**FACILITIES AND OTHER RESOURCES**

The resources and environment for INSERT PI NAME HERE laboratory in this project include:

* The Center for Discovery and Innovation
* Hackensack University Medical Center and the John Theurer Cancer Center
* Georgetown University and the Lombardi Comprehensive Cancer Center

**THE CENTER FOR DISCOVERY AND INNOVATION (CDI)**

The PI is the Member/Associate Member/Assistant Member of the **Center of Discovery and Innovation (CDI)**, a recently (2019) formed research institute dedicated to therapeutic and diagnostic research innovations for cancer, infectious diseases, autoimmune and other acute and chronic diseases. The PI also holds academic appointments of Professor at Georgetown University and Hackensack Meridian School of Medicine. The CDI is a stand-alone biomedical research enterprise housed within ~130,000 sq. ft. of newly renovated laboratories and vivarium support space at the former **Hoffman-La Roche research campus in Nutley, NJ**. The CDI already consists of over 27 full-time faculty members with more than 60 NIH prime and sub-prime awards. CDI PI’s have concurrent faculty appointments at the Hackensack Meridian School of Medicine and Georgetown University. All PI’s have access to the multiple well-established Shared Resources (core facilities) of the LCCC (see below) and additional core facilities on-site within the CDI.

**The PI’s laboratory ADD DETAILS SPECIFIC TO PIs LAB**

**Shared space**: The PI has access to >4,300 sq ft of conference room space that includes 5 conference rooms and a 125 seat auditorium. The CDI has 8,000 sq ft of shared equipment and core laboratory space. This includes 7 shared tissue culture labs, 6 freezer/cold storage farms and 8 shared/core equipment labs.

**Computers:** CDI supports PCs and Apple Computers and the following operating systems: Windows, Mac OS, and Linux. The lab has a customized high-end workstation with Xeon Gold 6154 36 core (72 thread), 384 Gigabytes of DDR4 2666 mhz ECC RAM and 60TB of storage for in-house bioinformatics analysis. Bioinformatics software for whole genome sequencing and RNA-Seq analysis are installed on the lab workstation. CDI has a collaboration with **Google Cloud Platform**, which provides a world-class infrastructure for secure data storage, powerful computing, and integrated analytics platforms that includes machine learning and AI. Office systems include monitor, scanner, and printer and have general productivity software (Microsoft Office, Adobe CS Illustrator, EndNote). External sharing of data is accomplished with a secure Web FTP system. The lab has additional 11 desktop PC and 2 Apple computers in the laboratory and office space.

**Imaging and Microscopy:** The laboratory has access to a large suite of state-of-the-art microscopy and other imaging equipment. This includes four confocal microscopes (Nikon A1 and C2 models and LeciaStellaris 5 and Stellaris 8), two Leica laser-capture microdissection microscopes (LMD 6 and LMD7 models), three Nikon stereomicroscopes with Fi2 cameras, and three Nikon inverted fluorescent microscopes (two Ti2 models and one Ts2 model for Live imaging). Other imaging equipment includes a Agilient/Bio-tek Cytation C10 and Nexcelom Celigo and Thermo Cellinsight CX5 high content imaging systems, An Invitrogen EVOS M7000 Live imaging system , a Typhoon multimode imager (Cytiva): a “four-instruments-in-one” imager that can image gels, membranes, multi-well plates, dishes, and tissue sections, and offers precise quantitation of fluorescent, color-stained, and radiolabeled biomolecules like proteins and nucleic acids.

**The flow cytometry suite** at CDI includes the following set of equipment:

* BD FACSAria III:  5-laser; 19 parameters (cell sorter)
* Two BD Melody: 2-laser; 4 parameters (cell sorter)
* Two BD Fortessa: 4-laser; 17 parameter (cytometer)
* BD A3 FACSymphony: 5-laser; 28 parameter (cytometer)
* BD A5 FACSymphony: 5-laser; 50 parameter (cytometer)

**Genomics & Epigenomics suite:**: CDI provides state of the art instrumentation for investigators performing genetic and epigenetic studies such as next generation sequencing (NGS), single nucleotide polymorphism (SNP) genotyping, copy number variation (CNV) analysis, DNA methylation analysis, and mRNA/miRNA expression profiling. The instruments include the Illumina NextSeq 2000, Illumina MiSeq, Fluidigm Biomark and Juno systems Applied Biosystems QuantStudio 3 and 5 Real-Time PCR (RT-PCR) Systems, and Covaris M220 Focused-ultrasonicator. For single cell analysis and tissue spatial profiling (transcriptome and proteome) CDI provides two 10x Genomics Chromium controller systems.

