2017

Technology & Innovation Development Office

ANNUAL REPORT

Boston Children's Hospital

Until every child is well™

From the Director

BOSTON CHILDREN'S HOSPITAL'S world leadership in clinical care is matched by our leadership in discovery and invention. Our innovators and scientists bring Boston Children's mission to life through their research discoveries, which range from basic research into biological processes to clinical research bringing novel treatments to our patients. In this report, you will see many examples: from basic insights into the workings of the immune system to the validation of novel gene therapies for rare childhood diseases.

At the Technology & Innovation Development Office (TIDO), our mission is to bring these discoveries to the largest number of patients by finding industry partners who will turn them into life-changing treatments, devices and diagnostics. We work closely with our researchers and clinicians to identify discoveries that have commercial potential; we protect Boston Children's intellectual property; we develop commercial strategies that give our nascent discoveries the greatest chance to reach the market; we connect our researchers and clinicians with partners in industry; we fund promising technologies to de-risk them; and we engage with and educate our research community about how best to see the fruits of their work transform patient care.

TIDO builds upon a tremendous research base of more than $350 million in research expenditures. In FY17, we entered into 75 new industry partnerships to move our discoveries closer to the market, spun out five new companies, funded six promising technologies through our Technology Development Fund and completed 753 agreements (including CDAs, MTAs, etc.) with more than 200 industry partners.

As we look to the future, I believe we are at an incredible moment at Boston Children's. We are on the cusp of bridging the gap between identifying genomic causes of rare diseases and translating that understanding into treatment. We are also teasing out causes of more common, multi-gene diseases. Our patients are our most important partners in these endeavors.

Every year brings challenges and opportunities. I hope this report gives you insight into the efforts being made at Boston Children's to bring our research to patients around the world.

Irene Abrams
Vice President, Technology Development and New Ventures
Technology & Innovation Development Office

TIDO in

FY17

RESEARCH EXPENDITURES **$355,000,000**

NEW INDUSTRY SPONSORED RESEARCH FUNDING **$14,950,000**

RESEARCH AGREEMENTS **54**

LICENSING AGREEMENTS **37**

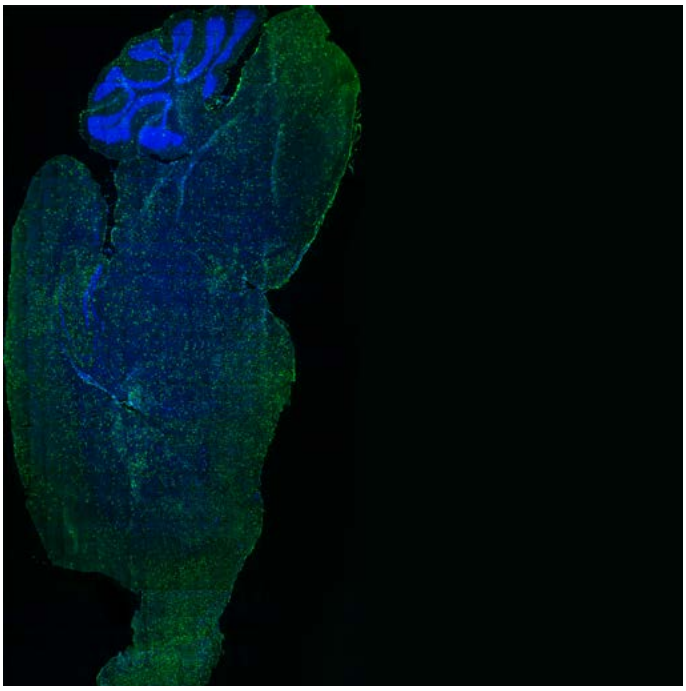
NET LICENSING REVENUE **$42,290,000***

INVENTION DISCLOSURES **144**

STARTUPS CREATED **5**

* Includes settlement of litigation

Cover: Image of a mouse brain that received a direct transplantation of hematopoietic stem cells. The image reveals the transplanted cells (green) rapidly engrafted and gave rise to new cells (also green) that have widely distributed throughout the entire brain. *Capotondo et al., 2017*



