FACILITIES & OTHER RESOURCES

The University of Tennessee Health Science Center (UTHSC) Institutional Core Facilities:
There are nine institutionally supported and subsidized core facilities located on the UTHSC campus, including the Lab Animal Care Unit (LACU), the Regional Biocontainment Laboratory (RBL), the Molecular Resource Center (MRC), the Molecular Bioinformatics (mBIO) core, the Flow Cytometry and Cell Sorting (FCCS) core, the Proteomics & Metabolomics Core (PMC), the Research Histology Core (RHC), the Medicinal Chemistry (MedChem) core and the Advanced Animal Imaging (AAI) core. An overview of core facilities may be found at https://www.uthsc.edu/research/institutional-cores/index.php. Institutional core facilities are widely used facilities managed by the Office of Research. Core service fees are very competitive, and currently rank in the bottom-third to bottom-half of the pricing for services offered by peer academic institutions located in the Southeast United States. Institutional core facilities serve investigators based at UTHSC, LeBonheur Children's Hospital, the Regional One Medical Center and the University of Memphis (the greater Memphis area), as well as several external customers from around the US and the world.

Lab Animal Care Unit (LACU); David Hamilton, DVM, Director:
The LACU administers the facilities and the program of animal care resources for the campus. The LACU is responsible for all animal care resources and the purchase and care of all animals on the UTHSC campus. The LACU also provides consultation for experimental design and for training of investigators and other personnel in the humane and responsible use of animals. The facilities are comprised of >40,000 net sq. ft. of animal space located in 5 buildings, and office spaces in the Coleman Building. The entire centralized animal care program has been fully accredited by the Assessment and Accreditation of Laboratory Animal Care (AAALAC) since 1993, and maintains an active Animal Welfare Assurance with the NIH Office of Laboratory Animal Welfare (OLAW). The LACU maintains a staff of 36 personnel, including 3 veterinarians, 2 veterinary residents, 2 veterinary technicians, 3 supervisors and 17 husbandry technicians and 8 cage wash technicians, along with additional business and operations support staff. 94% of the animal husbandry technicians are certified by the American Association for Laboratory Animal Science (AALAS). Emergency call is rotated among the veterinary faculty and residents. One veterinarian and one animal care supervisor are always on call and available for emergency care, 24/7, 365 days a year. The LACU offers small equipment available for investigator use, including several isoflurane anesthesia units and temperature-controlled circulating water pads. Larger equipment available includes the Visual Sonics Vevo 2100 ultrasound system, the CODA Tail-Cuff Blood Pressure Monitoring system, a STARR Life Sciences MouseOX monitor (pulse oximeter and EKG monitoring), Sedecal Vet-Ray digital radiography, a Perkin-Elmer (Xenogen) IVIS Lumina animal bio-imager with luminescent and fluorescent imaging capabilities, an Imtek MicroCAT II scanner for x-ray tomography, and an Abaxis VetScan HM5 blood analyzer.

Regional Biocontainment Laboratory (RBL); Colleen Jonsson, PhD, Director:
The RBL Core's mission is to provide state-of-the-art Biosafety Level 3 (BSL- 3) and Animal Biosafety Level 3 (ABSL-3) containment laboratories that support the research community and the National Biodefense Network. The UTHSC RBL is one of 11 such facilities throughout the country that was constructed with funds secured by an extramural (NIH/NIAID) award with a match by the University. Operational since 2010, the RBL is approved for select agent use through the Centers for Disease Control and Prevention and has AAALAC accreditation. The RBL is a 30,000 sq. ft. facility housing six ABSL-3 suites, eight BSL-3 laboratories, and one large BSL-2 multi-suite laboratory. All animals are housed in Allentown BioContainment Units (BCU) and are monitored via a WiCom system. The RBL provides specialized equipment and technical services to support internal and external research for academic or industrial focused projects including a Xenogen Perkin Elmer Spectrum animal bio-imager with luminescent and fluorescent imaging capabilities, the BioAerosol Nebulizing Generator (BANG) unit for nose-only aerosol delivery (mice), FACS Aria II, Luminex 200, MagPix, QuantiGene6, DiaSys respons 910Vet chemistry analyzer and X-pedite HEM3 Vet hematology analyzer, and a DeltaVision live-cell deconvolution microscope. The RBL has two highthroughput labs (1-BSL2, 1-BSL3). Each are equipped with Perkin Elmer Janus robots, MultiFlo™ FX and Envision readers. RBL technical staff also provide certification of all biosafety cabinets on campus and repair small laboratory equipment.

