KILACHAND FUND

In 2017, BU trustee Rajen Kilachand (Questrom'74, Hon.'14) made the largest gift in Boston University's history: $115 million. From that gift, $100 million established an endowment, the **Rajen Kilachand Fund for Integrated Life Sciences and Engineering**, to support research into some of the most complex problems that require interdisciplinary teams of life scientists, engineers, data scientists and others to solve them—challenges such as heart disease, cancer, fibrosis, or degenerative diseases impacting the brain.

In each funding cycle, faculty can apply for funding in the amount of $250,000 to $1,000,000 per year for 1 to 5 years. The purpose of the Fund is to support three interwoven goals:

- Groundbreaking interdisciplinary research at the nexus of life sciences and engineering, including the natural and mathematical and computational sciences
- Hiring and supporting world-class faculty who conduct such research
- Mentoring and supporting the very best graduate students engaged in such research

Since the inception of the fund, $12,000,000 in funding has been awarded to ten interdisciplinary teams of faculty with awards ranging from $500,000 to $5,000,000.

We are pleased to present the third cohort[1] along with a list of the past winners.

[1] *Previous cohorts of Kilachand Fund award winners were announced in 2019 and 2021.*

Boston University Rajen Kilachand Center for Integrated Life Sciences & Engineering

2022 WINNERS

CONVERSION OF THE BU CLINICAL TESTING LABORATORY INTO A CLOUD-BASED, CORE FACILITY FOR CLINICAL APPLICATIONS, SYNTHETIC BIOLOGY, AND MASSIVELY PARALLEL DATA GENERATION (DAMP- CTL)

$1,000,000 ***2022-2023***

Douglas Densmore, Professor, Electrical & Computer Engineering and Biomedical Engineering, ENG; **Catherine Klapperich**, Professor, Biomedical Engineering, Material Science & Engineering, Mechanical Engineering, ENG

In the spring of 2020, Boston University began developing the BU Clinical Testing Laboratory (CTL) to provide in-house COVID-19 PCR tests. Now that the CTL is no longer processing thousands of COVID-19 samples per day, the techniques and technology will be put to other uses and become part of the DAMP Lab, a core facility on the Charles River Campus. Professors Densmore and Klapperich have played a vital role in the CTL's development and will lead the transition.

This project will further the work of the DAMP Lab, which offers more than 30 microbiology-based services that are largely automated and accessible remotely. The facility acts as a "cloud laboratory" where researchers can automatically submit designs, receive results, and design experiments. These innovations increase the reproducibility and standardization of results, the scalability of experiments, and the portability of designs. This project will advance the DAMP Lab's vision to become a leader in academic cloud labs.

ELUCIDATING THE ROLE OF MYELIN DEGRADATION IN ALZHEIMER'S DISEASE WITH POLARIZED-LIGHT IMAGING

$500,000 ***2022-2024***

Irving Bigio, Professor, Biomedical Engineering & Electrical and Computer Engineering, ENG; **David Boas**, Professor, Biomedical Engineering, Electrical & Computer Engineering, ENG and Director, Neurophotonics Center

More than 10 percent of Americans over age 65 are living with Alzheimer's disease (AD). For decades, a variety of medical approaches for the treatment of AD have focused on the reduction of proteins, which build up in the cerebral cortex. In the search for more promising avenues to treat and prevent dementia due to AD, research teams have pivoted to focus on the status of the myelin, the sheath that insulates and protects nerve fibers. Existing methods of microscopy and larger-scale imaging are not well suited for imaging the status of myelin in brain tissue. Professors Bigio and Boas aim to implement microscopic and mesoscopic imaging of myelin with polarized light to succinctly image early stages of degradation. This imaging could provide new information to aid the development of novel AD treatments.

