

Facilities and Other Resources

Kansas State University provides significant infrastructure support for research and for training programs in research.

Specific University Core facilities relevant to this application are described below:

Beocat Big Data supercomputing: Beocat, the KSU research computing cluster, is currently the largest academic supercomputer in Kansas. Its hardware includes nearly 400 researcher-funded computers, approximately 3.3PB of storage and ~10,000 processor cores on machines ranging from dual-processor Xeon e5 nodes with 128GB RAM with 100GbE to 128-core, 1.5TB RAM servers with eight GPU accelerators, connected by 40-100Gbps networks (thus 40-100x faster than Google Fiber). Beocat and its staff have provided tours demonstrating the value of KSU research and a high-tech look at our research facilities for over 3,000 participants, including USD383 StarBase, current & prospective students, funding agencies, faculty recruitment, and outreach activities such as KAWSE. Classes supported include topics like bioinformatics, big data, cybersecurity, economics, chemistry, and genetics. Beocat is supported by many NSF and university grants, and it acts as the central computing resource for multiple departments across campus. Beocat staff includes two full-time system administrators with over ten years' experience in high-performance computing, a full-time applications scientist with a PhD in Physics and 25 years' experience optimizing parallel programs and assisting researchers, and part-time (~0.5 FTE) director.

Beocat is available to any academic researcher in Kansas and their partners under the statewide KanShare MOU. Under current policy, heavy users are expected to "buy in" through adding computational or personnel resources for the cluster ("condo computing"). Their jobs, then, are given guaranteed priority on any contributed machines, and they have access to other resources in the cluster on an as-available basis. Thus, projects can preserve a guaranteed base level of computation while utilizing the larger cluster for major computations. Users can also purchase archival data storage as needed. Beocat is located in a dedicated 1100-sq.-ft. data center in 1118 Engineering Hall on the K-State campus. K-State's chief information security officer provides technical monitoring and support to ensure systems are not compromised. Dr. Daniel Andresen is the KSU XSEDE Campus Champion in the event national-class computational resources are required.

Bioinformatics Center: The Bioinformatics Center at K-State was established in 2001 under the direction of Dr. Susan J. Brown. The primary goal of the center is to provide state-of-the-art bioinformatics support to biological researchers at K-State. It also serves as an active site for bioinformatics research and development in the state of Kansas. The K-State Bioinformatics Center is funded by the NIH through the Kansas IDeA Network of Biomedical Research Excellence (K-INBRE). The K-INBRE Bioinformatics Core was established to promote the use of bioinformatics in biomedical research. It provides bioinformatics support and educational programs to K-INBRE participants. **Services and Software:** Freely available bioinformatics software is maintained in the bioinfo file in the Beocat home directory. A complete list of available software is provided to Center users. The Bioinformatics Core contributes custom scripts from common NGS analysis to the K-INBRE i5K Github script sharing organization.

Following is a list of repositories in our Github Organization: transcriptome-and-genome-assembly; RNA-Seq-annotation-and-comparison; read-cleaning-format-conversion; lrys-scaffolding; genome-annotation-and-comparison. The Center provides: assistance with installation and maintenance of various bioinformatics software packages; services in sequence raw data processing, assembly and preliminary annotation; assistance in sequence analysis, including BLAST search, protein domain analysis, multiple sequence alignment, phylogenetic analysis, and other common sequence-based methods; assistance in microarray data normalization, transformation and basic statistical tests using the GeneSpring software package; and consultation on biological data acquisition and database design.

Biosecurity Research Institute (BRI): The BRI at Pat Roberts Hall is a unique biocontainment research, training and education facility that is adjacent to the College of Veterinary Medicine and the National Bio and Agro-defense Facility (NBAF) development site. It was designed for biosafety level-3 (BSL-3) and biosafety level-3 Agriculture (BSL-3Ag) capabilities. Facilities include 14 BSL-3 enhanced research laboratories plus associated support spaces, capable of research on zoonotic and foreign animal diseases in both large and small animals. An ACL-3 insectary is available for arthropod transmission studies. Education and training support facilities include a 50-seat lecture hall, and an integrated classroom and hands-on training laboratory. **Instrumentation:** Additional BRI equipment includes: autoclaves; biosafety cabinets; centrifuges; microscopes; nanodrop; spectrophotometer; thermocyclers; tissue culture incubator; and an ultracentrifuge.

