**FACILITIES and OTHER RESOURCES**

Located in Columbia, Missouri, the University of Missouri (MU) is the flagship campus of the University of Missouri System. MU offers more than 300 degree programs among its 18 colleges and professional schools, and has a total enrollment of more than 33,000 students. MU is designated “Highest Research Activity” by the Carnegie Classification of Institutions of Higher Education, and is a member of the prestigious American Association of Universities (AAU). The University of Missouri (MU) is a public institution that is one of only six universities nationwide with schools of medicine, veterinary medicine, law, engineering, agriculture, and a university hospital all on the same campus, and MU is one of only 13 universities with both an accredited school of medicine and an accredited college of veterinary medicine. MU is one of only 15 institutions in the country recognized as Wallace H. Coulter Translational Partnership awardees.

**MU School of Medicine**

The MU School of Medicine was the first publicly supported medical school west of the Mississippi River. It was established as a two-year school in 1872 and became a four-year program in 1957. The School of Medicine is a pioneer in the problem-based learning style of medical education that emphasizes problem solving, self-directed learning, and early clinical experience. Today the school offers an outstanding program that emphasizes a thorough medical education founded on clinical experience and research. A faculty of 149 basic scientists and 479 clinicians oversee the education and professional development of 416 medical students, 462 residents and fellows in 22 specialty programs, and 386 PhD and master’s degree candidates as of academic year ’16-’17.

**MU Institute for Clinical and Translational Science**

MU-iCATS represents a partnership among 12 MU schools/colleges and the University Extension, including the School of Medicine, Sinclair School of Nursing, School of Health Professions, College of Veterinary Medicine, College of Arts and Science, College of Agriculture, Food, and Natural Resources, College of Engineering, College of Education, Trulaske College of Business, School of Journalism, School of Law, and College of Human Environmental Science. Key leadership for MU-iCATS comes from the School of Medicine. The institute is the focal point of MU's efforts to develop clinical and translational science programs that improve health through better research, education and public service. In 2015 a formal partnership was established with the Washington University Institute of Clinical and Translational Sciences. This allows participation of MU faculty in pilot funding programs and the KL2 career development program at Washington University.

**Tiger Institute for Health Innovation**

The Tiger Institute, owned by the University of Missouri, is an intensive collaboration between MU and Cerner Corporation housed in Columbia Missouri. The Tiger Institute’s main goal is rapid cycle improvement of clinical information systems. Expanding beyond the care delivery strategy, the Tiger Institute spearheads new research and innovation to push the boundaries in health care delivery. Software engineers collaborate directly with clinicians, researchers and students to develop new solutions, with projects ranging from functionality enhancements within the MU Health Care System to first-of-a-kind innovations that are globally commercialized. Collaborative research utilizing large clinical and administrative data bases, including the MUHC enterprise data warehouse and Cerner’s multi-hospital Health Facts database, is a priority of the Tiger Institute. The Tiger Institute is responsible for maintaining MUHC’s electronic health records, registration, scheduling, claims and payment information systems. Included in these responsibilities is building and maintaining MUHC’s enterprise data warehouse. Two engineers at the Tiger Institute are dedicated to building research infrastructure for the School of Medicine and assisting with data projects.

In addition to the core patient care delivery sites, including inpatient beds and outpatient exam rooms, the CRC provides investigators with conference space, research work areas, and on-site computing and informatics resources. The facility also includes general research laboratory (with a bio-hood), investigational pharmacy, and dedicated clinical trial nurse space. In conjunction with the Department of Nutrition and Exercise Physiology, the CRC provides dedicated space for exercise and nutrition studies through state of the art exercise facility and metabolic kitchen. The exercise facility in the CRC contains 2 Startrac treadmills for training in addition to 1 Quinton-TM55 treadmill for exercise testing. In addition, the facility has a Quinton Q Stress EKG system for measurement of cardiac function and a Parvo True One 2400 metabolic cart (Parvo, Inc, Sandy, UT) for measurement of maximal oxygen consumption during graded exercise testing.

**Clinical Research Center**

The CRC is designed to facilitate programmatic growth in line with the MU-iCATS mission of stimulating interdisciplinary science with improved infrastructure for clinical research programs. The centralized approach of the CRC promotes the efficient use of personnel and resources, as well as the safety and satisfaction of the human subjects who choose to participate in clinical research studies. Located on the 5th floor of the Medical Sciences Building adjacent to the University Hospital, offices nearby house support functions including bioinformatics core, technology transfer core, administrative suite, grants and contracts support offices, and research participant advocate. The CRC is 5,225 sq. ft. and includes an out-patient facility and a 6-bed, inpatient unit. Dr. Elizabeth Parks is Associate Director of the CRC. The CRC is open 24/7 and staffed with 6 nurses and other clinical trial management staff. CRC physical resources include a 255 sq. ft. dedicated metabolic kitchen within the unit which is fully equipped with industrial quality equipment (freezers, refrigerators, stove, scales and the food preservation system) designed for making research meals for a single day or to feed research subjects over weeks. The CRC also houses a 400 sq. ft. core biochemistry laboratory, located adjacent to the in-patient CRC, and a 288 sq. ft. exercise and physical assessment room. A secure compounding pharmacy (128 sq. ft.) supports the preparation of stable isotope infusions for metabolic studies and insulin clamps.

Primary equipment include 3 treadmills in the exercise room, a metabolic cart for measurement of energy expenditure, a DEXA for measurement of body composition (2014 Hologic SN100158, Horizion A which can accommodate patients up to 350 lbs), two YSI glucose analyzers, stadiometers and other equipment for accurate assessment of subject anthropometrics. A Doppler ultrasound (Logic P5 GE Medical Systems) and a blood pressure cuff-based SphygmoCor XCEL system are available for vascular measurements and dedicated for research purposes only.

MU Clinical Research Center

Inpatient room Dedicated metabolic kitchen Exercise testing



Bionutrition Support for designing research diets is also available through the Department of Nutrition and Exercise Physiology where Drs. Parks and Padilla are on faculty. The Nutrition Center for Health (see below) is a larger facility located two blocks north of the CRC which is designed to support longer-term feeding protocols like the one used in the present application.

The CRC Statistical Core provides support for study protocol design and statistical analysis.

**The MU Nutrition Center for Health and Research Kitchen** The Department of Nutrition & Exercise Physiology has a new state-of-the-art, 3000 sq. ft. nutrition facility, Missouri University Nutrition Center for Health (MUNCH), which includes a metabolic research kitchen, an eat-in dining area, and an observational food choice behavior lab located in Gwynn Hall, two blocks from the Hospital inpatient clinical research center. The fully-equipped metabolic kitchen contains several professional-grade ranges, microwave ovens, a dishwater, refrigerator/freezer, ice machine, metabolic food scales, walk-in pantry, and walk-in cold room and freezer. In addition, the kitchen has adequate preparation space, supplies, and storage capacity to prepare in-house and packed-out meals for over 50 study participants.

The adjacent dining area provides a capacity to serve meals for up to 20 people at one time. MUNCH also provides a full time, certified food service manager and chef and additional staffing assistance including a research dietitian, and student research assistants. The kitchen has drive-up access so that research subjects who chose to pick up their food can pull up close to the building and have the food packed directly into their car for transport home.

MU Nutrition Center for Health



**The MU Investigational Pharmacy** is located in the MU Hospital, adjacent to the Clinical Resource Center. Sonja Grinfeld, PharmD, Investigational Drug Service Pharmacist, is in charge of protocols. The facility supports over 100 studies per year, Phase I to Phase IV, and is well-integrated with the MU IRB and Research Subjects Compliance systems. The pharmacy handles compounds including FDA-approved drugs, insulin used for hyperglycemic clamps and non-drug compounds such as stable isotopes administered in tracer quantities.

**The National Center for Gender Physiology (NCGP)**,directed byVirginia Huxley, PhD, spans across nearly all of MU's colleges and schools including the School of Medicine, the College of Veterinary Medicine, the School of Health Professions, the School of Nursing, the College of Agriculture, College of Arts and Science and the Dalton Cardiovascular Research Center. The mission of the NCGP is to improve the understanding of both the similarities and differences in male and female physiological responses, as well as to continue serving as a catalyst for the development of multidisciplinary, integrated collaborations in basic and clinical research in the arena of gender based biology and medicine. The present application is a reflection of the continuous interactions among MU faculty with an interest in gender physiology.

