

Agriculture Experiment Station Farms and Greenhouse Facilities

Peckham Farm is home to a variety of livestock including beef/dairy cattle, sheep, goats, swine, and poultry. The farm and its animals housed are used for research, teaching, and extension programs. The farm is roughly 20 acres, with 18 of it being pasture. All animal handling and the use of animal handling areas requires prior approval with the Farm Manager, Coleman Replogie (creplogie@uri.edu).

University of Rhode Island Institutional Animal Care and Use Committee (IACUC) requires animal protocols to be approved prior to commencing, submitted to the farm manager for filing, and displayed at the animal handling area. To ensure proper biosecurity practices, the farm manager oversees the introduction of all new animals to the farm. All new animals must have the relevant permits and health certificates and be associated with an approved IACUC protocol prior to their arrival. Users traveling to or working on other farms must wear separate clothing and footwear or properly sanitize their clothing and footwear before returning to the farm.

All veterinary pharmaceuticals brought onto a farm must be approved by the farm manager, URI's academic veterinarian, or practicing veterinarian. Pharmaceuticals are subject to inspection by the University of Rhode Island IACUC.

URI's Greenhouse facility totals 15,500 square feet in usable space, including the 2,100 square foot Horridge Conservatory. The greenhouse cost center can accommodate specific needs including supplemental lighting, shade cloth, whitewash, and special protocols; greenhouse space is assigned to priority users based on those needs. An adjacent growth chamber facility provides four environmental growth chambers and four incubators for highly controlled experimental environments, including temperature, light, humidity, and CO₂ manipulation. Three of the incubators are housed within URI's USDA certified biological control containment facility and are available to trained personnel with projects requiring use of the containment facility. Contact: Tim Sherman (timothy_sherman@uri.edu).

The Gardner Research Center (Agronomy Farm) has approximately 85 acres of land for research and education in vegetable and grain production. 40 acres are used to grow forage for the animals at Peckham Farm, with 15 in organic production. About 4 acres are certified organic. There are an additional 25 acres of fields protected by deer fencing and 4 acres of unfenced land. There are 8 high tunnels, a heated poly-house, and two weather stations. Contact: Tim Sherman (timothy_sherman@uri.edu).

East Farm contains roughly 85 acres of meadows, forests, orchards, greenhouses, and fish tank laboratories. East Farm is located a mile from the Kingston campus on Route 108 and is adjacent to Audubon Society property, making it ideal for bird and wildlife habitat research. The farm currently has a crabapple tree orchard, pollinator habitat, fish rearing facilities and fisheries outreach, integrated pest management capabilities, and demonstration gardens and greenhouses run by URI Cooperative Extension Master

Gardeners. Contact: Tim Sherman (timothy_sherman@uri.edu).

Biomedical Core

RI-INBRE Centralized Research Core Facility (CRCF) <https://web.uri.edu/riinbre/core-facility/> is funded by RI-IDeA Network of Biomedical Excellence (INBRE, P20GM103430, PI: Bongsup Cho) and is managed by Dr. Ang Cai with assistance from Research Associate III Janet Atoyan. The CRCF is a state-wide core facility to promote interdisciplinary and cutting-edge biomedical research and student training opportunities by providing researchers access to advanced chemical and molecular biological instruments.

The CRCF houses over 40 high-end molecular-biology, analytical, and imaging instruments to serve RI's biomedical scientists totaling 3800 sq. ft. in the URI College of Pharmacy building. Inside the main laboratory space, a cell culture suite contains a biosafety cabinet and two incubators. A separate NMR and Mass Spectrometry laboratory includes a NMR spectrometer and two mass spectrometers.

The staff trains and assists users to operate any CRCF instrumentation that may be needed in their research. As a training-focused cost center, the CRCF does not provide project-based analytical and technical services.

Major equipment includes:

- **Sciex LC/MS Triple TOF 4600 Mass Spectrometer** – Accurate mass triple quadrupole MS and MS/MS for qualitative and quantitative workflows with a mass range to 40,000D. LC is a Shimadzu Prominence liquid chromatograph with additional UV detector.
- **Shimadzu Axima Performance MALDI-TOF MS** – Matrix assisted laser desorption and ionization MS for peptides, proteins and DNA with a mass range to 500,000D.
- **Agilent LC/MS 6470B Triple quadrupole Mass Spectrometer** – Nominal mass triple quadrupole MS for quantitative workflows with a mass range m/z 5-3000.
- **Nikon Eclipse Ti2 Inverted Confocal Microscope** – Imaging for transmitted light, epifluorescence light, and laser confocal techniques. Confocal laser frequencies at 405, 488, 561 and 640 nm. Motorized XYZ stage.
- **Cytiva BiaCore T200 SPR** – a microfluidic platform for measuring binding between biomolecules using surface plasmon resonance optical technology.
- **BD FACSVerser Flow Cytometer** – counts cell populations based on fluorescent labels.
- **Agilent Seahorse Metabolism Analyzer** – measures changes in cellular energetics in real-time using a 96-well format.
- **BioTek Cytation 5 Imager** – Multimode plate reader and imager with temperature- and atmosphere-controlled sample chamber.
- **Bioautomation MerMade 4 DNA Synthesizer** – For preparation of DNA sequences using chemically-modified or standard nucleotides.
- **Roche LightCycler 96 qPCR** – Quantitative PCR instrument for measuring DNA