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Agreements

LICENSES **38**

LICENSE, OPTION AND RESEARCH AGREEMENTS EXECUTED **92**

CORPORATE SPONSORED RESEARCH & COLLABORATIONS **53**

NON-DISCLOSURE **174**

RECEIPT OF EQUITY **3**

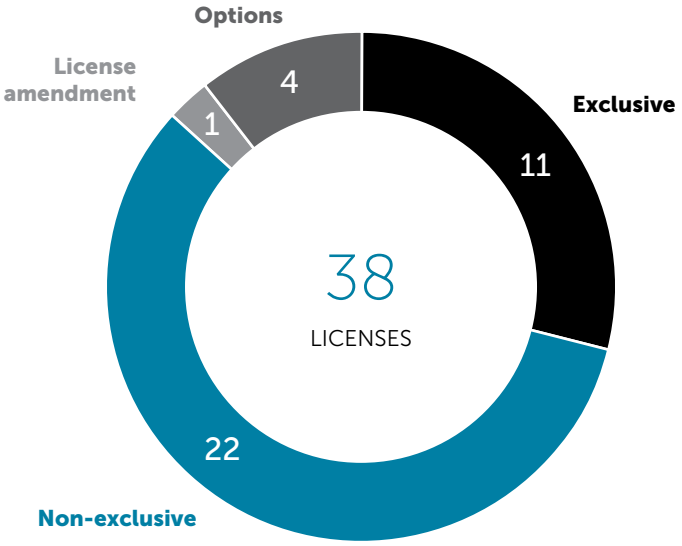
MATERIAL TRANSFER **405**

INTER-INSTITUTIONAL INVENTION ADMINISTRATION **10**

AMENDMENTS **14**

CONTRACT RESEARCH ORGANIZATIONS **19**

OTHER **14**



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Significant Figures

PATENTS ISSUED **121**

PATENT APPLICATIONS FILED **226**

INVENTION DISCLOSURES **140**

STARTUPS CREATED **5**

REVENUE FROM NEW LICENSES AND OPTIONS **$460,000**

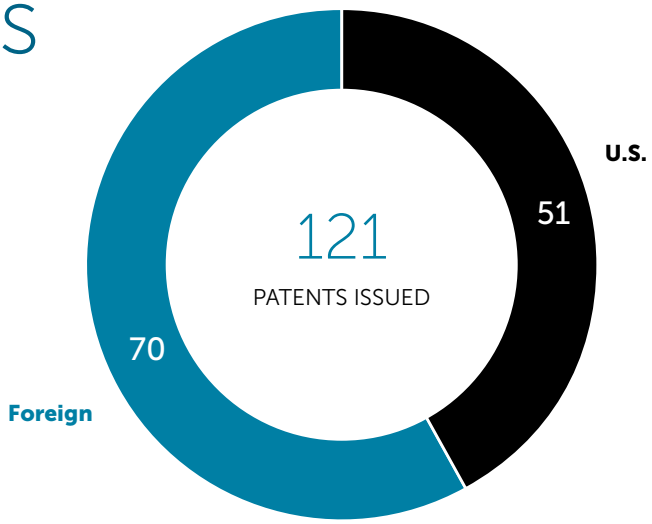
NET REVENUE **$42,290,000***

GROSS REVENUE **$44,080,000***

ACADEMIC PARTNERS **229**

INDUSTRY PARTNERS **223**

* Includes settlement of litigation



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Five-year Growth Trends

Sponsored Research and Collaboration Agreements

Industry-sponsored Research Funding

License and Option Agreements

Revenue from New Licenses

Net Licensing Revenue

* Includes settlement of litigation

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Technology Development Fund

Boston Children's Hospital's Technology Development Fund (TDF) completed its ninth funding cycle in 2017 with six projects selected for mentoring and funding. The TDF, managed by TIDO, is a seed-stage academic catalyst fund dedicated to translating high-impact academic technologies into the independently-validated, later-stage opportunities sought by industry partners and investors. TDF provides our clinicians and scientists with:

- mentoring and coaching through an advisory board of industry leaders in product development
- funds to execute the scope of work agreed upon with the mentors
- technical support and expertise through a network of service providers and collaborators
- active project management by the TDF team.

Technologies funded by TDF range from therapeutics and devices to diagnostics, vaccines and digital health for both pediatric and adult indications.

Since 2009, TDF awards have led to:

- **$8.3 million commitment** from the hospital for the development of 76 hospital innovations, leading to $26M of follow-on funding for the investigators.
- **9 startup companies,** which have collectively raised $82M from venture capitalists, government grants and foundations.
- **12 license agreements** generating $4.45M in revenue for the hospital.

Selected from 32 applications submitted for consideration, the 2017 grand awardees are:

2017 TDF AWARDEES


A self-assembling, self-adjuvanting whole-cell vaccine targeting diarrheal disease
Paula Watnick, MD, PhD and Julie Liao, PhD
Infectious Diseases


A novel method to treat the systemic inflammatory response syndrome (SIRS)
Brian McAlvin, MD Critical Care
Daniel Kohane, MD, PhD
Anesthesiology, Perioperative and Pain Medicine


Automated detection and quantification of injury, disease, drug effect and CNS drug side effect measures in rodents.
Clifford Woolf, MB, BCh, PhD and David Roberson, PhD, MBA Neurobiology Program

Intratumoral oxygen delivery to enhance the efficacy of cancer radiotherapy
Brian D. Polizzotti, PhD
Cardiology Research

DNA nanoswitches for high-sensitivity, low-cost biomarker detection
Wesley P. Wong, PhD
Program in Cellular Molecular Medicine


Validation of a microphysiologic tissue construct to accelerate age-specific human vaccine development
Guzman Sanchez-Schmitz, MSc, PhD and Ofer Levy, MD, PhD
Infectious Diseases

FY17 HIGHLIGHTS

Startups

Magenta Therapeutics launches to revolutionize bone marrow transplant technology

Magenta Therapeutics, a biotechnology company formed in late 2016 with backing from Third Rock Ventures, Atlas Venture and Google Ventures, is developing a portfolio of therapeutics to improve bone marrow transplant and extend its curative power to more patients. The company was founded based in part on discoveries made by **Derrick Rossi, PhD** and **Agnieszka Czechowicz, MD, PhD** of the Program in Cellular and Molecular Medicine, in collaboration with **Rahul Palchaudhuri, PhD,** and **David Scadden, MD,** of Harvard University. Fierce Biotech named Magenta Therapeutics one of its "Fierce 15" companies of 2017, designating it as one of the most promising private biotechnology companies in the industry.

I-PASS Patient Safety Institute launches to expand use of the I-PASS handoff tool

I-PASS, a mnemonic and training program to improve physician communication during patient handoffs, has been shown to reduce preventable adverse events by 30 percent. The system was developed by **Christopher Landrigan, MD, MPH** (research and fellowship director, Inpatient Pediatrics Service), **Theodore Sectish, MD** (program director, Boston Combined Residency Program in Pediatrics) and **Amy Starmer, MD, MPH** (director of Primary Care Quality Improvement; associate medical director of quality, Department of Medicine) in the Boston Children's Division of General Pediatrics, together with colleagues from other hospitals and funding from the U.S. Department of Health and Human Services. The I-PASS Patient Safety Institute has licensed the I-PASS trademark from Boston Children's Hospital for use with I-PASS implementation software and services. The institute was co-founded by physicians from Boston Children's and other institutions to achieve widespread adoption and sustainment of I-PASS for safer patient care.