**University of Missouri Health Care (MUHC)**University of Missouri Health Care (MUHC) is a multi-hospital system owned by the University of Missouri System comprised of five hospitals: University Hospital, Missouri Orthopaedic Institute, Missouri Psychiatric Center, Missouri Rehabilitation Center, and Women’s and Children’s Hospital. It also has over 50 specialty clinics. University Hospital, the flagship hospital of the University of Missouri Health Sciences Center, is a 307-bed tertiary care center that provides a full range of medical services. With ten University-owned primary care practices in Boone County, and additional practices in surrounding counties, MUHC also provides a substantial percentage of the primary care in central Missouri. Moreover, the three primary care departments (Family and Community Medicine, Internal Medicine, and Child Health) have all committed to transforming their practices into patient-centered medical homes. University of Missouri Health (MU Health) is one of the most comprehensive health care networks in Missouri. It includes: University Hospital; 50 primary and specialty clinics statewide; University Physicians, a group practice with over 600 members; Women’s and Children’s Hospital; Ellis Fischel Cancer Center; Missouri Psychiatric Center; Missouri Orthopaedic Institute; Mizzou Quick Care clinics in the three Columbia Hy-Vee grocery stores; and the Missouri Telehealth Network, which serves more than 60 Missouri counties and allows patients to stay in their own communities while being seen by a physician at a major medical center. In fiscal year 2016, physicians and staff served over 195,000 patients, cared for more than 25,000 hospital admissions, performed 614,113 clinic visits, performed 23,431 surgeries, and delivered 1,837 babies. MU Health Care also participates in two multi-system networks with a goal of advancing quality care. The Health Network of Missouri also includes 5 smaller, predominantly rural hospitals or health systems: Lake Regional Health System in Osage Beach, Bothwell Regional Health Center in Sedalia, Hannibal Regional Healthcare System, Capital Region Medical Center in Jefferson City, and Saint Francis Healthcare System in Cape Girardeau. MPact Health is a network spanning four states, including MU Health Care, Mosaic Life Care, and the Mercy System.

**University Physicians**

University Physicians is the largest physician medical group in Mid-Missouri. The group includes more than 600 physicians who are trained in more than 80 specialties and sub-specialties. Providing care at all of the MU Health Care Hospitals and Clinics, a great majority of the physicians also serve as faculty members of MU School of Medicine.

**Ellis Fischel Cancer Center (EFCC)**

The EFCC was founded in 1940 as the first hospital dedicated to cancer treatment and research west of the Mississippi River. Today, more than 130 Phase II and III oncology group trials, 30 pharmaceutical studies, and 12 in-house trials are coordinated through the EFCC Clinical Trials Office (CTO). An extensive tumor registry program is supported at EFCC. This registry is the oldest such registry west of the Mississippi, with a reference date of January 1, 1966. The registry accessions approximately 1,500 cases annually and the entire database includes 29,000 cases. This registry is based on Oncology, the national standard registry computerized database and contains complete abstracts for cases accessioned from 1991 forward. There are approximately 17,990 patients in the analytic database; 5,800 of whom remain in active follow-up. The rapidity and ease of access to the registry is critical for timely research (for example when interviews are required), and lifetime follow-up ensures complete information on treatment outcomes and disease progression. The EFCC tumor registry works closely with the Missouri Central Tumor Registry to coordinate cancer registries with 17 Midwestern states.

**Cerner HealthFacts**

Cerner Health Facts is a HIPAA-compliant database collected from participating clinical facilities. Since 2000, it has captured and stored de-identified, longitudinal electronic health record (EHR) patient data. HealthFacts then aggregates and organizes it into consumable data sets to facilitate analysis and reporting. The data are generated from Cerner and non-Cerner participating contributing facilities. Health Facts collects clinical records with time-stamped and sequenced information on pharmacy, laboratory, admission and billing data from all patient care locations. The database is designed to track a drug's or device's usage across diagnoses and major procedures, as well as by geographic region and hospital type. Additionally, a researcher can determine practice patterns, treatments, and outcomes.

Cerner Health Facts focuses on providing information on five health outcomes: clinical, economic, process, functional, and satisfaction. Specifically, the database includes data on patient demographics, encounters, diagnoses, prescriptions, procedures, laboratory test, locations of services/patients (e.g., clinic, ED, ICU, etc.) and hospital information, and billing.

**LIGHT2 data warehouse**

LIGHT2 was an Innovation award from the Centers for Medicare and Medicaid Services. This three-year $13.2 million project, awarded in June 2012, developed enhanced primary care for Medicare and Medicaid beneficiaries receiving primary care within the University of Missouri Health System, many of them chronically ill. The program employed advanced health information technology, evidence-based treatment planning, and a specialized workforce to coordinate care for both patients and the existing health care team. The LIGHT2 Health Information Analytics team designed a data warehouse of Medicare and Medicaid claims, hospital and clinic visits, diagnoses, prescriptions, and basic demographic data on LIGHT2 enrollees. This data warehouse became the source for required reporting to the Centers for Medicare and Medicaid Services and external auditors, as well as internal ad-hoc and quality-improvement analyses, and a LIGHT2 performance scorecard for internal use. This data warehouse and its performance scorecard have been adopted system-wide by the University of Missouri Hospitals and Clinics This data warehouse and its performance scorecard have been adopted system-wide by the University of Missouri Hospitals and Clinics. Data from the warehouse also include extensive information on care coordination and can link with geographic information. The data are available for research studies.

**The Center for Health Care Quality**

The mission of the Center for Health Care Quality (CHCQ) is to improve patient care quality, safety and value by building quality and performance improvement (QI/PI) capacity within the School of Medicine (SOM) and University of Missouri Healthcare (MUHC) through its education, consultation and technical and research activities. Since 2005 over 1,000 MU Health Care Professionals (many of whom subsequently assumed leadership positions), and future health care professionals being educated within MU’s health sciences schools have participated in CHCQ’s educational programs. These programs include both synchronous and asynchronous (on-demand) learning platforms, emphasizing an action-based learning approach in which the use of basic and advanced QI/PI methods and tools are applied to specific MU Health Care’s QI/PI initiatives. The CHCQ sponsors the Performance Improvement Leadership Development Program (PI-LDP), which is an action-based QI/PI program that develops participants through didactic sessions and participation on chartered interdisciplinary teams (e.g., direct care providers, support and administrative services personnel) that address significant improvement opportunities identified by MU Health Care’s senior leaders. Over a 7-9 month period, training includes a series of educational sessions covering specific QI/PI methods and tools (e.g., PDSA, Lean-6 Sigma, Implementation, Project Management). Between sessions, teams apply this content to their specific project and report back results at subsequent sessions. This facilitates learning about improvement and implementation theory and methods, and reinforces the role context plays in influencing outcomes. Through this process, teams conduct in-depth analyses, develop, prioritize, and test hypothesized interventions, and develop (sometimes implementing) plans to spread successful interventions throughout MU Health Care.

CHCQ’s Consultation and Technical Assistance are provided to both clinical and non-clinical QI/PI initiatives ranging from short term limited scope projects to longer term system-wide projects. CHCQ provides both general QI/PI consultation and technical assistance as well as QI/PI specific clinical and non-clinical analytic services. CHCQ’s research directly contributes to the national body of QI/PI research with an emphasis on innovations in QI/PI education and training, and use of electronically captured patient care related data to improve patient care processes and outcomes. The synergy created between CHCQ’s extensive QI/PI education and training, and its consultation and technical assistance services provide a vital laboratory for testing new improvement methods and tools, faculty and staff development, and research opportunities.

**The MU Center for Patient-Centered Outcomes Research**

The MU Center for Patient-Centered Outcomes Research (MU PCOR), directed by mPI Mehr, conducts research and serves as a resource to build capacity for PCOR at MU. Funded through the Agency for Healthcare Research and Quality (AHRQ) with significant additional institutional support, MU PCOR is a multidisciplinary center bringing stakeholders together to focus on improving patient outcomes. Active partners include faculty in the Schools of Nursing, Health Professions, Journalism, Social Work, and Medicine. MU PCOR supports stakeholder involvement in research and trains investigators in the process of engaging patients not only as participants but also as advisers in research. There is an active Patient Advisory Board, and all investigators funded by the Center are required to bring projects to the Board. Board members also serve as patient co-investigators and as representatives to the Greater Plains Collaborative (a PCORnet CDRN) patient group. AHRQ funding supports three major projects: (1) endovascular vs. open surgery for limb ischemia; (2) improving skilled nursing facility discharges to home to reduce re-hospitalization; and (3) improved care for chronic pain and opioid prescribing in primary care. The Center also provides funding for Small Project Awards designed to encourage PCOR and Comparative Effectiveness Research (CER) pilot projects that will lead investigators to major PCOR/CER funding initiatives. The Center provides mentoring for investigators developing applications, sponsors bi-weekly seminars, and has provided a post-doctoral fellowship position. The chronic pain project is in collaboration with the American Academy of Family Physicians National Research Network and was specifically designed with the goal of building that relationship.

