



Research Cores Summary



Beth Israel Deaconess Medical Center (BIDMC) maintains several core research facilities, available to BIDMC investigators as well as to scientists from the Longwood Medical Area and beyond. The shared scientific services provided through the BIDMC Cores enable researchers to advance their work in an efficient and cost-effective manner, while at the same time encouraging and promoting cross-departmental collaborations among investigators.

Institutional Cores

Berenson-Allen Center for Noninvasive Brain Stimulation

Director: **Mo Shafi, MD, PhD;**

mshafi@bidmc.harvard.edu

Co-Director: **Pete Fried, PhD;**

pfried@bidmc.harvard.edu

Administrative Director: **Alisha Roby, MBA;**

aroby@bidmc.harvard.edu

The Berenson-Allen Center for Noninvasive Brain Stimulation provides investigators with access to leading-edge noninvasive brain stimulation technology, including transcranial magnetic stimulation (TMS) and transcranial electrical current stimulation (tCS). Our center specializes in brain-image-guided TMS, combined TMS with electroencephalography (EEG) and electromyography (EMG), and neuronavigated TMS brain mapping for a variety of research studies.

Capabilities include the assessment of brain-behavioral relations, noninvasive cortical mapping, studies of brain cortical excitability, functional connectivity analysis, and cortical plasticity characterization and modulation in healthy participants and patients with a variety of neuropsychiatric disorders. Services also include basic and advanced training in TMS, customized group training in TMS for single- and multi-site clinical trials, consultation for noninvasive brain stimulation study design, development of novel brain stimulation paradigms, and advice on the design of clinical trials and the establishment of TMS clinics.

Biomedical Research Informatics

Director: **Griffin Weber, MD, PhD,**

gweber@bidmc.harvard.edu

The Biomedical Research Informatics Core (BRIC) builds and manages web-based tools that enable query, analysis, and visualization of clinical data. These include BILH i2b2 (formerly known as Clinical Query 2 or CQ2), which provides access to Epic data from all BILH hospitals and both current and historic data for BIDMC patients, and the Shared Research Information Network (SHRINE), which queries databases at other institutions.

Many investigators use i2b2/CQ2 or SHRINE for preliminary or exploratory research before working with the InSIGHT Core for more complex data analyses.

CRC – Clinical Research Center

Director: **Janet Mullington, PhD,**

jmullington@bidmc.harvard.edu

Manager: **Michelle Beck,**

mbeck1@bidmc.harvard.edu

The Clinical Research Center (CRC) at BIDMC provides a wide array of services and facilities to investigators to support the conduct of clinical research projects. Services provided include research nursing; nutrition services; research coordination and project management services; assistance with specimen collection; sample processing, short term sample storage; general outpatient and overnight rooms, and specialty testing labs. Highly skilled CRC clinical and technical staff work with investigators to implement study protocols, ensuring consistent and accurate data collection. CRC staff also work in tandem with other units where research is occurring to provide a high quality experience for participants and investigators. In addition, the CRC has an active Metabolism & Nutrition Research unit whose services include DXA, anthropometric measurement, indirect calorimetry, weighed meals, diet design, nutrient analysis, nutrition counseling, and education. Specialized research laboratories within the CRC include Transcranial Magnetic Stimulation, Gait and Movement, and Sleep. Research support may be provided within our research unit or by our staff in other locations in the hospital.

Clinical Research Coordinator Core

Director: **Janet Mullington, PhD,**

jmullington@bidmc.harvard.edu

Manager: **Michelle Beck,**

mbeck1@bidmc.harvard.edu

BIDMC's Clinical Research Coordinator Core provides investigators with access to administrative support for clinical trials across therapeutic areas. The core is of particular value for smaller trials that do not require a full-time coordinator. Specific services include: assistance with IRB application materials and

other IRB documentation; research participant recruitment and retention; assistance at study visits; case report form completion; research sample processing; and maintenance of source documentation.

REDCap eData Collection Core

Director: **Stephen Berry**, (617) 667-0710; sberry@bidmc.harvard.edu

REDCap Specialist: **Emily Merrill**, (617) 667-0712; edata@bidmc.harvard.edu

REDCap is a web-based electronic data collection system that enables basic and clinical researchers, quality control staff, and administrators to create electronic data capture forms for simple to complex multi-arm studies or to utilize the web survey functionality to create quick, simple surveys or multi-variable, repeated surveys that are compliant with relevant HIPAA and IS security guidelines. This service is provided at no cost to the user and is supported by the Harvard Catalyst grant. Please contact Emily Merrill or visit the REDCap website at: <https://redcap.bidmc.harvard.edu/redcap> to learn more.

Flow Cytometry Core

Director: **Peter Weller, MD**, (617) 735-4110

Manager: **John Tigges**, (617) 735-4191; jtigges@bidmc.harvard.edu

Providing scientists with the ability to rapidly analyze, enumerate, and physically separate cells suspended in fluid, the Flow Cytometry Core offers investigators the newest available software and machinery with both cell sort and analysis capabilities. A combination of highly specialized electronics, micro fluidics, and optics and fluorescence detectors, BIDMC's flow cytometry instrumentation can simultaneously analyze multiple parameters. We are able to answer technical questions, assist with flow cytometry experiments, analysis of extracellular vesicles, data acquisition, interpretation, and presentation. For more information, please visit: bidmc.org/research/core-facilities/flow-cytometry-core

