

Perelman School of Medicine Biomedical Research Core Facilities

The Perelman School of Medicine (PSOM) is committed to expanding the frontiers of medicine through novel research programs and applying medical and scientific advances to clinical care. Core facilities play a critical role in all forms of biomedical research and, indeed, PSOM investigators have access to numerous core facilities located throughout our 1.4 million net square feet of PSOM research space that provide services across all areas of contemporary biomedical research.

PSOM is home to a collection of centrally based research core facilities that offer a wide variety of services, ranging from molecular profiling to vector development to high resolution electron microscopy. Through these diverse resources, we provide access to state-of-the-art equipment and instrumentation, technical expertise, training and education – all designed to support innovative, cutting-edge basic and clinical research.

Significant effort and institutional resources go into creating and operating these central facilities. At PSOM, the Associate Dean for Research Integration is responsible for scientific oversight of the cores and ensuring timely, state-of-the-art service to the PSOM research community. The Associate Dean is supported by an Advisory Committee composed of leading scientists at Penn and neighboring institutions. The Committee convenes monthly to review the cores for quality service, user satisfaction, fiscal responsibility, and to allocate resources. The Committee also advises school leadership on the strategic direction of the School's core services and helps establish new cores and new services within existing cores.

Following are PSOM's centrally based biomedical research core facilities:

Acute Care Biobanking Core

Director: Ronald Collman, MD

The goals of the Acute Care Biobanking Core are to encourage and facilitate microbiome- focused research in the pathogenesis, diagnosis and treatment of patients with critical illness. Many patients who are critically ill are subject to processes and complications with microbially-driven or infectious mechanisms. The Core will assist in research by providing de-identified samples with linked clinical metadata to support research in this area, collect specimens as needed in support of microbiome research, and offer support for development of such research in the critical care setting.

Bioinformatics Core

Director: Paul Wang, PhD

The Bioinformatics Core (BIC) of the Institute for Biomedical Informatics (IBI) provides professional bioinformatics services that include data analysis and consultation to Penn Biomedical research community. The BIC core is also dedicated to the building of efficient pipelines that handle various biomedical data including Next-Generation Sequencing (NGS) data. Since its establishment four years ago, BIC has been serving 50 research groups from 20 Penn institutes and departments, helped the funding of multiple NIH grants, and co-authored in 20+ publications.

Biostatistics Analysis Center

Director: Michael Kallan, MS and Scott Appel, MS

The Biostatistics Analysis Center (BAC) is a University of Pennsylvania service center, offered by the Perelman School of Medicine's Department of Biostatistics, Epidemiology, and Informatics (DBEI). The BAC is staffed by professionally-trained biostatisticians and biostatistical programmers, and provides a wide range of biostatistical and epidemiological consulting services to the University's biomedical research community, as well as externally.

Brain Science Service Center

Director: John Detre, MD

The interdisciplinary Brain Science Center in the Penn Mahoney Institute for Neurosciences provides infrastructure support for research on human cognition, perception, affect, disordered cognition, and extension to preclinical models. By consolidating state-of-the-art methodological expertise in these domain areas as services, the Brain Science Center seeks to facilitate cutting-edge research using a largely shared set of methods and tools for elucidating brain-behavior relationships in health and disease.

Cancer Imaging Core

Director: David Mankoff, MD, PhD and Mark Rosen, MD, PhD

The Cancer Imaging Core serves ACC investigators with cancer-related clinical trials and translational research that involve imaging biomarkers and/or imaging-related endpoints. The overarching goals of the Core are to facilitate and support the use of high quality, advanced imaging modalities in clinical trials by providing easily accessed, reliable, reproducible, timely and validated imaging data and results in a timely and cost-effective manner. In addition to scientific imaging consultation, the Core provides protocol development services, standardized data acquisition methods for cancer imaging trials, and expert image response assessment analyses. The Core supports investigator access to a variety of cancer imaging methods, both standard clinical imaging studies and novel cancer imaging methods developed by Penn investigators, e.g., cancer imaging biomarker methods.

CDB Microscopy Core

Director: Andrea Stout, PhD

The Cell & Developmental Biology (CDB) Microscopy Core provides personalized assistance on all aspects of imaging, from tips on sample preparation to training on one of our microscopes to assistance with image data analysis. Our facility currently houses seven confocal microscopes, a Bruker Vutara 352 super-resolution system, a Zeiss Z.1 Lightsheet system, three widefield light microscopes, and several computers dedicated to image processing and analysis. In addition, we offer scanning electron microscope (SEM) sample preparation and imaging.

Cell Center Services Facility

Director: Tapan Ganguly, PhD

The Cell Center Services Facility provides basic cell culture training and services in various cell culture and related procedures e.g. Mycoplasma and Endotoxin testing. The services include cell culture at various scales, expansion of primary cells, seed cell cultures from on-site cell bank, cell storage; large scale growth of hybridoma and other cell lines followed by antibody purification by protein G column or

recombinant protein production; EBV induced transformation of lymphocytes. It offers hybridoma generation by cell fusion and screening and, the transfection of mammalian cells. The facility prepares specialized cell culture media, Drosophila media and, various tissue culture and molecular biological reagents.

Cell Center Stockroom

Director: Daniel Rader, MD

The Cell Center Stockroom is a division of the Genetics Core Facilities (GCF). The GCF is a University service center, established in 1973 to provide consultation, training, and services in the areas of cell culture and hybridomas. The Stockroom serves University of Pennsylvania investigators and affiliate institutions by coordinating relations with various suppliers of molecular biological research materials. This involves not only bulk purchasing of these products, but the negotiation of discounts and convenient delivery arrangements. There are over 1,100 products on-site for immediate delivery in the Stockroom. Special ordering of non-regularly stocked products is available from 28 bioreagent vendors with discounted pricing and overnight delivery.

