NYU) Medical Center

2007 - 2011

Robert Klitzman, M.D.

Associate Professor of Clinical Psychiatry,
College of Physicians and Surgeons of Columbia University

2007 - Present



H. Hugh Maynard-Reid, D.Min., B.C.C., C.A.S.A.C.

Director of the Pastoral Care Department in the
North Brooklyn Health Network,
Health and Hospitals Corporation of New York City

2007 - Present

Samuel Packer, M.D.

Chair Emeritus of the Department of Ophthalmology,
North Shore-Long Island Jewish Health System

2007 – Present

Robert N. Swidler, M.A., J.D.

General Counsel, Northeast Health

2007 – 2010

APPENDIX 2
Awards

Institutional Development Awards
Contract Start Date - April 1, 2008

Contract Number	Contract Amount	Principal Investigator	Institution
C023043	$ 606,422	Tramposch, Kenneth	Research Foundation of SUNY - Buffalo
C023044	$ 380,933	Spector, David L.	Cold Spring Harbor Laboratory
C023045	$ 198,000	Josephson, Ira R.	Research Foundation of CUNY - City College
C023046	$ 768,426	Young, Michael W.	The Rockefeller University
C023050	$ 1,000,000	Nikitin, Alexander Yu	Cornell University
C023052	$ 215,718	Hintze, Thomas H.	New York Medical College
C023053	$ 871,000	Brink, Peter R.	Research Foundation of SUNY - Stony Brook
C023055	$ 1,000,000	Goldman, James E.	The Trustees of Columbia University in the City of NY
C023056	$ 1,000,000	Guzick, David S.	University of Rochester
C023058	$ 999,715	Lehmann, Ruth E.	New York University
C023060	$ 192,267	Teitelman, Gladys	Research Foundation of SUNY - Downstate Medical
C023062	$ 1,000,000	Lemischka, Ihor R.	Mount Sinai School of Medicine
C023063	$ 100,000	Sell, Stewart	Ordway Research Institute, Inc.
C023065	$ 100,000	Levon, Kalle	Polytechnic University
	Total: $ 8,432,481		

*Nine additional awards terminated prior to FY 2009-10.

Planning Grants for Emerging Opportunities and Consortia Development for Stem Cell Research
Contract Start Date - November 1, 2008

Contract Number	Contract Amount	Principal Investigator	Institution
C023888	$ 120,000	Bouhassira, Eric	Albert Einstein College of Medicine of Yeshiva University
C023889	$ 76,800	Henn, Fritz A.	Brookhaven National Laboratory
C023890	$ 118,920	Stewart, David J.	Cold Spring Harbor Laboratory
C023891	$ 119,960	Vunjak-Novakovic, Gordana	The Trustees of Columbia University in the City of NY
C023892	$ 120,000	Goldman, James E.	The Trustees of Columbia University in the City of NY
C023893	$ 120,000	Nikitin, Alexander Yu	Cornell University
C023894	$ 118,180	Gupta, Sanjeev	Montefiore Medical Center
C023895	$ 120,000	Lemischka, Ihor R.	Mount Sinai School of Medicine
C023896	$ 119,705	Hintze, Thomas H.	New York Medical College
C023897	$ 85,409	Sell, Stewart	Ordway Research Institute, Inc.
C023898	$ 120,000	Temple, Sally	Regenerative Research Foundation
C023899	$ 120,000	Gudkov, Andrei	Health Research, Inc. - Roswell Park Cancer Institute
C023900	$ 119,797	Solomon, Susan L.	The New York Stem Cell Foundation
C023901	$ 119,948	Fossett, James	Research Foundation of SUNY - Albany
C023902	$ 120,000	Batuman, Olcay	Research Foundation of SUNY - Downstate Medical
C023903	$ 118,800	Cohen, Ira S.	Research Foundation of SUNY - Stony Brook
C023904	$ 76,751	Noble, Mark	University of Rochester
C023905	$ 117,127	Beal, M. Flint	Weill Medical College of Cornell University
	Total: $ 2,031,397		

Shared Facilities/Resources for Stem Cell Research
Contract Start Date - January 1, 2009

Contract Number	Contract Amount	Principal Investigator	Institution
C024172	$ 5,993,889	Bouhassira, Eric	Albert Einstein College of Medicine of Yeshiva University
C024173	$ 481,738	Spector, David L.	Cold Spring Harbor Laboratory
C024174	$ 1,629,645	Schimenti, John C.	Cornell University
C024175	$ 2,707,911	Studer, Lorenz	Memorial Sloan-Kettering Cancer Center
C024176	$ 3,812,528	Lemischka, Ihor R.	Mount Sinai School of Medicine
C024177	$ 1,923,269	Temple, Sally	Regenerative Research Foundation
C024178	$ 5,136,655	Feuer, Gerold	Research Foundation of SUNY - Upstate Medical
C024179	$ 5,861,451	Noggle, Scott	The New York Stem Cell Foundation
C024180	$ 4,864,705	Brivanlou, Ali	The Rockefeller University
	Total: $ 32,411,791		

Targeted Investigation of Induced Pluripotent Stem Cells and Other Derivation Approaches
Contract Start Date - January 1, 2009

Contract Number	Contract Amount	Principal Investigator	Institution
C024396	$ 240,000	Evans, Todd	Albert Einstein College of Medicine of Yeshiva University
C024397	$ 240,000	Lu, Jonathan	The Trustees of Columbia University in the City of NY
C024398	$ 240,000	Pruitt, Steven	Health Research, Inc. - Roswell Park Cancer Institute
C024399	$ 240,000	Salero, Enrique	Regenerative Research Foundation
C024400	$ 228,840	Fortier, Lisa	Cornell University
C024401	$ 240,000	Wang, Timothy	The Trustees of Columbia University in the City of NY
C024402	$ 1,080,000	Abeliovich, Asa	The Trustees of Columbia University in the City of NY
C024403	$ 1,080,000	Abeliovich, Asa	The Trustees of Columbia University in the City of NY
C024404	$ 1,080,000	Bishop, David	Mount Sinai School of Medicine
C024405	$ 971,489	Bouhassira, Eric	Albert Einstein College of Medicine of Yeshiva University
C024406	$ 1,080,000	Feng, Jian	Research Foundation of SUNY - Buffalo
C024407	$ 1,079,937	Gelb, Bruce	Mount Sinai School of Medicine
C024408	$ 1,080,000	Ghaffari, Saghi	Mount Sinai School of Medicine
C024409	$ 1,047,974	Goldman, Steven A.	University of Rochester
C024410	$ 1,080,000	Lemischka, Ihor R.	Mount Sinai School of Medicine
C024411	$ 1,076,309	Moll, Ute	Research Foundation of SUNY - Stony Brook
C024412	$ 1,080,000	Sadelain, Michel	Memorial Sloan-Kettering Cancer Center
C024413	$ 1,068,031	Tabar, Viviane	Memorial Sloan-Kettering Cancer Center
C024414	$ 1,000,000	Temple, Sally	Regenerative Research Foundation
C024415	$ 1,080,000	Wichterle, Hynek	The Trustees of Columbia University in the City of NY
	Total: $ 16,312,580		