Glycomics Core

Director: **Lauren Pepi, PhD**, lpepi@bidmc.harvard.edu

Scientific Advisor: **Richard Cummings, PhD**, rcummin1@bidmc.harvard.edu

Coordinator: **Jamie Heimurg-Molinaro; jheimbur@bidmc.harvard.edu**

The Glycomics Core provides services and insight on all things 'glyco'. The Core offers a variety of services and analytical technologies, including glycoprotein purification, glycan release, compositional and structural analysis by mass spectrometry (MS) and glycosite mapping. The Glycomics Core serves BIDMC research groups, external academic institutions both within HMS and outside, as well as corporate companies from around the globe. The services provided include, but are not limited to, N- and O-glycan compositional or structural analysis, glycolipid analysis, protein N- and O-glycosylation site mapping, and sialic acid linkage analysis. Our team has expertise working with a wide scope of biological samples ranging from purified glycoproteins to cells, serum and tissue. Our facility contains cutting-edge mass spectrometers, including high resolution Orbitrap Fusion Lumos Tribrid LC-MS system,

a triple quadrupole Altis LC-MS system and an Ultraflex MALDI MS. The Core also offers glycan microarray analyses with several defined and shotgun glycan arrays to choose from. Additional services available include the production of recombinant glycosyltransferases, microarray printing, distribution of in-house reagents, including several monoclonal antibodies to carbohydrate antigens, and consulting. The core is actively working to implement more services and develop new methods. If you are interested in a glyco-related service not listed on our website, please reach out to us directly to discuss your needs. To learn more about how the Glycomics Core can help you, please visit our website: <https://research.bidmc.org/glycomics-core/>

Histology and Microscopy (Morphology) Core

Director: **Susan J. Hagen, PhD**, (617) 667-5308; shagen@bidmc.harvard.edu

Histology Core

Histology Core Supervisor: **Suzanne White**, (617) 667-4117; swhite1@bidmc.harvard.edu

Histotechnologist: **Lena Liu**, (617) 667-1828; lzliu@bidmc.harvard.edu

BIDMC's Histology Core provides investigators with services in frozen tissue preparation and sectioning, paraffin histology for cells and tissues, including embedding, sectioning and routine and special staining.

Immunostaining and Microscopy Core

Immunostaining and Confocal Core Supervisor/ Confocal Specialist: **Xu Xu, PhD**, (617) 667-3567 xxu8@bidmc.harvard.edu

Immunostaining Specialist: **Daniel Roberts**, (617) 667-1880 drobot7@bidmc.harvard.edu

Electron Microscopy Specialist: **Kyle H. Smith** (617) 667-4188 khsmith@bidmc.harvard.edu

This Core has two active services. The Immunostaining and Microscopy Service provides technical assistance and instrumentation for immunostaining, conventional and live-cell confocal microscopy, near super-resolution microscopy, light and fluorescence microscopy, and digital image acquisition and processing. Training for independent or assisted use of instrumentation and/or software, and consultation for experimental design and analysis are also available. A formal relationship with the Harvard Center for Biological Imaging expands capability for independent users to advanced imaging equipment for tissue clearing, lightsheet microscopy, spatial genomics, TIRF/super-resolution, FLIM, multiphoton, and laser capture microdissection. The Electron Microscopy (EM) Service provides investigators with technical assistance and instrumentation for electron microscopy techniques including tissue processing, thick and thin sectioning, high pressure freezing/freeze substitution, and photographing grids containing thin sections. The core has established a workflow for 3-D spatial electron microscopy (FIB-SEM) by using equipment at Harvard Center for Nanoscale Systems. Support is available for image processing, including 3-D EM, as is consultation for experimental design and analysis.

Mass Spectrometry Core (phosphoproteomics, metabolomics and lipidomics)

Director: **John Asara, PhD**, (617) 735-2651;
jasara@bidmc.harvard.edu

The Mass Spectrometry Core specializes in a targeted and non-targeted mass spectrometry based proteomics approach as well as metabolomics and lipidomics profiling and flux analysis by liquid chromatography/tandem mass spectrometry (LC-MS/MS). The Core's specialty is targeted polar metabolomics analysis of all tissue and cells types, untargeted lipidomics profiling and the analysis of immunopurified peptides, proteins, protein complexes, in particular mapping and quantifying phosphorylation and other post-translational modifications involved in cellular signaling on a global and sub-complex scale using enrichment and TMT isotopic labeling reagents. This information is then used to assemble functional protein networks. Using leading-edge mass spectrometry instrumentation including high-resolution orbitraps, ion traps, and hybrid triple quadrupoles, the Core provides investigators with protein complex identification and quantification, identification and quantification of post-translational modifications, and quantitative profiling of endogenous cellular metabolites. The core is also capable of lipidomics profiling using high resolution mass spectrometry. The core also has capabilities for ex vivo and in vivo metabolic and lipidomic flux analysis with ¹³C and ¹⁵N sources using both targeted and non-targeted mass spectrometry including isotopomer analysis.

Preclinical MRI & Hyperpolarizer Core

Director: **Aaron Grant**, (617) 667-3265;
akgrant@bidmc.harvard.edu

The Preclinical MRI Core Facility at Beth Israel Deaconess Medical Center offers instrumentation and expertise for in vivo high-field magnetic resonance imaging and spectroscopy of rodents and other small animals. In addition, the Core provides high-performance quantitative imaging of tissue samples. Capabilities include both conventional anatomic imaging as well as functional and metabolic imaging. The Core is equipped with a carbon-13 hyperpolarizer which enables non-invasive real-time imaging of tissue metabolism. Current in vivo applications include disease monitoring in cancer models, functional neuroimaging (fMRI), stroke imaging, and metabolic imaging of cancer as a biomarker of treatment response. The Core is also utilized by clinical researchers who leverage the Core's quantitative imaging capabilities for post-mortem studies of musculoskeletal soft-tissue injuries and neurodegenerative diseases.

Research Glasswashing Core

Manager: **Mark Varhol**, (617) 975-8537;
mvarhol@bidmc.harvard.edu

The Glasswashing core is primarily responsible for the cleaning and sterilization of reusable laboratory glassware, reagents, and equipment. This centralized service eliminates the need for individual investigators to maintain space, equipment and personnel in their own laboratories to handle the washing and sterilization.