Biotechnology Core Laboratory: The Biotechnology Core Facility at K-State was established to provide a number of centralized services to researchers at K-State and elsewhere. The goods and services provided by the facility give researchers tools they need to identify new proteins, protein modifications, protein-protein interactions and enzyme substrates. The facility is supported in part by fees for services, which are quite competitive, the K-State College of Arts and Sciences, the Vice President for Research and the provost via a Targeted Excellence Award. Services offered include: custom oligonucleotide synthesis; peptide synthesis; protein fragmentation (chemical or enzymatic); protein/peptide isolation; peptide/protein sequencing; proteomic analysis; glycomic analysis; and mass spectrometry. Multiple types of protein resolution are provided including 2D liquid chromatography, 2D isoelectric focusing and differential gel electrophoresis. **Instrumentation:** Bruker Daltonics Ultraflex III MALDI TOF/TOF Mass Spectrometer, Finnigan Lasermat 2000 MALDI TOF Mass Spectrometer, Bruker Daltonics HCT Ultra ESI-Ion Trap Mass Spectrometer, Bruker Esquire 3000 plus ESI-Ion Trap Mass Spectrometer, 2D Capillary/Nano LC System (2), Bruker Daltonics Proteomeer Digest and Prep Workstation (2), Bruker Daltonics Proteomeer Automated Spot Picker (2), Beckman Gold HPLC system, Bio-Rad Protean 2D Gel Electrophoresis System, Invitrogen 2D Gel Electrophoresis System & IEF Zoom Fractionator, GE Typhoon 9410 Phosphorimager, Applied Biosystem 492 Protein Sequencer, Cary Eclipse Spectrofluorometer with microplate holder **Software:** Mascot and Phenix / Aldente - Mass data base search engines, Melanie - 2D Gel analysis, Protein Scape - Sample handling and data analysis.

Center for Outcomes Research and Epidemiology (CORE) at K-State is an interdisciplinary research and training center focused on the application and extension of outcomes research and epidemiology in animal health. The collaborative team excels in population-based and quantitative approaches to enhance animal health for the benefit of animals and society. Research and training programs capitalize on expertise in epidemiology, economics, research design, data analysis and interpretation, risk assessment, mathematical modeling, veterinary medicine, production agriculture, and population health management. The Center promotes excellence in experimental, observational, and research synthesis methods, and strives to deliver valid information that enables evidence-based and data-driven decisions.

Chemistry Department is well equipped with modern instrumentation, most of which is available for hands-on use by students. Major instruments include a Bruker Avance III 600Mhz NMR/MRI, a Varian 400-MHz multinuclear NMR spectrometer, a Tecmag 300 MHz solid state NMR spectrometer with magic angle spinning and static sample capabilities, a Hewlett-Packard GC/LC/MS facility with EI, CI and FAB ionization capabilities, and a laser desorption FT mass spectrometer.

Comparative Medicine Group (CMG): CMG is a centralized campus-wide core research fee-for-service support unit under the Office of the Vice President for Research (VPR) for the procurement, care, and use of laboratory animals for research, testing, and/or teaching purposes at K-State's main Manhattan campus. The CMG works closely with the VPR's University Research Compliance Office (URCO), Institutional Animal Care and Use Committee (IACUC), and Institutional Biosafety Committee (IBC) to ensure that all animal use at K-State complies with all applicable public laws/regulations, USDA standards, National Institutes of Health/Public Health Service (NIH/PHS) policies, and National Academy of Sciences/National Research Council/Institute for Laboratory Animal Research (NAS/NRC/ILAR) guidelines for the humane and ethical use of live vertebrate animals. Space is available for housing a wide variety of laboratory animal species to include rodents, amphibians, rabbits, dogs, cats, and domestic livestock species. The CMG manages/operates conventional, barrier, and ABSL-2 capable rodent/small animal facilities located in Coles Hall and Mosier Hall within the CVM complex (approx. 8,759 sq. ft. of indoor animal holding space and 6,615 sq. ft. of support space) and conventional and ABSL-2 capable large animal facilities at the Large Animal Research Center (LARC) (approx. 8,708 sq. ft. of indoor animal holding space, 61,120 sq. ft. of outdoor animal holding space, 8.7 acres of pasture, and 23,917 sq. ft. of support space) to include animal procedure rooms for investigator use. K-State's laboratory animal care and use program/facilities are fully accredited by the Association for Assessment and Accreditation of Laboratory Animal Care, International (AAALAC).