Molecular Resource Center (MRC) of Excellence; William Taylor, PhD, Director:
Established in 1985, the MRC is a Tennessee Higher Education Commission (THEC)-sponsored campus resource that consists of approximately 2,400 sq. ft. of laboratory/office/ conference room/computer server space and an additional 280 sq. ft. of space for freezers/storage in the newly constructed Translational Science Research Building (TSRB), which opened in Fall of 2015. The MRC maintains several pieces of equipment available for campus-wide use, including 2 LC480 Roche LightCycler real-time PCR machines (96- and 384-well blocks), along with the complete Roche Universal Probe Library, 1 Fluidigm Biomark (96x96) real-time PCR instrument that can also be used for digital PCR, 1 ND-1000 and 1 ND-8000 NanoDrop spectrophotometers, a Covaris S2 series sonicator for chromatin and DNA shearing, a Qubit analyzer to quantitate nucleic acids, and two Agilent BioAnalyzers to quantitate DNA/RNA/protein and/or to measure nucleic acid quality. For automated DNA and RNA isolation, a Qiacube robot is available, which is capable of isolating DNA or RNA with onboard DNase treatment from eukaryotic cells on a miniprep scale from tissue, blood and cells (96 samples per day). Sanger sequencing is provided in-house (1 ABI 3130XL capillary sequencer) or as a fee for service through GeneWiz. Genotyping of genetically-modified mice can be obtained through Transnetyx. Large equipment includes a 96-well fluorescence and luminescence plate reader (Biotek Flx80), a multimode colorimetric, luminescent reader (Molecular Devices Spectramax M2e) and a GenePix 4000B microarray scanner for analyzing a variety of custom slide arrays. For high-throughput technologies, an Eppendorf EPmotion liquid handling robot and 2 MJ Tetrad 4 block thermocyclers are available. A Luminex MagPix reader is also available, which is used with Affymetrix Quantigene assays for multiplex (up to 50) gene expression analysis and gene copy number determination. In addition, the MRC maintains a fluorescence microscope (Zeiss Axiophot) for use at no charge. For large-scale genomic analyses, a full range of Affymetrix microarrays for gene expression and genotyping are available as well as array services based on the Illumina iScan platform. One Life Technologies Ion Torrent PGM, two Life Technologies Ion Proton and one Illumina NextSeq500 sequencer(s) are available for next generation sequencing (NGS) applications, including sequencing of entire genomes, targeting sequencing, whole exome sequencing (WES), analysis of copy number variants (CNVs) or single nucleotide polymorphism (SNP) genotyping, SNP discovery or detecting mutations, RNA-seq, miRNA-Seq, ChIP-seq and microbiome sequencing. Libraries are prepared by MRC dedicated staff and can be produced in a high-throughput manner using the Hamilton Starlet automated robotics system. For computer resources, the MRC maintains a Dell Precision T7500 server with 2 x 6 core Xeon processors (3.47GHz) and 64GB of RAM. This server hosts the Affymetrix Expression and Genotyping Console, Dchip, GenMapp, and DAVID. The MRC distributes data to users via a similar instrument with 14TB of internal storage and 32TB of network attached storage. Basic or custom analysis of next generation sequencing (NGS) data may be requested via the Molecular Bioinformatics (mBIO) core, which is also housed in Room 110 TSRB.