Investigator Initiated Research Projects or Innovative Developmental or Exploratory Activities (IDEA) in Stem Cell Research – Generic Round 1

Contract Start Date - January 1, 2009

Contract Number	Contract Amount	Principal Investigator	Institution
C024281	$ 240,000	Anderson, Stewart	Weill Medical College of Cornell University
C024282	$ 240,000	Neelamegham, Sriram	Research Foundation of SUNY - Buffalo
C024283	$ 240,000	Awad, Hani	University of Rochester
C024284	$ 240,000	Bach, Erika	New York University
C024285	$ 240,000	Bernstein, Emily	Mount Sinai School of Medicine
C024286	$ 240,000	Brown, Anthony	Weill Medical College of Cornell University
C024287	$ 240,000	Doetsch, Fiona	The Trustees of Columbia University in the City of NY
C024288	$ 240,000	Fraser, Stuart	Mount Sinai School of Medicine
C024289	$ 240,000	Hadjantonakis, Anna-Katerina	Memorial Sloan-Kettering Cancer Center
C024290	$ 240,000	Hazelrigg, Tulle	The Trustees of Columbia University in the City of NY
C024291	$ 240,000	Hernando, Eva	New York University
C024292	$ 240,000	Huss, Wendy	Health Research, Inc. - Roswell Park Cancer Institute
C024293	$ 239,787	Kottman, Andreas	The Trustees of Columbia University in the City of NY
C024294	$ 240,000	Kumar, Mukesh	Albert Einstein College of Medicine of Yeshiva University
C024295	$ 240,000	Laufer, Edward	The Trustees of Columbia University in the City of NY
C024296	$ 240,000	Levy, David	New York University
C024297	$ 240,000	Lopez, Maria	Health Research, Inc. - Wadsworth Center
C024298	$ 240,000	Lowry, Natalia Abramova	Regenerative Research Foundation
C024299	$ 240,000	Manley, James	The Trustees of Columbia University in the City of NY
C024300	$ 239,628	Matushansky, Igor	The Trustees of Columbia University in the City of NY
C024301	$ 240,000	Nance, Jeremy	New York University
C024302	$ 224,103	Ortiz, Benjamin	Research Foundation of CUNY - Hunter College
C024303	$ 240,000	Owens, David	The Trustees of Columbia University in the City of NY
C024304	$ 240,000	Raghavan, Srikala	The Trustees of Columbia University in the City of NY
C024305	$ 240,000	Hylander, Bonnie	Health Research, Inc. - Roswell Park Cancer Institute
C024306	$ 240,000	Steidl, Ulrich	Albert Einstein College of Medicine of Yeshiva University
C024307	$ 232,678	Tall, Gregory	University of Rochester
C024308	$ 239,134	Timmermans, Marja	Cold Spring Harbor Laboratory
C024309	$ 227,452	Wallenfang, Matthew	Barnard College
C024310	$ 240,000	Xu, Lei	University of Rochester
C024311	$ 240,000	Yan, Jun	Regenerative Research Foundation
C024312	$ 240,000	Higgins, Paul	Albany Medical College
C024313	$ 1,080,000	Aaronson, Stuart	Mount Sinai School of Medicine
C024314	$ 1,080,000	Aguirre-Ghiso, Julio	Mount Sinai School of Medicine
C024315	$ 1,055,958	Andreadis, Stelios	Research Foundation of SUNY - Buffalo
C024316	$ 1,010,490	Andreadis, Stelios	Research Foundation of SUNY - Buffalo
C024317	$ 1,080,000	Bahou, Wadie	Research Foundation of SUNY - Stony Brook
C024318	$ 1,080,000	Baron, Margaret	Mount Sinai School of Medicine
C024319	$ 1,050,872	Bohmann, Dirk	University of Rochester
C024320	$ 1,001,308	Chen, Di	University of Rochester
C024321	$ 1,080,000	Christiano, Angela	The Trustees of Columbia University in the City of NY
C024322	$ 933,689	Dailey, Lisa	New York University
C024323	$ 1,079,996	Enikolopov, Grigori	Cold Spring Harbor Laboratory
C024324	$ 1,080,000	Ferland, Russell	Albany Medical College
C024325	$ 1,069,779	Feuer, Gerold	Research Foundation of SUNY - Upstate Medical

Contract Number	Contract Amount	Principal Investigator	Institution
C024326	$ 900,000	Fishell, Gordon	New York University
C024327	$ 1,080,000	Fishman, Glenn	New York University
C024328	$ 591,420	Ghazizadeh, Soosan	Research Foundation of SUNY - Stony Brook
C024329	$ 1,002,632	Goff, Stephen	The Trustees of Columbia University in the City of NY
C024330	$ 1,080,000	Hen, René	Research Foundation for Mental Hygiene, Inc. - NYS PI
C024331	$ 1,049,875	Jacobs, Christopher Rae	The Trustees of Columbia University in the City of NY
C024332	$ 1,080,000	Jessell, Thomas	The Trustees of Columbia University in the City of NY
C024333	$ 1,007,280	Lacy, Elizabeth	Memorial Sloan-Kettering Cancer Center
C024334	$ 1,080,000	Linhardt, Robert	Rensselear Polytechnic Institute
C024335	$ 719,890	Lu, Helen	The Trustees of Columbia University in the City of NY
C024336	$ 1,079,985	Mao, Jeremy	The Trustees of Columbia University in the City of NY
C024337	$ 1,040,161	Morse, Randall	Health Research, Inc. - Wadsworth Center
C024338	$ 358,500	Calvi, Laura	University of Rochester
C024340	$ 1,049,110	Palis, James	University of Rochester
C024341	$ 1,053,458	Perera, Tarique	The Trustees of Columbia University in the City of NY
C024342	$ 1,080,000	Pessin, Jeffrey	Albert Einstein College of Medicine of Yeshiva University
C024343	$ 1,069,157	Rogler, Charles	Albert Einstein College of Medicine of Yeshiva University
C024344	$ 1,023,800	Rosen, Michael	The Trustees of Columbia University in the City of NY
C024345	$ 1,080,000	Ross, Margaret Elizabeth	Weill Medical College of Cornell University
C024346	$ 1,080,000	Roy-Chowdhury, Jayanta	Albert Einstein College of Medicine of Yeshiva University
C024347	$ 1,070,964	Rutishauser, Urs	Memorial Sloan-Kettering Cancer Center
C024348	$ 1,080,000	Schildkraut, Carl	Albert Einstein College of Medicine of Yeshiva University
C024349	$ 1,048,941	Snoeck, Hans-Willem	Mount Sinai School of Medicine
C024350	$ 961,499	Steidl, Ulrich	Albert Einstein College of Medicine of Yeshiva University
C024351	$ 1,022,300	Suzuki, Gen	Research Foundation of SUNY - Buffalo
C024352	$ 1,049,036	Temple, Sally	Regenerative Research Foundation
C024353	$ 1,002,134	Terracio, Louis	New York University
C024354	$ 1,033,979	Tumbar, Tudorita	Cornell University
C024355	$ 589,686	Tzanakakis, Emmanouhl	Research Foundation of SUNY - Buffalo
C024356	$ 813,496	Wang, Hsien-yu	Research Foundation of SUNY - Stony Brook
C024357	$ 756,732	Zhang, Xinping	University of Rochester
C024358	$ 1,080,000	Zhou, Ming-Ming	Mount Sinai School of Medicine
C024964	$ 1,079,790	Jordan, Craig	University of Rochester
	Total: $ 53,418,699		