Preclinical Murine Pharmacogenetics Core

Director: **John (Seán) Clohessy, PhD**, (617)

735-2147 Staff: **Jonah Lee**

jclohess@bidmc.harvard.edu

One of BIDMC's newest Research Cores, the Preclinical Murine Pharmacogenetics Core (or Mouse Hospital as it is known) provides investigators with access to expertise in the design and implementation of preclinical trials to test new drugs, drug combinations and therapeutic modalities in a variety of models including standard xenograft, PDX and genetically engineered mouse models (GEMS) of human diseases. The Core offers the following services: Design and implementation of in vivo and in vitro assays to validate target specificity; collection of preclinical toxicity data for new agents or combinations of agents in GEMS; acquisition of preclinical efficacy evidences for novel drugs or drug combinations allowing for evaluation and documentation of therapeutic potential in GEMS; and facilitation in reaching the appropriate in vivo imaging facility when the efficacy of a treatment can be monitored by imaging analysis (such as micro-MRI, micro-PET, etc.).

SAIF – Small Animal Imaging Facility & Blood Lab Core

Director: **John (Seán) Clohessy, PhD**; (617) 735-2147; jclohess@bidmc.harvard.edu

The Longwood Small Animal Imaging Facility (LSAIF) provides investigators with a streamlined system for the transport, testing and imaging of small animals used in research studies. High-quality bioluminescence imaging is available to scientists and the Core's services extend to experimental design, advanced data analysis, and a satellite animal facility for longitudinal studies. In 2011, the Longwood SAIF expanded with the addition of the Animal Blood Testing Facility. Blood testing is a valuable tool that can reveal a wealth of data to investigators. Testing results measured against reference standards can show abnormalities, presence of disease, health of organs, and trends in experimental groups. The Blood Lab gives investigators access to a wide range of experimental tools, including: Blood Gas, Chemistries, and Complete Blood Count (CBC) for virtually any small or large animal. For more information visit: bidmc.org/research/core-facilities/small-animal-imaging-core

Spatial Technologies Unit (STU)

Director: [Ioannis Vlachos, PhD](#);
spatialtech@bidmc.harvard.edu
spatialtechnology.org

The Spatial Technologies Unit (STU) has been established to render cutting-edge spatial tissue profiling and single cell cutting-edge technologies accessible to all.

The STU can support from small pilot studies to extensive consortium efforts or clinical trials thanks to its highly specialized personnel and investment in robotics and automation. The STU supports academic and industry clients.

By colocalizing spatial technologies with extensive supportive equipment (tissue processing, tissue microarrays, imaging, next generation sequencing, bioinformatics) the STU can provide A- Z spatial and single cell services (from tissue to data), enabling researchers to focus on science and discovery. All services offered are production-grade, with complete control over the complete spatial/single cell pipeline.

Experienced specialists and beyond the state-of-the-art instrumentation enable us to go from tissue to data or even to perform all downstream data analyses in-house.

In brief, the STU services include:

Single Cell

- High content (from 1,000 and up to 1M cells) single cell or single nuclei RNAseq, T Cell Receptor / B Cell Receptor (TCR/BCR sequencing), surface protein abundance (CITE-Seq) and multi-omics from fresh, frozen, or FFPE. Additional automated capability for large scale studies and low sample to sample variation using robotics on 10x Genomics Connect or 10x Genomics X platforms.

Spatial Tissue Profiling Capabilities

- 10x Genomics Visium v2 and HD: We enable researchers investigate whole transcriptome in situ at 55um or 2um (single cell) resolution, in either 6.5x6.5mm or 11x11mm areas. Compatible with frozen tissue, FFPE blocks and slides. Samples can be submitted on standard histology slides.
- 10x Genomics Xenium: Detection of up to 5,100 genes in 2.4x1.2cm area through highly multiplexed single molecule FISH or customizable panels of up to 480 genes, allowing quantification and mapping of RNA molecules at single cell resolution. H&E can be performed on the same slide.
- Akoya Phenolmager HT: Medium-plexity (up to 8 antibodies per cell +DAPI) fully automated whole slide staining and antibody quantification at single cell resolution for any study size.
- Akoya PhenoCycler – Fusion (CODEX): High-plexity (up to 100 antibodies per cell) antibody staining, applicable to both FFPE and fresh frozen slides. H&E can be performed on the same slide.
- Bruker / NanoString GeoMx DSP: Whole transcriptome and up to 570 antibody detection in regions of interest on standard histology slides, with customizable selection of morphology markers.
- Bruker Vutara VXL: Super resolution microscopy in native 3D for spatial tissue profiling, chromatin conformation analysis, or live cell imaging at nanometer resolution.

- Customized sequencing capabilities ensure both large- and small-scale experiments are not delayed by long sequencing queues.

- Singular Genomics G4x Spatial Sequencer: Next generation spatial transcriptomics/proteomics instrument enabling in situ sequencing in very high throughput, low cost, and single cell resolution. The STU is the first location worldwide to host the G4x and to offer it as a service.

Training & Education

Workshops, seminars, custom courses, and hands on training on techniques, theory, and strategy. Can be customized for students, researchers, physicians, PIs, investors, or decision makers.

Grant Support

The STU personnel can support grant submissions requiring spatial tissue profiling or single cell expertise, including strategy, methods, or the NIH Data Sharing Plan. The STU has already supported numerous BIDMC PIs submit successful (funded) grant applications that required proven expertise in single cell and spatial studies, including NIH grants (multiple R01s, U54, P01, etc), Foundations awards, or Industry supported research agreements (SRAs).

Data Analysis

Our experienced personnel offer data analysis packages for all single cell/spatial assays performed in the STU. Our team of experts can provide raw data or perform all single cell/spatial tissue profiling bioinformatic analyses in close collaboration with your research group.

Additional Services

Generation of tissue microarrays (up to 60 donor blocks), tissue dissociation, cell/nucleus suspension generation.

Statistical Support Core:

Director: [Anna Modest, PhD](#),
ammodest@bidmc.harvard.edu
Administrative Director: [Douglas Reichgott](#),
[dreihgo@bidmc.harvard.edu](mailto:dreichgo@bidmc.harvard.edu)

The Statistical Support Core works in conjunction with Harvard Catalyst resources to provide statistical and epidemiological support for investigators throughout BIDMC. Services supported include statistical analysis for research projects, epidemiology & statistical support for grant preparation and educational activities for faculty and staff.