- amplification and gene expression by detecting fluorescence in real-time.
- **Azure Biosystems Sapphire Imager** – Multi-mode laser imager, capable of RGB, fluorescence and phosphor imaging. Lasers at 488nm, 520nm, 658nm, and 784nm.
- **Li-Core Odyssey CLX IR Imager** – Western blot and gel imager using IR fluorescence dyes at 700 and 800nm.
- **Nanotemper Tycho NT.6 Protein Quality Analyzer** – Verifies protein quality by measuring unfolding in a three-minute assay.
- **Beckman Optima L-100XP Ultracentrifuge** – Capable of 100,000 rpm with multiple acceleration and deceleration profiles. Type 70 Ti, Type 70.1 Ti, Type 90 Ti and SW 40 Ti swinging bucket rotors available.

The RI-INBRE Molecular Informatics Core (MIC) <https://web.uri.edu/riinbre/mic/> was formed from the merger of the RI-INBRE Bioinformatics Core and the sequencing component of the RI Genomics and Sequencing Center, a URI NSF EPSCoR facility. The MIC is an NIH Data Sciences Core for Biomedical Research facility and provides sequencing and bioinformatics support for URI and other institutions in the INBRE and EPSCoR networks.

The MIC is under the direction of Dr. Chris Hemme (Biomedical and Pharmaceutical Sciences, College of Pharmacy) and sequencing manager Janet Atoyan. The Core offers services in four general areas: 1) Sequencing and Sample Prep, 2) Bioinformatics and Data Science, 3) Molecular Modeling, and 4) Virtual Reality. The Core is working to establish start-to-finish pipelines that allow users to access any services from sample prep to sequencing to bioinformatics analysis and works with the RI-INBRE CRCF to provide a unified pipeline between select data generation and data analysis projects. We also provide access to molecular modeling software such as Spartan and Molecular Operating Environment. The Core maintains the College of Pharmacy virtual reality hardware and works with URI ITS and other collaborators to develop STEM-based VR apps for use in teaching, training and research.

The Biomedical Data Science component of the Core focuses on omics data analysis, biostatistics, general data science, and training. The Core primarily utilizes the URI high performance computing resources but is working with URI Research Computing and the NIH STRIDES initiative to increase access to cloud resources.

Bioinformatics Resources and Virtual/Augmented Reality Equipment

- **2 bioinformatics desktops/3 VR laptops** - two desktops located at URI loaded with a variety of software for molecular modeling, bioinformatics and virtual reality applications
- **HTC Vive/3 HTC Cosmos VR Headsets** - Virtual reality headsets available for use for teaching and training
- **Spartan License** - Software for molecular modeling with an emphasis on small molecules
- **Molecular Operating Environment (MOE) License** - Software for molecular modeling with an emphasis on large molecules (eg proteins)

The Sequencing Component of the Core currently offers both analytical and equipment

services using the following instrumentation:

- **ABI 3500xl genetic analyzer** - DNA Sanger sequencing and fragment analysis
- **Takara Bio Apollo 324 library prep system** - NGS gDNA library preparation
- **Illumina MiSeq** - next-generation sequencing

Additional Sequencing Resources include

- **Agilent 2100 BioAnalyzer** – a microfluidics-based platform for sizing, quantification and quality control of DNA, RNA, proteins and cells.
- **Covaris S220 high performance ultrasonicator** – provides automated acoustic disruption and homogenization of cells and tissue samples.
- **Roche LightCycler® 480 qPCR system (1)** – a multiwell-plate based qPCR platform used for highly accurate qualitative and quantitative detection of nucleic acids.

The Diving Research & Safety Program oversees all diving operations at the University of Rhode Island (URI), including education, outreach, and research activities following standards as set forth per the American Academy of Underwater Sciences (AAUS). This program falls under the Division of Research and Economic Development as a department. Curricular and regulatory functions are generously supported by annual funding from the College of Environment and Life Sciences and the Office of the Provost. The College of Arts & Sciences, the College of Engineering, and the Graduate School of Oceanography also provide additional support. The program is directed by Anya Hanson, Director and Diving Safety Officer, and Alexandra Moen, Associate Diving Safety Officer and Associate Teaching Professor.

The program oversees two facilities at the URI Tootell Aquatic Center and the Narragansett Bay Campus. Both facilities support multi-disciplinary instruction and international research collaborations. The facilities house an air compressor fill station with 6 storage DOT bottles of compressed gas, safety equipment (e.g. oxygen delivery systems), and all scuba diving equipment for a maximum of 12 divers including diving thermal protection, life-support equipment (e.g. cylinders, regulators, buoyancy compensator devices, dive computers, pressure gauges), accessories (weights, masks, snorkels, fins, compasses, depth gauges) and office equipment. Additional resources at GSO include the following underwater research equipment: dive flags, reels, slates, lift bags, surface marker buoys, dive knives, transects, quadrats, t-bars, corers, dive lights, 2 blue-water diving rigs, drysuits, 2 closed-circuit inspiration rebreathers, full-face masks, a safety recall system, diver safety alert systems, service kits for maintenance, storage bags, instructional first aid supplies (e.g. mannikins, oxygen masks, training AEDs, first aid kits), save-a-dive kits, dive logs, and dryer. The program also has photography equipment: Olympus TG-5 and TG-6 cameras and housings, Sea & Sea underwater strobes, Light & Motion video lights, Sony video camera and housing, and Canon 5D Mark IV camera, housing and additional accessories. All equipment is serviced and maintained internally to high industry and manufacturer standards using a magnehelic, cylinder inspection tools, tumbler, and other manufacturer-specific tooling.