Summer Undergraduate Experience in Stem Cell Research
Contract Start Date - May 1, 2010

Contract Number	Contract Amount	Principal Investigator	Institution
C026074	$ 229,471	Bynum, David R.	Research Foundation of SUNY - Stony Brook
C026075	$ 234,576	Southard, Laurel E.	Cornell University
C026076	$ 243,000	Heicklen, Alice J.	The Trustees of Columbia University in the City of NY
	Total: $ 707,047		

Development and Implementation of College and University Curricula Concerning Stem Cell Science and Related Ethical, Legal and Societal Implications

Contract Start Date - July 1, 2010

Contract Number	Contract Amount	Principal Investigator	Institution
C026077	$ 212,914	Chamany, Katayoun	The New School
C026078	$ 291,061	Kalderon, Daniel D.	The Trustees of Columbia University in the City of NY
C026079	$ 272,448	Markowitz, Dina G.	University of Rochester
C026080	$ 324,000	Russell, John M.	Syracuse University
C026081	$ 287,823	Van Buskirk, Robert G.	Research Foundation of SUNY - Binghamton
	Total: $ 1,388,246		

Targeted Projects in Human Embryonic Stem Cell Research

Contract Start Date - September 1, 2010

Contract Number	Contract Amount	Principal Investigator	Institution
C026184	$ 931,586	Egli, Dieter	The New York Stem Cell Foundation
C026185	$ 980,364	Noggle, Scott	The New York Stem Cell Foundation
C026186	$ 992,553	Paluh, Janet L.	Rennselaer Polytechnic Institute
	Total: $ 2,904,503		

Investigator Initiated Research Projects and Innovative, Developmental or Exploratory Activities (IDEA) in Stem Cell Research - Generic Round 2

Contract Start Date - November 1, 2008

Contract Number	Contract Amount	Principal Investigator	Institution
C026399	$ 274,744	Chambers, Stuart M.	Memorial Sloan-Kettering Cancer Center
C026400	$ 240,000	Colognato, Holly	Research Foundation of SUNY - Stony Brook
C026401	$ 327,822	Doetsch, Fiona	The Trustees of Columbia University in the City of NY
C026402	$ 329,844	Hadjantonakis, Anna-Katerina	Memorial Sloan-Kettering Cancer Center
C026403	$ 251,232	Lee, Gabsang	Memorial Sloan-Kettering Cancer Center
C026404	$ 321,242	Lee, Siu Sylvia	Cornell University
C026405	$ 330,000	Nimer, Stephen D.	Memorial Sloan-Kettering Cancer Center
C026406	$ 330,000	Perkins, Archibald S.	University of Rochester
C026407	$ 329,987	Ptashne, Mark	Memorial Sloan-Kettering Cancer Center
C026408	$ 330,000	Rangasamy, Tirumalai	University of Rochester
C026409	$ 299,700	Reizis, Boris	The Trustees of Columbia University in the City of NY
C026410	$ 330,000	Rendl, Michael	Mount Sinai School of Medicine
C026411	$ 330,000	Rendl, Michael	Mount Sinai School of Medicine
C026412	$ 253,994	Seigel, Gail M.	Research Foundation of SUNY - Buffalo
C026413	$ 319,907	Sim, Fraser J.	Research Foundation of SUNY - Buffalo
C026414	$ 316,609	Sirotkin, Howard I.	Research Foundation of SUNY - Stony Brook
C026415	$ 330,000	Stachowiak, Michal K.	Research Foundation of SUNY - Buffalo
C026416	$ 330,000	Steidl, Ulrich	Albert Einstein College of Medicine of Yeshiva University

Contract Number	Contract Amount	Principal Investigator	Institution
C026417	$ 330,000	Sun, Jun	University of Rochester
C026418	$ 330,000	Tabar, Viviane	Memorial Sloan-Kettering Cancer Center
C026419	$ 308,780	Thompson, Deanna M.	Rensselear Polytechnic Institute
C026420	$ 329,808	Wang, Jianlong	Mount Sinai School of Medicine
C026421	$ 321,699	Weiss, Robert S.	Cornell University
C026422	$ 314,552	Zhang, Xinping	University of Rochester
C026423	$ 319,792	Zhang, Yi	University of Rochester
C026424	$ 1,080,000	Antzelevitch, Charles	Masonic Medical Research Laboratory
C026425	$ 787,934	Benraiss, Abdellatif	University of Rochester
C026426	$ 1,080,000	Cai, Chen-Leng	Mount Sinai School of Medicine
C026427	$ 1,025,000	Fuchs, Elaine V.	The Rockefeller University
C026428	$ 1,029,124	Goldman, Steven A.	University of Rochester
C026429	$ 1,060,681	Gronostajski, Richard	Research Foundation of SUNY - Buffalo
C026430	$ 1,075,647	Hen, René	Research Foundation for Mental Hygiene, Inc. - NYS PI
C026431	$ 1,080,000	Hoffman, Ronald H.	Mount Sinai School of Medicine
C026432	$ 999,709	Kass, Robert S.	The Trustees of Columbia University in the City of NY
C026433	$ 1,056,229	Lemischka, Ihor R.	Mount Sinai School of Medicine
C026434	$ 1,024,200	Li, Xiajun	Mount Sinai School of Medicine
C026435	$ 1,080,000	Bieker, James J.	Mount Sinai School of Medicine
C026436	$ 829,071	Lin, Reigh-Yi	Mount Sinai School of Medicine
C026437	$ 1,080,000	Noble, Mark	University of Rochester
C026438	$ 1,079,866	Rafii, Shahin	Weill Medical College of Cornell University
C026439	$ 1,013,000	Roninson, Igor B.	Ordway Research Institute, Inc.
C026440	$ 1,078,000	Roy-Chowdhury, Jayanta	Albert Einstein College of Medicine of Yeshiva University
C026441	$ 728,189	Salzer, James L.	New York University
C026442	$ 544,130	Schimenti, John C.	Cornell University
C026443	$ 1,080,000	Shen, Michael M.	The Trustees of Columbia University in the City of NY
C026444	$ 1,080,000	Shen, Michael M.	The Trustees of Columbia University in the City of NY
C026445	$ 1,043,955	Sloan, Richard P.	The Trustees of Columbia University in the City of NY
C026446	$ 1,031,000	Studer, Lorenz	Memorial Sloan-Kettering Cancer Center
C026447	$ 1,080,000	Studer, Lorenz	Memorial Sloan-Kettering Cancer Center
C026448	$ 990,210	Tsang, Stephen H.	The Trustees of Columbia University in the City of NY
C026449	$ 1,019,668	Vunjak-Novakovic, Gordana	The Trustees of Columbia University in the City of NY
C026450	$ 865,357	Wolosin, Jose Mario	Mount Sinai School of Medicine
Total:	$ 34,750,682		

