

## URSMD SHARED RESOURCE LABORATORIES AND FACILITIES SUMMARY

**Overview and environment:** The University of Rochester School of Medicine and Dentistry (URSMD) is committed to providing and supporting Shared Research Laboratories (SRL) and Shared Research Resources (SRR) to support the research mission of the URSMD investigators in basic, translation and clinical research. These facilities cut across all departments and centers, and in 2012 were brought together under central leadership and administration. Over the last 6 years, the SRL and SRR have been a key component of the URSMD strategic plans. This can be highlighted by the continued subsidized support of the operation of these facilities, (~\$1.6 million for FY2016 [excluding an additional ~\$400,000 annual Vivarium subsidy]), as well as a major commitment to support the acquisition of new instrumentation and resources, highlighted by over \$1.5M commitment of new resources and renovation of lab space from over the last five years. Leadership: Timothy Bushnell, Ph.D., Director of Shared Resource Laboratories

**New equipment and research enhancements:** In the past several years, using a combination of institutional commitment and grant support, the URSMD Shared Resources have seen significant improvements and enhancements of the tools available to support the research mission. These recent enhancements include:

- 2012 – Awarded \$10 million from New York State for a high performance computing and big data initiative for Health Sciences Center for Computational Innovation
- 2012 – Acquisition of an IBM Blue Gene Supercomputer for the Center for Integrated Research Computing (CIRC)
- 2012 – Awarded an NIH SIG grant for acquisition of a CyTOF Mass cytometer (PI T. Bushnell) to enhance the Flow Cytometry Resource
- 2012 – Acquisition of a Palmbeam Laser Capture Microdissection Instrument, Confocal and Conventional Microscopy Resource
- 2012 – Acquisition of a Pascal 5 Zeiss 3-color laser scanning confocal, Confocal and Conventional Microscopy Resource
- 2012 – Completion of new \$3 million Stem Cell cGMP Facility supported by a New York NYSTEM grant (PI S. Dewhurst)
- 2013 – Acquisition of a Triple Quadrupole mass spectrometer for the Mass Spectrometry Resource Laboratory
- 2013 – Upgrades purchased for the Multiphoton Resource microscope to change to a 4-channel configuration, with SIM capabilities; via a 405 diode laser or a 488 argon laser
- 2013 – Awarded an NIH SIG grant for the acquisition of an Illumina HiSeq 2500 (PI S. Gill) to enhance the Genomics Research Center
- 2013 – Awarded \$500K from New York State for research equipment to the Health Sciences Center for Computational Innovation
- 2013 – Acquisition of an Illumina MiSeq to enhance the Genomics Research Center
- 2013 – Acquisition of a Celigo Adherent Cell flow cytometer for the foundation of the Pathways Discovery Resource
- 2014 - Acquisition of a Q-Exactive Plus for the Mass Spectrometry Resource Laboratory
- 2014 - Official Establishment of the Pathways Discovery Resource, including a new Perkin Elmer Zephyr compact liquid handling workstation and genome-wide RNAi library
- 2014 – Acquisition of next-generation Linux cluster (“BlueHive”) for Center for Integrated Research Computing
- 2014 – Genomics Research Center acquired a ABI QuantStudio 12k FLEX real-time PCR instrument with funds from a Finger Lakes Regional grant proposal to replace an aging instrument and to provide high throughput digital PCR capabilities.
- 2014 – Completion of VISTA Collaboratory (visualization center) for Health Sciences Center for Computational Innovation
- 2014 – Genomics Research Center acquired a Sage Science Pippin DNA size fractionation system with funds from a Finger Lakes Regional grant proposal to enhance micro RNA research workflows.
- 2015 – Genomics Research Center awarded NIH S10 (PI: S. Gill) for purchase of a Fluidigm C1 Single-cell AutoPrep instrument.

- 2015 - Genomics Research Center purchased EpMotion 5075 liquid handling system to be dedicated for NGS library preparation.
- 2016 – Mass Spectrometry Resource awarded NIH S10 (PI: Ghaemmaghami) for the payout of the Lease on the Q-Exactive Plus.
- 2016 – NIH S10 grant (PI: Williams) for the acquisition of an XSTRAHL Small Animal Radiation Research Platform (SARRP) and the creation of the Model Imaging and Tomotherapy Facility, a new URMCL.
- 2016 - Acquisition of a second Illumina MiSeq to enhance the Genomics Research Center capacity
- 2016 – Genomics Research Center created a Genomics bioinformatics analysis group to provide analytical and research support for investigators using genomic approaches

Additionally, the UR Clinical Translational Research Institute (CTSI), the Center for AIDS Research (CFAR) and the Rochester Human Immunology Center have provided critical and incremental support to multiple research resources.