**Mass spectrometry and analytical pharmacology:** The mass spectrometry facility at CDI is equipped with state-of the-art instrumentation and provides cutting-edge technologies and expertise to researchers within CDI and the local scientific community. Our current workflows encompass innovative combinations of mass spectrometry imaging with laser-capture microdissection and LC-MS/MS quantitation of drug compounds and endogenous molecules (lipids, metabolites, proteins, glycans). This unique combination enables researchers to selectively and routinely analyze regions of interest down to single cells from all kinds of tissues, even living cells from cell culture, to obtain results that are relevant, reproducible, and specific. We currently have a laser microdissection microscope inside our BSL3 facility thus enabling direct analysis of infected tissues. The mass spectrometry facility at CDI has the following instrumentation available to all CDI-affiliated researchers:

* Bruker SolariX 2xR 7T Hybrid QqFT-ICR Mass Spectrometer – MALDI/ESI
* AB Sciex 5500 Hybrid Tandem Quadrupole -- Linear Ion Trap Mass Spectrometer
* AB Sciex 5500 Hybrid Tandem Quadrupole -- Linear Ion Trap Mass Spectrometer
* AB Sciex 6500+ Hybrid Tandem Quadrupole -- Linear Ion Trap Mass Spectrometer
* Thermo Q-Exactive Quadrupole-Orbitrap Mass Spectrometer
* Thermo Orbitrap XL Hybrid Mass Spectrometer – MALDI
* Shimadzu Nexera X2 UHPLC system
* Leica Laser Microdissection Microscope 6
* Leica Laser Microdissection Microscope 7
* M3+ and M3 HTX-TM Sprayer - automated matrix deposition device

**The CDI BSL-3 laboratory** consists of two laboratories with over 1400 NSF of dedicated laboratory space for the safe handling of biosafety level 3 agents. The CDI BSL-3 laboratories are secure containment laboratory space that is fully equipped with biosafety cabinets, incubators, centrifuges, microscopes etc. The CDI BSL-3 also have automated liquid handling systems such as the Hamilton STARlet and Integra Viaflow 384 for high throughput screening of compounds of high level containment pathogens such as MERS, SARS CoV-2 and *M. tuberculosis*. CDI BSL3 maintains 24/7/365 security. Only qualified users, as determined by the Institutional Biosafety Committee (IBC) according to the latest federal guidelines may enter the BSL-3. For all BSL-3 labs, electronic door locks with pass-card access at the entrances of the ante-room of the BSL-3 suite and the BSL-3 work area restrict entry and maintain a computerized log of all people entering the facility. In addition, 24 hour video surveillance cameras with tape back-up are operational within the BSL-3 entrances. All users, operational support and maintenance personnel receive training from CDI for protections against risk in BSL-3 containment areas. All personnel are instructed in the proper use of personal protective clothing and devices, and their health status is coordinated by the Occupational Medicine Health of Hackensack Meridian Health. All users and technical support staff undergo training in the handling and proper disposal of free pathogens and hazardous waste and are required to pass separate safety courses mandated by the Manager of Biological Safety.

**Biosafety:** All work with *Candida auris* and other BSL-2 organisms is performed within annually inspected BSL-2 facilities. Any active manipulations of potentially infectious materials occur in an annually certified class II A2 biological safety cabinet. Any centrifugation of materials occurs in rotors that are sealed and gasketed. Staff dons laboratory coat, gloves, and eye and face protection as needed as their properly assigned personal protective equipment. All waste materials are disinfected with an appropriate EPA registered disinfectant. Any solid laboratory waste is handled by a licensed waste vendor. All laboratory staff that is directly manipulating or is working in the vicinity of these materials have received both annual biological and laboratory safety training, as well as mentorship with senior staff. This includes didactic training on laboratory processes and any emergency response activities that could be necessary in the course of their work.

Sharps precaution and disposal is implemented. Use of sharps is restricted to trained personnel. Needles and other sharps are avoided whenever possible, and plastic alternatives to glass are used if available. In addition, sharps are covered under regulatory waste guidelines and must not be disposed of with regular trash. Sharps are disposed of into an approved, puncture resistant, sharps container. Sharps used with genetically modified and biological materials are collected in red biohazard sharps containers for disposal.

Any exposures will be immediately treated by the HMH Occupational Health Department. Any exposures, releases, or other accidents will be immediately reported to the safety department for further follow up, reporting, and risk mitigation discussions.