Cell Culture Core

Director: Erle Robertson, PhD

The Cell Culture Core maintains a centralized repository of cells and reagents pertinent to digestive, liver and pancreatic disease research. It also provides training (especially for students and postdoc fellows) for labs in new cell culture (2D and 3D) techniques. Cells lines are established from freshly obtained surgical specimens, all aspects of which are approved by the University of Pennsylvania Institutional Review Board. Adenoviral, retroviral and lentiviral constructs are created, propagated and maintained under institutional guidelines for biohazardous materials.

Center for Advanced Computer Tomography Imaging Services (CACTIS)

Director: Harold Litt, MD, PhD

The CACTIS mission is to oversee proposed research protocols that involve human, animal, phantom or specimen studies in an effort to achieve two goals, to ensure that all research performed on the CT scanners comply with CACTIS and University policy, and Federal Regulations, and to determine if CACTIS can maintain the resources required to carry out each research protocol, including personnel, software, hardware and scan time. Additionally, CACTIS oversees the day-to-day operations of all CT procedures associated with research protocols, provides information regarding the use of the CT facilities to the research community at the University of Pennsylvania, provides CACTIS users with all of the policies of the institution governing research, and ensures that CACTIS is in compliance with these policies. The service center strives to support the Perelman School of Medicine's research endeavors by providing CT research services for a fee designed only to cover actual costs.

Center for Advanced MRI and Spectrometry (CAMRIS)

Director: David Mankoff, MD, PhD

The overall mission of CAMRIS is to provide oversight in the responsible use and application of Magnetic Resonance in research through leadership, education, and guidance. These principles are manifested in the development of new research and collaborations inside and outside the Radiology Department

which can translate into advanced clinical techniques; training in safe and efficient use of this investigative tool and dissemination of current, accurate and evolving MR Technology; scheduling upgrades of MR Systems and facilities; scheduling systems operations and personnel within the MR department; and receiving and acting on recommendations pertaining to the administration of CAMRIS Facilities.

Center for Biomedical Image Computing & Analytics (CBICA)

Director: Christos Davatzikos, PhD

CBICA focuses on the development and application of advanced computational and analytical techniques that quantify morphology and function from biomedical images, as well as on relating imaging phenotypes to genetic and molecular characterizations, and finally on integrating this information into diagnostic and predictive tools in an era of personalized medicine. Computational methods can contribute significantly to automated, reproducible and quantitative interpretations of biomedical images. One of CBICA's main goals is to translate advanced computational and analytical imaging methods to the clinic, by providing a forum in which interactions between researchers and clinicians facilitate the bidirectional flow of ideas, algorithms and data between the laboratory and the clinic.

Center for Biomedical Informatics in Translation (BIIT)

Director: J. Richard Landis, PhD

BIIT coordinates biomedical informatics for ITMAT, the academic home of Penn's CTSA. BIIT promotes strong collaboration among all informatics groups within Penn, The Children's Hospital of Philadelphia (CHOP) and the University of Pennsylvania Health System (UPHS), catalyzing the pursuit of enterprise-wide transformational goals. BIIT has been promoting enterprise-wide transformational strategic planning and institutional developments, while also focusing on the practical applied informatics needs of research investigators. In particular, resource development efforts are being targeted towards essential informatics infrastructure and applied informatics services for the wider research community.

Center for Human Phenomic Science (CHPS)

Director: Anne Cappola, MD, ScM and Lorraine E. Levitt Katz, MD

The Center for Human Phenomic Science (CHPS) was formed with the receipt of the Clinical and Translational Science Award (CTSA), an NIH Roadmap initiative. The CHPS has child and adult specific components at the Children's Hospital of Philadelphia (CHOP) and University of Pennsylvania, respectively, as well as joint components. The CHPS merged the General Clinical Research Centers (GCRCs) at both institutions, and introduced new programs and services. The goal of the CHPS is to provide the resources, environment, operations, and training to support and promote high-quality clinical and translational research by qualified investigators. For specific information regarding the CHPS at CHOP please visit: <https://chps.research.chop.edu/>

Center for Neurobiology and Behavior (CNB)

Director: Wade Berrettini, MD, PhD and R. Christopher Pierce, PhD

The CNB promotes interdisciplinary research in the basic neural and molecular mechanisms underlying complex behavior. The mission of the Center continues to be to strengthen behavioral neurobiology at

the Perelman School of Medicine at the University of Pennsylvania and the pre-eminence of basic research programs in the Department of Psychiatry. The primary scientific objective of the CNB is to foster interdisciplinary research and training in the basic neural and molecular mechanisms underlying complex behavior, including but not limited to psychopathologic behavior. The Center complements and extends the research program of the Department of Neuroscience by supporting an integrated systems approach to the neurobiology of mammalian and human behavior.

Center for Preventive Ophthalmology & Biostatistics (CPOB) Biostatistical Consulting

Director: Gui-shuang Ying, PhD

The CPOB Consulting Service supports consultation and collaboration in the areas of biostatistics and epidemiology to Penn vision scientists. Biostatisticians and data management experts provide advice on study design, and offer services in sample size determinations, data management, data analysis, data interpretation, and data presentation. They are active participants in the development and writing of grant applications and manuscripts. Consulting personnel are CPOB members. In addition to their methodological and technical expertise, consultants are knowledgeable about ocular conditions under study in the Penn vision community, about the commonly used measures that are unique to vision research (visual acuity, refractive error, visual field indices, etc) and the specialized statistical analysis techniques required for many experimental designs used in vision research (correlated data techniques to handle appropriately data from two eyes of the same subject). The majority of the projects are patient-oriented researchers; however, the CPOB Consulting Service also works on data analysis with bench laboratory scientists.

CFAR Virus & Reservoirs Core

Director: Katherine Bar, MD and Mohamed Abdel-Mohsen, PhD

The core facility provides comprehensive Viral and Molecular support to serve the needs of Penn/Wistar/CHOP investigators in the area of basic, translational and clinical HIV research. In addition to an offering of standard services, we are available to develop customized viral and molecular support services as needed in collaboration with CFAR investigators, training for new personnel, and consultation, training, and mentoring as needed. The facility offers virology and molecular support services, as well as Deep Sequencing support and single genome amplification services.