### Shared Resource Laboratories

The UR Medical Center has a number of successful core research facilities that provide services to all researchers at the Medical Center. These facilities are listed below.

- **Electron Microscopy.** The principal mission of the Electron Microscopy Resource Laboratory is to provide University of Rochester researchers support in high magnification (**700 to 600,000x** range) for ultrastructural analysis of cells and tissue in the fields of Transmission Electron Microscopy (TEM), Scanning Electron Microscopy (SEM) and combined Scanning/Transmission EM (STEM). Specialized instrumentation includes a Hitachi 7650 III Analytical Scanning/Transmission Electron Microscope (STEM) with a side mount Gatan Erlangshen 11 megapixel digital camera, an electron dispersive x-ray spectrometer (EDAX Instrument) for elemental analysis of nanoparticles and a Gatan Digiscan II undermount camera for STEM mode imaging (brightfield and darkfield with fine probe elemental analysis) (TEM occupies 470 sq.ft). Auxiliary equipment includes a new (2011) Boeckeler P-XL ultramicrotome, 2 Olympus double headed light microscopes, a 45 year old Bausch & Lomb stereo dissecting microscope, various centrifuges, a new 2013 acquired Tousimis 931 automated critical point dryer (for SEM specimens), Leica glass knife breaker and several diamond knives for 70nm thin sectioning of epoxy blocks (wet bench space occupies 670 sq.ft). For SEM imaging, the EM Core utilizes a 2008 Zeiss Auriga field emission SEM/STEM housed in the Hajim Engineering School on the University's non-medical River Campus. Director: Karen Bentley, M.S.
- **Flow Cytometry.** The mission of URMCL Flow Cytometry Resource Laboratory is to provide investigators with state-of-the-art instrumentation along with the technical expertise to support all that is possible now, while pushing the limits of what can be done with flow cytometry. The Core currently has traditional analytical tools including two Accuri C6's (4-colors) and 5 LSR-II's (one 8 color, one 12-color and three 18-color instruments) from BD Biosciences. We also have a BD 17-color FACSAria-II and an 18-color FACSAria-II for all cell sorting projects. In addition we have several non traditional analytical cytometers. The Amnis ImageStream GenX allows for imaging flow cytometry and the detection of up to 10 fluorescent parameters with cellular localization information. The CyTOF Mass Cytometer, which came online late 2012, uses lanthanide metal mass spectrometry as opposed to traditional fluorescent tags, allowing the analysis of upwards of thirty parameters to be studied simultaneously. The resource also added the Nanosight NS3000 in 2015 for the detection of nano sized particles. The Nanosight is capable of measuring the size distribution and concentration of particles as small as 10 nanometers by using light scatter and Brownian motion. Instrumentation is only part of what we offer. We also offer comprehensive training for staff, consultation for maximizing the effectiveness and cost of your experiments, as well as an environment that fosters success in both existing methods and crossing the boundaries into new frontiers. Director: Timothy Bushnell, Ph.D.; Technical Director: Matthew Cochran, M.S.
- **Mouse Genome Editing Resource.** The Mouse Genome Editing Resource Facility provides expertise and assistance in the production of transgenic mouse models by either DNA microinjection, CRISPR, or

gene targeting in embryonic stem (ES) cells. For gene targeting and transgenic projects, The Facility assists in all phases of the project, including design and construction of DNA constructs, homologous recombination in ES cells, microinjection of DNA/RNA and Cas9 into oocytes and of ES cells into mouse blastocysts in order to generate founder mice, breeding founder mice to germline transmission, and PCR and Southern genotyping. Other services include mouse embryo and sperm cryopreservation, re-derivation of mice to obtain Specific Pathogen Free (SPF) status, generation of congenic mice (backcrossing), colony management, and providing mice of common strains (C57BL/6, ICR, Cre, and FLP; regular and pregnant females or litters). The laboratory consists of a barrier facility for procedures involving production and maintenance of genetically modified mouse strains, a tissue culture facility for ES cells, and a molecular laboratory for generating gene-targeting constructs and genotyping experiments. Director: Lin Gan, Ph.D.