Participating Faculty: Michael Alosco; MED, Ann McKee, MED; Lei Tian, ENG

2021 WINNERS

HOW WE THINK: DYNAMICS OF BRAIN CIRCUITS FOR PROBLEM SOLVING *$1,500,000 2021-2024*

Michael Hasselmo, Professor, Psychological & Brain Sciences, CAS and Director, Center for Systems Neuroscience; **David Boas**, Professor, Biomedical Engineering, Electrical & Computer Engineering, ENG and Director, Neurophotonics Center; **Jerry Chen**, Assistant Professor, Biology, CAS; **Xue Han**, Professor, Biomedical Engineering, ENG; **Marc Howard**, Professor, Psychological & Brain Sciences, CAS; **Joe McGuire**, Assistant Professor, Psychological & Brain Sciences, CAS; **Ioannis Paschalidis**, Distinguished Professor of Engineering (ECE, BME, SE); Director, Rafik B. Hariri Institute for Computing and Computational Science and Engineering; **Chantal Stern**, Professor, Psychological and Brain Sciences, CAS and Director, Cognitive Neuroimaging Center

What if AI could learn as humans do, widening the scope and complexity of its problem-solving capacity? Professor Hasselmo's interdisciplinary team is working to understand mechanisms in the circuits of the brain's cortex with the aim of developing innovations in computational modeling and new experimental techniques for general intelligence. This research could provide insight into the general algorithm of higher-level cognitive function that explains how humans think, leading to potential breakthroughs in both AI and engineered systems in robotics.

METAMATERIAL AND AI-ENABLED ULTRA-LOW FIELD MRI FOR LOW-COST, PORTABLE BRAIN IMAGING *$1,500,000 2021-2024*

Xin Zhang, Professor, Mechanical Engineering, ENG; **Stephan Anderson**, Professor, Radiology, MED; **Ioannis Paschalidis**, Distinguished Professor of Engineering (ECE, BME, SE); Director, Rafik B. Hariri Institute for Computing and Computational Science and Engineering

Despite ongoing technical advancements, accessibility to magnetic resonance imaging (MRI) technology remains limited due to the huge size of superconducting magnets required. Professors Zhang, Anderson, and Paschalidis are working to build an ultra-low field MRI (ULF-MRI) system with smaller magnets and are developing a metamaterial-enhanced hardware to physically boost the signal received by the imaging system. Their proposed ULF-MRI could lower costs as well as increase mobility and portability, all of which will help expand access to MRI technology globally.

Participating Faculty: Margrit Betke, CAS; Thomas Bifano, ENG; Chad Farris, MED; David Greer, MED; Elissa Schechter-Perkins, MED

CLEANING THE BRAIN: VASCULAR FUNCTION OF SLEEP AS A MECHANISM AND BIOMARKER FOR NEURODEGENERATION *$500,000 2021-2023*

Anna Devor, Associate Professor, Biomedical Engineering, ENG; **Laura Lewis**, Assistant Professor, Biomedical Engineering, ENG

One function of sleep involves the clearance of toxic waste products from the brain. This process of "washing the brain" may reduce the risk of neurodegeneration by preventing a buildup of toxic proteins. Professors Devor and Lewis are developing a noninvasive technique for investigating how the brain's blood vessels control clearance during sleep and whether enhancing these vascular patterns can improve brain health. Ultimately their work could help detect a biomarker to pinpoint and monitor brain clearance in the early stages of neurodegenerative disorders like Alzheimer's and Parkinson's disease.

Participating Faculty: David Boas, ENG; Andrew Emili, CAS/MED; Benjamin Wolozin, MED

NEXT-GENERATION PLATFORM FOR MASSIVELY PARALLEL PROTEIN SEQUENCING *$500,000 2021-2023*

Aaron Beeler, Associate Professor, Medicinal Chemistry, CAS and Center for Molecular Discovery; **David Boas**, Professor, Biomedical Engineering, Electrical & Computer Engineering, ENG and Director, Neurophotonics Center; **Andrew Emili**, Professor, Biology and Biochemistry, CAS/MED; **Anderson Chen**, Lecturer, Biomedical Engineering, ENG and Neurophotonics Technical Director

The inappropriate expression, turnover, or mislocalization of proteins is linked not only to aging but also to diseases like cancer, Alzheimer's, and heart disease. Studying these proteins within living cells is currently a painstaking and impractical process, but Professors Beeler, Boas, Emili, and the Neurophotonics Center's Technical Director Anderson Chen are developing a new "fingerprinting" method employing spectral light called PRISM (PRotein Identification by Super-Spectral Microscopy) which enables the simultaneous identification, quantification, and localization of thousands of different protein molecules inside human cells.