Chemical and Nanoparticle Synthesis Core (CNSC)

Director: Andrew Tsourkas, PhD

The CNSC supports researchers by providing in-house expertise in medicinal chemistry, metal chelate chemistry, polymer synthesis, and nanoparticle production and surface functionalization. Our chemists provide custom, problem-specific support for researchers in medical, chemical, and materials science fields. Specific services include: consultation and assistance with the design of chemical/medicinal compounds, in-house synthesis of chemical/medicinal compounds, custom nanoparticle design and synthesis, custom nanoparticle surface functionalization, as well as polymer and dendrimer synthesis. In addition to custom services, the CNSC also provides a Catalog of pre-made reactive metal chelates for radiolabeling and other imaging applications, reactive near-infrared imaging agents, hydrophobic and hydrophilic nanoparticles.

Clinical Research Computing Unit (CRCU)

Director: Florence Speiser, MS

The Clinical Research Computing Unit (CRCU) is an Academic Clinical Research Organization that expertly provides the full range of services essential for the conduct of clinical research projects, including Phase I-IV, multi-center, randomized, clinical trials, registry, and cohort studies. The CRCU employs proven technologies and tools to ensure superior data quality. We can also provide custom development solutions when appropriate for project needs. The CRCU has extensive experience in managing multi-institution research networks as the data coordinating center and offer expert staff with a prime focus on quality data. The CRCU specializes in study design and development, site management and training, data collection, processing, quality control, regulatory requirements and reporting, database development, administration, security, data storage and proposal development.

Cluster for Biomedical Image Computing (CUBIC)

Director: Mark Bergman

The Cluster for Biomedical Image Computing (CUBIC) is a Linux-based High Performance Computing resource available to faculty conducting research related to medical imaging and informatics. There are over 150 compute nodes with more than 5000 Intel Xeon CPUs and 58TB of RAM, over 100 GPUs, and 600TB of storage in the cluster. The facility management structure is designed to encourage data sharing and use of common software on this powerful resource, particularly in the development of new software and the application of imaging to new domains.

Community Engagement & Research (CEAR)

Director: Karen Glanz, PhD, MPH

The Community Engagement and Research Core (CEAR Core) aims to facilitate and build capacity for community-based research and community engagement, while enhancing the translation of research and technological developments to key public health and community stakeholders. The CEAR Core offers consultation on community engagement, training in participatory research methods, and assistance with the development, implementation, and evaluation of community translation activities. This Core is part of the Penn Institute for Translational Medicine and Therapeutics (ITMAT).

Cooperative Human Tissue Network (CHTN)

Director: Diane McGarvey

The CHTN is a prospective human tissue procurement service within the Department of Pathology at HUP, that assists investigators with collection, processing and preservation of research samples. Our staff will personalize sample acquisition and processing to meet project requirements. Samples (malignant, normal, diseased, etc.) and biofluids can be preserved in a range of methods (fresh, frozen, fixed, etc.).

CRISPR Cas9 Mouse Targeting Core

Director: Jorge Henao-Mejia, MD, PhD

The CRISPR/Cas9 targeting core at the Perelman School of Medicine has been fully operational since February of 2017. Jorge Henao-Mejia M.D., Ph.D. has served as Scientific Director of and Leonel Joannas as the Technical Director. The core is located in the Institute for Immunology and the Scientific and

Technical Directors are part of the IFI. In addition, this recently established core is composed of 2 laboratory technicians that work under our guidance. The mission of the CRISPR/Cas9 targeting core is to streamline procedures to facilitate the use of the CRISPR/Cas9 genome editing technology by the larger UPenn/CHOP community to rapidly and economically generate novel mouse genetic tools. This core has had a significant positive impact in the community. Since we established this technology in campus we have generated over 200 new mouse models for 115 users at UPenn/CHOP and nationwide. In addition, our R&D efforts in this area should enable UPenn/CHOP to remain at the forefront of this technology.

Diabetes Research Center RIA/Biomarkers Core

Director: Michael Rickels, MD

The Radioimmunoassay and Biomarkers Core offers a large number of high quality immunoassay, metabolite, and HPLC services to basic, translational, and clinical investigators performing diabetes and related metabolic disease research. The RIA/Biomarkers Core is housed within in a new state of the art-laboratory within the Institute for Diabetes, Obesity & Metabolism (IDOM) located on the 12th floor of the Smilow Center for Translational Research. Approximately 100 different diabetes, obesity and metabolism-related biomarkers from multiple species including human can be assayed using radioimmunoassay (RIA), enzyme-linked immunosorbent assay (ELISA, both absorbance and fluorometric), multiplex ELISA on the Luminex platform, and enzymatic and HPLC methods for an expanding variety of diabetes and metabolism related metabolites, hormones, catecholamines and cytokines derived from blood, urine, and tissue samples.

Electron Microscopy Resource Lab

Director: Sudheer Molugu, PhD

The Electron Microscopy Resource Lab is a research core organized into three interdependent facilities. The Ultrastructure lab offers training as well as a pay-per-service to Standard-EM and Immuno-EM for cellular ultra-structures of tissue samples. Cryo-EM Screening and Training offers training on Microscopes and ancillary equipment for Negative Stain Imaging, Single-Particle Cryo-EM and Cryo-Tomography of large complexes and cells. The Beckman Center for Cryo-EM offers a pay-per-service for high-resolution data collection of prescreened and well-qualified samples for single particle analysis and Tomography using Titan Krios microscope with Gatan K3 camera.

Extracellular Vesicle (EV) Core Facility

Director: Rachel DeRita, PhD

The Extracellular Vesicle (EV) Core Facility located in the Rosenthal building at 3800 Spruce Street provides comprehensive or selected services in the necessary isolation, quantification and characterization of EVs. Isolation of EV is based on size exclusion using high-performance (SEC-HPLC) or gravity fed (e.g. iZon column) liquid chromatography, ultracentrifugation, and/or density gradient ultracentrifugation. We can accurately characterize EV particle size distribution and concentration using resistive pulse sensing techniques (nCS1, Spectradyne, LLC). Immunophenotype can be accomplished using nanoscale flow cytometry and/or chip array (ExoView™) techniques. We additionally provide services in training and education for individuals and lab groups in all methods above and study design consultation to ensure that your EV work is of the highest quality and prepared for high impact publication in this exciting and rapidly growing field.