Molecular Bioinformatics (mBIO) Core; Daniel Johnson, PhD, Director:
The mBIO core was established in early 2015, with the mission to provide researchers with access to the latest technologies, workflows, and standards for analyzing molecular data. The mBIO Core is located adjacent to the MRC and to the Proteomics and Metabolomics Core (PMC) in Suite 110 of the TSRB. Services include sequence assembly, sequence alignment, differential expression analysis, and custom software designs. Expertise is also available related to protein structure/ function prediction and proteomics/metabolomics. A Ph.D.-level trained bioinformatics analyst staff member with a statistics and molecular biology background, Dr. Daniel Johnson, is available for PI consultation on pre-experimental design and for data analysis. All analysis services are based on a flat fee. Dr. Johnson is also available as a collabrator to create custom scripts and programming as needed. Data mining and transformation services are offered at an hourly rate. Long-term storage of raw data is also available as a fee for service. A Slipstream server cluster (Dell T630; 2x Intel Xeon Process ES-2690, 8x2 core 3.2 GHz server package with 14TB of storage and 368 GB RAM) that hosts a local installation of GALAXY tools and datasets (including reference genomes for human, mouse, and other common model organisms) is dedicated to NGS data analysis. Once trained, users may access the GALAXY server at no charge to perform their own data analysis. Dr. Johnson also maintains four, custom servers to support computational analysis (4 AMD 16-core blade servers). The blade servers consist of two 16 core 4.0 GHz processors, 512 GB RAM, and 16 TB storage for each machine. The current server cluster can analyze up to 128 NGS samples simultaneously. The mBIO core provides investigators with access to software such as iPathway Guide, Broad Gene Set Enrichment Analysis, and StringDB. The mBIO Core also provides frequent workshops and hands-on training opportunities for PIs, postdocs, and UTHSC students who are

interested in learning the software, analysis pipelines, and statistics needed to perform bioinformatics analysis independently.

Flow Cytometry and Flow Sorting (FCCS) Core; Tony Marion, PhD, Director:
Established in 2003, the FCCS Core's mission is to provide investigators at UTHSC and in the Memphis area with access to state-of-the-art flow cytometry and cell sorting technology, instrumentation and training in flow cytometry principles. The FCCS Core is located in the Molecular Sciences Building on Madison Avenue. The FCCS Core provides the UTHSC and Memphis research community with access to state-of-the-art instruments expertise, instruction, and assistance with experimental design and data analysis for multicolor flow cytometry and cell sorting, including indexed single-cell sorting. The FCCS Core Flow Cytometry Specialist and Core Director are highly experienced in immunology, flow cytometry, and cell sorting. Services include one-on-one consultation at no-cost with FCCS staff for experimental design, training in the use of the FCCS Core instrumentation (hourly rate), data analysis (hourly rate), and software resources, including Diva (BD Biosciences), Evolution (Bio-Rad), ModFit (Verity) and FlowJo (BD Biosciences). The FCCS Core maintains a new high-performance Bio-Rad ZE5 flow cytometer with four lasers and 21-fluorescence parameter detection in a 4-7-7-3 configuration for blue, green, violet, and red lasers, respectively. The ZE5 cytometer is highly automated with programmable sample collection and includes a small particle FALS detector for exosomes, subcellular particles, and bacteria off the violet laser in addition to standard FSC and SSC light detection off the blue laser. The FCCS Core also maintains a BD Biosciences FACSAria IIu cell sorter equipped with four lasers and 12 fluorescence detectors in a 5-2-3-2 configuration for blue, violet, red, and UV lasers, respectively, in addition to forward (FSC) and side (SSC) scatter detectors off the blue laser. The sorter has two-and four-way sort capability into tubes or microtubes. The sorter is also equipped for indexed, single-cell sorting or multiple cell sorting into microwell plates or onto microscope slides. The sorter has temperature-controlled sample injection and collection chambers and aerosol (BSL2) containment.