Empire State Stem Cell Scholars: Fellow-to-Faculty Awards in Stem Cell Research
Contract Start date - November 1, 2010

Contract Number	Contract Amount	Principal Investigator	Institution
C026720	$ 1,078,500	Wang, Lan	Memorial Sloan-Kettering Cancer Center
C026721	$ 1,076,799	Freytes, Donald	The Trustees of Columbia University in the City of NY
C026722	$ 1,078,500	Chen, Ting	The Rockefeller University
	Total: $ 3,233,799		

Empire State Institutional Training Programs in Stem Cell Research for Predoctoral and Postdoctoral Fellows
Contract Start Date - July 1, 2011

Contract Number	Contract Amount	Principal Investigator	Institution
C026877	$ 1,781,977	Noble, Mark	University of Rochester
C026878	$ 1,869,721	Rafii, Shahin	Weill Medical College of Cornell University
C026879	$ 1,863,000	Studer, Lorenz	Memorial Sloan-Kettering Cancer Center
C026880	$ 1,884,320	Lehmann, Ruth E.	New York University
	Total: $ 7,399,018		

APPENDIX 3
Appendix Funding Commitments

NYSTEM Funding Commitments as of April 2010

	Infrastructure Shared Facilities/ Resources and Equip	**Research**	**Scientific Training** Training/ Conferences/ Workshops	**ELSIE** Etical, Legal, Societal Issues and Education	**Administration** Board Functions, Grant Admin, Peer Review	**Total**
25 Institutional Development Grants	$ 7,423,547	$ 5,973,965	$ 1,115,038	$ 0	$ 0	$ 14,512,550
18 Planning Grants for Consortia	$ 0	$ 2,031,397	$ 0	$ 0	$ 0	$ 2,031,397
9 Shared Facilities / LargeEquipment Grants	$ 32,411,791	$ 0	$ 0	$ 0	$ 0	$ 32,411,791
20 Targeted iPS Grants	$ 0	$ 16,312,580	$ 0	$ 0	$ 0	$ 16,312,580
78 Generic Grants - Round 1	$ 0	$ 53,159,750	$ 0	$ 0	$ 0	$ 53,159,750
3 Targeted hESC Grants	$ 0	$ 2,904,503	$ 0	$ 0	$ 0	$ 2,904,503
52 Recurring Generic Grants - Round 2	$ 0	$ 34,750,682	$ 0	$ 0	$ 0	$ 34,750,682
5 Curriculum Grants	$ 0	$ 0	$ 0	$ 1,388,246	$ 0	$ 1,388,246
3 Summer Internships Grants	$ 0	$ 0	$ 0	$ 707,047	$ 0	$ 707,047
Shared Facilities RFA - issued 8.27.09	$ 30,000,000	$ 0	$ 0	$ 0	$ 0	$ 30,000,000
Fellow to Faculty RFA - issued 8.27.09	$ 0	$ 4,312,500	$ 1,080,000	$ 0	$ 0	$ 5,392,500
Institutional Training RFA	$ 0	$ 0	$ 7,500,000	$ 0	$ 0	$ 7,500,000
Short Term Faculty Training RFA	$ 0	$ 0	$ 1,000,000	$ 0	$ 0	$ 1,000,000
Medical, Dental, Veterinary Student Training RFA	$ 0	$ 0	$ 1,500,000	$ 0	$ 0	$ 1,500,000
Training Fellowships RFA	$ 0	$ 0	$ 2,100,000	$ 0	$ 0	$ 2,100,000
Teacher Education RFA	$ 0	$ 0	$ 0	$ 2,700,000	$ 0	$ 2,700,000
Consortia RFA	$ 0	$ 80,000,000	$ 0	$ 0	$ 0	$ 80,000,000
Recurring Generic RFA Round 3	$ 0	$ 25,000,000	$ 0	$ 0	$ 0	$ 25,000,000
Peer Review Contract	$ 0	$ 0	$ 0	$ 0	$ 8,600,000	$ 8,600,000
Board / Grant Admin	$ 0	$ 0	$ 0	$ 0	$ 2,300,000	$ 2,300,000
Total - All Contracts and Approved RFAs / RFPs	$ 69,835,338	$ 199,445,377	$ 14,295,038	$ 4,795,293	$ 10,900,000	$ 324,271,046

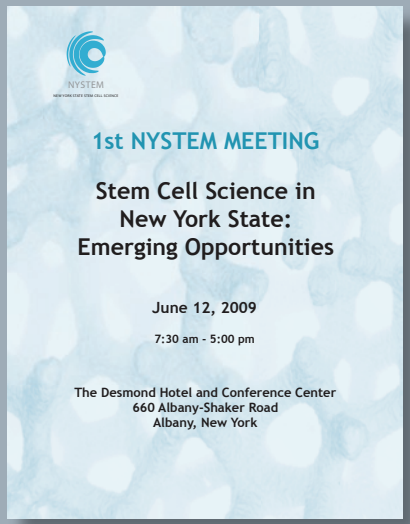
NYSTEM Funding Commitments as of April 2011