Flow Cytometry and Cell Sorting Facility (FCCSRL)

Director: Jonni Moore, PhD

The FCCSRL is dedicated to providing Penn investigators access to high-quality, cost-effective flow cytometric services, as well providing the scientific expertise necessary to effectively integrate this technology into their research projects. One of the Resource lab's primary missions is teaching this technology, consulting with investigators regarding integration of this technology into their research paradigms, and providing technical support to regular users. The facility offers training for investigator performed analysis on all bench-top analyzers, and cell sorter training is also available upon staff approval. A newly-integrated single cell genomic pipeline allows users to perform RNA-seq library preparation immediately after sorting. The facility can advise and/or collaborate on implementing advanced data analysis methods for large-scale or high-dimensional experiments in conjunction with Dr. Wade Rogers. Investigators may also access commercial data analysis software either by licensing through the facility (for a quarterly fee). Recognizing the complexity of cytomics, the Flow Cytometry & Cell Sorting Resource Laboratory has developed an educational program to enable investigators to make optimal and efficient use of the technology. This training and consultation program is a model for other shared resource labs throughout the country.

Flow Cytometry Core

Director: Bruce Shenker, PhD

The Penn Dental Medicine Flow Cytometry Core features a Becton Dickinson LSR II flow cytometer equipped with four lasers. The Blue laser can be used to detect forward and side scatter and 4 colors (eg., FITC/Alexa 488, PE, PerCP-CY55, PE-CY7), the red laser can be used to detect 2 colors (e.g., APC and APC-CY7), violet laser can be used to detect 2 colors (e.g., Pacific blue, Am cyan) and a UV laser which can also be used to detect 2 colors (e.g., INDO1 blue, Indo1-violet/DAPI). The instrument is located in Room 330 in the Levy Building (240 South 40th Street).

High-Throughput Screening Core (HTSC)

Director: Sara Cherry, PhD

The UPenn High-throughput Screening Core (HTSC) in the Perelman School of Medicine provides Penn and non-Penn scientists routine fee-for-service and services plus collaboration, including (1) Distribution of lentivirus based shRNA and cDNA plasmid DNA clones; (2) technical expertise in developing biological assays (i.e. biochemical-, cell-, and high-content) in miniaturized, multiwell microtiter plates that are laboratory automation compatible; (3) high-throughput chemical & functional genomic screening, including data analysis and interpretation. Our goal is to use cutting biological models to discover genes and small molecules that enable scientists to further study the functions of poorly understood proteins, signaling pathways, and cells in complex biological process relevant to human physiology and disease.

Histology Core

Director: Shuying Yang, MD, MS, PhD

The aim of the histological core in Penn Dental School is to provide high quality histological services as well as training in histological techniques to investigators with Penn Dental School, Penn Medical School and external institutes. Our goal is to assist investigators with tissue processing, embedding, sectioning, histological staining, guidance and support for result analysis.

Host-Microbial Analytic and Repository Core (H-MARC)

Director: Gary Wu, MD

The Host-Microbial Analytic and Repository Core (H-MARC) is a core within the Division of Gastroenterology. We provide services which represents the intersection between the host and their microbes in both preclinical and clinical human subject research. Specifically, a human biospecimen repository with associated clinical metadata, instrumentation/access to critical analytic services to characterize expression (i.e. genomics, transcriptomics, metabolomics, microbial culture, etc.) in both microbes and their mammalian hosts, as well as expertise to extend pre-clinical in vitro and animal model research into the human clinical domain.

Human Immunology Core (HIC)

Director: Eline Luning Prak, MD, PhD

The Human Immunology Core (HIC) provides wet bench expertise and infrastructure support for early phase clinical trials and other investigations. The HIC offers purified cell subsets from healthy human apheresis donors. HIC staff are internally and externally qualified to perform blood (PBMC) and tissue processing for viable cryopreservation following validated standard operating procedures. The HIC also offers a wide range of immunological assays including digital ELISA, ELISA, ELISPOT, Luminex, flow cytometry and immune repertoire profiling (NGS of BCR and TCR rearrangements in bulk and single cell formats). The HIC also offers investigators expertise and guidance in clinical trial sample processing, regulatory compliance, immunology assay design and validation, data analysis and grant writing support.

Human Intervention Core

Director: James Lewis, MD, MSCE

The Human Intervention Core offers a wide array of services to assist with the design and implementation of microbiome studies. The core can assist with longitudinal studies as well as pilot studies. Pilot studies can be rapidly implemented with human intervention core staff, project managers and research coordinators, to conduct these studies.

IBI Clinical Research Informatics Core

Director: Danielle Mowery, PhD

The Human Intervention Core offers a wide array of services to assist with the design and implementation of microbiome studies. The core can assist with longitudinal studies as well as pilot studies. Pilot studies can be rapidly implemented with human intervention core staff, project managers and research coordinators, to conduct these studies.

IFI CyTOF Service Center

Director: John Wherry, PhD

CyTOF enables multi-parametric high-dimensional single cell analysis of >40 markers per cell, with minimal background and compensation issues. The CyTOF Core offers a wide variety of CyTOF-related services including reagent distribution, consultation, antibody-conjugation, and data acquisition.

Investigational Drug Service (IDS)

Director: Kenneth Rockwell, Jr., PharmD, MS

IDS is the research pharmacy for the University of Pennsylvania community, providing services to investigators throughout any school on campus, as well as to the University of Pennsylvania Health System and its affiliates. We provide a wide range of services related to medications, natural products, biologics and medical devices, including product formulation, pilot-scale drug manufacturing and drug product testing, as well as packaging, dispensing, distribution, compliance tracking and inventory management. The IDS operates out of three locations on campus – at HUP, at PPMC and a new cGMP facility at 3600 Civic Center Blvd.