**The CDI Research Animal Facility (CDI RAF)** is a newly renovated ~40,000 sq. ft. state-of-the-art complex occupying the entire 3-6th floors of the Hackensack-Seton Hall Medical School Annex building, which is physically linked to the CDI. The CDI RAF received full AAALAC International accreditation on March 5, 2020. The CDI RAF has extensive capacity for rodents (>10,000 animals; mice, rats and guinea pigs) and rabbits (60 in ABSL3) all housed in individual ventilated caging (IVC) units and handled under sterile conditions. A full-time staff supports the facility, including a RAF manager, and experienced animal care technicians trained with all housed species and capable of performing routine animal manipulations. Routine veterinary oversight occurs onsite. The ABSL2/ABSL3 RAF is dedicated to pharmacokinetics in uninfected and infected animals and pathogen-based efficacy studies. Other animal studies in the CDI RAF include surgical models, cancer, graft vs. host disease, microbiome and immune function studies. The facility consists of multiple rodent housing rooms, a rabbit housing room with custom-designed biosafety enclosures, tissue culture labs, procedure rooms, and dedicated rooms for aerosol challenge of mice, rats, guinea pigs and rabbits. Metabolic mouse cages are available for in depth pharmacokinetic, metabolism and elimination studies. Infected animals are housed in micro-isolator cages within this ABSL3 facility. A Full Body Inhalation Exposure System (Glascol) placed inside a safety flow hood is available to uniformly infect up to 100 mice per run with aerosolized pathogen inoculum. A mouse and rabbit nose aerosol infection system is also set up in a safety flow hood. There are several small animal operating and procedure rooms within the facility. For in vivo imaging, the CDI RAF has a Leica Stellaris 8 confocal microscope for intravital imaging, Perkin Elmer X5 IVIS Multispectral imager with x-ray, bioluminescence, fluorescence, and radioisotopic imaging capabilities and a VisionSonics VEVO 3100 Small Animal Ultrasound Imaging System and a Piximus DEXA analyzer. A Rad source X-ray irradiator is also housed in the facility to prepare rodents for engraftment. The HMH Institutional Animal Care and Use Committee (IACUC) oversees the facility. The facility also contains a dedicated floor for ABSL3 rodent and small animal studies. The facility was designed according to the latest CDC Biosafety in Microbiological and Biomedical Laboratories (*BMBL*) 6th edition guidelines. All biocontainment-related studies are approved by the HMH IACUC and IBC. The CDI RAF maintains 24/7/365 security. Only qualified users, as determined by the Institutional Biosafety Committee (IBC) according to the latest federal guidelines may enter the ABSL-3 RAF. Electronic door locks with pass-card access at the entrances of the ABSL3 to maintain a computerized log of all people entering the facility. In addition, 24 hour video surveillance cameras with tape back-up are operational at the ABSL-3 entrance.

**Clinical Research Environment**: The HUMC John Theurer Cancer Center has more than 300 ongoing clinical trials conducted independently and in partnership with government- and private-research centers and pharmaceutical companies, research consortiums, patient advocacy groups and the National Institutes of Health. Many of these trials involve innovative treatment and patient support for patients with hematological and related cancers and those undergoing stem cell transplantation. The clinical trials are supported by the David and Alice Jurist Institute, which occupies 55,000 sq. ft. and provides administrative services, a library, conference rooms, and a lecture hall equipped with the latest audio-visual technology.

**Administrative Support**: The CDI and HMH provide full supportive services for all research projects including a full time Sponsored Programs Manager to help investigators comply with all relevant regulations and policies and managing grants. A financial analyst supports financial needs in sponsored research, cost analysis, procurement, and budgeting. The Research Department also has administrative support for all researchers.

**HACKENSACK UNIVERSITY MEDICAL CENTER (HUMC)**

HUMCis a 900 bed, full-service hospital that was established in 1886 and has expanded tremendously in recent years. It has been named one of the nation’s top 50 hospitals, the top hospital in New Jersey, and one of the top 3 hospitals in the New York Metropolitan area. Research conducted at HUMC is supported by the David and Alice Jurist Institute for Research, which opened in 2000 to provide state of the art research facilities and services for both clinical and basic research, including an Institutional Review Board, Research Biosafety committee, Institutional Data Safety Monitoring Board, Office of Research Integrity, Sponsored Programs Office, Research Finance and Contracts Office, Research Compliance Office, Clinical trials Advisor, Research Biostatistician, and Office of Commercialization and Technology Ventures.

The John Theurer Cancer Center (**JTCC**) at HUMC is the number-one ranked cancer center in New Jersey. It was listed among the top 50 cancer centers by *U.S. News and World Report* in 2013-2014, is the largest volume cancer-care provider in New Jersey, and one of the largest by volume in the United States. The JTCC is located across the street from the main HUMC campus. It has more than 300 ongoing clinical trials conducted independently and in partnership with government- and private-research centers and pharmaceutical companies, research consortiums, patient advocacy groups and the NIH.

Through recent investments in faculty recruitment and core equipment, the JTCC is fostering cancer research and related areas of biomedical research, including immunology and stem cell biology, at HUMC. As detailed below, five years ago the JTCC entered into a consortium agreement with the Georgetown Lombardi Comprehensive Cancer Center at Georgetown University, thereby giving HUMC investigators access to the extensive core facilities at Lombardi.

# RESEARCH PARTNERSHIP WITH THE GEORGETOWN LOMBARDI COMPREHENSIVE CANCER CENTER

Georgetown University and HMH Hospitals Corporation have an executed Cancer Center Research Integration Agreement. The mission of the cancer center is to prevent, treat and cure cancers by linking scientific discovery, expert and compassionate patient care, quality education, and partnership with the community, guided by the principle of cura personalis “care for the whole person”. Georgetown Lombardi is the only NCI-designated comprehensive cancer center in Washington, DC, and one of 50 in the country. In May of 2019, the John Theurer Cancer Center (JTCC) of Hackensack Meridian Health was approved by NCI as a CCSG research consortium partner of the Georgetown University Lombardi NCI-designated Comprehensive Cancer Center (LCCC). In order to facilitate research across the consortium, a master IRB reliance agreement as well as a master material transfer agreement have been executed between Hackensack Meridian Health and Georgetown University. Currently the LCCC has four research programs (Breast Cancer, Molecular Oncology, Cancer Prevention & Control, and Experimental Therapeutics) and nine shared resources.