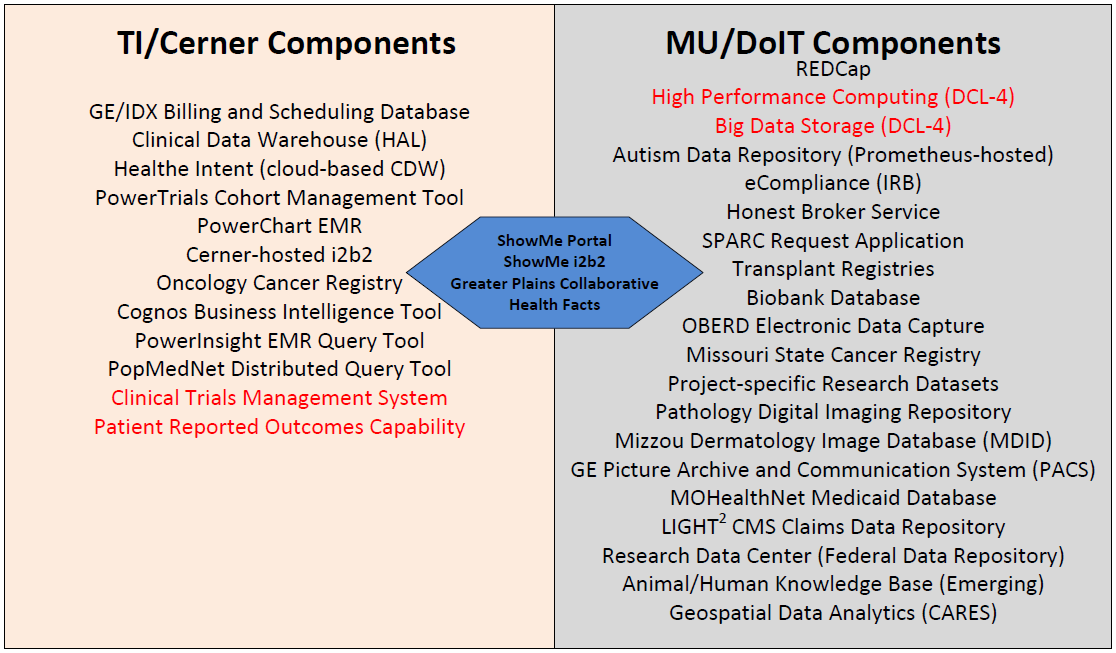
**Cyber infrastructure and Data Sources:**Over the past five years, the MU SOM has invested heavily in biomedical informatics manpower and resources to support academic biomedical informatics training and research. SOM has funded the technical expertise to operate informatics core resources, including faculty hires in the areas of research informatics, translational bioinformatics, and clinical informatics. With this expertise, the SOM has built a robust informatics environment including access to REDCap and i2b2, and has developed extensive training programs to help faculty use these emerging informatics resources and capabilities. MU Health Care also has entered into a contractual agreement with the Cerner Corporation to create the Tiger Institute for Health Innovation; this relationship makes extensive electronic data resources available to both clinicians and investigators. Tiger Institute hosts the PowerChart EMR, a clinical data warehouse, the COGNOS analytics environment, and the PowerInsight EMR query tool. Tiger Institute also hosts a local i2b2 instance that allows wide flexibility in terms of data integration. With this informatics infrastructure, MU has been able to participate in numerous research projects and collaborations; these include a CMS Health Care Innovation Award entitled, “Leveraging Information Technology to Guide Hi-Tech, Hi-To uch Care” and a PCORI-funded Clinical Data Research Network (CDRN) that includes 12 “flagship” Midwestern universities. Through the CDRN, MU will participate in the first national PCORI clinical trial entitled, “Aspirin Dosing: A Patient-centered Trial to Assess Benefits and Long-term Effects (ADAPTABLE).” The Tiger Institute for Health Innovation is also a valuable partner in large-scale health IT and informatics projects with private industry. Key players in SOM’s informatics infrastructure development and research activities include MUII core faculty and PhD graduates.

Figure 1 An overview of data and cyber infrastructure that are available for the T15 training program.

**SOM Departments**

**Curtis W. and Ann H. Long Department of Family and Community Medicine**

Established in 1975, the Department of Family and Community Medicine (FCM), home department of mPI Mehr, supports balanced missions of education, scholarship/research, and clinical care. For more than four decades, the department’s mission has focused on enhancing health and primary care for our communities, emphasizing rural and underserved areas. *US News and World Report* consistently has ranked MU among the top ten family medicine departments nationally during the past 24 years. The department has 75 faculty, including full- and part-time family physicians and full- and part-time masters and doctoral level faculty from several disciplines. Twenty-six of its physician faculty members have completed fellowship programs. FCM department staff also includes nurse practitioners, physician assistants, a research analyst and a medical librarian. Quality Improvement activities are prominent in the department led by clinical leaders and a dedicated senior staff person dedicated to quality improvement activities.

Patient Care. In fiscal year 2016, Family Medicine physicians managed 130,000 outpatient visits in eight practices at five locations – three in Columbia and three in small communities 15-25 miles outside of Columbia (Ashland, Fulton, and Fayette), plus an Urgent Care clinic and three Quick Care clinics in area grocery stores. Two other community practices, one in Columbia and one in Fulton have also recently become part of the department. In addition, Family Medicine faculty and residents help staff the Family Health Center (FHC), an FQHC caring for the medically underserved in mid-Missouri.

Education. The department has a strong interest and highly visible presence in all four years of the School of Medicine curriculum. FCM faculty members teach problem-based learning and introduction to patient care curricula for first- and second- year students. There is a required eight-week Family Medicine clerkship for third year students. In addition, FCM provides electives for fourth year medical students. The department has 36 residents participating in the three-year program. Since 1975, the FCM Residency program has trained 440 physicians now in 39 states and several countries. Of its alums, 16 percent work in rural areas, 17 percent provide care for the underserved, and 13 percent have pursued careers in academic medicine. The department has led a two-year Academic Family Medicine Fellowship since 1979 graduating more than 75 fellows. Fellows earn a Master of Science degree as part of the two-year curriculum designed to develop academic skills. FCM now offers a unique online MS degree in academic medicine with teaching/administration and research tracks. The department also has ACGME accredited fellowship programs in geriatric medicine and hospice and palliative care medicine.

Research. Research and scholarly activities are major Department of FCM priorities. Research efforts, which are focused on preventing and managing chronic diseases, have resulted in 1,372 publications in scientific journals since 1996. Recent research topics include community based smoking cessation, health status of sexual and gender minority populations, environmental risk factors for cancer, health services research in geriatrics, prevention of childhood obesity, caregiver support and team function in end of life care, improving primary care of patients with chronic pain, and optimizing EMR display of home and clinic blood pressure and medication data to diagnose and manage hypertension. The Department is home of the MU Center for Patient Centered Outcomes Research led by mPI Mehr. FCM has more than 7,500 square feet of space for its research offices and conference rooms. Conference rooms are equipped for multimedia, including teleconferencing and videoconferencing, and are spacious enough for team meetings. External grant support for fiscal year 2016 was valued at more than $2.6 million. Department investigators are currently funded by AHRQ, NIH, Missouri Department of Health and Senior Services, and the American Academy of Family Physicians Foundation among others.

**The Hugh E. Stephenson Jr., MD, Department of Surgery** provides exemplary care to patients, trains the surgical leaders of tomorrow and conducts research on advanced procedures and equipment. Surgery department faculty members, fellows and residents are also involved in research that addresses prevalent health problems, from cancer to obesity. The department has recently taken steps to strengthen their research endeavors. Dr. Kevin Staveley-O’Carroll, chair since 2015, has brought exceptional scientific leadership to the department. Strategic hires and facilitation of interdisciplinary collaboration with PCOR researchers, biomedical scientists, and engineers at MU have elevated the research culture. His own research group maintains a robust and longstanding NIH-funded research program. The Department of Surgery offers or actively participates in six scientific seminars, including a weekly journal club, Molecular Pathogenesis and Therapeutics (MPT) graduate students’ seminar, and MPT seminar series with outside speakers, operated by Immunology Center and Virology Center; a weekly Grand Rounds and a monthly Cancer Research conference operated by the Department of Surgery and Ellis Fischel Cancer Center; a weekly Collaborate2Cure meeting designed to stimulate regional collaboration across Columbia and the Kansas City area, is operated by the Kansas City Area Life Sciences Institute (KCALSI). An outcomes research group is being organized. The Department of Surgery also provides support to early career faculty with a “K Club,” for those interested in submitting an NIH mentored career award application. The group meets every other week with a grant writer and faculty mentors, to receive training and advice for submission of a responsive and effective proposal.