Confocal Microscopy and Microfluorometry Core: The Core provides expertise, training and access to equipment for confocal microscopy and microfluorometry. **Core Instrumentation:** The core includes three confocal microscopes. 1) Carl Zeiss LSM 880, consists of an inverted microscope outfitted with five objectives, 2.5x, 10x, 20x, 40x (1.1 NA Oil) and 40x (1.2 NA Water), six lasers, 405 (blue), 458 (blue), 488 (cyan), 514 (green), 561 (green) and 633 nm (red), three fluorescence emission detectors and one transmission detector. One fluorescence

detector is a gallium arsenide phosphide (GaAsP) detector, which is significantly more sensitive than conventional photo-multiplier tubes (PMTs), making it ideal for low SNR samples. The instrument is suitable for three-color co-localization with minimized spectral overlap, overlay of fluorescence onto bright-field images, tiling of images, 3D reconstruction, Fluorescence Recovery After Photobleaching (FRAP), and Fluorescence Resonance Energy Transfer (FRET). Further, the instrument supports microfluorometric measurements including programmed time-lapse imaging, ratio-metric imaging of pH and Ca²⁺ sensitive dyes, and line scans for fast events such as Ca²⁺ sparks. The Carl Zeiss LSM 880 is outfitted with a temperature-controlled 8-line superfusion setup for live-tissue microfluorometry including pH and Ca²⁺ measurements in conjunction with fast solution changes at 37°C. 2) A second Carl Zeiss microscope, an LSM 880 Airyscan, is outfitted identically to the first with the addition of Airyscan mode, which allows for super-resolution imaging, providing greater x, y and z resolution. 3) Carl Zeiss 700, consists of an inverted microscope outfitted with five objectives, 2.5x, 5x, 20x, and 40x (1.4NA Oil), four lasers, 405 (blue), 488 (cyan), 555 (green) and 639 nm (red), two fluorescence emission detectors and one transmission detector. The instrument is suitable for three-color co-localization with minimized spectral overlap, overlay of fluorescence onto bright-field images, fluorescence recovery after photo-bleaching (FRAP) and Fluorescence Resonance Energy Transfer (FRET). The Carl Zeiss 700 is set up for traditional work with tissue samples mounted on slides or held in glass-bottom culture dishes. The core includes a Leica CM3050S cryostat, which is a computerized microtome used to prepare cryosections of tissues for confocal microscopy. The core also includes a Vibratome 3000 sectioning system, which is used to process tissue specimens into ultra-thin slices. It consists of an advancing, vibrating blade to section tissue. The blade amplitude and cutting speed is fully adjustable as is the angle and cut thickness. Both manual and automatic cut modes are supported. This model has been modified to work in conjunction with a circulating chiller and has a Zeiss stereomicroscope with zooms of 2x, 4x and 8x to observe the sample while cutting. A variety of attachments and specimen holders are available for various applications. The instrument is suitable for fixed or fresh tissues that can either be mounted in an agarose block or glued directly to a tissue holder for processing.

Electron Microscopy Facility: The Nanotechnology Innovation Center of Kansas State (NICKS) hosts an electron microscopy (EM) facility, which can be used to enhance scientific output of K-State researchers, while providing faculty, students and staff with guidance for EM research. This is a fee-for-service facility. **Instrumentation:** The facility can conduct both transmission electron microscopy (TEM) and scanning electron microscopy (SEM) analysis. For TEM, there is an FEI Tecnai G2 Spirit BioTWIN that provides 0.34 nm resolution, 120 Kv and a GATAN digital imaging system with a HAADF detector for STEM imaging and an Oxford detector <135 eV for elemental analysis. For SEM, there is a Hitachi S-3500N scope that provides 3.0 nm resolution and is also equipped with an Oxford detector <135 eV for elemental analysis.

Electronics Design Laboratory (EDL): The EDL was created to support research and development programs within the Kansas Regents University System. EDL is an in-house design service for K-State researchers. The staff has both industry and research experience

with analog, instrumentation, and digital design, as well as software development, system engineering, system construction, and project management. This experience enables researchers to focus on their research, not on becoming electronics experts. EDL provides researchers with access to advanced electronics, assists with integrating electronics technology into research programs, and aids in electronics technology transfer to users by providing ongoing technical support. EDL works in cooperation with many diverse academic departments for a symbiotic approach to problem solving.