- **Genomics Research Center.** The UR Genomics Research Center (URGRC) located at the James P. Wilmot Cancer Center provides core laboratory support, technical advice, assistance with experimental design and data analysis for investigators using high-throughput genomic sequencing, genotyping and gene expression in their research programs. The URGRC currently provides support for RNA-Seq, ChIP-Seq, Exome/Genome sequencing, Single-cell genomics applications, qRT-PCR, Affymetrix microarrays, processing of RNA/DNA, as well as custom applications and approaches. In addition, URGRC staff lead collaborative projects with URMIC investigators to develop new methodologies and incorporate emerging genomic technologies into the URGRC workflow. The URGRC has a faculty-level director, a faculty-level Associate Director, a Lab Manager, 1 Senior Technical Associate, 2 Technical Associates, 2 technicians and four Bioinformaticians/data analysts. Dedicated computational support for hardware, data analysis and storage of high-throughput sequence data is provided by the Center for Integrated Research Computing (CIRC). The following major equipment is located in the GRC: one Illumina HiSeq2500 high-throughput DNA sequencer, two Illumina MiSeq DNA sequencers, one Fluidigm C1 Single-Cell AutoPrep System, one QuantStudio 12K FLEX real-time PCR instrument with autoloader, microfluidic card module, and open array module for digital PCR, one Sage Science PippinPrep size fractionation system, two ABI 9700 PCR machines, three BioRad DNA Engine PCR machines, one BioRad QX100 digital droplet PCR system, one EpMotion 5070 liquid handling robot, one EpMotion 5075 liquid handling system dedicated for NGS library preparation, two Agilent 2100 Bioanalyzers, one Agilent TapeStation, one BioRad gel documentation system, one Qubit Fluorometer, and multiple NanoDrop ND-1000 spectrophotometers. Director: Steven Gill, Ph.D. Associate Director: John M. Ashton, Ph.D.
- **Light Microscopy Shared Resource:** This resource provides UR researchers the ability to obtain high quality imaging data using state-of-the-art microscopy instruments. It also serves as one of the information hubs for UR resources centering around histological processing, imaging, and image processing and as a conduit for communication between imaging researchers on campus. Substantial one-on-one guidance is provided for obtaining and assessing high quality, quantifiable image-based data for each instrument. Collaborative guidance is given for experimental design and approach for multiple light microscopy applications. The core develops imaging plans to initiate imaging studies on all of the Light Microscopy instruments. Staff also is continuously available for updating and discussing results in real time. Specialized instrumentation includes:  
Confocal: an Olympus FV-1000 Laser Scanning Confocal Microscope is available which is configured with 4 lasers spanning the blue to far red spectrum and multiple high resolution objectives. Experimental capabilities include: 3-dimensional (z-stack), and 4-dimensional (z-stack with timelapse or multi-point timelapse) data acquisition, multiple FRET applications (sensitized emission, acceptor photobleaching, spectral FRET), and high resolution tiling. Additional capabilities are provided by a SIM scanner which provides capability for synchronized continuous imaging during photo-manipulation experiments such as FRAP and optogenetic experiments such as photoactivation and photoswitching.  
Laser Capture Microdissection: A Palmbeam (Zeiss) laser capture microdissection instrument equipped with multiple long working distance objectives and both brightfield and immunofluorescence capabilities is available. Substantial one-on-one guidance for captures as well as advice for processing both upstream and downstream of the capture process is provided.

Conventional: An Olympus Vanox AH brightfield/fluorescence conventional microscope; and a large specimen brightfield-imaging instrument are available. Additionally, a brightfield-based teaching microscope and a large format dissecting microscope are also available for reference.

Image Analysis Capabilities: The LM Shared Resource Image analysis software capabilities currently include: FV1000 post-processing analysis software, StereoInvestigator (MicroBrightfield, StereoInvestigator software) for stereological image analyses and Image Pro Plus for morphometric analyses. Additionally, the LM Shared Resource works with CIRC (Center for Integrated Resource Computing) to enable image analysis of large files on the UR SuperComputer. Currently, FIJI/ImageJ2 and Amira are accessible for use on the SuperComputer. Contact: Tim Bushnell, Ph.D.