The Department of Surgery with multiple academic and institutional partners is developing an enhanced recovery after surgery program termed **TIGER - Team InteGrated Enhanced Recovery.** TIGER protocols are a patient-centered approach to minimize the symptoms, enhance recovery, improve outcomes and enable the delivery of safe, effective and value-based care. Several academic departments and components of the MU health system have begun implementing this enhanced recovery protocol for surgical procedures, with an initial pilot in urological patients undergoing radical cystectomy and urinary diversion for bladder cancer. Enhanced recovery is a multidisciplinary, evidence-based approach that improves surgical outcomes through minimally invasive surgical techniques, goal-directed fluid therapy, use of short-acting intravenous anesthetics, minimizing the use of opioids for pain management, limiting routine use of tubes and drains, and encouraging early return to normal nutrition and physical activities. Core teams from departments such as anesthesiology, nursing and surgery work cohesively in this effort, though the full protocol involves a much larger team including pharmacists, dietitians, respiratory therapists, physical therapists, operating room staff, social workers, and information technology specialists. Protocols are modeled after similar enhanced recovery measures in place at MD Anderson Cancer Center and other leading surgical centers. The system is customized to meet the needs of unique patient populations, and feedback from patients has been incorporated into the protocols. Plans are in place to expand beyond the initial pilot for liver, pancreas, thoracic and colorectal surgeries and eventually to all surgical procedures offered at Ellis Fischel and the Department of Surgery.

**Health Management and Informatics (HMI).** The Department of Health Management and Informatics offers residential and executive master’s degrees in Health Management and Health Informatics, as well as certificates in Health Informatics, and Health Ethics. The Department also houses the Missouri Cancer Registry & Research Center (MCR-ARC), Health & Behavioral Risk Research Center, Health Information Technology Assistance Center, the Center for Health Ethics, and the HMI Consulting Group. Health services management and services research along with health informatics research form its primary research foci.

HMI offers a rich and diverse teaching and research environment including biomedical informatics, public health informatics and health care management. HMI faculty have extensive experience teaching graduate-level health informatics and health care management through the Master of Health Administration Program (MHA), Master of Science in Health Informatics (MHI), Graduate Certificate in Health Ethics (GCHE) and Graduate Certificate in Health Informatics (GCHI). The HMI Masters programs combined (MHA, MHI, GCHE, GCHI) have 191 students, 61 of whom are enrolled in health informatics training. In Fall 2016, HMI began a new Graduate Certificate in Public Health Informatics (GCPHI). The department has 21 full-time faculty, 36 adjunct faculty, and 4 emeritus faculty members, eight of whom are core faculty of MUII with a strong record of mentoring health informatics doctoral students since 2008. The Department with support from the School of Medicine recently created The Center for Bioinformatics Research, led by newly hired director Peter Tonellato, PhD.

**Center for Translational Neurosciences (CTN)**

The Center for Translational Neuroscience (CTN) within the Institute of Clinical and Translational Sciences (iCATS) at the University of Missouri School of Medicine (MU-SOM) has identified neuroscience as a critical area that needs attention. Building on the unique strengths of MU-SOM and its public university system, a group of investigators in different disciplines and departments are currently addressing how to develop new diagnostic tools and imaging tests for advancing translational neuroscience. These productive scientists have been brought into a single research center to identify ways to better prevent and treat diseases that affect the brain. The MU CTN provides four specialized neuroscience core facilities, including (1) animal brain surgery/ microsurgery core; (2) primary cell culture core; (3) e*x vivo* image analysis and neuro-histology core; and (4) neurobehavioral core, in concert with the MU existing research cores and animal diagnostic laboratories for services ranging from structural and cell biology, to immunology and pathology, to proteomics and transgenic animals. The CTN has 15 investigators working on age-related neurodegenerative disorders including Alzheimer, Parkinson, stroke, traumatic brain injury, sleep disorders, autism, and brain tumors The ultimate goal is to produce more rapid translation of their research findings to clinical treatments. This resource will complement with other Core facilities on MU campus and provide shared technologies for a state-of-the-art neuroscience research center for this training project.

**Translational and Cancer Bioinformatics Lab**

The Translational and Cancer Bioinformatics Lab, occupies over 500 sq. feet of laboratory space in the Pathology and Anatomical Sciences Department at MU-SOM. The lab is equipped with Sun Fire x4240, Quad AMD Opteron 2384, 8 GB RAM, 200 GB RAID 5 and 40 TB RAID 6 storage, quad Gigabit LAN ports (Aperio image array); 2 x Sun Fire x4240, Quad AMD Opteron 2384, 16 GB RAM, 683 GB RAID 5 storage, quad Gigabit LAN ports (VM server, spare server); 3 x HP ProLiant DL585 G7, Quad AMD Opteron 6174 2.19 GHz, 64 GB RAM, 2 TB RAID 5 storage (RDF computational server, MySQLserver, Aperio image server); and Dell Poweredge 1800, Dual Intel Xeon CPU 2.8 GHz, 1 GB RAM, 250 GB and 1 TB RAID storage.

**The University of Missouri Informatics Institute (MUII).** In the early 2000s, at the urging of the NLM, MU began the development of a dedicated, specialized informatics PhD program, to ensure that the University would maintain its successful focus on the informatics discipline. MUII’s first cohort entered the program in 2008; since then, MUII has grown, and currently enrolls 34 doctoral students, who train under 43 core faculty members from 17 departments and 8 colleges, offering informatics students the chance to participate in labs and research centers across MU’s campus with three emphasis/concentration areas in bioinformatics, health informatics, and geoinformatics. MUII is managed by the Interdisciplinary Degree Programs Office under the MU provost to ensure its autonomy from individual colleges and schools. MUII has been recognized as one of the most successful interdisciplinary degree programs on the campus. MUII has graduated 19 PhDs to date, with a 100% placement rate.

**MU Sinclair School of Nursing (SSON)**

The SSON is committed to promoting, maintaining, and improving nursing care through education, research, and innovative practice. These endeavors are linked through the practice focus of the discipline and include a full range of programs: Bachelor of Science in Nursing (BSN), Master of Science in Nursing (MS), Doctor of Nursing Practice (DNP), and Doctor of Philosophy in Nursing (PhD), as well as continuing education offerings through Nursing Outreach and Distance Education. The education of persons of diverse ethnic backgrounds is a high priority, and the SON offers fellowships and assistantships to qualified applicants. The SSON has a history of securing federal funding for cutting-edge academic programs. Research is a central focus within the School. Faculty members are deeply committed to generating usable new knowledge to improve health, well-being, and nursing care. Faculty had the highest scholarly productivity among all public nursing school members in the Association of American Universities. Research projects examine common health problems. The School has been in the top 20 percent of nursing research institutions receiving NIH grant funding in three of the past four years. Minority supplements to funded research grants further enhance the environment. Funding from private foundations and state contracts further enhance the scholarly mission of the school. The school’s research-related environment is thriving.

**TigerPlace,** named for MU’s mascot, is an innovative independent living environment built and operated by Americare of Sikeston, MO, in affiliation with the MU Sinclair School of Nursing. TigerPlace provides a unique opportunity in which to develop and evaluate technology in a collaborative setting with researchers from Sinclair School of Nursing, Electrical and Computer Engineering, Health Management and Informatics, Health Professions, Schools of Social Work and Medicine. These researchers have come together to conduct interdisciplinary research projects to improve the quality of life and care of seniors. No other setting in the U.S. offers the population of subjects, research infrastructure as well as the faculty and resources of a research university. Research projects are encouraged, and residents who choose to participate enjoy helping to develop new technologies to help other seniors age in place. TigerPlace residents are like other seniors in Missouri and the United States; they are concerned about maintaining independence and dignity, have at least one chronic illness and some limitations in activities of daily living; their average age is 85.

TigerPlace is a key component of the Sinclair School of Nursing Aging in Place project that was designed with MU faculty working with Americare. Located near the MU Columbia campus, TigerPlace is a 54-unit apartment complex specially planned to promote the independence of older adults. Nurses, physical therapists, occupational therapists, and specialists in environmental design participated in the building plan.  The project is so popular that a 23-unit expansion was opened in 2009.