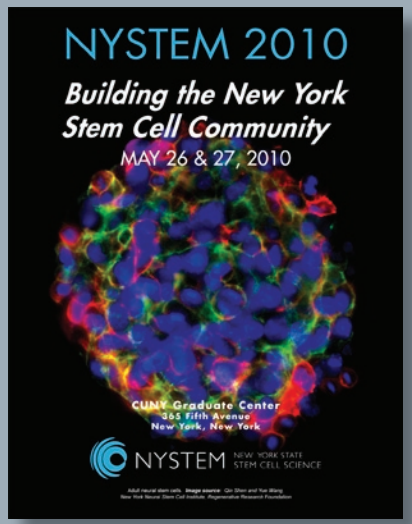
	Infrastructure Shared Facilities/ Resources and Equip	**Research** Grants	**Scientific Training** Training/ Conferences/ Workshops	**ELSIE** Etical, Legal, Societal Issues and Education	**Administration** Board Functions, Grant Admin, Peer Review	**Total**
25 Institutional Development Grants	$ 7,423,547	$ 5,973,965	$ 1,115,038	$ 0	$ 0	$ 14,512,550
18 Planning Grants for Consortia	$ 0	$ 2,031,397	$ 0	$ 0	$ 0	$ 2,031,397
9 Shared Facilities / LargeEquipment Grants	$ 32,411,791	$ 0	$ 0	$ 0	$ 0	$ 32,411,791
20 Targeted iPS Grants	$ 0	$ 16,312,580	$ 0	$ 0	$ 0	$ 16,312,580
78 Generic Grants - Round 1	$ 0	$ 53,159,750	$ 0	$ 0	$ 0	$ 53,159,750
3 Targeted hESC Grants	$ 0	$ 2,904,503	$ 0	$ 0	$ 0	$ 2,904,503
50 Recurring Generic Grants - Round 2	$ 0	$ 32,908,611	$ 0	$ 0	$ 0	$ 32,908,611
5 Curriculum Grants	$ 0	$ 0	$ 0	$ 1,388,246	$ 0	$ 1,388,246
3 Summer Internships Grants	$ 0	$ 0	$ 0	$ 707,047	$ 0	$ 707,047
7 Shared Facilities Grants	$ 27,264,509	$ 0	$ 0	$ 0	$ 0	$ 27,264,509
3 Fellow to Faculty Grants	$ 0	$ 2,586,136	$ 647,663	$ 0	$ 0	$ 3,233,799
4 Institutional Training Grants	$ 0	$ 0	$ 7,399,018	$ 0	$ 0	$ 7,399,018
Short Term Faculty Training RFA	$ 0	$ 0	$ 1,000,000	$ 0	$ 0	$ 1,000,000
Medical, Dental, Veterinary Student Training RFA	$ 0	$ 0	$ 1,500,000	$ 0	$ 0	$ 1,500,000
Training Fellowships RFA	$ 0	$ 0	$ 2,100,000	$ 0	$ 0	$ 2,100,000
Teacher Education RFA	$ 0	$ 0	$ 0	$ 2,700,000	$ 0	$ 2,700,000
Consortia RFA	$ 0	$ 80,000,000	$ 0	$ 0	$ 0	$ 80,000,000
Recurring Generic RFA Round 3	$ 0	$ 25,000,000	$ 0	$ 0	$ 0	$ 25,000,000
Journalist Education RFA	$ 0	$ 0	$ 0	$ 4,000,000	$ 0	$ 4,000,000
Institutional Training RFA Round 2	$ 0	$ 0	$ 7,500,000	$ 0	$ 0	$ 7,500 000
Peer Review Contract	$ 0	$ 0	$ 0	$ 0	$ 8,583,312	$ 8,583,312
Board / Grant Administration	$ 0	$ 0	$ 0	$ 0	$ 4,737,308	$ 4,737,308
Total - All Contracts and Approved RFAs / RFPs	$ 67,099,847	$ 220,876,942	$ 21,261,719	$ 8,795,293	$ 13,320,620	$ 331,354,421

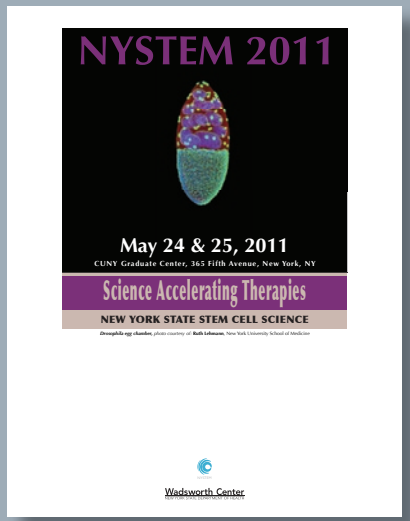
NYSTEM Funding Commitments as of April 2012

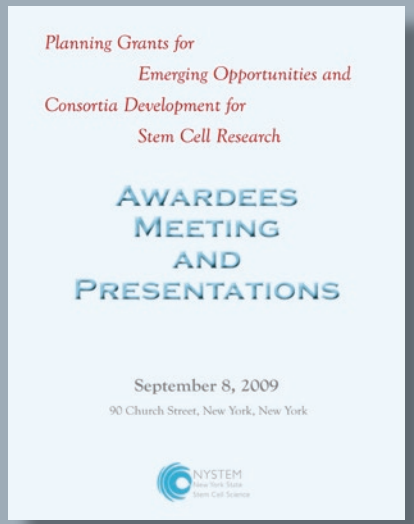
	Infrastructure Shared Facilities/ Resources and Equip	**Research** Grants	**Scientific Training** Training/ Conferences/ Workshops	**ELSIE** Etical, Legal, Societal Issues and Education	**Administration** Board Functions, Grant Admin, Peer Review	**Total**
25 Institutional Development Grants	$ 7,423,547	$ 5,973,965	$ 1,115,038	$ 0	$ 0	$ 14,512,550
18 Planning Grants for Consortia	$ 0	$ 2,031,397	$ 0	$ 0	$ 0	$ 2,031,397
9 Shared Facilities / LargeEquipment Grants	$ 32,411,791	$ 0	$ 0	$ 0	$ 0	$ 32,411,791
20 Targeted iPS Grants	$ 0	$ 16,312,580	$ 0	$ 0	$ 0	$ 16,312,580
78 Generic Grants - Round 1	$ 0	$ 53,159,750	$ 0	$ 0	$ 0	$ 53,159,750
3 Targeted hESC Grants	$ 0	$ 2,904,503	$ 0	$ 0	$ 0	$ 2,904,503
50 Recurring Generic Grants - Round 2	$ 0	$ 32,908,611	$ 0	$ 0	$ 0	$ 32,908,611
5 Curriculum Grants	$ 0	$ 0	$ 0	$ 1,388,246	$ 0	$ 1,388,246
3 Summer Internships Grants	$ 0	$ 0	$ 0	$ 707,047	$ 0	$ 707,047
7 Shared Facilities Grants	$ 27,264,509	$ 0	$ 0	$ 0	$ 0	$ 27,264,509
3 Fellow to Faculty Grants	$ 0	$ 2,586,136	$ 647,663	$ 0	$ 0	$ 3,233,799
4 Institutional Training Grants	$ 0	$ 0	$ 7,399,018	$ 0	$ 0	$ 7,399,018
Short Term Faculty Training RFA	$ 0	$ 0	$ 1,000,000	$ 0	$ 0	$ 1,000,000
Medical, Dental, Veterinary Student Training RFA	$ 0	$ 0	$ 1,500,000	$ 0	$ 0	$ 1,500,000
Training Fellowships RFA	$ 0	$ 0	$ 2,100,000	$ 0	$ 0	$ 2,100,000
Teacher Education RFA	$ 0	$ 0	$ 0	$ 2,700,000	$ 0	$ 2,700,000
Consortia RFA	$ 0	$ 80,000,000	$ 0	$ 0	$ 0	$ 80,000,000
Recurring Generic RFA Round 3	$ 0	$ 25,000,000	$ 0	$ 0	$ 0	$ 25,000,000
Journalist Education RFA	$ 0	$ 0	$ 0	$ 4,000,000	$ 0	$ 4,000,000
Institutional Training RFA Round 2	$ 0	$ 0	$ 7,500,000	$ 0	$ 0	$ 7,500 000
Education in Museums	$ 0	$ 0	$ 0	$ 4,000,000	$ 0	$ 4,000,000
Recurring Genetic RFA Round 4	$ 0	$ 25,000,000	$ 0	$ 0	$ 0	$ 25,000,000
Peer Review Contract	$ 0	$ 0	$ 0	$ 0	$ 8,583,312	$ 8,583,312
Board / Grant Administration	$ 0	$ 0	$ 0	$ 0	$ 4,737,308	$ 4,737,308
Total - All Contracts and Approved RFAs / RFPs	$ 67,099,847	$ 245,876,942	$ 21,261,719	$ 12,795,293	$ 13,320,620	$ 360,354,421