Islet Cell Biology

Director: Doris Stoffers, MD, PhD

The objective of the Islet Cell Biology Core is to provide state of the art support including experimental design, islet isolation, and performance of and/or training in an expansive range of assays for physiological, metabolic, and morphometric assessment of pancreatic islets as well as many other tissues and cell types. We offer islet isolation and culture, free intracellular Ca²⁺ measurements, quantitative oxygen consumption of pancreatic islets, electrode based closed cell respirometry, and access to Agilent's Seahorse Extracellular Flux Analyzer XFe96.

ITMAT Biobank

Director: Daniel Rader, MD

The Penn Medicine BioBank supports researchers by providing centralized access to a large number of annotated blood and tissue samples. This bank of samples and linked data will be an invaluable resource to the Penn Medicine basic, translational, and clinical research communities. Ultimately, this approach will enhance knowledge regarding the genetic and pathophysiological basis of multiple disease processes and will permit improved preventive and therapeutic strategies. Through these studies, researchers hope to find new ways to detect, treat, and maybe prevent or cure health problems. Some of these studies may be about how genes affect health and disease, or how genes affect response to treatment. Some of them may lead to new products, such as drugs or tests for diseases.

ITMAT Bioinformatics Facility

Director: Gregory Grant, PhD

The ITMAT Bioinformatics Facility provide project based bioinformatics support for ITMAT translational researchers. Our focus has been on providing the computational infrastructure and programming support needed to conduct high-throughput proteomics experiments. We also support other genomics high-throughput technologies to a lesser extent. The projects range from building Web applications for data analysis pipelines, scripting, clinical and basic science research support, and database and algorithm development. Recent efforts have focused on explorations of new models of computation, specifically cloud computing and GPUs, for use in genomic scale research.

ITMAT Community Outreach Using Health System Informatics (COHSI)

COHSI's mission is to promote the use of Penn Health System information resources in support of clinical research. COHSI goals include facilitating collection of data from operational information systems in the Penn health system, facilitating the creation of interventions in operational information systems in the Penn health system, fostering the use of information systems such as electronic medical record and computerized order entry in the conduct of clinical trials, enabling the use of Electronic Health Records, Computerized Order Entry Systems, Health System Administrative Databases, laboratory and other ancillary test information systems to provide primary data for epidemiological and health services research studies, and educating ITMAT investigators on the types and quality of data and limitations of its use for health system information systems. COHSI integrates outpatient, inpatient, and administrative databases, as well as an infrastructure of programmers and analysts with expertise accessing health system data.

ITMAT Study Design & Biostatistics Core (SDAB)

Director: Kathleen Joy Propert, ScD

The Study Design and Biostatistics (SDAB) Core works closely with existing resources to provide targeted study design and biostatistics support to ITMAT/CTSA investigators. The Core serves as a direct provider of services, including protocol review, study design, proposal development, and performance of simple to potentially substantial complex analyses. SDAB integrates the support available with the HUP and CHOP Center for Human Phenomic Science (CHPSs), the expertise and resources of faculty in the Center for Clinical Epidemiology and Biostatistics / Department of Biostatistics and Epidemiology (CCEB/DBE), the Biostatistics Analysis Center (BAC), and the Biostatistics and Data Management Core (BDMC) at CHOP.

Johnson Foundation Biophysical Structural Biology Core (JFBSB)

Director: Kushol Gupta, PhD

The Department of Biochemistry and Biophysics at the University of Pennsylvania is privileged to have a wide range of unique equipment and expertise to facilitate modern biophysical characterization and structural analysis of proteins and other biomolecules. These facilities, funded in large part through the generosity of the Johnson Foundation, are available for use by the research community at Penn and beyond.

Kinetics Modeling & Simulation (KMAS)

Director: Jeffrey Barrett, PhD

The KMAS core facility provides crucial infrastructure to the growing translational effort at the partner institutions of the University of Pennsylvania and Children's Hospital of Philadelphia Clinical & Translational Science Award (CTSA). The facility will aid in the development of drug assays; promote and assist in the performance of tracer kinetic studies; develop novel approaches to kinetic data analysis; provide pharmacokinetic (PK), PK pharmacodynamic (PD), and tracer kinetic modeling; and develop educational modules in pharmacokinetics and tracer kinetics to populate the educational initiatives pursued within the CTSA. KMAS supports members of the Penn/CHOP CTSA through the planning of experimental designs and clinical investigations as well as the quantitative analysis of such investigations via model-based approaches.

LDI Health Economics Data Pool (HEDAP)

Director: Rachel Werner, MD, PhD

The Health Economics Data Analyst Pool (HEDAP) is a Penn service center supported and managed by the Leonard David Institute of Health Economics (LDI) to provide LDI-affiliated investigators access to high-quality, skilled data analysts. HEDAP recruits, trains, and manages a group of masters-level and PhD-level statistical analysts. These analysts work with multi-disciplinary investigators across funded projects using statistical software packages such as SAS, Stata, and R to manipulate and analyze health care data under the guidance of the investigators and other collaborators.

LDI Health Services Research Data Center (HSRDC)

Director: Pete Groeneveld, MD, MS

The Health Services Research Data Center (HSRDC) is a Penn service center supported and managed by the Leonard David Institute of Health Economics (LDI) that provides a secure environment for investigators analyzing protected health information (PHI). It coordinates the acquisition, storage, and analysis of data from private and government sources (e.g., Medicare, Medicaid, and others) and facilitates their use by researchers who seek to answer important questions regarding health policy and health care.

Live Cell Imaging Core

Director: Kathy Boesze-Battaglia, PhD

Penn Dental Medicine Live Cell Imaging Core features a Nikon A1R Laser Scanning Confocal Microscopy system. This powerful and versatile system offers a wide array of live cell imaging applications. The system is equipped with 4 laser lines to provide 6 different excitation/emission configurations; multiple photomultiplier tubes (PMTs), 32-channel spectral detector, full complement of microscope objectives, high speed image scanner, fully motorized stage and completely controllable environmental chamber. Moreover, users have access to NIS Elements AR software and 2D/3D deconvolution module offering sophisticated image analysis and processing features.