- **Mass Spectrometry Resource Laboratory.** The Mass Spectrometry Resource Laboratory (MSRL) provides instrumentation and technical expertise to UR researchers seeking to conduct MS-based protein or small molecule assays. Technicians within the MSRL provide assistance with project design and planning, proper sample preparation (sample clean-up, protein concentration, western blotting, 1D and 2D gel electrophoresis, affinity-based enrichment, liquid chromatographic separations and proteolytic digestion) and interpretation of mass spectrometric data. Common analyses include the identification of unknown proteins, characterization of protein complexes, mapping of post-translational modifications (PTMs) and relative quantification of peptides and small molecules from a range of sample types, including complex clinical matrices, tissue extracts and cell lysates. Specialized MS instrumentation operated and maintained by the core include a Thermo Q Exactive Plus Hybrid Quadrupole-Orbitrap and a TSQ Quantum Access Max Triple Quadrupole. In addition, the laboratory has access to a variety of automated database searching software (Mascot, SEQUEST) as well as resources to facilitate discovery-based proteomics projects. MSRL technicians also have the ability to carry out *de novo* peptide sequencing for discovery-based proteomics projects. Director: Sina Ghaemmaghami, Ph.D.
- **Model Imaging and Tomotherapy Facility:** The new Model Imaging and Tomotherapy Facility offers researchers at the University of Rochester access to a Small Animal Radiation Research Platform (SARRP, Xstrahl) which allows delivery of radiation therapy protocols to animal models of human tumors through a means that is directly comparable to those used in current clinical practice. To this end, the SARRP is capable of delivering beams that make use of collimators varying from 0.5 mm to 10 cm, with an accuracy of 0.25 mm. Since this platform allows the generation of beams that can be rotated in directions ranging from vertical to 30° below horizontal, with 4-dimensional control over positioning of the model, recognized through the use of a laser-based positioning system, it provides flexibility for use in multiple applications and for diverse needs. The SARRP includes on-board cone-beam computed tomographic imaging, which is amalgamated with treatment planning and image fusion software. This component can be used independently as a small animal imaging device or, in conjunction with the dedicated dose planning system, can be used to generate individual conformal radiotherapy plans for preclinical studies or image fusion with other imaging data sets, including MR (any orientation) PET, etc. This technology is currently being developed to provide clinically-relevant protocols to a range of tumor models (brain, lung, pancreatic, bone), as well as investigate the development and prevention of post-therapeutic effects in normal tissues that affect cancer survivors, e.g. the bladder (cystitis), lung (pneumonitis and fibrosis), salivary glands (xerostomia), brain (necrosis; cognitive dysfunction), and post-therapy bone disease. Director: Jackie Williams, Ph.D.
- **Multiphoton Imaging Resource:** Specialized instrumentation for multiphoton microscopy includes an Olympus Fluoview 1000 AOM-MPM imaging system and a Spectra-Physics MaiTai HP DeepSee Ti:Sa laser system with dispersion compensation. The multiphoton microscope is capable of imaging thick fixed tissue (up to 500 um, up to 1 mm in cleared samples), multi-layer *in vitro* samples, and intravital preparations. The multiphoton resource is uniquely suited for intravital imaging and systems physiology in small animals, e.g., mice and rats. Small animal surgeries are routinely performed at two completely equipped surgical areas in direct proximity to the multiphoton microscope. Physiological measurements, such as arterial blood pressure, EKG, body-temperature, laser doppler, tissue oxygen, electrophysiology, pulse-oximetry, blood-gases, and blood-glucose can be started during surgery and

continued during the intravital imaging session. Significant upgrades to the multiphoton were recently added to the microscope to enable 4-channel imaging. A new blood gas analyzer and a new objective heater were also recently purchased. Substantial one-on-one guidance is provided for obtaining and assessing high quality, quantifiable multiphoton data. Contact: Timothy Bushnell, Ph.D.