APPENDIX 4
Meeting Agendas









APPENDIX 5
Dr. Daines commemoration

To Linda Skidmore Daines

In grateful appreciation for the privilege of working
with and beside your husband,

New York State Health Commissioner
Richard F. Daines, M.D.,

in our shared mission to chart a course to serve
the citizens of the State of New York
by supporting research that we believe will one day lead
to cures for the diseases and conditions that afflict New Yorkers
and human beings throughout the world.

We will always remember his quick brilliance,
his quirky humor, his unfailing optimism,
his respectfulness, fairness and integrity,
his determination, his dedication and
his unerring leadership.

It was our good fortune
to serve with him these four short years,
and the good fortune of all New Yorkers
to have him serve.

With warm affection and deep gratitude
from the members and staff of the
Empire State Stem Cell Board

November 14, 2011

APPENDIX 6
Administrative Expenses

As stated in its Strategic Plan, "the Board is committed to ensuring public access to information regarding its activities and programs and to the outcomes of NYSTEM funded research, training and development." That plan targets three to five percent of available funding to support administrative activities, including, but not limited to, the administration of an independent scientific merit peer–review process; program development and evaluation; contract monitoring; website development; outreach; and coordination of scientific meetings.

State Fiscal Year 2009-2010

Administrative expenditures during the 2009-2010 State Fiscal Year totaled approximately $2 million and constituted four percent of the $50 million appropriated. Specific administrative expenditures include:

- Personal services costs –$1,165,000: *Salaries and fringe benefits for program staff*
- Supplies – $15,000: *General office supplies and computer software for program and Board operations*
- Board meeting expenses – $25,000: *Travel reimbursement, speaker honoraria, and webcasting costs, for nine Board and Committee meetings, primarily convened in the Department of Health offices*
- Peer review services – $823,000: *Coordination of 12 independent peer review panels to evaluate 242 applications received in response to six RFAs*

State Fiscal Year 2010-2011

Administrative expenditures during the 2010-2011 State Fiscal Year totaled approximately $1.3 million and constituted less than three percent of the $44.8 million appropriated. Specific administrative expenditures include:

- Personal services costs – $1,100,000: *Salaries and fringe benefits for program staff*
- Supplies – $5,000: *General office supplies and computer software for program and Board operations*
- Board meeting expenses – $20,000: *Travel reimbursement, speaker honoraria, and webcasting costs, for five Board and Committee meetings, primarily convened in the Department of Health offices*
- Peer review services – $120,000: *Coordination of two independent peer review panels to evaluate 23 applications received in response to two RFAs*

State Fiscal Year 2011-2012

Administrative expenditures during the 2011-2012 State Fiscal Year totaled approximately $1.9 million and constituted slightly more than four percent of the $44.8 million appropriated. Specific administrative expenditures include:

- Personal services costs – $1,225,000: *Salaries and fringe benefits for program staff*
- Supplies – $5,000: *General office supplies and computer software for program and Board operations*
- Board meeting expenses – $18,000: *Travel reimbursement, speaker honoraria, and webcasting costs, for seven Board and Committee meetings, primarily convened in the Department of Health offices*
- Peer review services – $675,000: *Coordination of 12 independent peer review panels to evaluate 293 applications received in response to one RFA*

APPENDIX 7
Publications List

Selected Publications 2009-2010

Butler, J.M., Nolan, D.J., Vertes, E.L., Varnum-Finney, B., Kobayashi, H., Hooper, A.T., Seandel, M., Shido, K., White, I.A., Kobayashi, M., Witte, L., May, C., Shawber, C., Kimura, Y., Kitajewski, J., Rosenwaks, Z., Bernstein, I.D., Rafii, S. (2010). Endothelial Cells Are Essential for the Self-Renewal and Repopulation of Notch-Dependent Hematopoietic Stem Cells. Cell Stem Cell *6*, 251-264.

Gao, J., Graves, S., Koch, U., Liu, S., Jankovic, V., Buonamici, S., El Andaloussi, A., Nimer, S.D., Kee, B.L., Taichman, R., Radtke, F., Aifantis, I. (2009). Hedgehog Signaling Is Dispensable for Adult Hematopoietic Stem Cell Function. Cell Stem Cell *4*, 548-558.

Goldberg, A.D., Banaszynski, L.A., Noh, K.M., Lewis, P.W., Elsaesser, S.J., Stadler, S., Dewell, S., Law, M., Guo, X., Li, X., Wen, D., Chapgier, A., Dekelver, R.C., Miller, J.C., Lee, Y.L., Boydston, E.A., Holmes, M.C., Gregory, P.D., Greally, J.M., Rafii, S., Yang, C., Scambler, P.J., Garrick, D., Gibbons, R.J., Higgs, D.R., Cristea, I.M., Urnov, F.D., Zheng, D., Allis, C.D. (2010). Distinct Factors Control Histone Variant H3.3 Localization at Specific Genomic Regions. Cell *140*, 678-691.

Gough, D.J., Corlett, A., Schlessinger, K., Wegrzyn, J., Larner, A.C., and Levy, D.E. (2009). Mitochondrial STAT3 supports Ras-dependent oncogenic transformation. Science *324*, 1713-1716.

Hoi, C.S., Lee, S.E., Lu, S.Y., McDermitt, D.J., Osorio, K.M., Piskun, C.M., Peters, R.M., Paus, R., and Tumbar, T. (2010). Runx1 directly promotes proliferation of hair follicle stem cells and epithelial tumor formation in mouse skin. Mol Cell Biol.

James, D., Nam, H.S., Seandel, M., Nolan, D., Janovitz, T., Tomishima, M., Studer, L., Lee, G., Lyden, D., Benezra, R., Zaninovic, N., Rosenwaks, Z., Rabbany, S.Y., Rafii, S. (2010). Expansion and maintenance of human embryonic stem cell-derived endothelial cells by TGFbeta inhibition is Id1 dependent. Nat Biotechnol *28*, 161-166.