The SON was successful at obtaining a $2 million grant from the federal Centers for Medicare and Medicaid (CMS) to build the infrastructure for Sinclair Home Care and to evaluate the effectiveness of the aging in place model of care.In that research, elders repeatedly said they wanted to stay at home as long as possible; they feared moving to a nursing home. TigerPlace is a special facility where residents can age in place and never fear being moved to a traditional nursing home unless they choose to leave. Findings indicate that with the right supportive and restorative services it is possible to help elders improve their health and well-being and delay or prevent nursing home placement.

The wellness center at TigerPlace, led by the RN Care Coordinator for Aging in Place, performs on-going assessment of resident needs and health promotion activities including exercise and health classes to help residents remain active and vital. Aging in Place staff provide an array of home care services such as medication management, assistance with activities of daily living, care coordination of health conditions with residents’ physicians and other health care providers, and Medicare home health care when residents need and qualify for that service. The special setting of TigerPlace, with the unique capability of the RN Care Coordinator and other Aging in Place staff, helps position this study to be not only successful, but to be pioneering in its results to help elders maximize their independence.

**MU School of Journalism**, formed in 1908, was the first school of professional journalism established in the world.  Providing practical hands-on training in real-world news media and strategic communication agencies, the Journalism School aims to communicate the benefits of clinical and translational research to health care providers, policy makers and communities through the Health Communication Research Center (HCRC).  Supporting Health Literacy Missouri, the HCRC adopted evidence-based practices to create tailored stories with data and information specific for interests in each community with a media outlet (newspaper, radio or television station) that could be augmented with standard public relations practices to enhance local messaging within the community.  In over two years of this targeted program, disseminated news stories were picked up more than 600 times by 123 different newspapers covering 86 Missouri counties, with nearly 90% of the features covered in rural areas.

University of Missouri Research Reactor (MURR). MU operates the largest and most powerful research reactor at any university in the world. MURR is an interdisciplinary research and education center that provides MU with opportunities for research and education in the neutron-related sciences that are unmatched at any other US university. Because of its high power, unique design, and operation schedule, MURR leads the nation in the production of neutron rich radioisotopes for use in cancer therapy and research. A new 16 MeV cyclotron, owned and operated on the MURR site by Essential Isotopes, LLC, is available to create commercial products for medical imaging, and to support research into new and innovative products that will transform the future of medicine. In taking advantage of their inherent value but short shelf life, MURR and Essential Isotopes’ current focus is on delivering cyclotron-produced isotopes to hospitals at MU and the region, for their implementation and research use. The University of Missouri Research Reactor Center has an impeccable 40+ year record of safe operation. This safety record is a combination of stringent NRC-directed safety regulations, high-quality technical and operations staff, and a philosophy of proactive, preventive maintenance. MURR operates 6.5 days per week; 52 weeks per year.

**The Radiopharmaceutical Sciences Institute (RSI)** is home to internationally recognized research and educational programs that focus on the design, formulation, and study of novel radiolabeled biomolecular imaging agents and targeted radiotherapeutic pharmaceuticals. The RSI is the administrative unit for the Biomolecular Imaging Center, which has a full complement of micro-imaging instrumentation (e.g., micro-PET, SPECT/CT and MRI) that supports fundamental scientific and pre-clinical studies *in vivo*. The RSI is composed of over 25 faculty investigators whose primary appointments are in various departments in the School of Medicine (SOM), the College of Veterinary Medicine, and other campus units. The uninterrupted succession of extramural peer-reviewed grants from NIH and other federal agencies over the past 20 years has provided a base of support that has sustained continuity, permitted programmatic growth, and maintained a critical mass of expertise and infrastructure. Nuclear scientists at MU have invented a number of important cancer therapies, including Therasphere® for liver cancer, Quadramet® for bone cancer pain, and Ceratec ™ for brain imaging.

Comparative Medicine**.** MU is internationally recognized in the area of comparative medicine, and is the only university to hold awards for three (3) major NIH/NCRR Comparative Medicine Animal Resource Centers: (1) the Mutant Mouse Regional Resource Center; (2) the National Rat Resource and Research Center; and (3) the National Swine Resource and Research Center. In this regard, the MU Comparative Medicine Center is conducting internationally-recognized, NIH-funded research programs based on mouse, rat, and swine models.

**The Mutant Mouse Resource and Research Center** (07/2018)

MMRRC is the nation’s primary mutant mouse archive and distribution repository system the primary goal of which is to facilitate research by identifying, acquiring, evaluating, characterizing, cryopreserving, and distributing mutant mouse strains to qualified biomedical investigators. The MMRRC was established by the NIH to ensure the preservation, dissemination, and development of valuable mutant mouse lines and data generated by research scientists. The MMRRC is a consortium of four Centers, each hosting an archive and distribution repository, and an Informatics Coordination and Service Center (ICSC) within a trans-national network regionally distributed across the United States. Since the MMRRC Network began in 1999/2000, it has evolved into a major resource for the research community with capabilities and a combined inventory of mouse lines and embryonic stem (ES) cells that exceeds the capacity of other mouse repositories worldwide.

The MMRRC offers sperm cryopreservation and embryo cryopreservation services. Sperm cryopreservation requires submission of 3, preferably breeding, males, 10-24 weeks of age. You will receive frozen sperm aliquots in sterile CBS high-biosecurity straws. Embryo cryopreservation requires submission of 10, preferably breeding, males, 10-24 weeks of age, and submission of about 30 females 7-12 weeks of age. You will receive all cryopreserved morula-stage embryos collected from the donor females you provide (~20 embryos per sterile CBS high-biosecurity straws). Sperm cryopreservation offers several advantages over the embryo cryopreservation; sperm collection is simple, does not require hormone administration or mating prior to collection, and requires only a few animals. Furthermore, sperm cryopreservation is particularly efficacious for transgenic and knockout mice as thawed sperm can be used to fertilize oocytes in vitro from a selected common inbred, or hybrid, strain for production of offspring to re-establish a breeding colony for the strain.

Cryobiology Laboratory: A dedicated 1,400 square foot storage facility for maintenance of our cryopreserved germplasm inventory is supplied by a liquid nitrogen silo and vacuum jacketed lines. The facility is equipped with automated fill lines for gamete, embryo, stem cell line storage. A monitoring system with 24/7 temperature monitoring, as well as oxygen monitoring of the room, is present to ensure personnel safety. Within the Discovery Ridge building the following major equipment is available for cryopreservation and rederivation: micromanipulators, P97 micro pipet puller, osmometer, programmable freezer, Linkam Cryostage, Olympus inverted microscope with NK-2 Eppendorf micromanipulator and Prime-tech piezo injection unit, Hamilton Thorne IVOS Sperm Analyzer, microscopes including multiple stereomicroscopes and dissecting scopes (Leica M165C), mammalian cell propagation equipment, with laminar flow hoods for cell culture, incubators for mammalian cell and embryo cultivation, multiple water-baths and heat blocks, centrifuges (low, high and ultra-high speed), multiple refrigerators, -20°C freezers, and -80°C freezers.

Additional information can be found at <http://www.mu-mmrrc.com/>

**The National Swine Resource and Research Center**

The NSRRC laboratory facility located within the shower-in and -out NSRRC building, is a state of the art facility that is ~20,000 square feet includes offices, animal rooms and laboratories for embryology, cellular and molecular biology, and cryobiology. The NSRRC PD has an office located within the shower in and out NSRRC facility. The laboratory is proximal to the animal facilities that house the NSRRC Special pathogen free (SPF) pigs which allow for easy manipulation of the genome, cryopreservation or genotyping of the SPF pigs. The NSRRC building is a shower in and out confinement facility for swine. The facility has the capability to farrow pregnant animal, grow and develop gilts and boars. The NSRRC has its own surgery, surgery preparation, and sterilization room as well as two Intensive care rooms for C-section colostrum deprived piglets. The NSRRC has the capability to house ~100-250 animals depending on mature size of the animals (miniature pigs vs. domestic pigs). The NSRRC has state-of-the-art computers for use in data analysis, data base generation, word processing, spreadsheet, and graphics generation. All computers have access to literature search, email and internet resources by linkage to the campus network and thus access to Internet II. The NSRRC has separate servers, in the College of Agriculture, Food and Natural Resources, on which the NSRRC’s databases and external website are located. This server maintained by a full-time Computer Analyst supported by the NSRRC. Additional available equipment that is located within the NSRRC includes: a Nikon inverted Diaphots each equipped with either Narshigie micromanipulators and epi-fluorescence, a Nikon E600 fluorescence microscope, 3 dissecting microscopes, a BTX ECM-200 and an ECM-2001, a microcentrifuge, 2 water baths, an Eppendorf 5810R centrifuge, 4 slab gel electrophoresis apparatuses, Computer aided Semen Analysis system; SpermVision, 3 Forma CO2 incubators, a –80 Forma freezers, 2 Baker laminar flow hood, 2 thermocyclers, microcentrifuge, UV illuminators and UV box, Narshigie Microforge, Narshigie grinding wheel, a Sutter pipette pullers, cold box, 2 –20 freezers, a refrigerators, exhaust hood, a balance, 1 pH meters, 2 heated stir plates, a microwave ovens. Also available are: high-, low-speed and ultracentrifuges, freezing machines for cryopreservation, autoclaves, water purification systems, and 4 MVE 611 liquid nitrogen storage tanks. The NSRRC also has an environmental controlled box van for shipping of animals from Columbia, MO to investigators across the country.