Transgenic Core

Scientific Advisor: [Brad Lowell, MD, PhD](#),
(617) 735-3366; blowell@bidmc.harvard.edu Director:
[Joel Lawitts, PhD](#), (617) 667-0391,
jlawitts@bidmc.harvard.edu

The BIDMC Transgenic Core is a state-of-the-art facility that produces genetically altered transgenic mice and related services to the BIDMC research community. The Core's basic services include DNA injections; CRISPR injections; embryonic stem cell injections; embryo freezing; line import via cryopreserved sperm or embryos or line rescue via IVF.

X-ray Crystallography Core

Manager: **Gabriel Birrane, PhD**, (617) 667-0025;
crystallography@bidmc.harvard.edu

As a method of determining the arrangement of atoms within a crystal, X-ray crystallography is a central component of many scientific investigations. Through BIDMC's recently opened X-ray Crystallography Core, researchers have access to state-of-the-art instrumentation, as well as computing facilities that can be used for data acquisition, analysis and processing. Specific services include: Guidance on expression in bacterial, insect and mammalian cells, purification and crystallization of macromolecules for X-ray crystal structure analysis; characterization of crystals; and collection of X-ray data at ambient and cryogenic temperatures.

Zebrafish Core

Director: **Denise Glass** dglass@bidmc.harvard.edu
Core Facility Coordinator: **Tyler Mourey**, (617)
667-0603, tmourey@bidmc.harvard.edu

The BIDMC Zebrafish Core Facility, built by Pentair Aquatic Habitats, offers wild-type lines that are maintained in house for shared use, wet lab space for breeding and line maintenance, dedicated procedure room for embryo manipulation, and a full time manager available for assistance with training and questions. Assistance with Zebrafish protocol planning and preparation is also available.



Departmental Cores

Biomarker & Metabolism Core

Department: Emergency Medicine

Director: **Xiaowen Liu, PhD**, (617)667-0706

xliu4@bidmc.harvard.edu

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Blood Chemistry Core

Department: Surgery

Director: **Leo Otterbein, PhD**, lotterbe@bidmc.harvard.edu

Manager: **James Harbison**, jharbiso@bidmc.harvard.edu

Hematologic analyses specifically designed to help laboratory animal researchers generate accurate, reliable, quality results using a small sample volume. Wide spectrum of organ specific panels. Capable of measuring blood, plasma, serum, culture media, cerebrospinal fluid, and urine. Contact James Harbison for more information and pricing.

Center for Advanced Orthopaedic Studies (CAOS) µCT Core

Department: Orthopaedic Surgery Manager: **Daniel Brooks**, djbrooks@bidmc.harvard.edu

The CAOS µCT core provides high resolution 3D imaging of ex vivo specimens. Our main service is imaging of rodent bones for measuring bone microarchitecture and morphology. Additionally, we can image other types of specimens up to 36 mm in diameter and 80mm in length with voxel sizes as small as 6 µm. We also perform mechanical testing (bending and compression) of bone specimens to measure structural and apparent material properties. We are available for consultation both before and after the completion of your project.

<https://www.bouxseinlab.org/micro-computed-tomography/>

Center for Virology and Vaccine Research Immunology Technologies Core

Department: Medicine, CVVR

Director: **Sizun Jiang, PhD**, sjiang3@bidmc.harvard.edu

Associate Director - Flow Cytometry: **Michelle Lifton**, (617) 735-4512, mlifton@bidmc.harvard.edu

Associate Director - Tissue Technologies Unit: **Chi Ngai Chan, PhD**, cchan13@bidmc.harvard.edu

The CVVR departmental Immunology Technologies Core offers cutting edge flow cytometric, histotechnology and spatial-omics data generation services to clients and collaborators.

The Flow Cytometry Unit offers sterile cell sorting and acquisition specifically for isolating live, unfixed and infectious human, NHP and murine cells. The unit's dedicated staff will offer assistance with instrument operation, data analysis, and panel development. (<https://cvvr.hms.harvard.edu/cvvr-research-%20program/#flow-cytometry-core>)

The Tissue Technologies Unit provides research-focus histology, Immunohistochemistry, In-situ Hybridization (ACDBio RNAscope and Basescope) and Highplex Spatial-omics data generation (Akoya CODEX Fusion, 10X Genomics Visium HD, NanoString GeoMx and CosMx). Our other unique capabilities include BSL-2 NHP tissue processing and cryosectioning, tissue microarray (TMA) construction and multiplexing spatial transcriptomics and proteomics with (PANINI) and IN-DEPTH. (<https://cvvr.hms.harvard.edu/tissue-technologies-unit/#overview>)

Energy Balance (Metabolic) Core

Department: Endocrinology Director: **Alex Banks, PhD**, (617) 735-3268; asbanks@bidmc.harvard.edu

The BIDMC Metabolic Core exists to provide BIDMC, Harvard Medical School and area scientific community with access to cutting-edge resources for the measurement and analysis of metabolism in mice. The Core provides an extensive and growing variety of services to measure a range of metabolic parameters in mice, including: oxygen consumption (VO₂); carbon dioxide production (VCO₂); respiratory exchange ratios (RER); food consumption; locomotor activity levels; core body temperature and heart rate; body composition; heat lost due to thermal radiation; and food metabolism efficiency.

The BIDMC Metabolic Core is supported by the Harvard Digestive Diseases Center (HDDC), an NIH-funded Center that serves a broad community of scientists conducting basic and translational research relevant to the gastrointestinal tract. Within the HDDC, the BIDMC Metabolic Core forms the Metabolic Unit within HDDC Core D: Gnotobiotic Mice, Microbiology and Metagenomics.