The New Research Building (NRB) is a state-of-the-art research facility, with 103,769 net sq. ft. of assignable space. Building services include deionized water, natural gas, compressed air and vacuum. Lab modules are each approximately 500-600 sq. ft. in size and 11'-0" in width. Typical lab offices are 100 to 120 net sq. ft. Special equipment in the building is described below under Shared Resources, and includes two NMRs. The design of the NRB is flexible and maximizes wet laboratory space. It includes 52,891 net sq. ft. of laboratories; 14,377 net sq. ft. of support areas (common equipment rooms, etc.); 14,208 net sq. ft. of lab offices and work space; a 4,692 net sq. ft. lecture hall; and 9,628 net sq. ft. administrative/conference space; with the balance of 104,000 net sq. ft. in building support. The NRB is the primary home of all Lombardi laboratory activity with the remaining wet laboratory space primarily on two levels of the Preclinical Science Building.

On June 30, 2000 Georgetown University Medical Center (GUMC) and MedStar Health, Inc. finalized a clinical partnership agreement. Under the terms of the agreement, MedStar Health owns, operates, and has financial responsibility for Georgetown University’s clinical enterprise, which includes a hospital, a faculty practice group, and a network of community physician practices. The clinical structure joined MedStar Washington Hospital Center/Washington Cancer Institute (MWHC) and MedStar Georgetown University Hospital (MGUH) to five other sites, forming one large network, the MedStar Georgetown Cancer Network (MGCI. MedStar has invested significant resources in developing a cancer research infrastructure across this network. A Joint Cancer IRB has been instituted for all network hospitals, so that a study can be approved at all sites with one submission. MedStar Hospitals see about 7,000 new cancer patients each year.

**LCCC Shared Resources**

Animal Models Shared Resource (AMSR): Animal models are powerful cancer research tools and a vital link to translating laboratory studies into the clinic. The function of the Animal Models Shared Resource (AMSR) is to facilitate efficient, economical, and state-of-the-art use of animals for the performance of cancer-related studies. This is accomplished through a centralized resource, where AALAS-certified, highly trained veterinary technicians provide preclinical research services to LCCC members. A significant emphasis is placed on assisting users with the design and performance of animal studies using a wide-range of models, including zebrafish and a recently developed model to study endocrine resistance and breast cancer recurrence in an estrogen receptor positive rat model. Major services provided include all aspects of rodent studies, such as establishing genetically modified mouse colonies, administering carcinogens, monitoring tumor growth, collecting tissues and tumors at necropsy, and administering drugs, diets or other compounds. Studies using zebrafish include generating gene knockout or gene overexpressing models, screening for toxicity/drugs, and xenotransplantation experiments. Imaging services are also provided to monitor tumor initiation, progression, and response to therapy. The AMSR is located within Georgetown University Medical School’s Division of Comparative Medicine (DCM). The DCM is a centralized, AAALAC-accredited, USDA-registered animal facility and has an approved letter of assurance on file at NIH. The AMSR is codirected by Leena Hilakivi-Clarke, PhD, and Christopher Albanese, PhD, who oversee the animal and imaging components, respectively.

**Zebrafish** are housed in the Animal Facility, Division of Comparative Medicine. The room (RRF G17) is approximately 600 sq ft. This room is temperature controlled, there are six floor drains, the flooring is waterproofed, there is a large stainless steel sink and counter top, and the lights are on an automatic timer. A custom recirculation system, which was designed and installed by Aquatic Habitats, has the capacity to house up to 15,000 fish.

**Preclinical Imaging Research Laboratory (PIRL**). Dr. Christopher Albanese is the founder and Director of PIRL and Olga Rodriguez, MD, PhD is co-Director. The extensive laboratory space is made up of a main magnet room, an operator’s area, a well-equipped electronics workshop, an animal surgery room, a large office area and storage areas. The main magnet room houses a Bruker AVANCE III 7.0 tesla horizontal 20 centimeter bore magnet interfaced with a Bruker spectrometer/imager running ParaVision 5 software and hardware, running Linux. The magnet itself is equipped with microimaging gradients and is housed within a room-size copper Faraday cage. A number of coils are available for applications including a 4 channel brain coil, 72 mm, 30 mm and 22 mm proton resonator coils, 20 mm and 15 mm proton microimaging coils and single tuned surface coils. The laboratory also contains, among other hardware, an HP ParaVision 5 workstation, an HP 64-bit processor for DTI and 2 Mac workstations. The imaging services provided by PIRL also include an IVIS Fluorescence/Luminescence imaging workstation, small animal ultrasound (Vevo660) workstation, an X-ray imaging unit (Flaxitron) and a visible-near infrared spectroscopic imaging workstation (Maestro II). The PIRL is linked to a data storage center run by the University and all imaging is backed up both on terabyte external drive as well as off site.

