

# Biomedical Sciences Research Facilities Funding Program

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2018 Report to the Minnesota State Legislature  
February 2, 2018

UNIVERSITY OF MINNESOTA

## **OVERVIEW**

The University of Minnesota has set its sights on becoming one of the top public research institutions in the world. Achieving this goal requires state-of-the-art biomedical research facilities that can support leading edge research and attract and retain top-tier research faculty.

To catalyze this effort, the University asked the State of Minnesota to create the Biomedical Facilities Authority as the mechanism to provide a predictable funding source for planning and building research facilities that, in turn, would allow the University to attract and retain the nation's top biomedical research talent.

The State established the \$292 million Minnesota Biomedical Research Facilities Funding Program in 2008. This dedicated funding program provided appropriations by the State to the University for up to 75% of the costs to design and construct four new and expanded research buildings on the University's Twin Cities Campus, in the area known as the Biomedical Discovery District (BDD). The State's portion of this funding program is \$219 million; while the University's portion is \$73 million.

## **PROGRESS TO DATE**

Project #1 – Expansion of the Center for Magnetic Resonance Research – Completed July 2010

Project #2 & #3 – Cancer Cardiovascular Research Facility - Completed July 2013

Project #4 – Microbiology Research Facility – Completed October 2015

These four projects comprise 422,000 gross square feet of new research space housing 130 faculty and 729 research support staff.

The Cancer-Cardiovascular research facility also includes 35,000 square feet of shared research commons and support spaces. These areas house common instrumentation and research processing and support facilities, which are available to researchers throughout the district and broader University community, including:

- University Imaging Center
- Biomedical Genomic Center
- Mouse genetics
- Chronic, long term testing laboratories
- Flow cytometry.

In addition, several of the planning principles for the Biomedical Discover District provided for connectivity and the development of a cohesive research community. This interconnected, collaborative research environment is able to leverage common shared support spaces and resources while allowing for unique opportunities to collaborate across fields and disciplines of research.

The district has now been connected end-to-end by skyway to further enhance and support the principle of cohesiveness and opportunities for collaboration.

#### Current Occupancy

|                                                      | Principal<br>Investigators | Other<br>researchers/staff | Minnesota<br>Biomedical<br>Research<br>Program<br>Total |
|------------------------------------------------------|----------------------------|----------------------------|---------------------------------------------------------|
| <b>Cancer &amp; Cardiovascular Research Building</b> | 52                         | 263                        | 315                                                     |
| <b>Center for Magnetic Resonance Research</b>        | 24                         | 77                         | 101                                                     |
| <b>Microbiology Research Facility</b>                | 23                         | 95                         | 118                                                     |
| <b>Wallin Medical Biosciences Building</b>           | 31                         | 164                        | 195                                                     |
| <b>District Support Staff</b>                        |                            | 44                         | 44                                                      |
| <b>TOTAL</b>                                         | 130                        | 643                        | 773                                                     |

#### *Summary Research Programs*

##### Project # 1 – Center for Magnetic Resonance Research (CMRR)

CMRR is focused on advancing methodologies and instrumentation for biomedical imaging using ultrahigh field magnetic resonance imaging and spectroscopy. As an integral part of its mission, CMRR also provides access to its unique instrumentation, technical expertise, and infrastructure through collaborations and service functions to enable the faculty, trainees and staff at the University of Minnesota and in the larger biomedical research community, to carry out basic biomedical, translational and clinical research. Examples of the current large-scale research projects being conducted by CMRR includes a focus on technological developments to usher in the next generation of MR instrumentation, data acquisition and image reconstruction methods, as well as development of new, efficient and safe stimulation paradigms for Deep Brain Stimulation (DBS). Although the largest beneficiary of CMRR activities is the Medical School, CMRR impacts numerous departments outside the Medical School, including: Mathematics, Electrical Engineering, Biomedical Engineering, Nanotechnology, Chemistry, Economics and Psychology. There are currently more than 300 collaborators throughout the University. In FY17, the CMRR totaled \$7,326,870 of sponsored grant expenditures from agencies such as NIH and the State of Minnesota. In each of the past five years the CMRR has experienced steady growth, made possible by the investments in infrastructure and resources from the State of Minnesota.

2017 saw a number of firsts related to MR Imaging, Program Development, as well as pushing the boundaries of cutting edge technology development. Highlights include:

- The long-awaited first images from 10.5T MRI were received on December 14, 2017, nearly 4 years to the day of the delivery of this system. The 110-ton whole body-imaging magnet was ordered in 2009, with the magnet still being the world's most powerful whole body MRI to date. Several years of development, testing, and subsequent FDA approvals in August 2017 allowed for these first images of the human pelvis to be produced. As we conclude FDA testing in early 2018, we will move forward with fMRI research through 3 current NIH funded R01 grants to Drs. Ugurbil and Chen to create detailed maps of the human brain and body, showing brain structures with an expected resolution of a half-millimeter or less.
- Consistent interdisciplinary and interdepartmental collaborative work done within CMRR by our University partners was the basis for the addition of a third 3T MRI system. Research faculty from the Departments of Psychology, Psychiatry, and Radiology use this new scanner predominantly in research focused on the expansion of the Brain Research through Advancing Innovative Neurotechnologies (BRAIN) Initiative within the Human Connectome Project. CMRR has ongoing projects focused on imaging infants through mature and older adults and how individual experiences affect the ways in which different parts of the brain are connected and how these connections (the "connectome") change across healthy adulthood.
- In 2015, the Minnesota Legislature committed funding to the University of Minnesota Medical School to support the creation of Medical Discovery Teams (MDT) focused on tackling four major health concerns facing the state and nation. The teams were part of a recommendation by a blue ribbon commission appointed by Gov. Mark Dayton in 2014 to develop strategies for elevating the Medical School's national ranking. CMRR was awarded The University of Minnesota's Medical Discovery Team (MDT) on Optical Imaging and Brain Science as a multi-disciplinary effort focused on mapping the detailed circuits that underlie sensation, perception and complex behaviors in the developing and mature brain. This 10-year, \$30 million award focuses on a central vision within the BRAIN Initiative for the development of new approaches (microscopes, lasers, scanning methodologies, new fluorescent probes etc.) to overcome the limitation of optical techniques and the development of new computational and theoretical methods to exploit such rich data. This combination of technologies would provide the ability to bridge the scales of organization going from individual neurons to the whole brain envisioned in the BRAIN Initiative. The combined neuroimaging would also provide a bridge to electrophysiological recordings carried out in clinical settings, such as in DBS (Deep Brain Stimulation) surgery) and TMS (Transcranial Modulation Stimulation). The MDT in Optical Imaging and Brain Science is housed within CMRR in renovated space made possible during the most recent expansion in 2007. Recruitment in ongoing for

this program, with 2 new faculty members (Drs. Prakash Kara and Gordon Smith) already on board and beginning their research in early 2018.

#### Projects #2 & 3 – Cancer and Cardiovascular Research Building (CCRB)

Dr. Emilyn Alejandro was recruited to the Department of Integrative Biology and Physiology (IBP) in 2015. The goal of her laboratory is to understand how placental-insufficiency during pregnancy alters the offspring's pancreatic beta-cell function and susceptibility to Type 2 diabetes and to identify the mechanistic link between beta-cell programming and sensitivity to cellular stress involving ER stress, oxidative stress, autophagy and mitochondrial stress in chronic hyperglycemia and hyperlipidemia conditions.

Dr. Hai-Bin Ruan was recruited to the Department of IBP in 2016. His laboratory is centered on understanding how metabolic homeostasis is maintained by the intercellular, inter-tissue, and inter-organ communication. He aims to define the pathological alterations of metabolic communication in diseases including obesity, diabetes, digestive disease, and inflammation. Ultimately, he hopes to identify targets and to design therapeutics for these diseases.

Research projects in Dr. David Largaespada's laboratory are aimed at identifying mutations and other changes that drive the development of cancer, which must be determined for developing molecularly targeted therapeutics. The Largaespada lab pioneered the use of a vertebrate-active transposon system, called Sleeping Beauty (SB), for insertional mutagenesis in mouse somatic cells. SB is being used as a tool for forward genetic screens for cancer genes involved in sarcoma, hepatocellular carcinoma, mammary, gastro-intestinal tract and NF1 syndrome-associated nervous system cancers.

The University of Minnesota Genomics Center (UMGC), headquartered in CCRB, provides genomic technologies and services to researchers and clinicians at the University of Minnesota, and to external academic and industry scientists throughout the United States and internationally. The UMGC exists to advance the use of genomics, and achieve this mission by acquiring state-of-the-art instrumentation and offering an array of complete services, including sequencing, Next-generation Sequencing, long-read sequencing, expression analysis, genotyping, epigenomics, single-cell genomics, metagenomics, as well as related support services such as nucleic acid extraction and quality control. They strive to keep pace with the ever-broadening world of "omics" technologies and to expand their role at the University and the wider biotech community.

CCRB 3 year total research expenditures \$92M

#### Project # 4 Microbiology Research Facility (MRF)

Dr. Geoffrey Hart was recruited to the Department of Medicine in 2016. His primary interest is centered on innate immunity, particularly NK cells, in malaria. Using a basic immunology approach, he collaborates with on-going studies in malaria endemic regions of Africa to try to understand protective and pathological mechanisms of this deadly disease.

Dr. Gary Dunny's laboratory studies the regulation of expression of genetic transfer functions and the regulation of virulence in gram positive bacteria. He is especially interested in regulatory mechanisms involving cell-cell signaling by peptide mating pheromones. He also studies several novel intracellular regulatory RNA molecules that control expression of genes involved in conjugative plasmid transfer. Additional projects focus on functional genomics of enterococci, with special emphasis on biofilm formation, antibiotic resistance and virulence.

3 year total research expenditures for investigators in MRF \$38M