UNCOVERING THE ROLE OF microRNAS AS PERMISSIVE DRIVERS OF EVOLUTION *$500,000 2021-2023*

Daniel Cifuentes, Assistant Professor, Biochemistry, MED; **Mo Khalil**, Associate Professor, Biomedical Engineering, ENG; **Slava Labunskyy**, Associate Professor, Dermatology, MED

Living organisms are under constant selective pressure to evolve new traits, but little is known about the molecular mechanisms that introduce beneficial mutations into the genome. Professors Cifeuntes, Khalil, and Labunskyy hypothesize that small, regulatory RNAs that repress gene expression, called microRNAs or "miRNAs," allow organisms to efficiently explore the evolutionary space because miRNA effects are reversible (unlike random mutations, which are affixed). Their research is investigating whether human miRNA integrated into yeast leads to mutations that help the yeast adapt to challenging growing conditions.

2019 WINNERS

MULTICELLULAR DESIGN PROGRAM: DESIGNING MULTICELLULAR SYSTEMS, FUNCTIONS, AND THERAPEUTICS

$5,000,000 2019-2024

Christopher Chen, William F. Warren Distinguished Professor in Biomedical Engineering, ENG and Director, Biological Design Center; **Pankaj Mehta**, Professor, Physics, CAS; **Zeba Wunderlich**, Assistant Professor, Biology, CAS

Life sciences have a deep understanding of cells on an individual level, but multicellular communities— such as the bacteria that coexist in our gut or even the cells that cause infections and cancers—operate differently. Better understanding of multicellular communities could uncover new ways to heal wounds, regenerate organs, or fight infections. Professors Chen, Mehta, and Wunderlich are developing new medical therapies from groups of cells that work together like they do in nature. Their research focuses on how cell communities can create functioning tissues, resist antibiotics, or slow the growth of cancerous tumors.

Participating Faculty: Azer Bestavros, CDS; Jennifer Bhatnagar, CAS; Cynthia Bradham, CAS; Brian Cleary, CDS; Doug Densmore, ENG; Mary Dunlop, ENG; Jeroen Eyckmans, ENG; Thomas Kepler, MED; Mo Khalil, ENG; Mark Kon, CAS; Kirill Korolev, CAS; Darrell Kotton, MED; Joseph Larkin, CAS; Emma Lejeune, ENG; Gustavo Mostoslavsky, MED; John Ngo, ENG; Hadi Nia, ENG; Pawel Przytycki, CDS; Daniel Segré; CAS; Maria De Los Angeles Serrano, MED; Trevor Siggers, CAS; Alice White, ENG; Wilson Wong, ENG

A KILACHAND CENTER FOR PRECISION BIOSENSORS

$500,000 2019-2021

James Galagan, Professor, Department of Biomedical Engineering, ENG & Associate Director, Precision Diagnostics Center

Many problems involving biology can benefit from inexpensive, portable, and real-time biosensors. Sensors in wearable health devices, for instance, could monitor our well-being, detect health issues in their early stages, and track treatment progress. Using a screening approach they developed, Professor Galagan and his team are mining parts from bacteria that can be used to produce a host of new biosensor devices. In addition to wearable health technology, the team's biosensor research could impact fields like drug development, environmental monitoring, biotechnology, and agriculture.

Participating Faculty: Karen Allen, CAS; Doug Densmore, ENG; Mark Grinstaff, CAS/ENG/MED; Catherine Klapperich, ENG

CENTER FOR SYNTHETIC HUMAN BRIAN STUDIES

$500,000 2019-2021

Benjamin Wolozin, Professor, Pharmacology & Experimental Therapeutics and Neurology, MED; **Christine Cheng**[2], Adjunct Assistant Professor, Biology, CAS

Until recently, the only way to model brain disease pathology has been to use a mouse model, which is problematic because mouse and human neurons differ significantly. Professors Cheng and Wolozin and their interdisciplinary team are improving our ability to use a synthetic 3-D brain organoid (a living tissue that has human neurons) to model diseases. This approach could allow researchers to test potential treatments for diseases like Alzheimer's, amyotrophic lateral sclerosis (ALS), or Lou Gehrig's disease.

Participating Faculty: George Annas, SPH; Andrew Emili, CAS/MED; Xue Han, ENG; Tarik Haydar, MED; Mo Khalil, ENG; Gustavo Mostoslavsky, MED

[2] *Christine Cheng moved to the J. Craig Ventor Institute and continues to collaborate with Professor Wolozin.*