Additional components of both facilities include access to showers and restrooms

(locker rooms at Tootell), gear cleaning bins, dehumidifiers, and ample storage for URI and divers' personal equipment. A Ford F-250 vehicle transports divers to/from field sites. An NSF-funded portable van designed to support ship-based research diving operations aboard the R/V Endeavor or other UNOLS ships is available.

The Engineering Analytical Core <https://web.uri.edu/nano/analytical-core/> is located in the Fascitelli Center for Advanced Engineering and is managed by Dr. Vinka Craver, Professor of Civil and Environmental Engineering (craver@uri.edu). The equipment contained in this core includes:

- **Shimadzu LCMS-8060** . Ultra High-Pressure Liquid Chromatography (UPLC) Triple Quadrupole UPLC/MS/MS system for ultra-trace analysis with high-sensitive Multiple Reaction Monitoring (MRM) component analysis.
- **Shimadzu Nexera-XR ultra**. Fully-integrated high-performance liquid chromatography (HPLC) system with three detectors: the SPD-M20A, RF 20A and Sedex 90 ELSD detector.
- **Shimadzu ICPMS-2030**. Inductively Coupled Mass Spectrometer with autosampler and collision cell.
- **Shimadzu GCMS-TQ8050 NX**. Triple Quadrupole GC/MS/MS for ultra-trace analysis. Includes Purge & Trap autosampler. AOC-6000 autosampler. With three injection tools: liquid, headspace, and solid phase microextraction (SPME)
- **Shimadzu RF-6000 Spectrofluorometer**. Xenon lamp with high-speed scanning of 60,000 nm/min. Extended range scan wavelength up to 900 nm.
- **Shimadzu DSC-60A Plus**. This device can measure phase changes starting at -140°C. This model also comes with a 24 pan autosampler.

The Environmental Data Center <https://www.edc.uri.edu/> is a Geographic Information System (GIS) and geospatial data analysis laboratory in the URI Department of Natural Resources Science. The mission of the EDC is to support the use of contemporary tools for spatial data processing and electronic dissemination in the analysis, visualization, and distribution of environmental data. This is achieved through cross-college collaborative research with faculty and experiential learning opportunities with students, fellows of the URI Coastal Institute, planners at the URI Coastal Resources Center, and partners in agencies external to URI. In addition, the EDC plays a key role in transferring technology to local and state coastal and terrestrial resource managers, private industry, non-governmental organizations, K-12 audiences, and the public through its

The EDC is recognized as the center of technical expertise in GIS for the State of Rhode Island in RI State Statute and is incorporated into the General Laws of RI, Title 42 State Affairs and Government [Chapter §42-11-10 \(g\) \(3\)](#), Title 16 Education [Section § 16-32-30](#) and [Section §16-32-31](#)).

The EDC curates the public facing elements of the **Rhode Island Geographic Information System (RIGIS)** geospatial database, online web map collection, and imagery services <https://www.rigis.org/> The RIGIS database is the most comprehensive and detailed of any state in the country and contains information on almost all aspects of Rhode Island's natural and cultural resources (e.g., wetlands, aquifers, hydrography, soils, forests, land use, open space, topography, transportation, historic sites, etc.).

The major areas of research at the EDC are in terrestrial and coastal imaging using aerial and submersible drone technology, developing and deploying web mapping and field data collection apps; conducting ecological mapping, data integration, spatial data modeling and geospatial visualizations in support of natural resources management, environmental hazard planning, risk modeling, and emergency response.

Geospatial Training: The EDC is integral to the development and delivery of the new [URI Online Accelerated Graduate Certificate in GIS and Geospatial Technologies](https://web.uri.edu/uri-online-accelerated-graduate-certificate-in-gis-and-geospatial-technologies/). The format of this accelerated certificate is ideal for accommodating working professionals, military service members, as well as domestic and international students. The certificate trains students to become proficient in the high-demand geospatial technology skills associated with Geographic Information System (GIS). One-half and 3-day short courses in GIS are also offered for educators, resource managers, professionals and the general public.

Marine Science Research Facility

The **Marine Science Research Facility Analytical Labs** service center (<https://web.uri.edu/marinefacility/analytical-laboratories/>) is directed by Dr. Malia Schwartz (URI GSO) and has one technical staff (Dawn Outram). Its goal is to provide the tools necessary for scientific research as well as aid in student training and sample analysis. Lab space is available for bench work (DNA extractions, molecular work, and sample preparation and analysis). General resources include 7 Percival Upright Incubators (6 range from -2 to 44°C, 1 ranges from 2-44°C), autoclaves (2 large, 1 small benchtop) and 2 laminar flow hoods with and without UV light. Services provided include training on equipment usage, consultation on experimental design, and sample analysis.