MU is at the forefront of biomedical research using pig models. Evidence of the research success on campus using pig models is the 15 years of successive funding of an NIH funded PPG in the area of cardiovascular disease and exercise along with numerous other federally funded projects utilizing porcine models. NSRRC is housed on campus and has generated a number of transgenic pig models in addition to maintaining various pig strains for the study of human disease. Facilities are available for breeding colonies to generate pigs, house, and study these animals in controlled settings on campus. Facilities exist to analyze body composition, chronically insert catheters for metabolic testing, take tissue biopsies, and analyze tissue and plasma for an array of biomarkers and metabolites.

**PUBLIC HEALTH FACILITIES:**

**The Center for Applied Research and Environmental Systems (CARES),** an interdisciplinary center in the Division of Applied Social Sciences, College of Agriculture, Food and Natural Resources, is an award-winning mapping and data visualization resource at MU. Since 1992, CARES has been working to integrate the use of technology and information in decision making processes. Their early work was applied to better understanding natural resource systems and evaluating risks to public health. CARES now works in a number of health and community-based areas, partnering with foundations, non-profits, government agencies, and researchers on a variety of topics. The full-time staff specializes in information management and analysis, and has extensive experience working with others to make meaning of available data. CARES has worked extensively with geographic information system (GIS) technology and data, was an early adopter of web-based mapping systems, and continues to innovate and extend the field to many subject areas.

**Center for Health Policy (CHP)**

CHP staff has over a half century of combined experience in collaborative health equity work with health systems, academia, advocacy groups, community based organizations, public health officials and policymakers. The team includes a medical doctor with years of experience serving patients. She has also worked with policymakers in healthcare and academia, including local, state, and national representation. The staff has a wide spectrum of expertise in the social sciences, public health, and public policy and has extensive experience developing training and community-based programs for health care stakeholders, policymakers, professionals, and patients. They have developed and implemented workshops on health literacy, inclusion and social justice, community engagement and advocacy, quantitative and qualitative research analysis, and cultural consciousness. CHP has the organizational capacity to concurrently manage several large contracts and grants and work on projects that bridge science, education and service, bringing academic and local resources to bear on health equity issues that matter most to the communities we serve.

**Population, Education and Health Center (PEHC)** was established in 2014, with funding from the University of Missouri (MU) Provost and a diverse range of academic divisions, in order to facilitate collaboration among research faculty who conduct population-level research using “big data” sources. PEHC supports national and international research in the area of population studies. The PEHC hosts a monthly seminar series that is focused on the broad interests of faculty who conduct population, education and health research; the seminar series seeds collaborations among interdisciplinary faculty, hosts national speakers and trains graduate students in methods of population research. The PEHC was also part of a successful proposal to the National Science Foundation and the U.S. Bureau of the Census, and will thus be home to the University of Missouri Research Data Center (MU RDC) that will open in 2015. In addition to providing a physical home for the MU RDC and access to data for researchers, the PEHC provides graduate fellowships and funding to support training and increased use of restricted federal data in population research.

**University of Missouri Research Data Center (MU RDC)** is part of the part of the Federal Statistical Research Data Center program and is a satellite branch of the Kansas City RDC that is located at the Federal Reserve Bank of Kansas City. The MU RDC will provide MU faculty with access to highly valuable, restricted federal data for their research. The MU RDC provides a secure environment where researchers have access to confidential economic, health and demographic microdata, with appropriate safeguards to protect data confidentiality. The MU RDC will allow access to hundreds of federal datasets that will support research in economics, sociology and public health.

**MU CORE FACILITIES**

**The Electron Microscopy Core** (EMC) is a resource center located in the Veterinary Medicine Building in a renovated 2,600 square foot suite of twelve rooms for scanning and transmission electron microscopy, providing investigators with consultation, training and services. The EMC is a campus-wide resource center for scanning and transmission electron microscopy, providing investigators in both life sciences and material sciences with consultation, training, services, and access to instrumentation. The EMC offers exceptional instrumentation for preparing and analyzing specimens with a wide array of electron microscopy techniques. Among the instruments in the Core is a Hitachi S-4700 cold cathode field emission scanning electron microscope (FESEM) for sample surface imaging with resolutions down to 2-3 nanometers. The FESEM is equipped with digital imaging capabilities and a cryostage, and an energy-dispersive spectrometer (EDS) for elemental analysis and mapping is currently being purchased. The second SEM, an AMRAY 1600, has been digitally upgraded and is equipped with both EDS and magnifications. Ancillary equipment for sample processing and preparation of biological material includes a microwave processing system, a cryopreparation system for the Hitachi S-4700, a critical point dryer, and two top-of-the-line Leica Ultracut UCT ultramicrotomes. One of the ultramicrotomes is equipped for cryosectioning of frozen material. Cutoff saws, a slow speed diamond saw, a grinding station and a two-stage polishing table are available for cross-sectioning in materials science applications. There are also sputter coaters and vacuum evaporators for metallic or carbon depositions. Recent additions include a low-temperature ultraviolet-light polymerization system for immunocytochemistry TEM, a Leica EMPact high-pressure freezer, and Leica AFS freeze-substitution apparatus. These most recent additions allow state of the art specimen preparation capabilities for viewing biological tissues in their frozen, hydrated state, thus avoiding artifacts of conventional chemical fixation and dehydration. Additionally, there are three light microscopes, a dual head Olympus BX4OCY cytology microscope system with video adapter, a low power binocular scope and a petrographic microscope with both transmitted and reflected light sources. Digital imaging capabilities include a high resolution scanner, Nikon CoolPix 880 digital camera, a workstation for image processing and analysis, and printers. All instrumentation is either available to the investigators directly or aided by two full-time Electron Microscopy Core staff members.

**The DNA Core** facility provides high-throughput DNA sequencing services to all four campuses of the University of Missouri system and external researchers. The facility has performed next generation sequencing services since 2008. Core staff are experienced with RNA/DNA QC techniques, library construction methods, and data generation on Illumina instruments. The facility maintains an Illumina HiSeq 2500, NextSeq and two MiSeq instruments, as well as, necessary ancillary equipment. The combined data yield of these instruments allows the DNA Core to provide sequencing capacity for both the small and large project. The DNA Core currently provides library construction services for several methods, including: Illumina Small RNA Library, Illumina mRNA Stranded Library(RNA-Seq), Clonetech Ultra Low Input RNA Library(RNA-Seq), ChIP-Seq Library, Illumina DNA PCR-free Library, and NEB Whole Genome Bisulfite Sequencing (WGBS). Sanger Sequencing services are also provided. The DNA Core accommodates both single sample users and high-throughput projects. The facility utilizes a 3730xl 96-capillary DNA Analyzer with Applied Biosystems Big Dye Terminator cycle sequencing chemistry. The 96-capillary instrument with robotic plate handler provides a high throughput capacity at minimal cost to investigators. Projects of varying size are accommodated. Read lengths up to 900 bases per reaction are routine, providing the template is of high quality. Turn-around time for submissions is 24 -36 hours.

**Cell & Immunobiology Core (CIC)** is hosted by the Department of Molecular Microbiology & Immunology (School of Medicine), provides custom monoclonal antibodies, flow cytometric analysis and tissue culture reagents via three subcores: the Tissue Culture Core, Flow Cytometry, and a Supply Center. The Flow Cytometry Subcore features two flow cytometers - a Becton Dickinson FACS Vantage cell sorter and a FACScan cell analyzer.

**Informatics Research Core Facility.** In January, 2009, the Missouri Life Science Trust Fund awarded funding for the University of Missouri to establish an Informatics Research Core Facility (IRCF). The goal of funding the IRCF is to enhance Life Sciences research projects across Missouri by using the trust fund’s one-time investment to establish a self-sustaining operation. This shared resource is intended to serve as the focal point from which research teams can access and gain bioinformatics expertise for improved design, data management, and analysis of their research projects, as well as provide a data warehouse to store and disseminate their research data sets and resulting analyses. Core services include consulting, software development, and data analysis.