Lee, G., Papapetrou, E.P., Kim, H., Chambers, S.M., Tomishima, M.J., Fasano, C.A., Ganat, Y.M., Menon, J., Shimizu, F., Viale, A., Tabar, V., Sadelain, M., Studer, L. (2009). Modelling pathogenesis and treatment of familial dysautonomia using patient-specific iPSCs. Nature *461*, 402-406.

Lee, G., Chambers, S.M., Tomishima, M.J., and Studer, L. (2010). Derivation of neural crest cells from human pluripotent stem cells. Nat Protoc *5*, 688-701.

Mannik, J., Alzayady, K., and Ghazizadeh, S. (2010). Regeneration of multilineage skin epithelia by differentiated keratinocytes. J Invest Dermatol *130*, 388-397.

Papapetrou, E.P., Tomishima, M.J., Chambers, S.M., Mica, Y., Reed, E., Menon, J., Tabar, V., Mo, Q., Studer, L., and Sadelain, M. (2009). Stoichiometric and temporal requirements of Oct4, Sox2, Klf4, and c-Myc expression for efficient human iPSC induction and differentiation. Proc Natl Acad Sci U S A *106*, 12759-12764.

Shabbir, A., Zisa, D., Leiker, M., Johnston, C., Lin, H., and Lee, T. (2009). Muscular dystrophy therapy by nonautologous mesenchymal stem cells: muscle regeneration without immunosuppression and inflammation. Transplantation *87*, 1275-1282.

Zhang, Y.V., Cheong, J., Ciapurin, N., McDermitt, D.J., and Tumbar, T. (2009). Distinct self-renewal and differentiation phases in the niche of infrequently dividing hair follicle stem cells. Cell Stem Cell 5, 267-278. *

Carvajal-Vergara, X., Sevilla, A., D'Souza, S.L., Ang, Y.S., Schaniel, C., Lee, D.F., Yang, L., Kaplan, A.D., Adler, E.D., Rozov, R., Ge, Y., Cohen, N., Edelmann, L.J., Chang, B., Waghray, A., Su, J., Pardo, S., Lichtenbelt, K.D., Tartaglia, M., Gelb, B.D., Lemischka, I.R. (2010). Patient-specific induced pluripotent stem-cell-derived models of LEOPARD syndrome. Nature *465*, 808-812.

Ding, B.S., Nolan, D.J., Butler, J.M., James, D., Babazadeh, A.O., Rosenwaks, Z., Mittal, V., Kobayashi, H., Shido, K., Lyden, D., Sato, T.N., Rabbany, S.Y., Rafii, S. (2010). Inductive angiocrine signals from sinusoidal endothelium are required for liver regeneration. Nature *468*, 310-315.

England, S.J., McGrath, K.E., Frame, J.M., and Palis, J. (2011). Immature erythroblasts with extensive ex vivo self-renewal capacity emerge from the early mammalian fetus. Blood *117*, 2708-2717. *

Garcia-Fernandez, M., Kissel, H., Brown, S., Gorenc, T., Schile, A.J., Rafii, S., Larisch, S., and Steller, H. (2010). Sept4/ARTS is required for stem cell apoptosis and tumor suppression. Genes Dev *24*, 2282-2293.

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Selected Publications 2010-2011

Green, M.D., Chen, A., Nostro, M.C., d'Souza, S.L., Schaniel, C., Lemischka, I.R., Gouon-Evans, V., Keller, G., and Snoeck, H.W. (2011). Generation of anterior foregut endoderm from human embryonic and induced pluripotent stem cells. Nat Biotechnol *29*, 267-272. *

Hsu, Y.C., Pasolli, H.A., and Fuchs, E. (2011). Dynamics between Stem Cells, Niche, and Progeny in the Hair Follicle. Cell *144*, 92-105. *

Jing, D., Parikh, A., and Tzanakakis, E.S. (2010). Cardiac cell generation from encapsulated embryonic stem cells in static and scalable culture systems. Cell Transplant *19*, 1397-1412.

Kapoor, A., Goldberg, M.S., Cumberland, L.K., Ratnakumar, K., Segura, M.F., Emanuel, P.O., Menendez, S., Vardabasso, C., Leroy, G., Vidal, C.I., Polsky, D., Osman, I., Garcia, B.A.,

Hernando, E., Bernstein, E. (2010). The histone variant macroH2A suppresses melanoma progression through regulation of CDK8. Nature *468*, 1105-1109.

Kobayashi, H., Butler, J.M., O'Donnell, R., Kobayashi, M., Ding, B.S., Bonner, B., Chiu, V.K., Nolan, D.J., Shido, K., Benjamin, L., Rafii, S. (2010). Angiocrine factors from Akt-activated endothelial cells balance self-renewal and differentiation of haematopoietic stem cells. Nat Cell Biol.

Lee, C.H., Cook, J.L., Mendelson, A., Moioli, E.K., Yao, H., and Mao, J.J. (2010). Regeneration of the articular surface of the rabbit synovial joint by cell homing: a proof of concept study. Lancet *376*, 440-448. *

Liu, J.Y., Peng, H.F., Gopinath, S., Tian, J., and Andreadis, S.T. (2010). Derivation of functional smooth muscle cells from multipotent human hair follicle mesenchymal stem cells. Tissue Eng Part A *16*, 2553-2564.

Papapetrou, E.P., Lee, G., Malani, N., Setty, M., Riviere, I., Tirunagari, L.M., Kadota, K., Roth, S.L., Giardina, P., Viale, A., Leslie, C., Bushman, F.D., Studer, L., Sadelain, M. (2011). Genomic safe harbors permit high beta-globin transgene expression in thalassemia induced pluripotent stem cells. Nat Biotechnol *29*, 73-78. *

Shmelkov, S.V., Hormigo, A., Jing, D., Proenca, C.C., Bath, K.G., Milde, T., Shmelkov, E., Kushner, J.S., Baljevic, M., Dincheva, I., Murphy, A.J., Valenzuela, D.M., Gale, N.W., Yancopoulos, G.D., Ninan, I., Lee, F.S., Rafii, S. (2010). Slitrk5 deficiency impairs corticostriatal circuitry and leads to obsessive-compulsive-like behaviors in mice. Nat Med *16*, 598-602.

Wang, R., Chadalavada, K., Wilshire, J., Kowalik, U., Hovinga, K.E., Geber, A., Fligelman, B., Leversha, M., Brennan, C., and Tabar, V. (2010). Glioblastoma stem-like cells give rise to tumour endothelium. Nature. *

Woo, S.H., Stumpfova, M., Jensen, U.B., Lumpkin, E.A., and Owens, D.M. (2010). Identification of epidermal progenitors for the Merkel cell lineage. Development *137*, 3965-3971.