Major Equipment includes: BD Influx Flow Cytometer with sorting capabilities; Lachat Nutrient Analyzer (Ammonium, Silicate, Phosphate, Nitrate and Nitrite); Beckman Coulter Counter Multisizer 4; QPCR Thermocycler; Flow Cam Imaging Particle Analyzer; Membrane Inlet Mass Spectrometer; Turner Designs Field Fluorometer; Fluorescence Induction Reduction Fluorometer; Spectramax Plate Reader; PCR machines; and Nikon Epifluorescence Microscope with Digital Camera.

Minor Equipment includes: Microbalances; Eppendorf microcentrifuge; Filter manifold with 25 and 47 mm filter cups; Gel visualization box; Gel Imager; Handheld YSI with DO, pH, salinity and temperature probes; Heating/cooling block; Homogenizer; Laboratory fridge/freezer; Laminar Flow Tank; Biospherical PAR Sensor w/laptop; Micropipettes (12); Milli-Q water system; Nanodrop 1000; Qubit Fluorometer; Nikon Inverted Scope with Hoffman Contrast; Olympus Stereomicroscope; pH meter; Shakers (4); Small Strip tube centrifuge; Stingray Microscope Camera; Vacuum pump; Vortex (2); Jaz Spectrometer; Bead Beater; and PreSens Oxygen meter.

The **Marine Science Research Facility Shared Seawater Facilities (SSF)** service center (<https://web.uri.edu/marinefacility/seawater-facilities/>) at the Narragansett Bay Campus is jointly managed by URI's Graduate School of Oceanography (GSO) and College of the Environment and Life Sciences (CELS). Edward Baker

(ebaker@gso.uri.edu) provides day-to-day oversight and technical support. The SSF is housed in four buildings: the Ann Gall Durbin Marine Research Aquarium, the Ark Annex, the Luther Blount Aquaculture Research Lab, and the Marine Ecosystem Research Lab. With 8,000 square feet of indoor wet lab space and nearly unlimited exterior space, any marine environmental condition can be replicated apart from extreme depth and vastness. Tanks range in size from 3m in diameter to smaller aquaria.

Facility features include specialty wet labs for pathology and transgenic research (with dedicated effluent systems), a pier, four seawater intake pipes, a pump house, shallow estuarine mesocosms, and numerous outdoor tanks. Customizable temperature, salinity, photoperiod, filtration, aeration, flow rates, and sunlight are all available.

The facility also includes four environmental chambers (-4 to 24°C) with photoperiod control and high and low alarm controls, a walk-in -20°C freezer, a laminar flow tank, 3 large-scale incubators, and 24/7 generator back-up and emergency response personnel.

The Pharmaceutical Development Institute (PDI) <https://uripdi.thinkific.com/> is a multi-functional operation that supports the biopharmaceutical industry, entrepreneurial academic researchers, and student education. The main PDI operations take place in a 7,000 sq ft pharmaceutical cleanroom manufacturing/training facility in the lower level of the URI College of Pharmacy (Avedisian Hall), where solid oral dosage forms (e.g., tablets, capsules, powders, etc.) are developed and manufactured. The PDI has high-tech equipment, three separate manufacturing suites, and a team of highly experienced veteran scientists and engineers from the pharmaceutical industry. The fundamental goal of the PDI is to enable established and start-up pharmaceutical firms, including entrepreneurial academic and medical researchers, to bring new innovative drugs into necessary development studies and first-in-human clinical trials. A separate 1,500 sq ft analytical development/quality control laboratory is also an integral part of the PDI, where all raw materials and final products undergo rigorous quality testing. The facility operates under Good Manufacturing Practices (GMPs), and the staff team is highly experienced and well-versed in the guidance and requirements for submissions to regulatory authorities (e.g., INDs, IMPDs, CTAs, NDAs, BLAs, etc.).

Another key mission of the PDI is to train individuals, both students and external professionals, for advanced careers in biopharmaceutical manufacturing. To date, the PDI offers beginner, intermediate, and advanced training programs for employees in the biopharmaceutical industry. Individuals are given the opportunity to gain hands-on experiences with equipment used in cleanroom environments meeting ISO 5 to ISO 8 specifications. Emphasis is placed on aseptic processing (from inoculation in shaker flasks through bioreactors transfers), viable and non-viable environmental monitoring, cell culture, cell harvest, and purification. Currently, internships are available for URI students to work side-by-side and hands-on with the PDI staff, and the PDI expects to offer one or more courses related to “real-world” pharmaceutical development and the biopharmaceutical industry, taught by PDI staff and other experienced biopharmaceutical industry professionals.

PDI services include:

Contract Development and Manufacturing

A 6,000 sq ft manufacturing facility, including 3 independent GMP process suites, provides formulation/process development and manufacturing of solid oral dosage forms (e.g., tablets, capsules, powders, etc.). The equipment and capabilities assist clients to achieve product quality expectations and meet clinical development milestones with adequate supplies for development, stability, animal/toxicology studies, and human clinical trials. Major equipment/instrumentation includes:

- **Tablet Presses (Natoli and Vanguard)** – the PDI has three tablet presses (single-station manual, single-station automatic, and 16-station rotary) with a capability of up to 28,000 tablets/hour.
- **Encapsulation Machine (Vanguard)** – a semi-automatic encapsulator is available to manufacture powder-filled two-piece gelatin and HPMC capsules.
- **Tablet Pan Coater (Vanguard)** – coating equipment is able to apply non-functional (e.g., aesthetic, color, etc.) and functional (e.g., taste masking, enteric, etc.) coatings to the surfaces of tablets.
- **Roller Compactor (Freund Vector)** – facilitates densification of fine powders into flowable and compressible granules without the need for granulating solutions.
- **High Shear Granulator (Freund Vector)** – facilitates densification of fine powders into flowable and compressible granules using aqueous- or solvent-based granulating solutions.
- **Fluid Bed Systems (Glatt)** – the PDI has two small-scale fluid bed systems, which are capable of granulation, drying, and coating.
- **Powder Blending (Vanguard)** – V-blender that operates on diffusion blending of powders.
- **Mills (Vanguard, Globe Pharma, Freund Vector)** – several mills available to reduce particle size of large granules for downstream processing.
- **Testing Instruments** – tablet hardness tester, friabilator, powder loss-on-drying, sieve analysis (particle size distribution), etc.

Analytical, Quality Control, and Stability Testing

A 1,500 sq ft analytical, quality control, and stability testing laboratory offers full analytical and quality control services, including method development and qualification, raw material and compendial testing, drug substance and drug product testing for development, release, stability, and method transfer. Major instrumentation includes:

- **Ultra-Performance Liquid Chromatograph (Waters)** – UPLC equipped with Photodiode Array Detector (PDA) and Charged Aerosol Detector (CAD) is available for quantitative analysis of components in a complex mixture. The PDA detector allows for multi-wavelength measurement and generation of spectra for each component. The CAD detector is useful for quantitating compounds that do not contain chromophores.
- **Gas Chromatograph (Agilent)** – GC capabilities with Flame Ionization Detection (FID) is targeted for installation in 1Q/2023. The GC/FID permits analysis of residual solvent levels in pharmaceutical products.
- **Automated Dissolution System (Apparatus I & II) (Distek)** – Instrument is utilized to evaluate drug release characteristics and consistency of drug

products. Apparatus I (rotating basket) and Apparatus II (rotating paddle) methods are routinely used for release and stability testing of solid oral dosage forms, such as tablets and capsules.

- **Disintegration System (Pharmatron)** - Instrument is utilized to measure the amount of time it takes a sample (usually a tablet or capsule) to totally disintegrate inside a liquid medium.
- **Coulometric KF Titrator (Metrohm)** - Coulometric KF determines the water content (bound and unbound water) in a sample using classic titration. The instrument can determine low water levels (e.g., 0.001 - 1% water) and is routinely used for release and stability testing of solid oral dosage forms, such as tablets and capsules.
- **Stability Chambers** – several stability chambers will be available (target installation 1Q/2023) for controlled temperature and humidity storage of pharmaceutical drug products.

Customized Training

The PDI offers specialized biopharmaceutical training to specific industry segments and utilizes a 1,000 sq ft training facility. The PDI works collaboratively with client firms to customize training to their unique and detailed process-specific requirements, thereby enhancing employee capabilities and expertise. Taught exclusively by industry professionals, the workshops include: Introduction to BioPharmaceutical Manufacturing, Cell Harvesting, Aseptic Processing, Introduction to Validation, Quality Assurance and Compliance, Advanced Chromatography, and other specialized topics. Major equipment/instrumentation includes:

- **Eppendorf Bioflo 120 Bioreactors:** The PDI has two Bioflo 120 bioreactors, which are used to manufacture monoclonal antibodies and advanced therapy medicinal products (ATMPs). The Bioflo 120 reactors are robust, scalable, operate in a nearly identical manner to larger bioreactors, and are adaptable to single use systems.
- **Biological Safety Cabinets (BSCs):** The PDI has three 6 ft NuAire Class II BSCs, which are used for aseptic operations such as cell thaw and cell culturing. Units provide an ISO 5 aseptic work area for learning or advancing aseptic processing skills.
- **Met One/Climet Particle Counters:** Several particle counters are available for monitoring the air quality of work environments for non-viable particle loads.
- **Super 180 Viable Air Samplers:** Several particle counters are available for monitoring the air quality of work environments for viable particle loads.
- **KAYE Validator:** This validation instrument is used for temperature mapping activities (e.g., from the precalibration of thermocouples to final verification) for purposes of demonstrating temperature control of equipment/rooms and controlled steam sterilization cycles.

Research Computing Resources at URI are hosted in the Tyler Hall data center located on-campus in Kingston, RI. This data center is operated by the University IT Services under the leadership of URI's chief information officer, Dr. Karlis Kaugars. The data center is configured with emergency power supplies and high-speed internet access through the URI central power and network connections. Central cooling is

provided to maintain a climate-controlled environment for the operation of HPC systems. Dedicated IT staff provide operation, management and monitoring support to ensure the smooth operation of the data center facility.

The URI Center for Computational Research (<https://ccr.uri.edu>) includes an IT Research Computing Services team that consists of several specialists: Dr. Kevin Bryan manages HPC systems, Dr. Michael Puerrer is a Research Computing Facilitator, Christian Vye handles the support for software applications, licensing and 3 graduate students offer consultation and training. This team is led by Dr. Gaurav Khanna who serves as Director and is also a Professor in the Physics Department. The Center is advised by a committee of URI faculty representing widely different areas of research. The Center also has a supporting external advisory group consisting of regional experts drawn from the Massachusetts High-Performance Computing Consortium (MGHPCC) in the area of research computing.