- **Pathway Discovery Resource.** The Pathway Discovery Resource (PDR) is a high throughput screening facility providing cost effective screening methodologies for cell based assays. Currently, the PDR offers cell based screening with the Silencer® Select Human Druggable Genome siRNA Library V4 and three chemical compound libraries (Spectrum, Chembridge, and Prestwick). The following major equipment is located in the PDR: one Celigo S Cell cytometer, one Perkin Elmer Zephyr compact liquid handling workstation, ThermoFisher MultiDrop, one Envision High Throughput Plate Reader equipped with optics for Fluorescence, Luminescence, Fluorescence Polarization (FP), Time Resolved Fluorescence (TRF), Absorbance, Alpha Screen, and FRET based detection in 96 or 384 well formats, one Janus dual-arm robotic liquid handling system, and one Flexdrop plate filler. The PDR is Co-directed by two Faculty-level Instructors experienced in high throughput cell and molecular biology techniques. In addition, the PDR is operated by a full time Technical Associate with significant experience in high throughput technologies. The PDR integrates with various other shared resource facilities at University of Rochester including; genomics, flow cytometry, and proteomics. Co-Directors: Wojciech Wojciechowski, Ph.D. and John M. Ashton, Ph.D.

### Other Research Resources

- **Biosafety Level 3 (BSL-3) Facility.** The Biosafety level three facility (BSL-3) is available for the use of any researcher at the university whose work requires manipulation of biological agents which may cause serious or potentially lethal disease as a result of exposure by the inhalation route (such as TB). The BSL-3 Core laboratory is a fully self-contained facility and includes 4 biosafety cabinets, several incubators as well as -80 freezers and a liquid nitrogen storage tank. Additional equipment includes a tabletop centrifuge with high and low speed rotors, an inverted microscope (Olympus CK40), a sonifier, visible light spectrophotometer, electroporator, and cell lysis equipment. Director: Martin Pavelka, Ph.D.
- **Cold Storage Core (CSC).** The CSC provides a discrete area where investigators can keep freezers for long-term storage of research materials. The entire facility is alarmed and power protected. There are also spare freezers (4°C, -20°C, -80°C, and -140 °C) available to all URMCI investigators in case of emergencies. Director: Christopher Lane.
- **Center for Integrated Research Computing (CIRC):** The UR established the Center for Integrated Research Computing (CIRC) to provide researchers across the University with technology, software, training, and support necessary to utilize high-performance computing (HPC) and big data technology fully in research activities in all areas of academic scholarship. CIRC presently supports faculty-led research projects from over 40 departments and centers across the Medical Center and River Campus. CIRC offers University researchers state of the art computing technology and software, and currently maintains about 420 teraFLOPS of high performance computing systems, including an IBM Blue Gene/Q system (see HSCCI, below). CIRC has over 2 petabytes of storage for data-intensive applications, and a variety of scientific software applications and tools.

CIRC's Linux cluster ("BlueHive") provides approximately 210 TFLOPS of computing capacity. This system consists of 284 nodes with a high-speed, low-latency, InfiniBand interconnect. The BlueHive Cluster houses 2 x 12-core Intel Ivy Bridge processors (for a total of 24 cores per node), and ranges in memory from 64 GB to 512 GB. A number the 64 GB nodes have two dedicated coprocessing cards, including NVIDIA's K20X (Kepler) GPUs and Intel Phi 5110P accelerators. The entire cluster is equipped with water-cooled rear-door heat exchangers to leverage additional power and cooling savings, provided by the Blue Gene/Q. The entire BlueHive cluster has an InfiniBand-attached storage system providing almost 2 PB of configurable raw disk within a GPFS file system. 108 nodes with varying capacity have been integrated into the BlueHive cluster for faculty investigators who have purchased additional priority-based compute capacity for the environment. CIRC runs the SLURM

resource scheduler and queuing system to optimize usage and to support multiple users of the BlueHive Linux cluster environment. Additionally, users have access to an NX-based technology to connect to BlueHive using a resumable GUI interface.

The Center's efforts in collaboration, consultation, expertise, and community building are essential for facilitating the research mission of the UR. CIRC provides resources to faculty, staff, and students to ensure access to technology and knowledge necessary for effective computational research. These resources include technology (computer systems, software, storage, etc.), 8 full-time staff members (director, assistant director, 3 computational scientists, 3 system administrators), 3 part-time student research assistants, information sharing and collaboration tools, and an education and training program. Every summer, CIRC provides a six-week long program in training for computational and data science. Known as the "CIRC Summer School" this program is open to all University of Rochester faculty and students and provides hands-on, workshop-style training on a number of techniques and programming languages useful for developing tools and exploring research data. Past modules of the summer school include: Using Linux, Programming Python, Using Databases, Parallel Programming with MPI and OpenMP, Code Acceleration with NVIDIA CUDA and Intel Phi, Using MATLAB, and Data Analysis with STATA, SAS, and R. This program has recently expanded to include an offering in the winter months. Known as the "CIRC Winter Boot Camp," classes focused on programming and tools for data analysis are open to students, faculty, and staff at the University of Rochester. *Director: Brendan Mort*