Flow Cytometry Laboratory: The Kansas State University Flow Cytometry/Immunology Core Laboratory is a multi-user flow facility housed within the College of Veterinary Medicine. The facility serves the needs of the Kansas State University research campus, including clients of the Colleges of Agriculture, Arts and Sciences, Health and Human Services, and Veterinary Medicine. Flow cytometric research in cell, molecular, and developmental biology spans multiple focus areas including cancer biology, immunology, stem cell biology, and embryology/development. **Instrumentation:** The facility contains a state-of-the-art special order research product flow cytometer manufactured by BD Biosciences equipped with violet, blue, yellow-green, and red lasers and appropriate bandpass filters and detectors allowing users to perform 13-color and 2-dimensional size parameter analysis. We recently purchased a BD FACSMelody™ BVYG 8 color with 4 way sorting that should arrive this spring. **Personnel:** The Flow Cytometry core is staffed by PI Springer, a full-time assistant professor, boarded in clinical pathology, and Mr. Kaori Knights, MS, a full-time research associate who is certified as a Cytometry Specialist through the American Society for Clinical Pathology (ASCP). These individuals assist with study design, technical support, and data analysis.

Integrated Genomics Facility (IGF): The mission is to provide services and technologies for ultrahigh throughput sequencing and gene expression analysis. Workshops in these technologies are an important part of facility operations. The IGF can perform Illumina NGS library preparation from a variety of starting materials, including genomic DNA, PCR products, BACs, total RNA or mRNA. These NGS libraries can be sequenced with various Illumina's platforms such as the MiSeq Personal System, NextSeq 500, HiSeq 2500, etc. Applications include de novo sequencing, resequencing of whole genomes and target DNA regions, sequencing of individual chloroplast genomes and metagenomics environmental samples, RNA analysis, and many more. **Instrumentation:** PacBio Sequel IIe system for high throughput, long-read sequencing; 10X Genomics Chromium iX system for single cell gene expression, single cell immune profiling, and single cell Assay for Transposase-Accessible Chromatin (ATAC); Illumina NextSeq 500 sequencing system for sequencing; Illumina MiSeq System for sequencing; Agilent 2100 Bioanalyzer, a microfluidics-based instrument designed for the analysis of DNA, RNA, and protein samples using nano- or picogram amounts of material; Agilent 2200 TapeStation to automate RNA, DNA, and protein sample QC, including sample loading, separation, and imaging; Covaris DNA Fragmentation; Qubit 2.0 Fluorometer; Pippin Prep (Sage Science) based size selection for DNA, RNA, or Protein; Biomek FXP Laboratory Automation Workstation plus TRobot for liquid handling. This facility also provides full data analysis support.

Kansas Lipidomics Research Center: The Center provides a range of mass-spectrometry-based lipid analytical services to K-State scientists and to scientists from around the world. The mission of the Kansas Lipidomics Research Center is threefold: 1) The Analytical Laboratory provides comprehensive, quantitative profiling of lipid molecular species with high sample throughput using mass spectrometric technologies; 2) The Technology Development Component works to expand lipid profiling and other metabolomic capabilities; and 3) The Scientific Research Component promotes collaborative research among lipid scientists and provide training opportunities for postdoctoral, graduate, and undergraduate students. Some goals of lipidomics are to: a) Determine specific lipid compositional changes occurring in organismal or cellular responses; b) Determine the function of genes involved in lipid metabolism or signaling; c) Diagnose the physiological state of an individual organism; and d) Identify and utilize biomarkers. Other services include: 1) Fatty acid analysis; 2) Sterol analysis; 3) Accurate mass analysis for structural elucidation; and 4) Other metabolite and lipid analysis (inquire). **Instrumentation:** Advion chip-based ESI sample introduction; Applied Biosystems API 4000; Applied Biosystems 4000 Q-Trap; Applied Biosystems QSTAR Elite; ESI-quadrupole/time-of-flight hybrid MS; ESItriple quadrupole MS/MS; Waters Xevo TQS triple quadrupole mass spectrometer; (2) Agilent Gas Chromatograph/Mass Spectrometer; Mini-PAL autosamplers.