Existing high-performance computing (HPC) resources

Bluewaves high-performance computing cluster

Bluewaves HPC cluster contains 62 standard computer nodes [20 physical cores; 128 GB (60), 256 GB (1), or 512 GB (1) memory, 2TB local storage], two large memory nodes (24 physical cores, 512 GB memory, 4TB local storage), and over 1.1 PB hard disk spaces for fast I/O and secondary storage. The storage disks are configured with RAID 6 protection. The computer nodes are connected with InfiniBand QDR network cables and switches and are assembled in three 42U racks. The cluster is in its seventh year of operation. The cluster, while still operating, is near the end of its life cycle and has limits for further expansion. The equipment is shared among a wide group of URI faculty and is running close to its maximum capacity.

Andromeda high-performance computing cluster

The *Andromeda* HPC cluster is a similar scale cluster that largely serves groups of contributing users with some support for the broader URI user community. It is established with contributions from individual researchers and currently has 47 nodes, providing 1704 cores with nodes having 64GB (8), 128GB (29), 256GB (3), 512GB (4), or 768GB (1) memory. These are connected via an Omni-Path 100Gbps network, with shared storage to the 1.1 PB hard disk on *Bluewaves*.

URI campus central data center

Both clusters are located in a Data Center located in the Tyler Hall Building on the Kingston campus. The 2,300 sq. ft. Data Center provides a climate-controlled environment with 90 tons of cooling for the operation of HPC systems and is equipped with 160 kVA of UPS battery backup as well as a 450 kW Generator that provides emergency power supplies. The Tyler Hall Data Center is operated by the URI Information Technology Services (ITS) and is monitored and maintained by ITS staff.

Collaborative high-performance computing (HPC) resources

The *Massachusetts Green High-Performance Computing Center* (MGHPCC) is a collaboration of the five major research universities in Massachusetts including Boston University, Harvard, MIT, Northeastern and UMass. The collaboration built a dedicated

data center in 2012 located in Holyoke, MA that hosts the research computing infrastructure of these universities. The URI *Colab for Research Computing* has begun multiple collaborative programs with the MGHPCC, allowing for URI researchers to get access to the following MGHPCC resources:

UMass – URI collaboration: UNITY cluster

URI and UMass are building and operating a new shared HPC environment at the MGHPCC. Researchers have access to this “UNITY” cluster via the *InCommon Federation*. Details of the cluster may be found at the UNITY cluster portal (<https://unity.uri.edu>). The cluster currently offers ~250 nodes with an expectation of significant growth in the near future. The nodes include both Intel and AMD multi-core processors and Nvidia GPGPUs for HPC and AI/ML computations.

MIT – URI collaboration: SuperCloud

URI researchers have access to the MIT Lincoln Labs “SuperCloud” resource via the *InCommon Federation*. Details of the cluster may be found at the SuperCloud cluster portal (<https://supercloud.mghpcc.org>). The cluster currently offers 200+ nodes, each with 40 Intel Xeon cores, 2 Nvidia V100 GPGPUs and 384GB memory and 400+ nodes with 48 Xeon cores and 192GB memory.

Tape archival storage: NESE

The North-East Storage Exchange (NESE) is a storage collaboration led by Harvard and Boston University (<https://nese.mghpcc.org>) funded by NSF hosted at the MGHPCC. URI researchers have access to this facility for their data backup and tape archival needs via the *InCommon Federation*.

Active research data storage: OSN

The OpenStorageNetwork (OSN) is a national distributed storage collaboration (<https://openstoragenetwork.org>) funded by NSF, with a node hosted at the MGHPCC. URI researchers have access to this facility for their active research data storage and collaboration needs. Access to URI researchers is enabled through the *InCommon Federation*.

High-speed access (10 Gbps) between the MGHPCC and URI is enabled via a collaboration between OSHEAN and UMassNet.

The Rhode Island Consortium of Nanoscience and Nanotechnology (RIN2)

<https://web.uri.edu/nano/> is a multi-user materials characterization facility that enables cutting-edge academic and industrial research and education through access to advanced material characterization techniques for research in materials science, nanotechnology and the life sciences. RIN2 aims to service users from different scientific disciplines, with several integrated microscopic and analytical techniques and specialty sample preparation methods such as cryogenic electron microscopy. RIN2 is supported by the College of Engineering at URI, NSF EPSCoR C-AIM #OIA-1655221 and 401 Tech Bridge.

Specific objectives of RIN2 are to: 1) offer advanced material characterization to users at URI, other academic institutions, non-profits and industries, 2) provide theoretical and hands-on training on these tools to the next generation of researchers and

technologists, at the pre-college, undergraduate, graduate and post-graduate level, 3) enable reaching the highest standards of research in materials science and nanotechnology by expanding the available technique portfolio on an as-needed basis and advising from expert RIN2 personnel, up-to-date with the pertinent literature, and 4) connect researchers from different disciplines to solve grand challenges.