Twentyeight-Seven Therapeutics develops technology to regulate microRNA expression

Twentyeight-Seven Therapeutics has exclusively licensed technology from Boston Children's to modulate microRNA (miRNA) activity, developed by **Richard Gregory, PhD,** principal investigator in the Stem Cell Program of the Division of Hematology/Oncology and **George Daley, MD, PhD,** principal investigator in the Stem Cell program and dean of Harvard Medical School. miRNAs are short non-coding RNAs that modulate the expression of genes regulating a variety of cellular processes. Aberrant expression of certain miRNAs is associated with disease, particularly cancer. This biotechnology company, funded by MPM Capital, is developing small molecules to control the activity of disease-relevant miRNAs by targeting cellular proteins that interact with them. This is a novel approach to the treatment of cancer and can be extended to many diseases in the future.

1upHealth spins out of Boston Children's to improve electronic health records

1upHealth, a platform for patients, providers and software developers to aggregate and share medical data from wearable sensors, launched in mid-2017. The company was founded by **Gajen Sunthara, MS,** director of Innovation R&D in Boston Children's Innovation & Digital Health Accelerator. 1upHealth aims to extend the lifespan of patients through intelligent analysis of consumer sensor data and information collected within the hospital setting.

FY17 HIGHLIGHTS

Select Licenses

Orchard Therapeutics and Boston Children's advance gene therapy for SCID-X1 into clinical trials

Orchard Therapeutics has exclusively licensed intellectual property from Boston Children's related to X-linked severe combined immunodeficiency (SCID-X1), a lethal condition affecting mainly boys that leaves them unable to combat infection. **David Williams, MD,** Boston Children's chief scientific officer and senior vice president and chief of the Division of Hematology/Oncology, and **Sung-Yun Pai, MD,** associate director of the Gene Therapy Program in the Division of Hematology/Oncology, have co-led an international effort to develop gene therapy to correct the SCID-X1 gene mutation. The agreement gives Orchard Therapeutics access to data and know-how from an NIH-sponsored multicenter clinical trial (NCT03311503) led by Williams and Pai at Dana-Farber/Boston Children's Cancer and Blood Disorders Center. They anticipate that the trial will enroll its first patient in Q1 2018. Orchard Therapeutics, which recently completed a $110M Series B financing round, is a clinical-stage biotechnology company developing innovative gene therapies to transform the lives of patients with rare disorders.

Cambridge Epigenetix licenses method to develop new tools to understand the epigenome

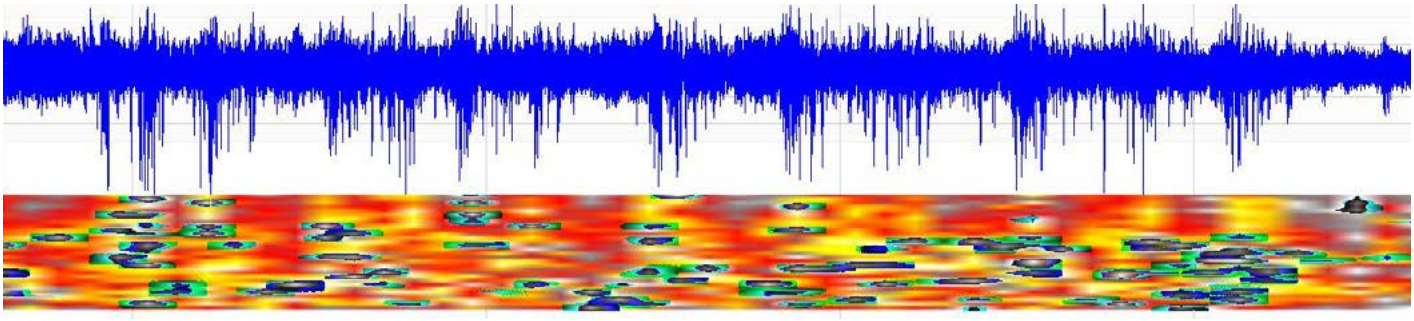
Cambridge Epigenetix has exclusively licensed a series of methods to detect the cytosine modification status of DNA, specifically cytosine hydroxymethylation (5hmC). The methods were developed by **Anjana Rao, PhD,** formerly an investigator in the Program in Cellular and Molecular Medicine, who discovered the novel catalytic activity of the TET protein family in converting 5-methylcytosine (5mC) to 5hmC in DNA. 5hmC is a new epigenetic mark that previously could not be identified with traditional sequencing methodologies for detecting DNA modification, such as bisulphite sequencing. DNA methylation and hydroxymethylation are critical to normal development and health and are known to be aberrant in developmental diseases and cancer. The company will develop detection kits for research and diagnostic use.

Industry-sponsored Research

Navitor Pharmaceuticals sponsors drug development for autism's core behavioral symptoms

Autism spectrum disorder (ASD) is one of the most common developmental disorders, characterized by varied social, behavioral and sensory abnormalities. There are currently no approved treatments for these core symptoms. Genetic studies of ASD and related syndromes have revealed a common dysregulated pathway: mTORC1. Navitor Pharmaceuticals is sponsoring a project led by **Mustafa Sahin, MD, PhD,** director of the Translational Neuroscience Center, to study an mTORC1 agonist in a mouse model of ASD. The Experimental Neurophysiology Core will analyze treated mice for neurophysiological improvements that may validate the mTORC1 pathway as a therapeutic target for treating core ASD symptoms.