Functional Genomics & Bioinformatics Core

Department: Endocrinology

Directors: **Arpita Kulkarni, PhD** and **Linus T. Tsai, MD, PhD**, funngen.core@gmail.com

The Functional Genomics and Bioinformatics Core provides services to investigators within BNORC and the Boston area looking to expand their research using state-of-the-art genomic applications, such as CHIP-seq, ATAC-seq, Cut & Run, and single cell RNA-seq. The Core utilizes next generation technologies and sequencing platforms to help identify the complex molecular mechanisms underlying human disease. Core staff can consult with researchers to ensure optimal experimental design on a case-by-case basis.

Downstream or stand-alone data analysis pipelines are also offered to help researchers get the most from their datasets. For more information visit: <https://research.bidmc.org/functional-genomics-and-bioinformatics-core>

Genomics and Proteomics Core

Center Director: **Towia Libermann, PhD**, (617) 667-0760; tliberma@bidmc.harvard.edu.
Genomics: **Xuesong Gu, PhD**, (617) 667-0761; xgu@bidmc.harvard.edu

Proteomics: **Simon Dillon, PhD**, (617) 667-0884; sdillon1@bidmc.harvard.edu

The Genomics and Proteomics Core provides personalized and comprehensive systems level proteomics approach to human health and disease in order to define new standards of precision and personalized patient care.

The Genomics and Proteomics Core is at the forefront of the next generation of proteomics for biomarker discovery and provides investigators access to comprehensive proteomics services to drive biomarker discovery and precision medicine. The core is the first certified provider in the Boston/Longwood Medical Area for the most comprehensive new, state-of-the-art protein biomarker discovery and validation platform, SomaScan, a major advance in exploring disease and wellness biomarkers for precision medicine. SomaScan v5.0 is a high multiplex, high sensitivity aptamer-based immune-like protein and biomarker discovery platform that simultaneously quantifies 11,000 proteins with deep coverage across all major pathophysiological pathways in all types of protein extracts. The assay requires very low amounts of starting material, has broad proteome coverage, a median lower limit of detection (LLOD) of 40 fM (<1pg/ml), an exceptional dynamic range of more than 10 logs and excellent reproducibility (median coefficient of variation [CV] of <5%).

The Core offers services to prepare whole cell lysates from any kind of tissue and most model organisms. For biomarker validation and assays requiring absolute quantitation the Core runs the Ella multiplex ELISA assay by ProteinSimple.

The Core offers services to prepare whole cell lysates from any kind of tissue and most model organisms. For biomarker validation and assays requiring absolute quantitation the Core runs the Ella multiplex ELISA assay by ProteinSimple. To directly guide investigators in the interpretation of more complex data the Core's full bioinformatics services provide access to phenotypically annotated proteomics data as well as an array of analytic procedures with which to explore the data sets for further hypothesis generation.

For more information, please contact Towia Libermann at tliberma@bidmc.harvard.edu

InSIGHT (Integration of Standard Information Gathered using Healthcare Technology) Core

Department: Center for Healthcare Delivery Science

Manager: **Karla Pollick**, (617) 975-7556;

kpollick@bidmc.harvard.edu

Technical Director: **Larry Markson, MD**,

lawrence.markson@bilh.org The InSIGHT Core helps researchers and quality improvement teams use the vast array of data available in BIDMC's clinical data repositories. We help you leverage these data to answer important questions, using tools of traditional clinical epidemiology and health services research. Services range from supplementing data in traditional clinical research (e.g. pulling admission laboratory test results for every patient in a cohort you have already collected) to building complete, high-complexity, large electronic cohorts for complex analyses.

MindLAMP, Smartphone Digital Phenotyping and Interventions, Technical Digital CORE

Director: **John Torous**, jtorous@bidmc.harvard.edu

Co-Director: **Sean Ryan**, Staff: **Matt Flathers**

The LAMP Platform is a neuropsychiatric research and clinical care management platform designed to help you run remote smartphone-based research studies that can include surveys (ecological momentary assessments), mobile cognitive tests, sensors (native to the smartphone and external), and digital interventions delivered via the smartphone. The LAMP Platform functions as 4 pieces, the App, the Dashboard, the Database, and Cortex.

App: The patient uses the native Android and Apple app for a variety of purposes customized to your needs. This can include taking real-time surveys, playing cognitive games, accessing helpful tips and resources, doing meditation and breathing exercises, etc; and when enabled and configured, the app can also collect sensor data from the mobile device's accelerometer, GPS, pedometer, and more in the background without interrupting the patient.

It also collects metadata about the patient's use of the app, like how long certain questions took to answer in a survey, or which helpful tips they appreciated the most, and uploads the data securely to a server you or your organization owns (or the CORE hosts for you or your organization owns (or the CORE hosts for you). All content (psychoeducation, surveys, interventions, and feedback) as well as sensors activated can be fully customized and toggled off/on. The CORE can support any use case desired from the app acting as a simple medication reminder to a customized after care support tool to a full digital phenotyping suite.

Dashboard: Clinicians and Researchers can create, customize, and schedule activities for patients or participants to interact and receive notifications, and tap into near-real-time information about patients to better inform decision making. The dashboard also allows for unique interactive features for specialized research or clinical-specific use. Additionally, the dashboard now has a fully functional Data Portal for an in-depth and comprehensive view of all patient and participant data. The CORE can support custom dashboards and reporting or help with use of the flexible default.

Database: The Database securely and chronologically indexes the data through the LAMP Protocol for programming and data science. It informs custom data analysis code in real-time that new patient data has arrived. Researchers can better build reusable tools, analysis pipelines, and conduct reproducible science, knowing that others around the globe using the LAMP Platform can easily work with their data or replicate their unique study. The CORE can provide support to host your own database or host your data in a private and secure manner.

Cortex: The Cortex data analysis pipeline is designed to easily hook into the Database and extract important and clinically useful secondary data features, such as sedentary behavior, time spent at home, device/screen usage, sleep estimates, and much more, from the terabytes of raw data. It can trigger custom just-in-time adaptive interventions and produce useful interactive visualizations viewable by patients and clinicians. The CORE can run default or custom analysis on your data.