Major equipment includes:

- **Scanning transmission electron microscope (S/TEM)** with cryogenic and elemental analysis capabilities: JEOL F200 with a cold field emission gun, equipped with a Gatan 626 cryotransfer holder, Gatan RIO9 CMOS camera, Gatan K3 direct electron camera, Gatan Continuum S electron energy loss spectrometer (EELS) and JEOL energy dispersive X-ray spectrometer (EDS).
- **Scanning electron microscope (SEM)** with cryogenic and elemental analysis capabilities: Zeiss Sigma-VP field emission SEM equipped with variable pressure, secondary electron, in-lens and backscattering detectors, a Gatan Alto cryogenic preparation and loading module, and Oxford Instruments energy dispersive X-ray spectrometer (EDS).
- **X-ray diffraction (XRD)**: Rigaku Ultima IV X-ray powder diffractometer.
- **Confocal Raman microscope (CRM)**: WITec alpha 300 R equipped with motorized XYZ stage for large area acquisition, two excitation laser wavelengths (785 and 532 nm) and 10x to 100x objectives.
- **High-content screening system (HCS)**: Perkin Elmer Opera Phenix high-throughput confocal fluorescence microscope.
- **Fourier transform infrared spectrometer and microscope (FTIR)**: Shimadzu IRTracer-100 FTIR spectrometer equipped with attenuated total reflection (ATR) for solids and liquids, suitable for transmission and reflection measurements, and coupled to a Shimadzu AIM-9000 microFTIR system.
- **X-ray fluorescence (XRF)**: Shimadzu EDX-8100 XRF system for elemental analysis of powder, bulk and liquid samples. Atmospheric, vacuum and helium measurements for low detection limits.
- **Scanning probe microscope (SPM)**: Shimadzu SPM-9700 atomic force microscope (AFM) with options for measuring topography, phase analysis, force curves, Kelvin force microscopy, mapping of electrical conductivity at the nanoscale, magnetic force microscopy and analysis in liquid.
- **X-ray microscope (XRM)**: Zeiss Xradia Versa 610 XRM for non-destructive 3D imaging of specimens. Absorption and phase propagation contrast, large area image stitching. In situ temperature, tensile and compression testing. Maximum spatial resolution 500 nm. For samples 5 cm diameter, resolution is 1 μm .

Ancillary sample preparation equipment and tools include:

- Plunge freezer for cryoTEM: Mark II Vitrobot, for vitrification of samples for cryoTEM.
- Gold sputter coating for SEM: Cressington 108 Auto gold sputter coating system with thickness monitor and rotating/tilting stage, for SEM sample preparation.
- Critical point dryer for SEM: Tousimis Samdri-PVT-3B for biological specimen dehydration.
- Ultramicrotome for TEM and SEM: Sorvall MT2-B for analysis of embedded cell

- or nanoparticle specimens in the TEM.
- Embedding resins and polishing materials for SEM and TEM analysis of cross sections: EpoFix, LR White, hand polishing.
- Negative stains for TEM analysis: UranylLess.
- Vertical stubs for SEM analysis of cross-sections.
- Stub for screening of TEM grids using SEM.
- Antistatic gun and manual pestle and mortar for XRD sample preparation; small volume, low background sample holder for XRD analysis.
- Opentrons OT-2 automated liquid handler for high-throughput cell culture plate fluorescent staining for HCS sample preparation.
- Incubators and biosafety cabinet for preparation of biological samples.
- BioRad KnowItAll Raman database for analysis of data by CRM.
- ICDD database for analysis of data by XRD
- Dragonfly Pro software with machine learning for 2D and 3D image analysis and segmentation

The Robert Carothers Kingston Library & Learning Commons

<https://web.uri.edu/library/contact/carothers-building-directory/> contains several laboratories with sophisticated equipment available for research and teaching needs. Access and training on all laboratory equipment is coordinated by Keith Ranaldi (kranaldi@uri.edu).

The XR/VR lab contains:

- 4 Vive headsets with Valve Index Controllers
- 4 Meta Quest 2 headsets
- 3 Alienware Gaming PCs: Intel Core i9 Processor
 - Live Stream on three 90" TVs
- 2 Pod Cast Quality Microphones w/ USB port access
- Panasonic piano synthesizer

The MakerSpace contains:

- 2 Makerbot Replicator + 3d printers
- 8 Dremel 2d20 3D printers
- 1 Lulzbot Taz Workhorse 3d printer
- 2 Form 3 resin printers
- 2 Form Wash and Form Cure
- Einscan Pro X2 Plus 3D scanner
- GCC Spirit LS Laser engraver
- 2 Brother XM2701 sewing machines
- 1 Singer Heavy Duty 4423 Sewing machine
- 1 Singer M3400 Sewing machine
- 1 Brother PE-770 embroidery machine
- 1 Brother PE535 embroidery machine

- 2 LED high output light lamps
- 1 Light box for product shots
- 1 Light Pad for design
- 1 Inventables New X-Carve CNC Machine + software
- Full Variety of Hand Tools
- Matte Cutter
- Heat Press large format, Heat Press small format
- 4 Cameo, Silhouette Vinyl Cutting Machines
- 1 Samsung Flip 55" Interactive Digital Flipchart

The Launch Lab contains:

- 1 Smart TV w/ telecoms capability 100" screen on mobile apparatus
- 2 Macbook Pro w/ Adobe Suite (Graphic Dx, Video Editing, Wireframing)
- 3 Dell Inspiron Laptops
- 1 JBL EON208P * Bluetooth Speaker + Stand + Microphone

The Think Lab contains:

- 1 Smart TV w/ telecoms capability 100" screen on mobile apparatus
- 16 iPad Pro 12.9 - inch (ability to interconnect)
- PowerLite L530U Laser Projector (Installed)