Kansas State Veterinary Diagnostic Laboratory (KSVDL): The KSVDL is a full service AAVLD- accredited veterinary diagnostic laboratory that provides high quality diagnostic and consultative services to veterinarians, livestock producers, animal owners, public health officials, researchers, and commercial enterprises. The KSVDL protects regional animal health and biosecurity with service in the CDC's Laboratory Response Network and the USDA's National Animal Health Laboratory Network (NAHLN). As a NAHLN laboratory, the KSVDL is the first line of defense in diagnostic testing in the event of a foreign animal disease investigation. Experienced laboratory and clinical personnel are trained in the detection of emergent, foreign, and bioterrorism agents. Secure, automated, two-way communications between the KSVDL and regulatory agencies creates a national repository for animal health data. KSVDL is involved in the development and implementation of standard diagnostic techniques for identification of endemic and select agents, including rapid, high-throughput polymerase chain reaction (PCR) technologies and next-generation sequencing.

Molecular Biology Core: The Molecular Biology Core was established in 2002 upon an alignment of expertise, need, vision, altruism, and funding from the National Institutes of Health (NIH-P20-RR017686), the College of Veterinary Medicine (CVM), and Kansas State University (K-State). The Core provides expertise, training and access to equipment for nucleotide and protein analysis. The Molecular Biology Core serves K-State faculty, postdoctoral fellows, students and staff. The Core is currently funded by the CVM. Users are not charged fees for training and use of the Core but are expected to acknowledge in all publications: Molecular Biology Core supported by Kansas State University College of Veterinary Medicine.

Instrumentation: Nanodrop 8000 absorption spectrophotometer; Nanodrop ND 3300 fluorescence spectrophotometer; Agilent BioAnalyzer lab-on-chip system to analyze up to 12 RNA or DNA samples; two Applied Biosciences StepOnePlus thermocyclers (96-well format) for

real-time detection; Fluid handling station / pipetting robot, Beckman Coulter Biomek NXp, used to assemble RT-PCR reactions in the 96-well format; Kodak Image Station 4000 for the analysis of immunoblots by chemiluminescence; FluorChem HD2 imager for the analysis of gels and blots by fluorescence or chemiluminescence. Filters available support fluorescence detection of ethidium bromide, SYBR-Green, GFP and Cy5.

Nanotechnology Core Facility: A multiuser facility serving the CVM, the K-State campus, and research and commercial institutes outside the campus. A well-equipped tissue culture facility can provide service for multiple investigators. A dedicated microscopic imaging room includes bright field, dark field, and fluorescence microscopy. The core has two plate readers capable of absorbance, fluorescence, and luminescence-based assays. The range of molecular biological instrumentation includes a QuantStudio 7 Flex, a Luminex 200, and a Chirascan CD spectrophotometer, allowing the core lab to be used for RT-PCR, ELISA, chemokine and cytokine assays, and thermodynamic and 3D structural characterization of proteins. State-of-the-art nanoparticle characterization equipment, such as Zetasizer, Nanosight, and a CPS high resolution disk centrifuge are available for measuring size and concentration of nanoparticles in suspension. A fully equipped surgical suite for small animals (up to 100 lb.) and an IVIS bio-imaging system facilitate in vivo experiments are also available. A complete description of available instrumentation is included at the website.

National Agricultural Biosecurity Center (NBAF): The National Bio and Agro-defense Facility is the U.S. Department of Homeland Security's/USDA foremost animal disease research facility. The \$1.25 billion facility is a biosafety level-4 laboratory and will replace the aging Plum Island Animal Disease Center in New York. The facility has completed construction adjacent to the CVM and the Biosecurity Research Institute on Kansas State University's Manhattan campus. NBAF is expected to be open in 2024. This strategic location places NBAF near important veterinary, agricultural and biosecurity research and expertise and in turn will also provide opportunities for collaborations and trainee training.

Nuclear Magnetic Resonance (NMR) Facility: The mission of Biomolecular NMR facility is to assist K-State life science researchers interested in (1) characterizing protein domain constructs of novel biologically important gene products, (2) developing robust and general methods for high-level expression and isotopic (^{15}N , ^{13}C and ^2D) enrichment of these domains for NMR studies, (3) applying multi-dimensional NMR methodology for determining 3D structure of these domains and in studying binding of inhibitor on protein molecules, and (4) identifying the small molecular weight metabolites by means of NMR spectroscopy. **Instrumentation:** The facility includes a 'state-of-the-art' 14 Tesla 600 MHz Bruker Ascend NMR Superconducting Spectrometer System equipped with pulsed field gradient accessory, a four channel detection system, two waveform generators, a 5 mm latest generation carbon enhanced Cold Probe, a 3 mm [$^1\text{H}/^{13}\text{C}/^{15}\text{N}/^{31}\text{P}$] Penta probe, a 5 mm [$^1\text{H}/^{13}\text{C}/^{15}\text{N}$] triple resonance and indirect detection probe and a 5 mm [$^{15}\text{N}-^{31}\text{P}$] broadband probe with high stability temperature controller for multinuclear/multi-dimensional NMR experiments. Five Linux workstations with modeling programs and processing software are available for off-line NMR data processing and storage, and 3D structure calculations.