PERFUSE Core

Department: Cardiovascular Medicine
Chairman: **Michael Gibson, MD**, (617) 975-9950, sjaminet@bidmc.harvard.edu
Program Director: **Meghan Leitao**, mleitao@bidmc.harvard.edu

Imaging Core Laboratory: PERFUSE functions as an angiographic, ECG/EGM, coronary MRI core laboratory for many clinical trials. We perform quantitative and qualitative analysis on defined physiologic variables derived from the specified patient population of each trial.

Global Principal Investigator/Study Chairman of Trial: Dr. Gibson serves as the overall trial Principal Investigator for multi-center, international clinical trials. He leads the trail interacting with the sponsor, lead country investigators, local site investigators, DSMB and other trial personnel.

Clinical Event Adjudication Committee (CEC): PERFUSE serves as the CEC adjudicating protocol specified, clinical site reported/clinical database generated, adverse clinical events or presenting diagnoses in a clinical trial.

Data Safety Monitoring Board (DSMB): Dr. Gibson serves as both an organizer and or a member to assemble an independent DSMB for specific clinical trials. A DSMB reviews safety and tolerability data through the period of the primary endpoint for all patients receiving any amount of study drug.
Steering/Executive Committee Member: Dr. Gibson provides academic and scientific leadership via expert opinion on study planning and conduct, including protocol design and development, research strategy, development of statistical analysis plan, reviewing trial process and clinical data, oversee the writing of the final trail results for publication. Statistical Support: PERFUSE provides statistical support for clinical trials including programming and analysis

Precision RNA Medicine Core

Department: Pathology

Academic Directors:

Dr. Winston Hide, PhD, white@bidmc.harvard.edu

Dr. Frank Slack, PhD, fslack@bidmc.harvard.edu

The Precision RNA Medicine Core (PRM) provides state-of-the-art Spatial Tissue Profiling, Single Cell, RNA detection, quantification, delivery, and Next Generation Sequencing. It provides investigators not only the ability to identify new targets and biomarkers, but also the capability to validate them as relevant to the disease they are studying. We offer the following services to all researchers:

- Detection, quantification and discovery of RNAs and ncRNAs including in research and clinical specimens.
- Specialized bioinformatics for interpretation of discoveries.
- Precision delivery of RNA therapeutics to diseased tissue in vitro.
- RNA-related grant writing support & consultaon
In the future the Core plans to add: functional ncRNA characterization.

Website: noncodingrna.org

Translational MRI Research Core

Department: Radiology

Director: **David Alsop, PhD**, dalsop@bidmc.harvard.edu

The Translational MRI Core of the BIDMC Department of Radiology provides state-of-the-art MRI capabilities for imaging human subjects and potentially large animals as part of research studies. The facility operates a research dedicated 3 Tesla system. In addition to commercial tools for clinical imaging, customized software and protocols for applications including functional and structural brain imaging, abdominal perfusion and diffusion, muscle functional imaging and spectroscopy are available to users. Additional customization of applications either by the Core staff or in collaboration with the Division of MRI Research is encouraged. For more information visit: bidmc.org/mriresearch

For more information about the BIDMC Research Cores, please scan this QR Code to direct you to: bidmc.org/research/core-facilities





Research Cores Equipment



Beth Israel Deaconess Medical Center (BIDMC) maintains several core research facilities, available to BIDMC investigators as well as to scientists from the Longwood Medical Area and beyond. The shared scientific services provided through the BIDMC Cores enable researchers to advance their work in an efficient and cost-effective manner, while at the same time encouraging and promoting cross-departmental collaborations among investigators.

Institutional Cores

Berenson-Allen Center for Noninvasive Brain Stimulation

For equipment inquiries contact: **Peter Fried**, pfried@bidmc.harvard.edu or **Alisha Roby** aroby@bidmc.harvard.edu

Clinical Research Center

For equipment inquiries contact: **Michelle Beck**, (617) 667-4269; mbeck1@bidmc.harvard.edu

Flow Cytometry Core

Contact: **John Tigges**, (617) 735-4191; jtigges@bidmc.harvard.edu

Cell Sorters

- BD FACSSymphony S6
- Beckman Coulter Astrios EQ
- Beckman Coulter SRT

Spectral Analyzers

- Cytex Aurora Spectral Analyzer
- Beckman Coulter CytoFLEX Mosaic

Analyzers

- Beckman Coulter CytoFLEX LX
- Beckman Coulter CytoFLEX S

Nano-flow cytometry

- Beckman Coulter CytoFLEX nano

Image based cytometry

- Revvity Celigo

MLSC MassNano Core Facility

Contact: **John Tigges**, (617) 735-4191, jtigges@bidmc.harvard.edu

Particle Characterization, Size, and Concentration

- Unchained Labs Leprechaun Interferometer
- Unchained Labs Stunner UV/Vis and DLS
- Spectradyne ARC MRPS
- Particle Metrix Evolution NTA
- SPARTA AGIS1 Raman Spectrometer

SRRF Microscopes for nanoparticles

- ONi AploScope
- Zeiss LSM 900
- EV Isolation
- EXOKERYX
- DEMETER

Glycomics Core

Contact: **Lauren Pepi, PhD**, lpepi@bidmc.harvard.edu

- Two Sciencion non-contact Microarray Printers
- (funded by Massachusetts Life Sciences Center)
- Two Molecular Devices ScanArray Pro microarray scanners (funded by MLSC)
- Three Shimadzu HPLC systems with autosampler, fluorescence and UV detectors, and fraction collector
- Bruker UltraFlex II MALDI-TOF mass spectrometer
- Thermo Fusion Lumos Tribid Orbitrap mass spectrometer
- Thermo Altis Plus Triple Quadrupole mass spectrometer (funded by MLSC)
- Life Technologies Attune acoustic focusing cytometer (funded by MLSC)

Histology and Microscopy (Morphology)