The Artificial Intelligence Lab contains:

- Nvidia DGX-1, a high-performance GPU (graphics processing unit) server
- 6 Lambda Tensorbooks and one DELL PC, run Ubuntu OS and preinstalled with AI development frameworks, TensorFlow, PyTorch, Caffe, Caffe 2, Keras, CUDA, and cuDNN
 - Processor: Intel™ Core® i7-7700HQ; GPUs: 1x NVIDIA GeForce GTX 1070; Memory: 32 GB DDR4 RAM; Storage: 1 TB NVME SSD
- 6 Spiderbot: Hiwonder Hexapod Programming Robot for Arduino
- 6 Programmable Dancing Robots
- 1 Samsung Flip 55" Interactive Digital Flipchart

The Sensors and Surface Technology Partnership (SSTP) Microscopy Laboratory

originated in 1994 to form a team of faculty aimed at tackling the challenges of developing thin film sensors and looking at surface coatings. This multi-user facility has been supporting the research efforts of faculty and industrial partners for over 30 years. This laboratory is managed by Michael Platek, an Electrical Materials Engineer, and many of the instruments are set up as service centers (mplatek@uri.edu).

Major equipment includes:

- **JEOL 5900 LV environmental scanning electron microscope.** This system has an **extra-large chamber** for handling a wide variety of samples. It has both high vacuum in addition to low vacuum capability for handling samples that can not be coated. It has EDS chemical analysis to understand the chemical

composition.

- **Physical Electronics Multitechnique Surface Analyzer:** capable of performing Auger Electron Spectroscopy (AES) and X-ray Photoelectron Spectroscopy (XPS) with a Argon Ion sputter gun for depth profiling. Both of these techniques are suited for understanding the true surface chemistry (50 to 100 angstroms). The argon ion gun enables users to not only probe the surface chemistry but understand how the chemistry up to 20,000 angstroms into the film.
- **Thermo K-Alpha X-ray Photoelectron Spectrometer** with Argon Ion sputter gun can look at the surface chemistry (50 to 100 angstroms) with a larger stage to handle multiple samples. The argon ion gun can perform depth profiles to understand how the chemistry changes deeper within the sample.
- **Shimadzu Maxima 7000 XRD:** capable of doing powder & thin film diffraction.
- **Shimadzu Electron Probe MicroAnalysis (EPMA)** is a field emission microscope which has state of the art EDS and WDS analysis. WDS has higher resolution which enables you to quantify peaks that could not be resolved using traditional EDS analysis.
- **MRC 8667 RF Sputtering instruments (3)**
- **Optical Associates Mask Aligner**

Minor equipment includes a full photolithography laboratory, a wide variety of annealing furnaces, Zeiss stereomicroscope, Nikon Optiphot reflective microscope, Dektak for surface morphology studies and polishing tables for metallography.

Facilities and Equipment Planning Resources

CoresRI (<https://coresri.apps.brown.edu/>) is a collaborative effort across RI, hosted by Brown University, which provides a searchable, updated directory of core research facilities, services, and instrumentation available to Rhode Island researchers.

Renovation of Space If, in order to meet the requirements associated with a grant submission, a space renovation for a PI's existing space or shared core facility is required, the Facilities Group needs to be contacted prior to the submission of the grant application, to properly identify the cost and schedule of any proposed renovations. To begin this process, please submit a work request at web.uri.edu/facilities/work-order-request-form/

The Office of Space Allocation and Analysis (OSAA) manages the university space request process. If a grant proposal will require additional space, coordinate with OSAA early in the proposal planning process. OSAA is also responsible for space data for university facilities at all four campuses and off campus locations. OSAA can provide floorplans, square footage, and related spatial data for offices, laboratories, classrooms, and support spaces. Additionally, OSAA can assist with boundaries, acreage, location data, and associated attributes for university properties and outdoor locations. Contact Jeff Ulricksen, Manager, Space Allocation and Analysis (julricksen@uri.edu) for assistance with spatial data for grant applications or reporting.

Research Collaboration Agreements are agreements covering an unfunded

collaboration where both URI and the other party are contributing to the performance of a research scope of work. This can be with a for-profit, non-profit or academic entity. These agreements are processed through the URI Office of Sponsored Projects. Contact: Ted Myatt, AVP Research Administration (tedmyatt@uri.edu).

Planning and Real Estate Development manages the real estate portfolio for the university. If a third-party collaborator for a grant proposal will require the use of university facilities, subsequent to the execution of a Research Collaboration Agreement, a Facilities Use and License agreement must be in place before the collaborator can occupy the space. Contact Dulcie Ilgenfritz, Coordinator, Planning and Real Estate Development (dilgenfritz@uri.edu) for assistance.

Property and Support Services is responsible for the management and oversight of \$128 million in moveable assets for the University. This inventory includes assets above five thousand dollars which translates into equipment for research, grants and both state and federal jurisdictions. This equipment is located across URI's campuses as well as remote locations globally.

Additionally, Property and Support Services provides support for Centralized Warehouse and Receiving, which is dedicated for packages and deliveries to support the University's infrastructure. Both Mail and Printing Services are available as other support services. Please contact Jeffrey Wosencroft, Director of Property & Support Services at (j_wosencroft@uri.edu) for assistance.