Mustafa Sahin, MD, PhD



Alterations in the brain activity of mice and human patients can be measured by EEG. The raw EEG (top panel) can be used to detect abnormalities and differences in the patterns of brain activity, and then can be quantified through spectral analyses (bottom panel). Here, a seizure is captured in a mouse model of tuberous sclerosis complex (TSC). *Credit: Meera Modi and Sameer Dhamne*

Industry sponsor to back an RNA-based therapy for Niemann-Pick disease

Niemann-Pick disease type C (NPC) is a rare genetic disease in which fat accumulates inside of cells, causing damage throughout the body, most notably leading to liver failure and neurocognitive decline. Treatment of NPC is limited to addressing symptoms, and to date there is no effective therapy to halt or reverse the neurodegeneration seen in NPC. **Olaf Bodamer, MD, PhD,** associate chief of the Division of Genetics and Genomics, is testing RNA-based therapies to treat the underlying defect in the *NPC1* gene. The project, sponsored by a biotechnology company, will test the approach in both newborn and adult mouse models to mirror disease onset in humans.

Olaf Bodamer, MD, PhD

Moderna Therapeutics sponsors computational epidemiology study for cytomegalovirus vaccine

John Brownstein, PhD, chief innovation officer and director of the Computational Epidemiology Lab, is conducting a computational study to assess cytomegalovirus infection in the day-care setting. The goal of the study, being sponsored by Moderna Therapeutics, is to better track transmission risk in different populations (children, parents and care providers) and regions to inform vaccine design and vaccination policies.

John Brownstein, PhD

Amgen sponsors investigation of rare pain conditions to identify novel drug targets for pain treatment

Amgen is sponsoring a significant research initiative for several Boston Children's investigators: **Charles Berde, MD, PhD** and **Michael Costigan, PhD,** of Anesthesiology, Perioperative and Pain Medicine Research; and **Catherine Brownstein, MPH, PhD,** of the Division of Genetics and Genomics and The Manton Center for Orphan Disease Research. The researchers will study patients with rare pain conditions to identify new pain mechanisms and targets, then test these findings in animal models with Amgen.


Charles Berde, MD, PhD


Michael Costigan, PhD


Catherine Brownstein, MPH, PhD

ClearPath Vaccines and Astellas sponsor design of a novel *S. aureus* vaccine

A large number of health-care-associated infections and antibiotic-resistant infections are caused by *Staphylococcus aureus,* a pathogen for which there is currently no available vaccine. Boston Children's and collaborators at ClearPath Vaccines and Astellas Pharma, Inc. have entered into a two-year collaborative sponsored research agreement to develop an *S. aureus* vaccine. The vaccine is based on a novel platform, the Multiple Antigen Presenting System (MAPS), which was developed by **Richard Malley, MD, Fan Zhang, PhD** and **Yingjie Lu, PhD** in the Division of Infectious Diseases. This collaboration, which also includes **Kristi Moffitt, MD** of the Division of Infectious Diseases, will accelerate the development of a much-needed candidate vaccine.


Richard Malley, MD


Fan Zhang, PhD


Yingjie Lu, PhD


Kristi Moffitt, MD

Bluebird bio expands research collaboration to develop gene therapy constructs for treating hemoglobinopathies

Bluebird, Inc. is expanding its support of gene therapy research at Boston Children's. **David Williams, MD,** chief scientific officer and senior vice-president of Boston Children's Hospital and president of the Dana-Farber/Boston Children's Cancer and Blood Disorders Center, has pioneered a gene therapy approach to treat hemoglobinopathies. This project will explore elements to improve the modulation of *BCL11A* expression using vector architecture developed by Williams's group inserted into bluebird's proprietary viral vector.


David Williams, MD

HelpSteps program expands with Mass211 and Boston Public Health Commission

Boston Children's HelpSteps program, a partnership with Boston Public Health Commission developed by **Eric Fleegler, MD, MPH,** physician in the Division of Emergency Medicine, has started a new collaboration with Mass211, a program of the United Ways of Massachusetts, to better connect individuals and families in need with social service resources throughout the state. HelpSteps is a web-based tool designed to combat negative social determinants of health. Users can access information and referrals based on their location, language, service needs, nearest public transport route and more. The collaboration will expand the program's reach in Massachusetts and improve the service through data sharing and analysis.


Eric Fleegler, MD, MPH

Pfizer collaborates to identify strategy to promote immune tolerance

Regulatory T cells (Tregs) temper our immune responses, letting our bodies fight off infection without attacking our own cells. Autoimmunity — when the immune system does attack our healthy cells — can occur when Tregs are dysfunctional. **Talal Chatila, MD,** MSc and **Louis-Marie Charbonnier, PhD,** of the Division of Allergy and Immunology, have discovered that the metabolic programs of normal and dysfunctional Tregs are different, such that dysfunctional Tregs take on characteristics of effector T cells. The team is now collaborating with Pfizer to better understand the metabolic alterations, with the hope of identifying a therapeutic strategy to re-program the metabolic state of dysfunctional Tregs to promote immune tolerance.