Flow Cytometry & Cell Sorting Shared Resource (FCSR) provides flow cytometry and fluorescence activated cell sorting (FACS) support to researchers of the Georgetown Lombardi Comprehensive Cancer Center. Karen Creswell, PhD, director of the facility, has extensive experience with flow cytometry and cell sorting including immunofluorescence methods, cell cycle analysis, and sterile cell sorting is available for development of specific applications. Services provided include:

* Three flow cytometers facilitate efficient utilization of this technology for routine, as well as more complex applications
  + BD FACSAria IIu is a cell sorter with 375nm, 405nm, 488nm and 633nm laser lines. It is currently configured for 3-laser, 9-flourochrome sorting and analysis
  + BD LSRFortessa (2) are analysis flow cytometers configured for 3 laser, 14 flourochrome analysis.
* Staining services such as staining for cell cycle analysis and Annexin V apoptosis assay
* Computer software is available for DNA cell cycle phase analysis as well as a variety of other multiparameter research applications. A site license to FCSExpress 6 (compatible with both MAC and PC) allows researchers to analyze their own data.

Genomics & Epigenomics Shared Resource (GESR): The various “omic” technologies have emerged relatively recently and evolved rapidly, becoming essential to almost every aspect of cancer research. The objective of the GESR is to provide investigators with diverse state-of-the-art services for genetic and epigenetic studies such as next generation sequencing (NGS), single nucleotide polymorphism (SNP) genotyping, copy number variation (CNV) analysis, DNA methylation analysis, and mRNA/miRNA expression profiling. To facilitate these services, the GESR assists users in DNA/RNA quality assessment as well as DNA plating and assay preparation using Agilent Bioanalyzer and Beckman Multimek NXP Robotic Liquid Handling System, respectively. GESR uses state-of-the-art instruments and assays to provide these services. These include the Illumina NextSeq 550, Illumina MiSeq, Illumina iScan, NanoString nCounter SPRINT Profiler, Affymetrix Microarray System, Agilent Microarray System, Applied Biosystems QuantStudio Real-Time PCR (RT-PCR) System, and Covaris M220 Focused-ultrasonicator. The Resource Director, Habtom W. Ressom, PhD, has experience in designing and developing workflows to ensure reproducible “omic” experiments. In addition, the GESR provides bioinformatics support for omic data analysis and training for user-operated instruments (e.g., RT-PCRs, plate readers, spectrophotometers, and densitometers). The Resource Assistant Director, Aykut Uren, MD, is an expert in surface plasmon resonance (SPR) technologies and their application for measurement of the concentrations of specific molecules and determination of intermolecular interactions.

Located within the GESR, the Biacore Molecular Interaction Service provides customized biomolecular analysis services. The two Biacore instruments, Biacore T-200 and Biacore 4000, utilize Surface Plasmon Resonance (SPR) to study molecular binding events on a chip surface. The basic principle of SPR involves immobilization of a ligand on a sensor chip followed by delivery of an analyte by a microfluidic system. Any protein, DNA, RNA, lipid, carbohydrate, polysaccharide, cell, virus, drug, or drug-like molecule (organic or inorganic) can be used as the ligand or analyte. In addition to identifying binding partners to a target molecule, SPR also provides quantitative data on specificity, concentration, kinetics, and affinity.

Histopathology & Tissue Shared Resource (HTSR) allows investigators access to human tissue for translational research and provides comprehensive, high quality laboratory and interpretive pathology services. The HTSR collects and distributes fresh, frozen and formalin-fixed paraffin-embedded tissues (10,600+ patients consented to date) as well as provides technical and pathological support to investigator-driven collection protocols including the novel conditionally reprogrammed cells project. The HTSR Co-Director Brent Harris, MD, PhD provides comprehensive pathology services related to human and animal tissues. Under the day to day direction of co-Director Deborah Berry, PhD, the laboratory provides comprehensive histology services including necropsy, tissue processing, microtomy, staining, immunohistochemistry, laser capture micro-dissection and tissue microarray construction, staining and high throughput analysis. In addition, the HTSR provides expert technical support, pathology database search capabilities, consultation services and educational support and training for users. The HTSR also coordinates with the company Indivumed for the collection of high-quality biospecimens including matching fresh frozen and formalin fixed tissues, serum, plasma, urine and comprehensive clinical data.

Microscopy & Imaging Shared Resource (MISR), under the direction of Michael Johnson, PhD, provides instrumentation and expertise for light and electron microscopy. Users incorporate a variety of imaging techniques into their studies including total internal reflection fluorescence microscopy (TIRF), laser scanning and spinning disk confocal, and automated image acquisition for screening of multiwall samples. Applications include fluorescence resonance energy transmission (FRET), fluorescence lifetime intensity microscopy (FLIM) for FRET measurements, fluorescence recovery after photobleaching (FRAP), and other live imaging applications; multispectral emission imaging, and epifluorescence and brightfield time-lapse microscopy, microinjection, immune-light and –electron microscopy and two- (pixel) and three-dimensional (voxel) image analysis to study tumor cell biology. Workshops, lectures and seminars encompassing state-of-the-art imaging techniques are offered periodically. Cytogenetic Services are provided under the direction of Jan Blancato, PhD, and include: 1) Ploidy analysis with DAPI counterstain; 2) Chromosome harvest and ploidy analysis of mouse and human cell lines and primary specimens; 3) molecular cytogenetic/ fluorescence in situ hybridization FISH services; 4) Gene mapping by FISH: BAC clone or cosmid mapping to chromosomal band in human and mouse models; 5) FISH analysis of specific chromosome number; and 6) FISH analysis of chromosome rearrangements using translocation base probes and whole chromosome probes in cell lines and other samples.