Core

Contact: **Susan J. Hagen**, (617) 667-5308;
shagen@bidmc.harvard.edu

Histology (not available for independent usage)

- Leica TP1020 Tissue Processor
- Leica EG1160H-C Embedding Center and Hot Plate
- Leica XL Autostainer
- Leica IPS Slide Printer
- Leica CM 1850 Cryostat
- Leica RT2125 Rotary Microtomes

Confocal and Widefield Microscopy

- Zeiss 880 Upright Confocal System
- Zeiss LSM 880 Live-Cell Confocal System with Fast Airyscan (includes Z-Stack, Tilt scan, Multi-time, location, and movies capability)
- Zeiss Axioimager M1 (Epifluorescence, Brightfield, Photodocumentation)

Advanced Instrumentation available via collaboration with the Harvard Center for Biological Imaging, Harvard Cambridge Campus

- Zeiss Lightsheet.7 Microscope System
- X-CLARITY Tissue Clearing System
- Zeiss 990 System with Airyscan2
- Zeiss LSM 990 NLO Multiphoton System
- Zeiss ELYRA 7 Super-resolution Microscope System with Lattice SIM and SMLM
- Zeiss LSM 880 Confocal System with FLIM
- Zeiss AxioScan Z7 (2 systems available)
- Zeiss PALM Laser Capture Dissection System
- Image Processing
- Dell Precision 3630 Tower Workstation
- Imaris Image Analysis software
- Image J software
- Dragonfly software

Immunostaining (not available for independent usage)

- DAKO Dap48 AutoStainer Plus
- Electron Microscopy
- Zeiss Stemi 508 Stereomicroscope
- Vibratome
- Ultracut E Ultramicrotomes
- JEOL JEM-1400 Transmission Electron Microscope
- Bal-Tec MED 020 Vacuum Evaporator
- Wohlwend Compact HPFO2 High Pressure Freezer

Advanced Instrumentation available via collaboration with the Harvard Center for Nanoscale Systems, Harvard Cambridge Campus

- Zeiss Crossbeam 550 (FIB-SEM)
- Image Processing
- Dell Precision 3630 Tower Workstation
- Dragonfly software

Mass Spectrometry (phosphoproteomics, metabolomics and lipidomics) Core

Contact: **John Asara**, (617) 735-2651;
jasara@bidmc.harvard.edu

- Thermo Orbitrap Exploris 480 with Thermo Vanquish UPLC and EASY-nLC 1200 UPLC
- Thermo QExactive HFX Orbitrap with EASY-nLC 1200 UPLC and Agilent 1200 HPLC
- Thermo QExactive Plus Orbitrap with Agilent 2D-HPLC
- AB/SCIEX 6500 QTRAP hybrid triple quadrupole with Shimadzu UFLC
- AB/SCIEX 5500 QTRAP triple quadrupole with Shimadzu UFLC
- Three Peak Nitrogen Generators
- Thermo Vanquish UV-UHPLC for offline fractionation
- Denator tissue heat stabilizer
- Andrew Alliance robot liquid handler
- Laminar and clean hoods for sample preparation

Preclinical MRI & Hyperpolarizer Core

Contact: **Aaron Grant, PhD**, (617) 667-3265;
akgrant@bidmc.harvard.edu

- Bruker Biospec 9.4 Tesla horizontal bore MRI scanner for imaging and spectroscopy in tissue samples, mice, rats, and other small animals
- Carbon-13 Hyperpolarizer for in vivo metabolic and functional imaging
- Gas anesthesia and animal monitoring facilities

Preclinical Murine Pharmacogenetics Core

Contact: **John (Seán) Clohessy, PhD**, (617) 735-2147; jclohess@bidmc.harvard.edu

- Vevo 2100 Ultrasound system

Transgenic Core

Contact: **Joel Lawitts, PhD**, (617) 667-0391;
jlawitts@bidmc.harvard.edu

- 3 micromanipulation stations consisting of: Nikon inverted microscope, Narishige micromanipulators, Narishige picoinjector, TMC anti-vibration table
- Nikon stereo microscopes
- Sutter pipet puller
- Narishige pipet grinder
- Narishige microforge
- BioCool controlled rate freezer

SAIF - Small Animal Imaging Facility Core

Contact: **John (Seán) Clohessy, PhD**, (617) 735-2147; jclohess@bidmc.harvard.edu

- Xenogen IVIS Bioluminescence
- Isoflurane Vaporizers
- Animal Blood lab instruments: Hemavet (CBCs), and Ortho Vitros 350 (Chemistries)
- Imaging Software: VivoQuant; Living Image

Spatial Technologies Unit (STU)

Director: **Ioannis Vlachos, PhD**;
spatialtech@bidmc.harvard.edu
spatialtechnology.org

Single Cell and Spatial Tissue Profiling Equipment

- 10x Genomics Connect: Robotics single cell/nuclei platform for maximized repeatability
- 10x Genomics X: High content (up to 1M cells) single cell capture from fresh, frozen, or FFPE samples
- 10x Genomics CytAssist: Enables spatial transcriptomics (Visium v2 and HD) across 6.5*6.5mm or 11*11mm capture areas on a standard pathology slide (frozen or FFPE)
- 10x Genomicx Xenium: Single molecule FISH with up to 5,100 genes quantified per cell at single cell resolution. Compatible with frozen and FFPE
- Akoya Phenolmager HT/ Vectra Polaris: Whole pathology slide multispectral scanner (8 antibodies + DAPI quantified per cell, frozen or FFPE)
- Akoya PhenoCycler (CODEX) and PhenoCycler-Fusion: high plexity multiplexed immunofluorescence platform (up to 100 antibodies and DAPI quantified per cell, frozen or FFPE)
- Bruker / NanoString GeoMx DSP: Spatial transcriptomics / proteomics platform (whole transcriptome or 570 antibody quantification across a whole pathology slide)
- Bruker Vutara VXL: Super resolution microscope for spatial tissue profiling, chromatin conformation analysis, or live cell imaging
- Singular Genomics G4x Spatial Sequencer: Next generation high throughput spatial transcriptomics/proteomics platform (up to 500 genes in situ + antibody panels) at single cell resolution.
- Vizgen MERSCOPE: high plexity single molecule FISH platform, up to 500 genes quantified per coverslip (frozen)