Proteomics and Metabolomics Core (PMC); David Kakhniashvili, PhD, Director:
Established in 2015, the PMC's mission is to provide the UTHSC community with state-of-the-art mass spectral technology and support to facilitate molecular-level discoveries that transform and advance our understanding of biological systems to solve challenging, relevant scientific questions in the life sciences. The PMC is located in Suite 110 of the TSRB. The PMC provides consultations to optimize experiment design and to interpret generated data. Services include identification and absolute or differential quantification of metabolites, drugs, and other small molecules in body fluids, cell and tissue extracts, identification of individual proteins in simple and highly complex protein mixtures, identification and mapping of posttranslational and other modifications of proteins, differential protein expression analysis based on precursor ion quantification (SILAC, dimethyl labelling), reporter ion quantification (iTRAQ/TMT labelling), and precursor ion area detection (label-free analysis), analysis of protein-protein interactions, and determination of the molecular masses of analytes. The Core is equipped with a Thermo Orbitrap Fusion Lumos mass spectrometer - a tribrid mass spectrometer combining a Quadrupole, a Dual Linear Ion Trap, and an Orbitrap mass analyzers able to perform CID, HCD, or ETD fragmentation, operate in parallel mode, and provide excellent resolution (500,000 FWHM @m/z 200), accuracy (1 ppm), sensitivity (quantification of 1 attomole at CV<15%), and high scan rate (20 Hz). The instrument operates in line with an ultra- HPLC system- Ultimate 3000RSLC Nano for nano-flow applications or Vanquish for micro-flow applications. The software tools for system operation/data acquisition and post-acquisition analysis of raw MS data include Xcalibur/SII 4.1, Proteome Discoverer 2.2, PMI-Preview 2.16, PMI-Byonic 2.16, Compound Discoverer 2.1, TraceFinder 4.1, LipidSearch 4.1, and others. The Metabolic Phenotypic Mass Spectrometry (MPMS) unit fo the PMC opened in July 2018, directed by Dr. Michelle Puchowicz. The MPMS Facility maintains an Agilent-7000C, QQQ gas chromatograph and mass selective detector (GC-MS/MS). This technology enables performing small molecule targeted metabolomics and stable isotopomer analysis through mass spectrometry-based phenotyping techniques. These applications enable the identification of regulatory mechanisms that impact metabolism. MPMS services are unique and distinct from untargeted metabolomic profiling services offered by the Proteomics & Metabolomics Core (PMC) on the Orbitrap instrument. The Agilent 7000C is a revolutionary, advanced system with high efficiency & resolution, and mass accuracy with low-to-high detection limits; the source consists of a triple quadrupole mass spectrometer. This GC-MS system coupled to the Mass Hunter Software program enables greater throughput and screening capacity/proficiency with absolute quantitative & mass accuracy detection of small molecule metabolites (including isotope mass accuracy for isotope analysis) and the ability to perform quantitative

metabolomic profiling with higher throughput capacity compared to the previous single quadrupole GC-MS models and LC-MS/MS systems. The 7000C Quadrupole MS/MS includes the option for EI/CI modes and a MS/MS mainframe, EI source, ion gauge, coupled to an Agilent 7890B Series GC Custom with a 7693 interface, 20-ramp oven programming and 7693A autoinjector, transfer Turret / 16-sample turret; LAN interface and workstation includes software programs such as the NIST 2014 MS Library Bundle, 243k spectra with names, chemical structures, and retention indices, MS/MS Spectra Lib, and NIST search and AMDIS programs, as well as the Mass Profile Professional (MPP; Agilent) program.