Proteomics and Metabolomics Shared Resource (PMSR) is equipped to provide a broad spectrum of proteomics and metabolomics services. The proteomics section, under the direction of Junfeng Ma, PhD and Stephen Byers, PhD is equipped with TripleTOF 6600 and QTRAP 6500 mass spectrometers (Sciex) which can be interfaced with nanoAcquity UPLC systems (Waters) or cHiPLC enabled 2D nanoLC system (Sciex). In addition the shared resource houses an Agilent 1100 nanoflow HPLC interfaced with an LC Packings Probot, 2D gel electrophoresis system (BioRad) with an imaging unit for DIGE quantification (GE Healthcare), Acquity UPLC with fluorescent detector, and an ELISA ECL sector imager 2400 (Mesoscale). A diverse range of services to characterize peptides, proteins, and proteomes from a variety of samples (including immunoprecipitates, whole cell lysates, tissues, biofluids, etc.), including but not limited to the following: 1) molecular weight determination; 2) protein identification from gel bands and/or complex mixtures; 3) characterization of post-translational modifications; 4) protein quantification including iTRAQ, DIGE andSWATH; and 5) targeted quantification by multiple reaction monitoring and parallel reaction monitoring. The metabolomics section, under the direction of Amrita Cheema, PhD, works with different sample matrices including cell extracts, plasma, serum, urine, feces, and tissue and has developed a number of standardized assays. The facility has two Waters instruments, Xevo G2 and Xevo G2-S. In addition, the facility has a Leco GC-ToF that performs untargeted profiling. A seahorse XF analyzer measures mitochondrial respiration and glycolysis simultaneously in live cells, in real time. The facility also provides nuclear magnetic resonance (NMR) for chemical compounds to provide information in regards to physical and chemical properties.

Tissue Culture and Biorepository Shared Resource (TCBSR) assists investigators with all of the tissue culture-related aspects of their research. The Resource provides consultation, facilities and services to a diverse group of investigators. Specifically, TCBSR generates primary cell lines from normal and tumor tissues, using a novel conditionally reprogrammed cell methodology that allows researchers to have an inexhaustible supply of cells for comparative genetic and molecular analysis; provides a B lymphocyte transformation service to facilitate cancer genetics studies; provides quality control tests for cell lines including mycoplasma testing and genetic fingerprinting of cells; provides cell culture and banking service; provides a safe, secure cryo-storage facility for investigators to keep frozen stocks of their cancer cell lines; prepares, tests and supplies tissue culture reagents of the highest quality that have been specifically tested for suitability in the relevant systems, as inexpensively as possible; equips, monitors, stocks and services four separate shared tissue culture laboratories for the use of investigators; maintains the biorepository of cell lines; provides processing and banking of blood and other biofluids for cancer patient biorepository; provides expert consultation and training regarding the use of tissue culture techniques in research.

Biostatistics & Bioinformatics Shared Resource (BBSR) goal is to provide basic, translational, clinical and population science investigators with access to high quality statistics and informatics. Ming Tan, PhD, Chair of the Biostatistics, Bioinformatics, and Biomathematics Department and Subha Madhavan, PhD, Director of Innovation Center for Biomedical Informatics are co-directors of BBSR. BBSR functions include: study design, statistical analysis and reporting of research studies including clinical trials, studies with high dimensional “omics” and imaging data including pathway analysis; review and monitoring of clinical protocols through membership on the Protocol Review and Monitoring System and Data and Safety Monitoring Committees; and provision of biostatistics and informatics training and expertise in the collection, integration, management, and application of biomedical data. In addition, the BBSR provides investigators with advanced statistical and bioinformatics methods and expertise developed independently by BBSR faculty. The BBSR has excellent computing resources, informatics systems, and informatics and statistical software necessary for efficient and effective support of LCCC research. The BBSR collaborates with members in all four Research Programs and with multiple Shared Resources including the Genomics & Epigenomics and the Proteomics & Metabolomics Shared Resources. BBSR supports the development of the information architecture for connecting data and metadata from clinical, biospecimen, and research systems to enable all forms of cancer research.

Survey, Research, and Biospecimen Collection Shared Resource (SRBSR) was established in July 2017, and provides an integrated suite of comprehensive services for planning and implementing research projects. The SRBSR facilitates implementation of studies through provision of an integrated suite of services spanning the continuum of research, starting with early planning and design through the production of final datasets for analysis. The suite of services includes survey design and administration, screening for eligibility, subject recruitment in cancer and non-cancer clinics located in MedStar Georgetown University Hospital and MedStar Washington Hospital Center, database programming to facilitate participant tracking, biospecimen collection, data entry, medical record abstraction, and merging datasets containing diverse data sources. In addition, the SRBSR created and continues to update and maintain a centralized cancer patient registry of more than 3,000 registrants enrolled to facilitate and coordinate recruitment and reduce duplication effort. The patient registry obtains consent to re-contact patients for future studies, acquires biospecimens, and administers a core patient survey. The SRBSR’s goals are to optimize the efficiency in the design and execution of studies, facilitate best practices, and enhance collaborative, transdisciplinary observational and interventional studies. The SRBSR does not recruit subjects for treatment clinical trials. Administrative, nursing, recruitment, and data management support for these clinical trials are provided by the Clinical Research Management Office.