**Molecular Cytology Core** is a resource for all types of light microscopy, immunocytochemistry, in situ hybridization techniques and general scientific image processing. The MCC is hosted by the Division of Biological Sciences and houses a BioRad Radiance 2000 confocal system coupled to an Olympus IX70 inverted microscope, two photomicroscopes (Olympus IX70 and Nikon Optiphot 2) equipped with bright field, phase, DIC, dark field and fluorescence optics and cooled digital cameras. MetaMorph and ImagePro are available for 2D and 3D image analysis and processing. Equipment within this core facility will assist with proposed histological analysis.

**The Nuclear Magnetic Resonance Core (NMR)** facility is a campus-wide resource hosted by the Department of Chemistry. The NMR Facility was the first core research facility to be established at MU and continues to serve researchers from many disciplines. Instrumentation includes a Bruker Avance III 600 MHz Spectrometer (with sample changer), a Bruker Avance III 500 MHz spectrometer (with sample changer), a Bruker AVII+ 300 MHz spectrometer and a DRX 300 MHz (widebore) spectrometer with solid state capability. An 800 MHz instrument was added in early 2008 and is housed in the Schweitzer Hall Addition. The 500 and 600 MHz spectrometers were upgarded in 2014. All spectrometers have multinuclear capability. The NMR Facility and staff are available for research support to investigators who want to use NMR for structural elucidation of molecules and for the study of chemical and biological reactions. Assistance in the design of experiments and spectral analysis is available upon request.

**The Charles W. Gehrke Proteomics Center** in the Bond Life Science Center, provides advanced technologies in protein separation and mass spectrometry identification for researchers at MU. The Proteomics center accepts any non-hazardous, non-pathogenic, and non-radioactive samples for analyses. These samples can be whole organism, tissue, or purified protein. Specific services include: two-dimensional electrophoresis, image analysis, in-gel digestion of proteins for mass spectrometry, mass spectrometry identification of proteins, intact mass analyses, post-translational modifications, quantitative proteomics by mass spectrometry and training for software and instrument access

**The Structural Biology Core’s** mission Core is to enhance the research infrastructure available to MU life scientists by ensuring sustained access to functional state-of-the-art equipment and to faculty expertise in the fields of structural biology and peptide synthesis. To accomplish that goal they provide equipment maintenance and infrastructure support for structural biology research; provide structural biology computational (hardware and software) support; and provide an interface for MU researchers seeking structural biology expertise on campus. In 2003, a Peptide Synthesis Core was added under the SBC umbrella. The mission of the peptide synthesis core is to provide synthetic peptides in milligram to gram quantities containing non-natural amino acids, metal chelators, peptide-nucleic acid (PNA) conjugates, phospho-peptides, multiple antigen peptides (MAPs), cyclic peptides and fluorescent tagged peptides to researchers across MU.

**Transgenic Animal Core** provides many services, including: chromosome counting, generation of transgenic mice on FVB and c57BI6 strains using client's DNA, genotyping assays, and many more.

**Other “Core-type” Facilities:**

**The Histology Core** contains all the necessary equipment for anticipated histology/immunohistochemistry support. This includes; a Microm Rotary microtome (HM355s), a Leica CM 1850 cryostat, 3 fume hoods, a Sheldon lab oven, a dry incubator, a refrigerator and abundant slide and tissue block storage. The Histology section also contains 2 image acquisition and analysis stations for digital storage and analysis of slides. This includes; one Oympus BX 61 Microscope and Dell Precision T3400 computer with 25” monitor and one Olympus BX 60 with an Optiplex 755 computer with 19” monitor including Image pro 6.2 and Spot Advanced analysis software. The BX61 station is equipped with a motorized stage and automated image capture software to allow total slide digital imaging at high magnification. An additional workstation equipped with Image Pro 6.2 is available for analysis.

**Veterinary Medical Diagnostic Laboratory (VMDL)** The VMDL is a full-service Veterinary Medical Diagnostic Laboratory fully accredited by the [American Association of Veterinary Laboratory Diagnosticians](http://www.aavld.org/) and member of the National Animal Health Laboratory Network (NAHLN). It provides in-depth laboratory diagnostic support to veterinary practitioners, livestock and poultry industry interests, companion animal interests, wildlife conservationists, scientists utilizing animals in their research throughout the university, state and regulatory officials, and clinicians of the MU Veterinary Medical Teaching Hospital (VMTH). The laboratory handles more than 200,000 specimens a year and serves Missouri's 114 counties and surrounding states by performing over 300,000 diagnostic tests annually.

The VMTH diagnostic imaging facility houses the following imaging instrumentation:

* 64-slice Toshiba CT scanner  (Toshiba,  Tustin CA)
* Diagnostic ultrasound GE Logiq 9  (GE Healthcare, Milwaukee WI)
* 3 Tesla Toshiba MRI (Toshiba,  Tustin CA)
* Philips C-PET Plus dedicated scanner  (Philips, Andover MA)
* Siemens Oncor Impression Plus linear accelerator (Siemens, Malvern, PA)

These and other facilities available within the VMTH allow the full range of following procedures for the care and treatment of animals: Thoracic radiographs; abdominal radiographs;  abdominal ultrasound;   abdominal CT with Contrast; abdominal pelvic MRI with contrast; PET imaging; dosimetry calculations; dosimetry for external beam and intratumoral administrations of radiotherapeutic and diagnostic agents; and linear accelerator delivered external beam therapy.

**Whole Slide Imaging Analytics Lab**

The Whole Slide Imaging Analytics Lab occupies over 500 sq. feet of laboratory space at Pathology and Anatomical Sciences Department at School of Medicine. The lab has a Leica Aperio CS Whole Slide Scanner, a Nikon pathology microscope, a Leica Aperio Digital Pathology Spectrum information system (pathology PACS), a Leica Aperio Algorithm Development Kit with WSI Genie Pattern recognition, and an HP WSI computer workstation with fiber optic light source control system. Drs. Arthur, Hammer, and Shin regularly utilize this lab for their research.

**Computational Imaging and Visanalysis (CIVA) Lab**

This 1200-square-foot laboratory space located in MU in Engineering Building West includes imaging workstations, workspace modules, conferencing, compute and visualization servers for algorithm development, storage servers, and gigabit research network to all desktops. There are cubicle style workspaces for about 15 graduate students and a separate shared office space of ~300 sq ft for postdocs. All offices are in close proximity for ease of collaboration. Computing infrastructure currently consists of high performance Linux, Apple, Dell and Compaq PCs, and visualization workstations. The lab has software licenses for a number of packages including Matlab, Mathematica, AutoCAD, Adobe products, MS Office, etc. and open source software for computer vision and graphics application research including Octave, OpenCV, CUDA SDK, CImg, Kitware VTK/ITK, MapTK, vxl, Blender, Paraview, Utah SCI Suite, Meshlab, PCL, VisualSfM, CMVS, ImageJ, ImageMagik, ffmpeg, Boost, Qt, Eclipse, CMake, git, subversion, php, MySQL, python, Django, VMWare, etc. The lab has a VR 3D display systems and specialized Apple AJA HD nonlinear video processing and editing equipment using 5K displays. The virtual reality workstations have stereo capability and are used to develop 3-D displays. Two Linux-based server (Supermicro) running CentOS with Intel Xeon E5 2.4 GHz (dual CPU, 16 cores, 32 hyperthreaded), 128 GB DDR4 RAM, 32 TB storage, 4U GPU server, dual 30" displays. Second system is Intel Xeon X5650 2.67GHz (dual CPU, 6 cores each, 24 hyperthreaded), 24 GB RAM, 16 TB storage, nVidia GTX 460 GPU, and access to 10 Gbps Ethernet to the Great Plains Internet2, a 4 TB Fibre-channel disk array XServ RAID storage system. High performance demonstrations at Supercomputing 2015 and in previous years have been created to visualize large satellite, geospatial and high resolution video analytics datasets. Funding for CIVA lab equipment comes from AFRL, NIH, NRL, NASA and industry.

**OTHER:**

**School of Medicine (SOM) Informatics Support Group**

The MU School of Medicine Informatics Support Group is located on the 5th floor of the Medical Sciences Building, which is adjacent to MU Health Care. The group has expertise in software engineering, data warehousing, data management, and electronic data capture. It manages MU’s implementation of i2b2 and REDCap, Capabilities of the SOM Informatics Support Group are augmented by the Tiger Institute for Health Innovation which is comprised primarily of Cerner associates, who oversee the management of the Electronic Health Record and other research-relevant applications such as PowerTrials and online forms. All computers in the Informatics Support Group are connected to a 1-Gigabit-per-second local area network that provides more than 300 Gigabytes of network file storage. Dedicated and virtualized servers support i2b2 and REDCap production environments. Networked file servers provide constant hardware backups of stored data through daily backups to disk; daily tape backups are also performed for offsite copy. The local area network is connected to a switched, 10-Gigabit Ethernet backbone that provides high speed Internet access through MU’s Internet2 communication network. Currently MUHC's Internet2 access is provided via the Missouri Research and Education Network (MOREnet).