Talal Chatila, MD, MSc


Louis-Marie Charbonnier, PhD

FY17

New Technologies

Novel therapeutic pathway to treat the neurological symptoms of lysosomal storage diseases

Lysosomal storage disorders (LSDs) are a broad class of genetically inherited metabolic diseases characterized by a deficiency of lysosomal enzymes, leading to accumulation of undegraded substrates in the lysosomes and subsequent cell death and tissue damage. The central nervous system (CNS) is severely affected in many LSDs, which are clinically characterized by cognitive and/or motor impairment. Available therapies for LSDs include bone marrow transplantation and enzyme replacement, both of which are still poorly effective in treating the neurologic symptoms of most patients. The Biffi laboratory, led by **Alessandra Biffi, MD,** director of the Gene Therapy Program in the Dana-Farber/Boston Children's Cancer and Blood Disorders Center, has identified members of the metallothionein (MT) family of proteins that are highly expressed in the CNS of patients and animals with LSDs and putatively play a neuroprotective role. By studying LSD model mice that overexpress MT1, the group found that MT can alleviate symptoms and improve survival. This discovery provides insight into a novel therapeutic option for patients suffering from LSDs.

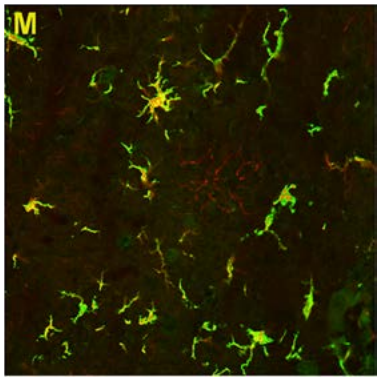
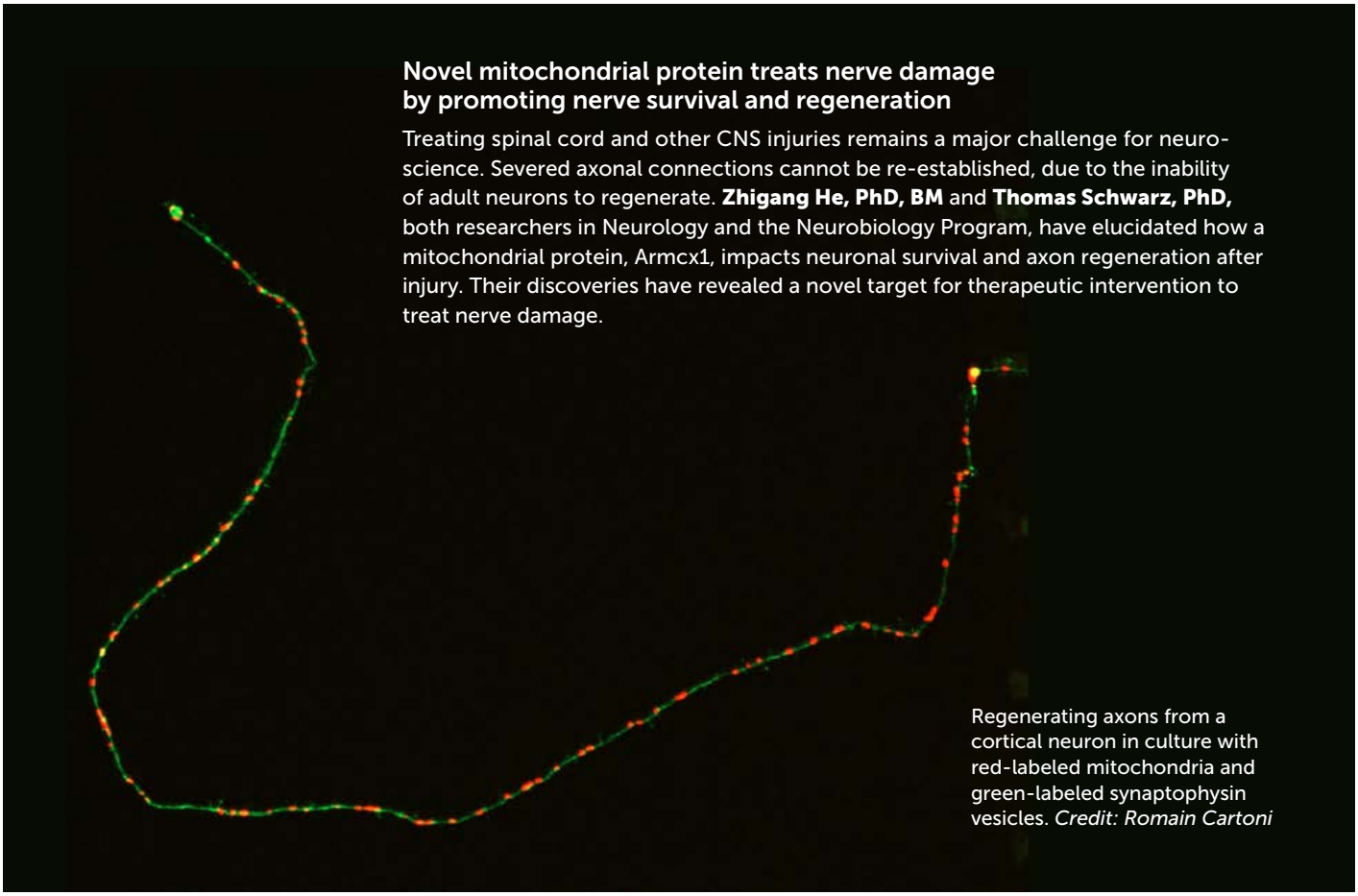


Image of mouse brain that received a direct transplant of hematopoietic stem cells. Ninety days after transplantation, the transplanted cells (green) have differentiated into microglia-like cells. *Adapted from Capotondo, et al., 2017.*

Novel mitochondrial protein treats nerve damage by promoting nerve survival and regeneration