Research Histology Core (RHC); Abdallah Azouz, MD, PhD (Medical Director) and Louisa Balazs, MD, PhD, (Scientific Director):
The Research Histology Core's mission is to provide researchers with access to high-quality histology services and to expert consultation on histopathology to support basic and translational research. The RHC is a new institutional core that launched July 2017. The RHC supports processing, embedding, sectioning, H&E-staining and a variety of special stains of tissues for research purposes- primarily tissues derived from rodent models or human specimens xenografted into mice. The RHC also offers expert consultation services during the project design phase, and for evaluating histopathology and molecular pathology of processed samples by the Core Director. Additional services include optimizing immunostaining conditions, and referrals to obtain whole digital slide scanning using the ThermoFisher Pannoramic FLASH III system with software bundles for quantification of whole slide images or tumor microarrays that is maintained by the Department of Pathology and Laboratory Medicine. Special projects are priced based on the scope of the proposed work in consultation with the Core Directors. The RHC maintains a Leica TP1020 automated tissue processor and a Thermo Histo3 embedding station for processing research histology samples. The RHC is staffed by three experienced full-time clinical pathology histotechnologists. Dr. Balazs and Dr. Azouz are board-certified anatomic pathologists with expertise in basic and translational research.

Medicinal Chemistry Core (MedChem); Jiawang Liu, Ph.D., Director
The Medicinal Chemistry Core's mission is to offer services related to all aspects of small molecule drug development and synthesis, including, but not limited to, target validation, lead optimization, tool compounds provision, small scale and multi-gram scale synthesis, structural determination, purity and stability analysis. The Core is located in the College of Pharmacy building withinin a standard laboratory module, including a chemical fume hood, and is equipped with top-of-the-line instruments needed for synthesis, such as an automatic flash column purification system with a 3-way UV detector, a microwave synthesizer, and a pressure adjustable rotavapor with ultra-low pressure pump. There are also several major instruments currently located in the College of Pharmacy Building that are part of a College of Pharmacy-supported shared analytical facility that the MedChem core has full access to use, including NMR spectrometers (Varian Inova 500 and Bruker Avance III 400), LC/MS (Waters Xevo G2-S QTOF with Waters Acquity UPLC and SCIEX TQ5500 with Shimadzu Nexera XR HPLC), and other analytical instruments, such as IR spectrometers, UV spectrometers, and a polarimeter. In addition to serving as a service center dedicated to the generation of new products and raw data, the core also provides one-on-one consultation with internal investigators at no charge, as well as services for literature searches, oral research reports and consulting on experimental design.

Light Sheet Microscopy Unit (LSFM) of the Advanced Animal Imaging (AAI) Core; Wen-Lin Sun, PhD, Unit Director
Light-sheet fluorescence microscopy (LSFM) has the unique ability to image cleared, large biological specimens for extended periods of time and in three- dimension without sectioning artifacts and without damaging the specimens due to photobleaching that is typical of standard confocal microscopy. A LaVisionBioTec Ultramicroscope II instrument coupled to a NKTPhotonics Super K EXTREME EXW-12 model light source, an Andor Neo scientific low noise sCMOS camera and a high power data analysis workstation were installed in June 2018 in the Translational Science Research Building (TSRB) to support light sheet microscopy. The LSFM core will open for campus use beginning in the Fall 2018. Services include hands-on training to use the microscope at an hourly rate, assistance with raw data analysis, consultations for study design, including offering recommendations for tissue clearing methods.

Advanced Imaging Core (AIC); Rachel Escur Helms, PhD, Microscopy Manager
The Advanced Imaging Core (AIC) is an exciting new addition to the UTHSC family of institutional cores. The AIC's mission is to accelerate research progress by providing advanced microscopy imaging and data analysis services through its state-of-the-art equipment and expertise. The AIC houses light-sheet fluorescence, wide-field fluorescence, and super-resolution flourescence microscopy imaging equipment, enabling researchers to capture subcellular structures and to identify protein localization patterns with high accuracy in both 2D and 3D. A LaVision Ultramicrscope II light-sheet fluorescent microscope (LSFM) is available in the LSFM Unit and a Zeiss Elyra 7 system is available in the super resolution microscopy (SRM) Unit. These cutting-edge technologies minimize sample photodamage during imaging. Live imaging on the Elyra 7 system allows users to track fast cellular processes, such as vesicle movement, and to observe various signaling events. In addition to maintaining these specialized instruments, the AIC offers expert technical assistance to investigators, including experimental design/consultation, microscope training, assistance with imaging, and post-acquisition image data analysis.