Yang, C., Yang, Y., Brennan, L., Bouhassira, E.E., Kantorow, M., and Cvekl, A. (2010). Efficient generation of lens progenitor cells and lentoid bodies from human embryonic stem cells in chemically defined conditions. FASEB J *24*, 3274-3283. *

Yap, K.L., Li, S., Munoz-Cabello, A.M., Raguz, S., Zeng, L., Mujtaba, S., Gil, J., Walsh, M.J., and Zhou, M.M. (2010). Molecular interplay of the noncoding RNA ANRIL and methylated histone H3 lysine 27 by polycomb CBX7 in transcriptional silencing of INK4a. Mol Cell *38*, 662-674.

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Selected Publications 2011-2012

Andreu-Agullo, C., Maurin, T., Thompson, C.B., and Lai, E.C. (2012). Ars2 maintains neural stem-cell identity through direct transcriptional activation of Sox2. Nature 481, 195-198.

Ang, Y.S., Tsai, S.Y., Lee, D.F., Monk, J., Su, J., Ratnakumar, K., Ding, J., Ge, Y., Darr, H., Chang, B., et al. (2011). Wdr5 Mediates Self-Renewal and Reprogramming via the Embryonic Stem Cell Core Transcriptional Network. Cell. *

Biteau, B., Hochmuth, C.E., and Jasper, H. (2011). Maintaining tissue homeostasis: dynamic control of somatic stem cell activity. Cell Stem Cell 9, 402-411.

Bragado, P., Estrada, Y., Sosa, M.S., Avivar-Valderas, A., Cannan, D., Genden, E., Teng, M., Ranganathan, A.C., Wen, H.C., Kapoor, A., et al. (2012). Analysis of Marker-Defined HNSCC Subpopulations Reveals a Dynamic Regulation of Tumor Initiating Properties. PLoS One 7, e29974.

Chang, C.J., Mitra, K., Koya, M., Velho, M., Desprat, R., Lenz, J., and Bouhassira, E.E. (2011). Production of embryonic and fetal-like red blood cells from human induced pluripotent stem cells. PLoS One 6, e25761.

De Marco Garcia, N.V., Karayannis, T., and Fishell, G. (2011). Neuronal activity is required for the development of specific cortical interneuron subtypes. Nature 472, 351-355.

Ding, B.S., Nolan, D.J., Guo, P., Babazadeh, A.O., Cao, Z., Rosenwaks, Z., Crystal, R.G., Simons, M., Sato, T.N., Worgall, S., et al. (2011). Endothelial-derived angiocrine signals induce and sustain regenerative lung alveolarization. Cell 147, 539-553.*

Ding, J., Xu, H., Faiola, F., Ma'ayan, A., and Wang, J. (2012a). Oct4 links multiple epigenetic pathways to the pluripotency network. Cell Res 22, 155-167.

Ding, L., Saunders, T.L., Enikolopov, G., and Morrison, S.J. (2012b). Endothelial and perivascular cells maintain haematopoietic stem cells. Nature 481, 457-462.

Encinas, J.M., Michurina, T.V., Peunova, N., Park, J.H., Tordo, J., Peterson, D.A., Fishell, G., Koulakov, A., and Enikolopov, G. (2011). Division-coupled astrocytic differentiation and age-related depletion of neural stem cells in the adult hippocampus. Cell Stem Cell 8, 566-579.

Hartford, S.A., Luo, Y., Southard, T.L., Min, I.M., Lis, J.T., and Schimenti, J.C. (2011). Minichromosome maintenance helicase paralog MCM9 is dispensible for DNA replication but functions in germ-line stem cells and tumor suppression. Proc Natl Acad Sci U S A 108, 17702-17707. *

Isern, J., He, Z., Fraser, S.T., Nowotschin, S., Ferrer-Vaquer, A., Moore, R., Hadjantonakis, A.K., Schulz, V., Tuck, D., Gallagher, P.G., et al. (2011). Single-lineage transcriptome analysis reveals key regulatory pathways in primitive erythroid progenitors in the mouse embryo. Blood 117, 4924-4934.

Itoh, M., Kiuru, M., Cairo, M.S., and Christiano, A.M. (2011). Generation of keratinocytes from normal and recessive dystrophic epidermolysis bullosa-induced pluripotent stem cells. Proc Natl Acad Sci U S A.

Jiang, H., Ren, Y., Yuen, E.Y., Zhong, P., Ghaedi, M., Hu, Z., Azabdaftari, G., Nakaso, K., Yan, Z., and Feng, J. (2012). Parkin controls dopamine utilization in human midbrain dopaminergic neurons derived from induced pluripotent stem cells. Nat Commun 3, 668. *

Kriks, S., Shim, J.W., Piao, J., Ganat, Y.M., Wakeman, D.R., Xie, Z., Carrillo-Reid, L., Auyeung, G., Antonacci, C., Buch, A., et al. (2011). Dopamine neurons derived from human ES cells efficiently engraft in animal models of Parkinson's disease. Nature. *

Min, I.M., Waterfall, J.J., Core, L.J., Munroe, R.J., Schimenti, J., and Lis, J.T. (2011). Regulating RNA polymerase pausing and transcription elongation in embryonic stem cells. Genes Dev 25, 742-754.

O'Loghlen, A., Munoz-Cabello, A.M., Gaspar-Maia, A., Wu, H.A., Banito, A., Kunowska, N., Racek, T., Pemberton, H.N., Beolchi, P., Lavial, F., et al. (2012). MicroRNA Regulation of Cbx7 Mediates a Switch of Polycomb Orthologs during ESC Differentiation. Cell Stem Cell 10, 33-46.

Oshimori, N., and Fuchs, E. (2012). Paracrine TGF-beta signaling counterbalances BMP-mediated repression in hair follicle stem cell activation. Cell Stem Cell 10, 63-75.

Pastrana, E., Silva-Vargas, V., and Doetsch, F. (2011). Eyes wide open: a critical review of sphere-formation as an assay for stem cells. Cell Stem Cell 8, 486-498.

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Selected Publications 2011-2012

Qiang, L., Fujita, R., Yamashita, T., Angulo, S., Rhinn, H., Rhee, D., Doege, C., Chau, L., Aubry, L., Vanti, W.B., et al. (2011). Directed conversion of Alzheimer's disease patient skin fibroblasts into functional neurons. Cell 146, 359-371. *

Riviere, I., Dunbar, C.E., and Sadelain, M. (2012). Hematopoietic stem cell engineering at a crossroads. Blood 119, 1107-1116.

Sahay, A., Scobie, K.N., Hill, A.S., O'Carroll, C.M., Kheirbek, M.A., Burghardt, N.S., Fenton, A.A., Dranovsky, A., and Hen, R. (2011a). Increasing adult hippocampal neurogenesis is sufficient to improve pattern separation. Nature.

Sahay, A., Wilson, D.A., and Hen, R. (2011b). Pattern separation: a common function for new neurons in hippocampus and olfactory bulb. Neuron 70, 582-588.

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