To ensure synergy with other shared resources, the SRBSR, which collects biospecimens, works closely with the Histopathology & Tissue Shared Resource (HTSR) and the Tissue Culture and Biobanking Shared Resource (TCBSR) that process and store the biospecimens. This provides investigators with access to patients and data that can be linked to blood samples as well as tumor and non-tumor tissue.

The SRBSR also encompasses the Familial Cancer Registry (FCR), which is an integrated and comprehensive resource of individuals at high genetic risk for cancer and includes detailed demographic data, family history information, medical history, cancer risk factors, tissue from surgeries (benign and malignant), tissue micro-array, and biospecimen, all of which can be linked securely and confidentially to results of genetic testing.

**Other Resources at Lombardi or Georgetown:**

Center for Cell Reprogramming (CCR). The CCR in the Department of Pathology unites the many laboratories at Georgetown University that have research programs involving stem cells and stem-like cells. These laboratories focus on ES cells, iPS cells, and CR cells and address a myriad of basic and clinical questions. The main goal of the CCR is to promote interactions, communication and collaborations between these laboratories. Embedded within the CCR is the Conditionally Reprogramming Laboratory (CRL) that offers intramural stem cell researchers unique tools for expanding stem cells. Xuefeng Liu, PhD serves as Scientific Director of the CRL. The CRL was established by the Lombardi Cancer Center and the Department of Pathology in 2012 to provide a shared resource for university investigators who wish to establish conditionally reprogrammed cells (CRCs) from either normal or diseased tissue. It is a secured, highly integrated, internet-linked facility that can correlate de-identified patient data with corresponding cell cultures generated in the CRC. The CRC has 600 sq ft of dedicated space that contains two BCL-2 tissue culture hoods, three regular incubators and one low-oxygen incubator (Thermo Scientific Heracell 150i (1-20% O2). Two phase microscopes are in the lab, one of which is a flat-screen Evos LX microscope that is linked to the internet so that images can be stored with the corresponding cell culture files. In addition, there is a bar-coding system (with mobile reader) and printer that is used to codify all cell lines and related information, including storage sites. The bar-coding system also allows additional data (gels, karyotype, STR data, etc.) to be linked to cultures. There is a new 12 stack liquid nitrogen freezer that is used solely for the storage of CRCs. Finally, there is an ACEA Bioscience xCelligence system that uses a computer-linked 96 well plate for the real-time monitoring of cell growth. This system provides a medium-throughput system for screening cell culture sensitivity to drugs.

The Georgetown Database of Cancer (GDOC) is designed to serve as a cutting-edge data integration platform and integrative knowledge discovery system for the oncology and translational research communities. By aggregating public and proprietary clinical and –omics data from across the Medical Center, GDOC is expected to help bring about significant advances in personalized medicine for patients and to promote identification of new drug targets and therapeutic modalities. Along with a comprehensive set of advanced analysis and visualization capabilities, this portal can assist with hypothesis generation and testing across biomedical disciplines.

Library Resources provide optimum services, facilities and resources to enhance the pursuit of knowledge and academic excellence. The present holdings of all University libraries total over 1,740,000 volumes and 1,850,000 microforms. The Joseph Mark Lauinger Memorial Library has a collection of over one million volumes. Georgetown is a U.S. Government Documents Depository. Blommer Science Library covers the subject fields of biology, chemistry, mathematics, physics, and computer science. The book and bound journal collection there numbers over 63,000 volumes; and almost 900 journals are currently received. Other library resources include: The Maternal and Child Health Library, the Woodstock Theological Library and the National Reference Center for Bioethics Literature. The John Vinton Dahlgren Memorial Library is the major library for the Georgetown University Medical Center. The Library occupies over 31,000 square feet on four levels. The staff is comprised of academic librarians, computer scientists, and support staff. The library provides access to several medical databases including MEDLINE, EMBASE Alerts, and the Micromedix drug information system. The library’s print collection includes more than 172,442 volumes (including 43,372 books and 118,188 bound journal volumes), current subscriptions to 1,831 journals, and over 2,700 audiovisual and microcomputer software programs.

Office of Minority Health and Health Disparities Research is a community-based space for The Georgetown Office of Minority Health and Health Disparities, led by Lucile Adams-Campbell, PhD, opened in 2011, located at 1000 New Jersey Ave, SE, Washington, DC, 20003. The space allows for improved access between LCCC and minority and underserved communities which facilitates research engaging the local minority community in our effort to address cancer health disparities. The location is 15 minutes from Lombardi and in close proximity to metro stops and several bus lines, which provide easy access to the community outside of Georgetown.