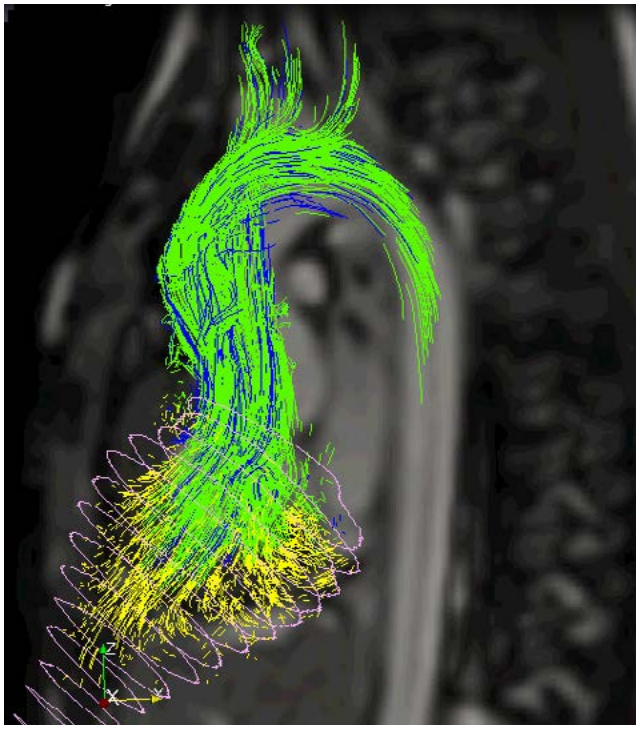
Treating spinal cord and other CNS injuries remains a major challenge for neuroscience. Severed axonal connections cannot be re-established, due to the inability of adult neurons to regenerate. **Zhigang He, PhD, BM** and **Thomas Schwarz, PhD,** both researchers in Neurology and the Neurobiology Program, have elucidated how a mitochondrial protein, Armcx1, impacts neuronal survival and axon regeneration after injury. Their discoveries have revealed a novel target for therapeutic intervention to treat nerve damage.



Regenerating axons from a cortical neuron in culture with red-labeled mitochondria and green-labeled synaptophysin vesicles. *Credit: Romain Cartoni*

New algorithm for free-breathing cardiovascular MRI imaging

Cardiac MRI is a standard approach for assessing heart function, but it is difficult to achieve accurate images because it requires highly skilled operators and repeated breath-holding by patients. This is particularly challenging in pediatric and very ill patients, who may not be able to hold their breath. To overcome these challenges, researchers in Boston Children's Department of Cardiology developed a respiratory motion compensation algorithm. Led by **Tal Geva, MD, Mehdi Moghari, PhD,** and **Andrew Powell, MD,** the researchers compared their algorithm, which generates 3D images from free-breathing patients, to standard 2D images. They obtained comparable results in less time and with simplified planning. This technology will improve clinical workflows and patient experience for cardiac assessments.



The figure shows the blood flow circulation in the left ventricle. The yellow particles show the retained inflow, the blue particles show the delayed ejection blood flow and the particles in green are the direct outflow.
Credit: Mehdi Moghari

Discovery of disease-modifying genes may lead to novel therapeutic option for facioscapulohumeral muscular dystrophy patients

Facioscapulohumeral muscular dystrophy (FSHD) is the third most common form of muscular dystrophy, affecting muscles of the face, shoulder blades and upper arms. FSHD is an autosomal dominant disease, most likely linked to changes on an area of chromosome 4 where the transcription factor DUX4 is encoded. Usually expressed at low levels, this mutant form of DUX4 is activated and extremely toxic. However, presence of the mutant is not an exclusive determinant of FSHD. By studying modulators of aberrant DUX4 expression, **Louis Kunkel, PhD,** director of the Genomics Program, and his laboratory in the Division of Genetics and Genomics discovered enrichment in certain genes that enable resistance to *DUX4* toxicity. These genes may be targets for novel therapeutic intervention to treat FSHD.

Louis Kunkel, PhD

Oligonucleotide approach to treat splicing defects, such as those causing Batten disease

Batten disease is a rare neurodegenerative condition that manifests in infancy or childhood with progressive decline in vision, cognition and motor skills, ultimately leading to death. **Timothy Yu, MD, PhD,** principal investigator and attending physician in the Division of Genetics and Genomics, discovered a rare mutation in the *CLN7* gene that results in abnormal splicing, and is spearheading the effort to develop an oligonucleotide-based approach to treat a girl with this mutation. Yu's work has the potential to inform therapeutic approaches to other diseases caused by splice mutations, and could set novel precedents in the development of "N-of-1" therapies.

Timothy Yu, MD, PhD

FY17 PATENTS

Issued U.S. Patents

Mucosal delivery of therapeutic molecules, proteins or particles coupled to ceramide lipids
Lencer, Wayne 9,457,097

Scaffolds comprising nanoelectronic components for cells, tissues and other applications
Kohane, Daniel S. 9,457,128

Vaccine nanotechnology
Von Andrian, Ulrich 9,474,717
9,526,702
9,539,210

Chromosomal modification involving the induction of double-stranded DNA cleavage and homologous recombination at the cleavage site
Mulligan, Richard 9,458,439

Estimation of incoherent motion parameters from diffusion-weighted MRI data
Warfield, Simon 9,492,101

Modified biotin-binding protein, fusion proteins thereof and applications
Malley, Richard 9,499,593

Co-activation of mTOR and STAT3 pathways to promote neuronal survival and regeneration
He, Zhigang 9,511,036