- **Health Sciences Center for Computational Innovation (HSCCI).** The UR recognized a growing need to improve support for Data Sciences related to biomedical research and has built state of the art infrastructure in response. Beginning in 2008 the UR created the HSCCI, a world-class center for the advancement of health-related research supported by high-performance computational (HPC) resources. The mission of the HSCCI is to facilitate collaboration among research faculty, computational biologists, programmers, and software developers to advance biomedical research. The Center will provide pilot funding for both research staff and HPC computational resources. The HSCCI is supported through a mix of corporate partnerships, direct institutional support, federal research grants, and state programs. The heart of the HSCCI is IBM's next-generation BlueGene/Q supercomputer, one of the first of its kind deployed in an academic setting in North America. The UR's current BlueGene/Q is a 209 teraflop system, providing 1024 compute nodes, each having 16 cores for 16,384 processing cores total, and is housed in University's new state-of-the-art, high-reliability, newly completed UR **Research Data Center (RDC)** and managed by the CIRC (see CIRC listing above). HSCCI research domains include projects concentrated in the following areas:
  - Modeling Complex Biological Systems and Integration of Big Data: Vertical integration of multiple high-dimensional data sets from different levels of a complex biological system-incorporates genomics, microbiomics, proteomics, and organ-level data.
  - Biomedical Imaging: Improved computational methods for analyzing images collected by a variety of technologies including MRI, ultrasound, and multiphoton microscopy. Includes development of analytical tools and computational methods for four-dimensional (3D over time) data.
  - Molecular and Fluid Dynamics: Structural simulation and prediction of RNA, protein, and intermolecular interactions; fluid dynamics related to medical diagnostics and biological processes (eg. microfluidic devices and blood or air flow).
  - Biomedical Informatics: Personalized medicine, mining Electronic Medical Records, perform virtual clinical trials

The HSCCI recently completed the construction of a state-of-the-art data visualization research lab - Visualization-Innovation-Science-Technology-Application (VISTA) Collaboratory. The mission of the VISTA is to provide collaborative space to house technology, research, and education in the data visualization sciences. Our approach is to bring together expertise in computer science, software, vision research, brain and cognitive sciences, statistics, and mathematics to work with experts in imaging, medicine, and biology to use, develop, and teach visualization technologies for large complex data. The

VISTA houses an 8' x 20', 50 megapixel HD CineMassive display connected directly to the Blue Gene/Q and BlueHive supercomputers through a dedicated high speed, high bandwidth optical cable to the RDC. Executive Director: David J. Topham M.S., Ph.D.; Associate Director: Benjamin Miller, Ph.D.