The office space measures 4,437 square feet, and includes 8 offices for faculty and patient/participant intake privacy, and 9 modular offices for staff, graduate students and postdoctoral fellows. Each staff member is provided with a data encrypted desktop computer, or equivalent. The suite also houses a conference room, reception and waiting areas, photocopy machine, and data/voice access. There is also an exercise physiology lab, and a nutritional education area that includes a kitchen. The exercise physiology lab includes a metabolic unit, treadmills, elliptical machines, and weight training machines. In addition there are 2 Wii-Fit exercise rooms including video games and televisions, and a room with a DEXA machine, which measures body position.

Indivumed- Georgetown Tumor Biobank & Clinical Database: In 2008, Georgetown University and Indivumed, Inc. established a partnership at Georgetown University Medical Center to create a tumor biobank and clinical database of all types of cancer (solid tumors). Indivumed is a privately held biotech company focused on the generation, characterization and analysis of highly standardized biological samples from human cancer for the development of individualized cancer therapies. This partnership has led to the creation of a growing academic biobank that meets the highest possible standard of biobanking and, thus, allows analyzing molecular reality in patient samples in conjunction with a comprehensive clinical data base.

The partnership involves the collection, storage, analysis and utilization of biospecimens according to the Indivumed standard, and prospective and standardized collection of pre-, intra-, and post-surgical patient data and biospecimen data by specially trained research associates. Georgetown physicians, pathologists and staff have been trained in Indivumed’s SOP, which has been adapted to the local situation in MGUH’s operating room. Biospecimen collection includes: tumor tissue from periphery and center areas that are fixed by both liquid nitrogen and formalin, plasma, serum, PBMC and urine. As quality control, H&E staining of one FPPE block is done for each collection. Other quality controls (e.g. RNA quality) are performed shortly before use of all specimens. At the time of specimen collection, study nurses obtain all clinical data from medical notes and interviews with patients and physicians. Trained document assistants are present for quality control of all data prior to its entry into the data base.

The necessary infrastructure for this biobank is in place at GUMC, with a designated state-of-the-art laboratory in the Preclinical Science Building. This laboratory performs the following procedures: 1) Blood preparation for serum, plasma, and peripheral blood cells; 2) urine preparations separating sediment and supernatant; 3) paraffin embedment (FPPE); 4) storage of FPPE blocks; 5) -80 degree Centigrade storage of fluids;6) protein, RNA, and DNA preparation; 7) standard microscopy. In the clinic, GUMC has obtained IRB approval of HIPPA-complaint consent forms and data acquisition forms. Staff hired with Indivumed-Georgetown partnership funds have been trained in all biobanking steps.

Innovation Center for Biomedical Informatics (ICBI): ICBI is a premier biomedical informatics research and education center at Georgetown University. ICBI’s mission is to enhance translational research at Georgetown University Medical Center and in turn, attract and educate the next generation of scientists and physicians who are critical to the transformation of healthcare. The Center conducts research, collaborates with external entities and provides specialized research services. ICBI is home to about 18 faculty and staff whose activities can be grouped into inter-related focus areas that include Precision Health, Data Integration and Structure, Data Science Methods and Tool Development.

ICBI maintains a local computer infrastructure including over 40 Intel/Windows workstations, Mac OS and Linux workstations, cutting edge data visualization capabilities, and disk storage/backup capabilities in a hybrid wired / wireless network. Dedicated computers are set up as servers and restricted backup devices for collecting, storing, analyzing, and distributing gene microarray data to collaborating laboratories. Specialized software and development packages are available for decision support, molecular modeling, processing, advanced statistical analysis, knowledge management, mathematics, data mining and big data processing. The computing capabilities include the latest technologies and secure environments for conducting data collection to do research and education or clinical care.

The ICBI advanced data visualization infrastructure allows researchers to visualize large data sets in high fidelity. The infrastructure consists of a NVIDA Quadro K5000 video card housed in a Dell Precision T5600 workstation and two 55 inch ultra-high fidelity (4K) monitors. The system is capable of displaying over 16 million pixels of data in a single view. The ICBI visualization system was created through an NVIDIA corporation hardware donation grant and hardware contributed by the University Information Systems department. ICBI has received a grant from Amazon.com to conduct research in high performance computing using AWS.

High Performance Computer Cluster: Medusa is a High Performance Computing (HPC) Cluster for researchers at Georgetown University. All faculty, staff and collaborators are eligible for access to Medusa as Principal Investigators of research projects. Medusa infrastructure is continually upgraded based on research needs.

Computational Chemistry Shared Resource (CCSR): The primary mission of the CCSR, under the direction of Sivanesan Dakshanamurthy, PhD, MBA, is to accelerate the development of research projects and molecular therapeutics for Georgetown University members. The CCSR provides a wide array of proprietary and commercial services for drug screening, computational-based simulations and modeling of chemical and biological systems. The CCSR offers specialized expertise to researchers to develop and test hypotheses in silico. CCSR provides a range of support services including new small molecule screening & discovery, drug repurposing, chemo- and pharmaco-informatics, systems pharmacology, and molecular modeling including: 1) small molecule virtual screening; 2) molecular modeling and analysis; 3) biomolecule simulations; 3) chemo-informatics services; and 5) systems pharmacology/network services.