Metabolomics Core

Director: Chris Petucci, PhD

The Metabolomics Core is overseen by the Cardiovascular Institute and is a partnership with the Abramson Cancer Center and the Institute for Diabetes, Obesity and Metabolism at Penn. The Metabolomics Core provides expertise in targeted and untargeted metabolomics of biological samples using liquid chromatography/mass spectrometry. Our mission is to perform the assays and assist in the interpretation of the results. The core is available to the entire Penn research community, external research investigators, and industry.

Microbial Culture & Metabolomics Core

Director: Gary Wu, MD and Elliot Friedman, MD

The Microbial Culture and Metabolomics Core Facility features facilities and equipment for the aerobic and anaerobic culture of microbial species in both batch and continuous systems, as well as targeted metabolomic services. The facility offers training and usage for culture equipment; consultation regarding experimental design, and; anaerobic culture services. Working with researchers, the core will

purchase, receive, and revive strains from commercial culture collections (i.e., ATCC, DSMZ). The facility can prepare glycerol stocks, liquid cultures, or gavage-ready suspensions for inoculation of animals with pure or define-mixed microbial communities.

MIN Machine Shop

Director: Fred Letterio

The Machine Shop serves the entire Penn community by designing and building novel instruments and apparatus for research to user specifications. The shop has been serving a wide range of laboratories in the Penn community for 50 years. The shop works with users to develop an initial project drawing, and will explore alternate designs to insure desired functionality. The shop will fabricate user devices to high tolerance, using state-of-the-art machine tools and materials, and can repair laboratory devices even if the devices were constructed elsewhere.

Mixed Methods Research Lab (MMRL)

Director: Frances Barg, PhD, MEd

The goal of the Mixed Methods Research Lab (MMRL) is to foster the use of qualitative and mixed methods research methodologies with a focus on integrating key stakeholder perspectives and goals into research designs. The MMRL collaborates with investigators to address timely, pressing questions across diverse disciplines and works with investigators to provide conceptual as well as technical support for broad research programs, including clinical, community-based, and implementation science research questions.

Molecular Pathology and Imaging Core (MPIC)

Director: Jonathan Katz, MD

The Molecular Pathology and Imaging Core (MPIC) provides histological services, equipment, and technical expertise for the processing and analyses of digestive, pancreatic, and liver tissues as well as three-dimensional tissue culture models. The MPIC is part of the Center for Molecular Studies in Digestive and Liver Diseases

Mouse Cardiovascular Phenotyping Core

Director: Swapnil Shewale, PhD

The Mouse Cardiovascular Physiology Core provides services to assess cardiovascular function in mouse models and to provide validated surgical models of heart and vascular disease in mice to assess genetic or therapeutic interventions. We will work with investigators to design and implement the study along with any associated grant applications, animal protocol submissions and manuscript preparation. While the central focus of the facility is cardiovascular research, the techniques employed are often useful to investigators in other fields. Our Core staff will work with you to assess your needs and provide the necessary technical training and scientific assistance in animal protocol preparation. The Core runs on a fee-for-service model. Accordingly, investigators will be responsible for the costs incurred for their projects and prior animal protocol approval by Penn IACUC.

Neurobehavior Testing Core (NTC)

Director: W. Timothy O'Brien, PhD

The Neurobehavior Testing Core (NTC) provides equipment and services to investigate behavior phenotypes of models related to neurological and other disorders. The core is utilized by scientists across disciplines that are interested in the behavioral consequences of unique physiological disruptions (e.g., metabolic, drugs etc.). We provide assessment of many domains of behavior including, but not limited to, sensory, motor, social, communication, affect-related behaviors and learning and memory. The NTC was established in 2012 through generous startup funds from the Penn School of Medicine, the Institute for Translational Medicine and Therapeutics (ITMAT), Center for Sleep and Circadian Neurobiology (CSCN) and Penn Medicine Neuroscience Center (PMNC).

Neurons R Us (NRU)

Director: Jai-Yoon Sul, PhD

The NRU (NeuronsRUs/Brain Cell) Core supplies suspensions of neuronal cells prepared from rodent brain for various downstream applications, including primary cell culture. The Core currently supplies rat or mouse cells isolated from cortex or hippocampus either in suspension or plates. Custom dissection services are available for other brain regions or for user-supplied genetically modified mice.

Next Generation Sequencing Core (NGSC)

Director: Klaus Kaestner, PhD

The Next-Generation Sequencing Core (NGSC) provides a full set of services related to single-cell and bulk whole-genome RNA-Seq, ATAC-Seq, BIS-Seq, Exome-Seq, CHIP-Seq, CLIP-Seq, etc. We have experience with difficult, low input samples as well as sequencing and analyzing novel library types. We have a small Oxford Nanopore sequencer which allows for full-length RNA or cDNA sequencing as well as very long read (100KB+) sequencing from genomes. Come see us for experimental design services prior to starting your experiment. We offer self-service access to a NextSeq and MiSeq for experienced users.

Nonhuman Primate Core

Director: James Hoxie, MD

The Nonhuman Primate Core Facility, based at the Tulane National Primate Research Center in Covington, Louisiana, provides highly integrated clinical management and laboratory investigations. The core facility acquires, houses, and cares for macaques used by CFAR members and is responsible for regulatory compliance and the daily clinical care of animals and animal procedures such as immunizations, treatments, collection of body fluids (blood, cerebrospinal fluid, saliva, etc.), bronchoalveolar lavage, endoscopies, surgery, biopsies, and real-time telemetry and video monitoring. The laboratory component of the core facility performs hematology, clinical chemistry, ova and parasite examination of feces, microbiology, and pathologic examination of all necropsies and biopsies performed on animals utilized in these studies. The core facility also provides viral stocks, viral isolation, and advanced immunology procedures and services, including polychromatic flow cytometry, molecular pathology (PCR, RT-PCR, in situ hybridization) and multicolor fluorescent confocal microscopy and image analysis.