MU-iCATs, as part of its biomedical informatics infrastructure enhancement, has deployed the NIH-funded National Center for Biomedical Computing based at Partners HealthCare System, i2b2. Informatics for Integrating Biology and Bedside (i2b2) is an informatics framework to leverage existing data for cohort identification, retrospective data analysis, and hypothesis generation. The data in i2b2 reflects a subset of the data from the MU Healthcare Cerner Millennium EMR. MU-iCATS also utilizes REDCap, Research Electronic Data Capture (REDCap) is a secure, web-based application for building and managing online surveys and databases. It provides automated export procedures for seamless data downloads to Excel and other common statistical programs, such as SPSS, SAS, Stata and R. REDCap also has a built-in project calendar, scheduling module, ad hoc reporting tools and other advanced features, including branching logic, file uploading and calculated fields.

**The Biostatistics and Research Design Unit** (BRDU) within the Department of Health Management and Informatics provides statistical expertise in study design, data analysis, and grant and manuscript preparation for researchers at MU’s Schools of Medicine, Nursing, Health-Related Professions and Veterinary Medicine. BRDU’s primary mission is to foster health sciences research at MU and to collaborate with faculty to help them become more productive and competitive researchers. The BRDU consists of five doctoral-level statisticians and two master’s-prepared statisticians. Collectively, they have over a century of experience conducting interdisciplinary research and securing grant funding. In addition to routine analyses, BDRU statisticians provide consultation in complex survey sampling designs, high-throughput genome-wide studies, data mining and exploratory analyses, manuscript preparation, descriptions of the statistical methods used and interpretation of the statistical results, as well as review of manuscripts to accurately communicate statistical findings.

**Library Resources**

The Libraries provide extensive resources for faculty and student research. Holdings in the University of Missouri library system number over 3 million volumes, 7.5 million microforms, and 36,000 serial titles, many of which are available electronically. There is an extensive collection of federal and state reports and statutes. Online computer database searching is readily available to faculty, students and staff. The MU Libraries offer access to Medline, CINAHL, HealthSTAR, SocioFile, PsychINFO, and other computerized databases. The Health Sciences Library, has 279,535 volumes unique to its collection and provides access to 222 electronic databases pertaining to medicine, nursing, hospital administration, and related fields. The HSL has eight professional librarians and 14 support staff members. HSL is part of the National Library of Medicine’s National Network of Libraries of Medicine (NN/LM) Program, which is a nationwide network of more than 4,000 health sciences libraries and information centers.

Integral to the **University of Missouri Informatics Institute** are the services of the **Health Sciences Librarians**. Librarians provide services, instruction and online guides that cover:

* Expert searching upon request to identify relevant publications.
* Instruction on software (End-Note, Zotero) for managing citations and references.
* Quick courses on methods for creating scientific posters for presentation at professional conferences.
* Assistance for researchers with data management plan principles, best practices, and resources.
* Ensuring researcher understanding of compliance with NIH and HSF public access policies, including consultation on specific instances upon request.
* Introduction to metrics related to research quality and impact.
* Consultation regarding MOSpace, the Libraries’ institutional repository, and when it is an appropriate location for researcher content.
* Instructional sessions tailored to meet the needs of specific researchers and the interests of the informatics fellows.

**Rnet External Network Connectivity**

Rnet enables collaborations with HPC resources throughout the 4-campus University of Missouri System through a core fiber-optic network and 10 Gigabit (Gb) optics operated by the Missouri Research and Education Network (*MOREnet*). The MOREnet connectivity allows MU researchers to connect via high-speed networks and collaboration services such as videoconferencing with Missouri’s 900 node research and education network for higher education, K-12 education, telehealth sites and public libraries, as well as state government and their affiliates. Connectivity to Internet2 from Rnet is available directly if needed, and through MOREnet and the Great Plains Network (*GPN*) consortium. The direct connection to Internet2 is being upgraded with 100 Gbps connectivity with built-in redundancy provided by MOREnet for route protection to avert network disruption due to faults. These connections enable MU to leverage and participate in various national-level advanced cyberinfrastructure efforts such as *InCommon* Federated Identity Management Service, *XSEDE* for HPC/Big Data resources/expertise access, and *GENI* Future Internet Testbed. In fact, MU researchers are leading several GENI experiment efforts and are developing Gigabit apps using national-level testbeds involving Health Care and Advanced Manufacturing communities, as part of the *US Ignite* initiative supported by NSF and The White House Office of Science and Technology Policy. MOREnet also connects Rnet today at 10 Gbps network speeds (100 Gbps connectivity option for future is possible with MOREnet’s current fiber and optical infrastructure) to international R&E network peering points such as *StarLight* in Chicago.

**MU Division of Information Technology (DoIT)**

The Division of Information Technology strives to deliver high-quality information technology services to support teaching, learning, research, and administration for the University of Missouri and its enterprise affiliates. Among others, services include the following:

• Box cloud storage accounts: Box provides document storage and collaboration and is accessible through web browsers and mobile devices. Individuals at outside institutions can be given access to Box folders. This service may be used to store all classifications of data, including DCL4, such as data covered under HIPAA. DCL4 does require permission from the unit’s information security officer.

• The MU Data Center, operated by the Division of Information Technology, provides a secure and environmentally controlled facility that houses computing systems for MU and other University of Missouri organizations. The center offers the following standard services and features:

* Environmentally controlled cooling and humidity.
* Redundant power to all rack locations.
* Uninterrupted power supply and generator backup.
* Fire suppression.
* Physical security with video surveillance.
* 24x7x365 system monitoring.

• Information Security: The Information Security & Access Management (ISAM) team is responsible for providing security expertise and resources necessary to protect the University’s information assets and technology resources. All applications are reviewed for security. All MU and UM System employees must change their password annually. Employees of the University Hospital and Clinics and the Schools of Health Professions and Medicine must reset their password every 180 days. Accounts are reviewed daily to ensure that only individuals entitled to continued access are allowed to maintain their accounts. Laptops of those with access to protected health information are required to have disk encryption.

• Research Computing: The Research Computing Support Services (RCSS) group provides computing support, training, and consulting to the MU research community. Their staff works closely with researchers to help evaluate their research computation needs and recommend solutions that allow them to take full advantage of the resources available. RCSS also works to ensure that the campus’ computing, storage, and networking infrastructure meets the growing needs of the research community. One resource is High Performance Computing (HPC). HPC is a system-wide service that provides the advanced computational and data-driven capabilities needed for innovative and collaborative research activities at the University of Missouri. The HPC environment includes a state-of-the-art shared-resource cluster, an experimental cluster, and a number of grant-friendly investor services. A teaching and learning cluster for students is also under development. The HPC shared resource cluster was recently upgraded and currently consists of 40 machines with two Haswell E5-2670 v3 CPU’s with a total of 24 cores running at 2.3 Ghz with between 128G and 256G ram connected to 100TB of high speed network scratch and over 2 Petabytes of storage. In addition thanks to NSF major research instrumentation (MRI) funding, there is an experimental cluster with 20 similar nodes and 10 K20/K40 GPU’s and 16 Intel Phi nodes. These systems are connected with 10Gigabit Ethernet and 40 Gigabit Infiniband fabrics. The system is part of the campus’s Science DMZ with a dedicated Internet2 connection and is connected to the Internet2 AL2S Software Defined Network (SDN) at 100 Gigabit. Two full time system administrators manage the system.

• High Performance Internet Connectivity: MU was among the first in the US to create a separate research network (RNet). Serving MU’s research community since 1999, RNet exists and is administered separately from, but is interconnected with, MU’s high-speed network. RNet has an autonomous set of virtual local area networks (VLANs) that co-reside within the internet address space of the university, but are on a separate high-speed routing and switch infrastructure. RNet enables accessibility to high performance computing (HPC) resources throughout the four-campus University of Missouri System through a core fiber-optic network and 10 Gigabit (GB) optics operated by the Missouri Research and Education Network (MOREnet). This network enables MU researchers to connect via high-speed networks and collaboration services such as videoconferencing with Missouri’s 900 node research and education network for higher education, Kindergarten-grade 12 education, telehealth sites, and public libraries as well as state government and their affiliates.