Supporting Equipment

- S100 Singulator (S2 Genomics) automated tissue dissociation and cell/nuclei isolation system
- Nikon Ti2-Eclipse inverted microscope
- Leica Bond Rx Autostainer
- Leica CM3050s cryostat and Histocore AutoCUT microtome
- EpreDia/3D Histech TMA GrandMaster automated large scale tissue microarrayer
- Agilent Fragment Analyzer library, RNA, or DNA/ cDNA quality control
- Opentrons OT-2 automated sample handling robot
- Singular Genomics: Next generation sequencer, enabling us to sequence all libraries in-house, reducing turnaround time and costs.

X-ray Crystallography Core

Contact: **Gabriel Birrane**, (617) 667-0025;
crystallography@bidmc.harvard.edu

The laboratory houses instrumentation consisting of:

- Micromax 007 X-ray generator
- R-Axis HTC detector
- Osmic VariMax HF confocal optics
- X-Stream 2000 cryogenic device for data collection at 100K
- Two Olympus microscopes are available for inspecting and photographing crystal trays
- Two incubators (4°C - 25°C) are available for crystallization experiments
- An Art Robbins Instruments CrysCam for plate imaging
- A TTP Labtech Mosquito Crystallization robot
- Malvern VP-ITC
- Bio-Rad NGC chromatography systems for protein purification
- Two New Brunswick/Eppendorf S41i incubators for HEK293, CHO and insect cell culture
- Several refrigerated incubators for bacterial cell culture
- A NanoTemper Technologies Tycho for protein characterization

Zebrafish Core Facility

Contact: **Tyler Mourey** (617) 667-0603
tmourey@bidmc.harvard.edu

- (3) large recirculating aquaculture systems for housing zebrafish
- (2) standalone quarantine systems in a designated quarantine room
- 4) benches equipped with microscopes and microinjectors for embryo injection
- An incubator for growing embryos

Departmental Cores

Biomarker & Metabolism Core

Contact: **Xiaowen Liu, PhD**, (617) 667-0706;
xliu4@bidmc.harvard.edu

- Functional Metabolic Analysis in Live Cells
- XFe96 Extracellular Flux Analyzer: Simultaneously measure the two major energy pathways of the cell - mitochondrial respiration and glycolysis - in live cells, in real time.
- Multiplexing biomarker and cytokine assays
- MESO QuickPlex SQ 120: a high performance, multiplexing imager for electrochemiluminescence immunoassays.

Center for Advanced Orthopaedic Studies (CAOS) μ CT Core

Contact: **Daniel Brooks**,
djbrooks@bidmc.harvard.edu

- BOSE Electroforce axial-torsional materials testing machine (1kN capacity)
- Instron 8511 axial materials testing machine (8kN capacity)
- Two Scanco μ CT40 μ CT scanners. Ideal for ex vivo scanning of specimens up to 36mm in diameter and 75mm in length. Voxel sizes down to 6 μ m.

Center for Virology and Vaccine Research Immunology Technologies Core

Department: Medicine, CVVR

Director: **Sizun Jiang, PhD**,
sjiang3@bidmc.harvard.edu

Associate Director - Flow Cytometry: **Michelle Lifton**,
(617) 735-4512, mlifton@bidmc.harvard.edu

Associate Director - Tissue Technologies Unit: **Chi Ngai Chan**,
PhD, cchan13@bidmc.harvard.edu

- Sakura Tissue Tek VIP6 AI Tissue Processor (For FFPE tissues)
- Rankin HistoPro 650 H Tissue Embedder (For FFPE tissues)
- Leica Histocore Autocut Microtome (For FFPE tissues)
- Leica CM3050 S Research Cryostat (For Frozen tissues)
- Dako PT Module (For antigen Retrieval)
- Akoya Fusion CODEX system (For CODEX, PANINI and IN-DEPTH)
- Bruker Spatial GeoMX System (For Spatial Transcriptomics and IN-DEPTH)
- Bruker Spatial CosMX System (For Spatial Transcriptomics and IN-DEPTH)
- 10X Genomics Visium HD (For Spatial Transcriptomics and IN-DEPTH)
- Keyence Microscopes

Functional Genomics & Bioinformatics Core

Department: Endocrinology

Directors: **Arpita Kulkarni, PhD and Linus T. Tsai, MD, PhD**,
fungen.core@gmail.com

- Agilent 2100 Bioanalyzer
- Illumina Nextseq500 benchtop Sequencer
- Formulatrix MANTIS Liquid Handler
- The 10x Genomics Chromium X
- Miltenyi Biotec GentleMacs Dissociator
- Invitrogen Qubit 3 Fluorometer

Genomics and Proteomics Core

Contact: **Towia Libermann** (Director), (617) 667-0760

Xuesong Gu (Genomics), (617) 667-0761;
xgu@bidmc.harvard.edu

Simon Dillon (Proteomics), (617) 667-0884;
sdillon1@bidmc.harvard.edu

- SomaScan Tecan Fluent robotic assay
- Agilent SureScan microarray scanner (Model D)
- BioTEK SynergyMX plate reader
- Biotechne Ella fully automated multiplex platform
- Ingenuity (IPA) pathway analysis

Precision Medicine RNA Core Facility

Contact:

Dr. Winston Hide, PhD, whide@bidmc.harvard.edu

Dr. Frank Slack, PhD, fslack@bidmc.harvard.edu

- The NanoAssemblr Spark
- The NanoAssemblr Benchtop
- The NanoAssemblr Blaze
- DLS

For more information about the BIDMC Research Cores, please scan this QR Code to direct you to: bidmc.org/research/core-facilities