Nuclear Medicine Physics & Instrumentation Group

Director: Joel Karp, PhD

Penn has a long history of development of nuclear medicine instrumentation in both SPECT and PET dating back to the pioneering work of David Kuhl, MD, in the 1970s. The Nuclear Medicine Physics and Instrumentation Research Group strives to continue this tradition in an environment that encourages the development of new technology and the collaboration between basic scientists and clinicians to evaluate new instruments and optimize their use for new applications in both clinical and pre-clinical (animal) imaging situations. The laboratory includes equipment to build, test and characterize detectors for PET imaging. In addition, the laboratory operates a cluster of high-powered Linux computers, which reconstruct, process, and analyze imaging data. Most recently, faculty has focused on the development of time-of-flight technology, which increases the signal-to-noise of reconstructed images for whole-body studies. The faculty also conducts research on SPECT imaging with an emphasis on applications to small animal and brain imaging. The Nuclear Medicine Physics and Instrumentation research group additionally oversees the operation of the cyclotron and imaging probe synthesis facilities.

OCRC Tumor BioTrust Collection

Director: Ron Drapkin, MD, PhD

The Ovarian Cancer Research Center (OCRC) has opened a Tumor BioTrust Collection (TBC) to the Penn research community on July 1, 2018. Specimens that are available through the OCRC TBC include gynecologic cancer specimens such as fresh and frozen tissues, plasma, serum, peripheral blood mononuclear cells, blood, formalin fixed paraffin embedded (FFPE) samples, and Tissue Microarrays (TMAs). All samples collected have clinical annotation including demographic patient profiles, pathological & clinical notations, treatment history, and detail disease information, etc. We are building and maintaining a centralized research database according to HIPPA specifications and Penn IRB standards.

Penn Genomic Analysis Core: DNA Sequencing Facility

Director: Tapan Ganguly, PhD

As part of the Penn Genomic Analysis Core the DNA Sequencing Facility offers sequencing services on three platforms, gold standard Sanger sequencing on ABI capillary sequencers, next-generation sequencing (NGS) on Ion Torrent PGM and S5 and, Illumina MiSeq along with experimental design and data analysis. The NGS service includes library preparation for multiple applications including targeted sequencing, RNA-Seq and Exome-Seq. The capillary sequencers also enable microsatellite genotyping and fragment analysis for VNTR, SNaPshot and Human Cell Line Authentication. The molecular biological services include PCR, cloning, subcloning, mutagenesis, construct preparation and, plasmid DNA preps at different scales.

Penn Genomic Analysis Core: Molecular Profiling

Director: Tapan Ganguly, PhD

As part of the Penn Genomic Analysis Core the Molecular Profiling Facility provides full service whole genome and targeted molecular profiling of DNA and RNA on multiple platforms. The Core supports quantitative RNA profiling (gene expression) on Affymetrix GeneChips and high-throughput Gene Titan instruments, Fluidigm BioMark HD and, ABI QS 12K real-time PCR machine. DNA profiling (genotyping) is offered on Affymetrix SNP GeneChip and high-throughput Gene Titan instruments, Fluidigm BioMark HD and, ABI QS 12K. Agilent aCGH platform provides genome-wide chromosomal analysis. The users benefit

from consultation and training available throughout their projects, including during experimental design and budget development, sample accrual, data management and analyses and, manuscript preparation.

Penn Gnotobiotic Mouse Facility

Director: Yongwon Choi, PhD

Our core provides access for researchers to small experimental isolators for a variety of in vivo studies utilizing germ-free mice. The core personnel are well trained & provide technical support for germ-free experiments. A new addition to the core is a state-of-the-art Isocage system.

Penn Induced Pluripotent Stem Cell Facility

Director: Wenli Yang, PhD

Our mission is to provide resources for disseminating human pluripotent stem cell technology within UPenn and surrounding research communities. Our services include derivation of patient-specific iPSCs, genome engineering of stem cell lines using CRISPR/Cas9 technology, and lineage specific differentiation of iPSCs/hESCs in 2D and 3D organoid culture. The Core has a large collection of patient-derived iPSC lines and cell lines of the gastrointestinal tract (esophageal, pancreatic and intestinal) available to users. The core is also committed to training investigators in stem cell culture techniques and providing quality tested stem cell reagents to users.

PET Center

Director: David Mankoff, MD, PhD

The PET Center is dedicated to continuing the advancement of molecular imaging and seeks to build a network of collaborators to conduct translational research using existing and new radiotracers to help better understand the diagnosis, physiology and treatment of multiple diseases. The center strives to educate referring clinicians and their patients about the emerging benefits of PET/CT diagnostic procedures, other radiotracer imaging methods and radionuclide therapies as tools in their research and clinical practice. The PET Center is committed to providing opportunities and mentoring for individuals interested in pursuing work or collaborations within the molecular imaging field. The PET/CT Center includes 4 scanners as well as a cyclotron facility.

Quantitative Proteomics Resource Core (QPRC)

Director: Benjamin Garcia, PhD

The Quantitative Proteomics Resource Core (QPRC) provides investigators with access to the most advanced high-resolution MS-based proteomics technologies. These approaches are implemented with a broad variety of mass-spectrometry-based experiments to characterize and quantify proteins from biological samples from a wide variety of sample types, from purified proteins to complex mixtures such as cell lysate, tissue, and biofluid (plasma, serum, and urine).

Research Instrumentation Shop (RIS)

Director: Michael Carman and Bill Pennie

The Research Instrumentation Shop [RIS] is a shared resource machine shop serving various University of Pennsylvania Schools and Departments. The RIS mission is to assist University researchers to design

and construct both laboratory and clinical instruments. RIS provides mechanical and machining services to the University community.