Methods for predicting anti-cancer response
Szallasi, Zoltan 9,512,485

Methods to treat neurodegenerative diseases
Woolf, Clifford 9,517,223

High throughput genome-wide translocation sequencing
Alt, Frederick W. 9,518,293

TIKI inhibitors
He, Xi 9,534,059

Multi-layer hydrogel capsules for encapsulation of cells and cell aggregates
Langer, Robert S. 9,555,007

Gene encoding a multidrug resistance human P-glycoprotein homologue on chromosome 7p15-21 and uses thereof
Frank, Markus 9,561,264

Intravesical drug delivery device
Cima, Michael 9,561,353

Methods for inducing cardiomyocyte proliferation
Wang, Dazhi 9,562,229

Regulators of NFAT and/or store-operated calcium entry
Rao, Anjana 9,567,580

Prominin-1 peptide fragments and uses thereof
D'Amato, Robert 9,597,371

Capillary refill time diagnostic apparatus and method
Bezzerides, Vassilios J. 9,603,559

Antibody molecules to TIM-3 and uses thereof
Umetsu, Dale 9,605,070

NMR-based metabolite screening platform
O'Day, Elizabeth M. 9,606,106

Sperm-specific cation channel, Catsper2, and uses thereof
Clapham, David 9,618,521

Treatment and prevention of liver disease associated with parenteral nutrition
Puder, Mark 9,566,260
9,629,821

Methods for treating and preventing neutrophil-derived NET toxicity and thrombosis
Wagner, Denisa D. 9,642,822

Methods for the treatment and prevention of inflammatory diseases
Umetsu, Dale 9,657,046

Natural IgM antibodies and inhibitors thereof
Carroll, Michael C. 9,657,060

Compounds and methods for the treatment of muscular disease, and related screening methods
Kunkel, Louis M. 9,662,314

Inhibition and enhancement of reprogramming by chromatin modifying enzymes
Daley, George Q. 9,670,463

Multiphase systems for diagnosis of sickle cell disease
Brugnara, Carlo 9,678,088

Modulation of TIM receptor activity to combination with cytoreductive therapy
Umetsu, Dale 9,683,049

Method of treatment of SETDB1 expressing cancer
Zon, Leonard I. 9,683,995

Diagnosis and treatment of taxane-resistant cancers
Zetter, Bruce 9,687,467

Biochemically stabilized HIV-1 ENV trimer vaccine
Harrison, Stephen 9,707,289

A broadly neutralizing human antibody that recognizes the receptor-binding pocket of influenza hemagglutinin
Harrison, Stephen 9,718,873

Hydrophobic tissue adhesives
Del Nido, Pedro J. 9,724,447

Method for reducing blood glucose
Ozcan, Umut 9,730,985

Methods and compositions for the treatment of proliferative vascular disorders
Bischoff, Joyce 9,737,514

Methods for enhancing hematopoietic stem/progenitor cell engraftment
Zon, Leonard I. 9,737,567

Peptides for assisting delivery across the blood brain barrier
Narasimhaswam, Manjunath 9,757,470

Collagen scaffolds
Murray, Martha M. 9,757,495

Therapeutic target for the treatment of cancers and related therapies and methods
Puder, Mark 9,763,905

Combined chemical modification of sphingosine-1-phosphate (S1P) and CXCR4 signalling pathways for hematopoietic stem cell (HSC) mobilization and engraftment
Zon, Leonard I. 9,763,980

Fused antigen vaccines and compositions against *Streptococcus pneumoniae*
Malley, Richard 9,765,125

Conversion of somatic cells into functional spinal motor neurons, and methods and uses thereof
Woolf, Clifford 9,770,471

BPI and its congeners as radiation mitigators and radiation protectors
Levy, Ofer 9,770,483
9,770,484

High-throughput image-based chemical screening in zebrafish blastomere cell culture
Zon, Leonard I. 9,771,560

Detection of 5-hydroxymethylcytosine by glycosylation
Rao, Anjana 9,816,986

Selective inhibitors of tumor-initiating cells
Lieberman, Judy 9,689,040

FY17 PATENTS

Issued Foreign Patents

Method to modulate hematopoietic stem cell growth
Zon, Leonard I.
Australia 2015207905
Japan 6041711

Vaccines and compositions against *Streptococcus pneumoniae*
Malley, Richard
Indonesia IDP000045600
Israel 227554
Japan 6126993
Mexico 344120
Russian Fed. 2623174
South Korea 10-1748453

Improved methods and compositions for the treatment of open and closed wound spinal cord injuries
Teng, Yang Dong (Ted)
Australia 2015271864
India 282872
Japan 6141351

Modulation of BCL11A for treatment of hemoglobinopathies
Orkin, Stuart H.
Mexico 345116
Netherlands 2334794
Saudi Arabia 5181
Austria, Belgium, Denmark, EPO, France, Germany, Greece, Ireland, Italy, Luxembourg, Portugal, Spain, Switzerland, United Kingdom 2334794

Neosaxitoxin combination formulations for prolonged local anesthesia
Kohane, Daniel S.
Australia 2014232881
New Zealand 710890

Pro-angiogenic fragments of prominin-1 and uses thereof
D'Amato, Robert
Australia 2011210825
Japan 6063626

Methods and uses for *ex vivo* tissue culture systems
Mammoto, Akiko
Australia 2012262139
Russian Fed. 2631807

Self-cleaving ribozymes and uses thereof
Mulligan, Richard
EPO 2476707
Italy EP2476707

Multiple antigen presenting immunogenic composition, and methods and uses thereof
Malley, Richard
Australia 2012253359
Japan 6152378