- **Rochester Human Immunology Center Core.** The Rochester Human Immunology Center (RHIC) and its core laboratory were established to acquire, refine and develop expertise in cutting-edge techniques and to support applications in Human Immunology research. The RHIC serves to enhance multi-disciplinary research initiatives catalyzing key clinical and basic immunology research in vaccines, HIV/AIDS, autoimmunity, allergy/asthma, transplantation as well as cancer immunology. The Center's core lab provides assistance and expertise in immunological method development, standardization and validation through individual and group training programs as well as collaborative projects through its fee for service cost center. The RHIC has served over 50 individual research projects over the past twelve years, resulting in multiple new grant awards. The RHIC expertise covers techniques such as 18-color flow cytometry, 35 parameter CyTOF™ mass cytometry, multiplexed bead array assays (Luminex Xmap™), ELISPOT and EIA as well as regulatory expertise in GLP and GCP for support of clinical translational research. The RHIC Core Lab also provides specimen processing and management, analytical and sorting flow assays and panel development and Luminex and ELISA assays on a fee for service basis. Director: Sally Quataert, Ph.D.
- **Molecular Imaging Facility.** The Molecular Imaging Facility provides researchers at the UR with access to state of the art instruments capable of detecting and quantifying the levels and positions of radio- and fluorescently labeled molecules in a variety of formats including gels, blots and microtiter plates. Major instrumentation includes a Storm 820 Phosphorimager for phosphorimaging and a Typhoon 9410 (acquired in 2007). The Typhoon 9410 is housed within the Center for RNA Biology, and handles gel sandwiches, agarose and polyacrylamide gels, membranes, microplates, and microarrays, with the capacity for multiplexed detection of chemiluminescence, fluorescence and ionizing radiation. Director: Scott Butler, Ph.D.
- **RCBI (Rochester Center for Brain Imaging).** The Rochester Center for Brain Imaging (RCBI) provides researchers at the UR, as well as neighboring institutions, with access to a state-of-the-art 3T scanner for research using magnetic resonance imaging (MRI). The Center is able to provide structural images of any part of the human body, functional imaging of the brain, and spectroscopy of living tissues. The heart of the RCBI is a Siemens TIM Trio 3T whole-body human scanner, with maximum gradient amplitude of 40 mT/m and a slew rate 200T/m/s. A variety of RF coils are available for head, knee, and body imaging, including a 32-channel phased array head coil (capable of parallel imaging using SENSE/GRAPPA) for brain studies. Pulse sequences installed on the Trio system allow capability for many types of research applications, including high-resolution structural MRI (3D T1 and T2 weighted), functional MRI (BOLD fMRI), diffusion-weighted scans including diffusion tensor imaging (DTI - for imaging white matter tracts in the brain), blood vessel and perfusion imaging, and single- and multi-voxel spectroscopy. Custom RF coils are available through the staff of the RCBI, permitting high resolution imaging of small animals. An upgrade to the next generation Siemens PRISMA 3T scanner is planned for 2017. Director: Richard Aslin, Ph.D.
- **Animal Resource.** The Animal Resource is a centralized resource facility with staff and programs that support the research and educational uses of laboratory animals. These facilities are fully accredited by AAALAC, International and are in compliance with state law, federal statute and NIH policy. The Division of Comparative Medicine (DCM), formerly known as Division of Laboratory Animal Medicine (DLAM) consists of two board certified laboratory animal veterinarians, two additional laboratory animal veterinarians, & a staff of six trained and NYS licensed veterinary technicians. Support is provided for research with all major animal species. Services provided by DCM include colony health monitoring, quarantine services, animal acquisition from other research facilities, surgical support/anesthetic services, 24/7 on-call veterinary emergency services, clinical management of any cases of spontaneous or experimental disease, necropsy and histopathology services, training in specialized techniques (including inhalation anesthesia of all species, blood collection, aseptic surgical technique) and rodent breeding colony management for PIs. Core services provided by the Animal Resource include daily husbandry practices, daily observations for health problems, special request services

(special diets, water, fasting), provision of federally mandated enrichment to animals, and cage wash, autoclave and room sanitation services. Major equipment includes HEPA filtered ventilated cages & hoods for barrier maintenance of SPF mice, "gnotobiotic mouse flexible film isolator units, dedicated BSL2 mouse housing & procedural space", inhalation anesthesia machines for rodents and large animals, diagnostic "digital" X-ray machine, autoclave for surgery packs, Intensive Care Unit, CO2 euthanasia stations, MRI capabilities and a Gammacell 40 Exactor Low Dose-rate Research Irradiator for irradiation of small animals within the resource (used principally in support of bone marrow transfer studies in mice). The UR Medical Center has recently expanded large animal (sheep, pig, cattle) surgical services with long term post-operative housing available at an AAALAC accredited sister institution located 35 minutes from the university. Director: Jeffrey Wyatt, DVM

- **Small Animal Multispectral Imaging Core.** The Small Animal Multispectral Imaging Core offers state-of-the-art longitudinal multispectral (bioluminescence and fluorescence) imaging capabilities, to compliment and boost the extensive imaging resources available to University of Rochester Medical Center (URMC) researchers engaged in wide ranging areas of biomedical research with emphasis on clinical translation in alignment with the mission of the Clinical and Translational Sciences Institute (CTSI). The Core houses an IVIS® Spectrum system with unique capabilities for sensitively imaging both bioluminescent and fluorescent reporters within the same animal without mixing the multi-spectra. The system performs both epi- and trans-illumination fluorescent imaging and uses high efficiency narrow band-pass filters coupled with spectral unmixing algorithms to differentiate between multiple shallow and deep fluorescent sources. Director: Hani Awad, Ph.D.