Rodent Metabolic Phenotyping Core (RMPC)

Director: Joseph A. Baur, PhD

The Rodent Metabolic Phenotyping Core (RMPC, formerly MPPMC) is a state-of-the-art metabolic core directed by Dr. Joseph Baur and Dr. Jennifer Rojas. Our facility offers cutting edge technology and phenotyping services to allow investigators of the Penn Diabetes Research Center (DRC) to study metabolism in pre-clinical rodent models. Services include measurements of body composition (fat and lean mass) using NMR and DEXA, energy balance (food intake, locomotor activity, energy expenditure) using indirect calorimetry, and other in vivo metabolic phenotyping services (glucose clamps, insulin and glucose tolerance tests, telemetric monitoring). The core employs three highly skilled surgeons, Drs. Qingwei Chu, MD, MS, Xiaoyan Yin, MD and Jie Wu, MD, MS, each with more than 10 years of experience handling rodents, including the use of metabolic equipment.

Small Animal Imaging Facility (SAIF)

Director: Jim Delikatny, PhD

The SAIF combines state-of-the-art instrumentation and a nationally recognized staff to assist investigators with a wide range of imaging based experimental approaches. The SAIF currently provides a comprehensive suite of imaging modalities including magnetic resonance imaging (MRI), spectroscopy (MRS), optical imaging (including bioluminescence, fluorescence, and near-infrared imaging), computed tomography (CT), positron emission tomography (PET), single photon emission computed tomography (SPECT), and ultrasound (US). In addition, dedicated housing is available for mice and rats undergoing longitudinal imaging studies. Ancillary facilities and resources of the SAIF are devoted to radiochemistry and image analysis.

Stem Cell and Xenograft Core

Director: Martin Peter Carroll, MD

The Stem Cell and Xenograft Core is a comprehensive resource laboratory committed to supporting translational research. We offer services centered around 2 components: An extensive repository of live and fully annotated cells from adult patients with hematologic malignancies (AML, ALL, MPN, MDS), and hematopoietic stem/progenitor cells from healthy donors (BM, CB, and FL). A full array in vivo services and xenograft models (PDX, humanized immune system), in a dedicated BSL-2 barrier space equipped with optical imaging, for applications ranging from immunotherapy, cancer biology, infectious diseases and regenerative medicine.

Transgenic and Chimeric Mouse Facility

Director: Stephen Liebhaber, MD

The Transgenic & Chimeric Mouse Facility provides a centralized service to efficiently produce genetically altered mice for basic research. They include transgenic, chimeric and genome-edited mice carrying transgenes or gene “knockout” and “Knock-in” of specific interest. The Core also provides embryo and sperm cryopreservation as well as in vitro fertilization and re-derivation of live and cryopreserved lines, along with long-term storage of cryopreserved samples.

**Translational Bio-Imaging Center (TBIC) /
Center for Magnetic Resonance and Optical Imaging (CMROI)**

Director: Ravinder Reddy, PhD

The Translational Bio-imaging Center mission is to act as a portal for the research community into the substantial Bio-medical imaging resources of the University of Pennsylvania. TBIC's goals include creating and maintaining access for the research community to state of the art Bio-medical imaging technologies, enabling research investigators to benefit from Bio-imaging expertise and experience that exists within the TBIC research community, and educating researchers about Bio-medical imaging options through targeted seminars, research fellowships, and established training programs. The Center for Magnetic Resonance and Optical Imaging (CMROI) is dedicated to the development and application of innovative, novel magnetic resonance and optical imaging techniques. The facility's core sections provide research and computing resources for numerous user, collaborative, and training projects. The focus of this resource is on developing instrumentation, methodologies, and data analysis techniques for the quantitative assessment of functional, structural, and metabolic parameters in humans with the use of multinuclear magnetic resonance, novel spectral, perfusion, functional, and optical imaging techniques.

Tumor Tissue/Biospecimen Bank (TTAB)

Director: Michael Feldman, MD, PhD

The Tumor Tissue and Biospecimen Bank (TTAB) is a centralized biorepository of human biosamples. TTAB is responsible for the collection, processing, and storage of human blood, fluid, and tissue at the University of Pennsylvania Health System. TTAB has a collection bench within the Surgical Pathology Suite at the Hospital of the University of Pennsylvania (HUP). Our collection bench sits adjacent to the frozen section teams managing clinical sample collection and allowing for tight integration of the tissue sample collection with the clinical pathology teams.

Ultrasound Research Laboratory

Director: Chandra (Sandy) Sehgal, PhD

The goals of the Ultrasound Research Laboratory are to develop new ultrasound technologies and clinical applications, to bridge the gap between technology and clinical applications, and to provide ultrasound imaging resources to other research groups within the Penn community and in other institutions. The laboratory consists of a core group of scientists, sonographers and technicians with expertise in ultrasound technology and computer programming. This group works with clinicians in multiple specialties; including radiologists, cardiologists and surgeons. Ultrasound Research Services, an arm of the laboratory, furnishes a state-of-the-art ultrasound scanner dedicated to research and serves the research community. There is a full-time sonographer and a part-time radiologist on staff to conduct clinical and pre-clinical imaging. The research laboratory has been a valuable resource to several groups working on diverse projects. These include studies involving the measurement of angiogenesis, vascularity, tissue elasticity, contrast agents, and the effects of various physical and pharmaceutical agents on blood flow and tissue vascularity. The studies span a range of clinical areas including research on cancer, cardiovascular disease and musculoskeletal disease.

Vector Core

Director: Julie Johnston, PhD

The University of Pennsylvania (Penn) Preclinical Vector Core is a World-recognized resource for investigators requiring viral vectors for preclinical studies and other basic research applications such as gene therapies for acquired and inherited diseases. The mission of the Preclinical Vector Core is to provide the greatest service to the community through the production of high quality vectors and the widespread distribution of improved vector technologies. The Core has evolved considerably since its establishment over two decades ago, both in scope and capacity, as dictated by the needs of a changing field. The main objective of the Core is to provide investigators access to state-of-the-art adeno-associated viral vector technology.

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