The KSU Plant Cell Biology and Cytogenomics Core Facility has a Zeiss LSM 780 Confocal Microscope. The LSM 780 is equipped with Zeiss 40x/1.2 NA and 63x/1.2 NA C-Apochromat water immersion objectives for imaging of subcellular dynamics inside living tissue. The microscope is equipped with Differential Interference Contrast (DIC) microscopy. The spectral imaging capability of the LSM780 allows generation of a lambda stack and use of a mathematical algorithm to separate autofluorescence and up to 9 additional fluorescence channels. This microscope has an exclusive 32 channel ultra-sensitive gallium arsenide phosphide (GaAsP) detector that provides twice the quantum efficiency of other detectors. The GaAsPP detector enables accurate details and contrast-rich imaging of challenging specimens with weak fluorescence signals and facilitates live cell imaging with lower photobleaching and phototoxicity. Photon counting, fluorescence correlation spectroscopy (FCS) and other advanced techniques are possible. The OSCiscan function allows faster acquisition of high-quality data and better time resolution.

Protein and Biopolymer Analysis Core Lab will open in May 2023 and will provide well-maintained, state-of-the-art instrumentation and critical expertise to the Kansas State University and surrounding entities including NBAF and Scorpius Biomanufacturing. The lab's mission is threefold. One is to provide both cutting edge affordable proteomic/protein characterization and glycan analysis services with a rapid turnaround time. Two is to develop and implement cutting edge and novel proteomics methods and to work collaboratively with scientists, both on and off campus, to apply these methods to their unique scientific projects. Three is to provide analytical imaging and characterization resources for qualitative and quantitative analysis of macromolecules and to foster relevant collaborations for drug development. **Instrumentation:** The facility will include an Applied Photophysics SX20 with double mixing and UV/Vis PDA, BMG CLARIOstar plus microplate reader (with fluorescence polarization capability), CEM Liberty Blue 2.0 HT4 automated microwave peptide synthesizer with Razor cleavage, GE AKTA Pure 25 FPLC system, GE Amersham Imager 680, GE Amersham Typhoon 5, KinTek RQF-3 rapid quench-flow, Leica Thunder imager 3D live cell, Thermo Scientific Nanodrop One dilution-free UV-Vis Spectrometer, Waters ACQUITY advanced polymer chromatography (APC) coupled with Malvern OMNISEC REVEAL detectors (RI, UV/Vis PDA, light scattering, and viscometer), Waters ACQUITY H-class UPLC with UV/Vis PDA and fluorescence detectors, Waters Xevo G2/XS high-resolution mass spectrometer coupled with Waters ACQUITY M-Class nanoUPLC, and two Lenovo workstations loaded with complete software for proteomic and glycan analyses.

Veterinary Health Center (VHC): The veterinary hospital at K-State is the largest in Kansas and one of the largest in the nation. The VHC is housed in the 185,000 square foot Mosier Hall facility. Annually, 23,000 animals from around the area are treated by VHC faculty and students. Patient breakdown includes approximately 17,000 in-house patients, nearly 7,000 ambulatory patients and over 3,500 shelter animals that are managed for sterilization and routine preventative health. The teaching hospital is located on the north end of K-State's campus and is available for appointments as well as for emergency care. Specialty areas include Small Animal internal medicine, Small Animal orthopedic and soft tissue surgery, radiology,

dermatology, dentistry, oncology, ophthalmology anesthesiology, exotic and zoo animal medicine, cardiology, equine medicine and surgery, livestock medicine and surgery, and beef production. The oncology staff are also members of the JCRC and established the Center of Excellence for Translational and Comparative Oncology Research to assist and expedite the pre-clinical development and testing of cancer related therapeutics in non-rodent animal models.