Methods and uses thereof of prosaposin
Watnick, Randolph S.
Australia 2013203640

Saposin-A derived peptides and uses thereof
Watnick, Randolph S.
Australia 2010339794

Therapeutic and diagnostic methods relating to cancer stem cells
Frank, Markus
Australia 2009314556

ABCB5 positive mesenchymal stem cells as immunomodulators
Frank, Markus
Australia 2013204421

Targeting ABCB5 for cancer therapy
Frank, Markus
Australia 2013204245

Modified biotin-binding protein, fusion proteins thereof and applications
Malley, Richard
Australia 2012253327

N-terminal deleted GP120 immunogens
Harrison, Stephen
Australia 2012279018

Compositions and methods for modulating cell signaling
Springer, Timothy
Australia 2013341353

Antibody molecules to TIM3 and uses thereof
Umetsu, Dale
Bahamas 2670

Halofuginone analogs for inhibition of tRNA synthetases and uses thereof
Rao, Anjana
Canada 2,737,219

A broadly neutralizing human antibody that recognizes the receptor-binding pocket of influenza hemagglutinin
Harrison, Stephen
China 201280046220

Methods for diagnosis and prognosis of cancers of epithelial origin
Moses, Marsha
EPO 1709421

Treatments for neuropathy with XIB4035
Corfas, Gabriel
EPO 2240177

Vaccine nanotechnology
Von Andrian, Ulrich
EPO 2217269
EPO 2630966

Implantable drug delivery device and methods of treating male genitourinary and surrounding tissues
Cima, Michael
Hong Kong HK1158992

Method of predicting acute appendicitis
Kentsis, Alex
Hong Kong HK1163253

Device and methods for analysis of rodent behavior
Woolf, Clifford
Israel 245321

Method of adjusting proliferation of hematopoietic stem cells
Zon, Leonard I.
Japan 6208719

Prominin-1 peptide fragments and uses thereof
D'Amato, Robert
Japan 6063626

Angiogenesis-promoting fragment of prominin-1 and uses thereof
D'Amato, Robert
Japan 6046493

Regulators of NFAT
Rao, Anjana
Japan 6025758

Permanently charged sodium and calcium channel blocker as anti-inflammatory agent
Woolf, Clifford
Japan 6205133

Methods and compositions associated with mesenchymal stem cell exosomes
Mitsialis, S. Alex
Japan 6204830

Diagnostic marker and therapeutic target of Kawasaki disease
Kentsis, Alex
Japan 6072768

Radiation relaxing agent and BPI and the like as radiation protective agent
Levy, Ofer
Japan 6040223

Device for high throughput study of inter-cell interaction
Tharin, Suzanne
Japan 6170431

Immunogenic compositions of multiple antigen presentation, methods and applications relating thereto
Malley, Richard
Russian Fed. 2619176

Regulators of NFAT
Rao, Anjana
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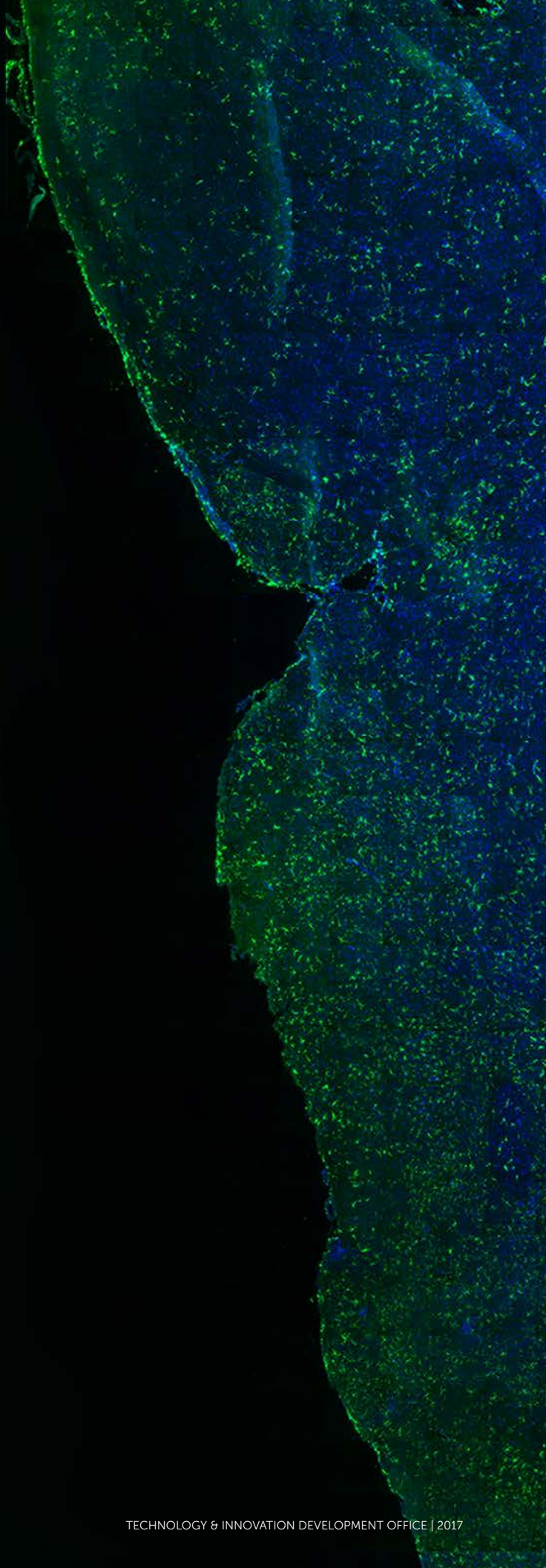

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