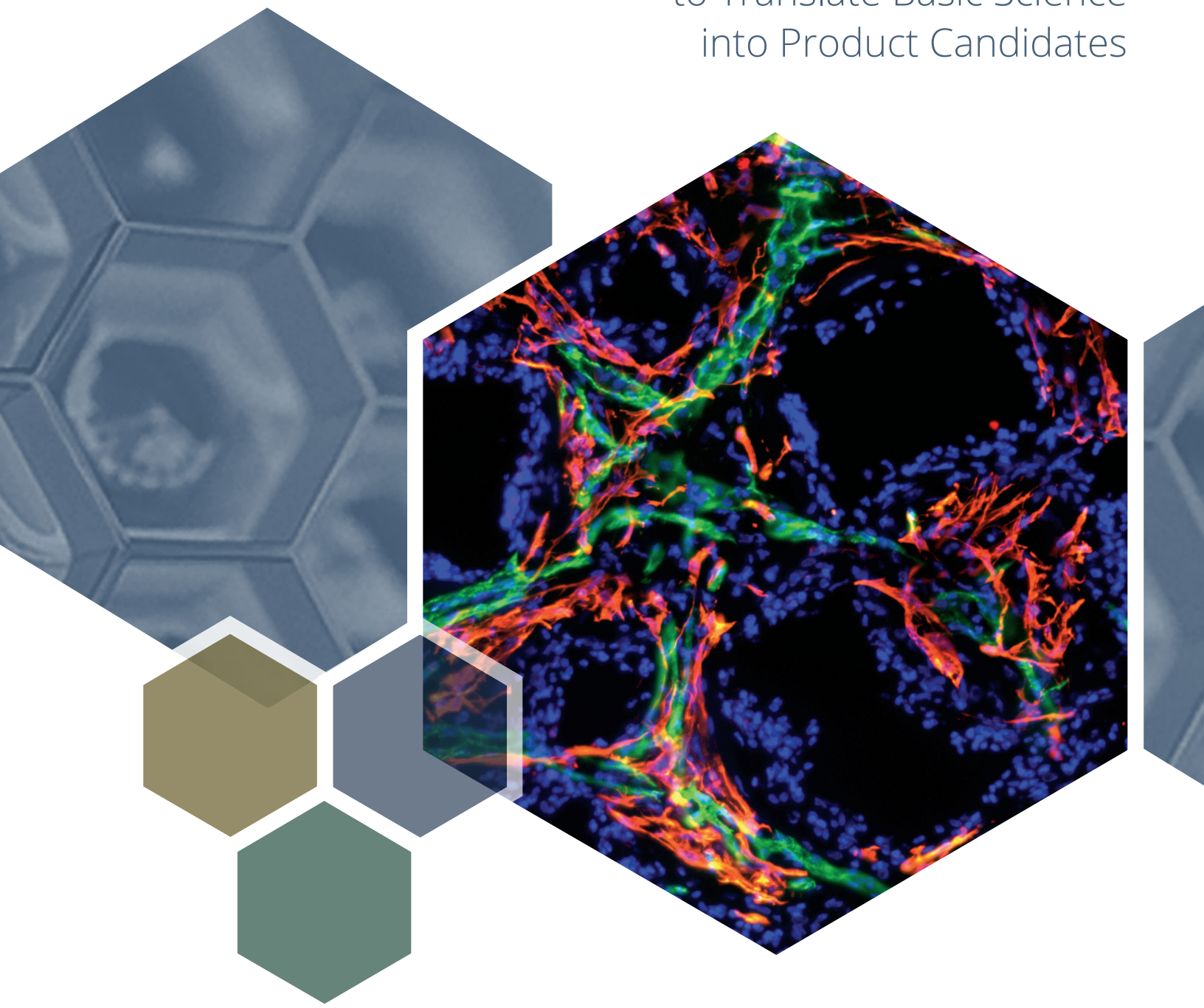
# Research and Innovation to Translate Basic Science into Product Candidates



UMassAmherst

Institute for
Applied Life Sciences

On the cover: *Synthetic Model of Metastatic Breast Cancer*,
(Red: Tumor Cells; Green: Blood Vessels; Blue: Cell Nuclei)
Prof. Jungwoo Lee, Chemical Engineering and M2M
Design and production: Lisa Korpiewski '97
Photography: John Solem and Lisa Korpiewski


# From the Director

Our vision for the Institute for Applied Life Sciences (IALS) is to translate fundamental research into innovative product candidates, technologies, and services that deliver benefits to human health and well-being. To achieve this vision we combine deep and interdisciplinary expertise of more than 200 faculty led research groups from 29 departments on the UMass Amherst campus, with the diverse capabilities from industry and government partners.

The Institute is organized into three large centers that focus on creating state-of-the-art wearable devices in the Center for Personalized Health Monitoring (CPHM), new types of biomolecule/delivery vehicle combinations in the Center for Bioactive Delivery (CBD), and discovering novel disease-related cellular pathways, drug-targets, and therapeutic candidates in the Models to Medicine (M2M) Center.

IALS has also just launched more than 30 core facilities – that facilitate a wide range of projects, from device prototyping, precision manufacturing and roll-to-roll fabrication, to human motion and gait studies, calorimetry, magnetic resonance imaging and spectroscopy, as well as, EEG and sleep studies. These facilities are equally accessible to academic, government, and industry collaborators.

In close proximity to these core facilities are "collaboratories" – lab space available to industry partners to work closely with and alongside IALS faculty. Our Industry Sabbatical Program allows industry researchers to spend time embedded in UMass research laboratories or in the IALS Core Facilities.

In summary, IALS works with industry partners to combine the best in academic innovation with an industry-like focus on delivering commercially significant products, services, and technologies over a defined timeline. Hence, by design, IALS is product-focused, interdisciplinary, collaborative, outward-looking, and entrepreneurial. To explore how IALS can help you advance your goals, please reach out to us at contactials@umass.edu.

Peter H. Reinhart, PhD
Founding Director
Institute for Applied Life Sciences

# Center for Bioactive Delivery

The Center for Bioactive Delivery (CBD) is advancing the field to a predictive science – a fundamental break from its empirical, single carrier and single application roots. Our teams are developing fundamental carrier design principles that integrate an understanding of the bioactives from the onset and applying them to various disease models.

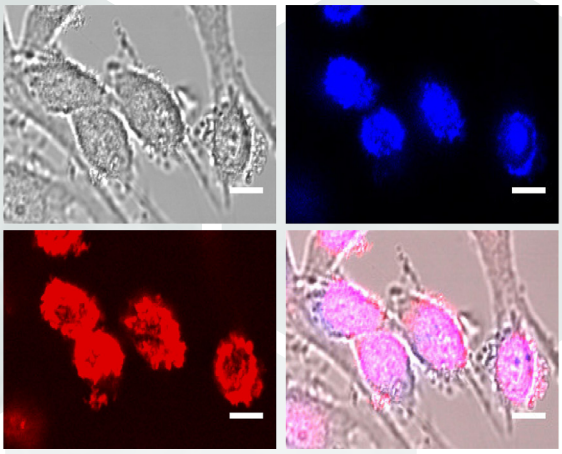
## Our Mission

Bioactive delivery is a multi-dimensional challenge that remains a critical and often unsolved issue in product development. At the heart of CBD are organized multi-disciplinary teams focused on solutions to this complex landscape.

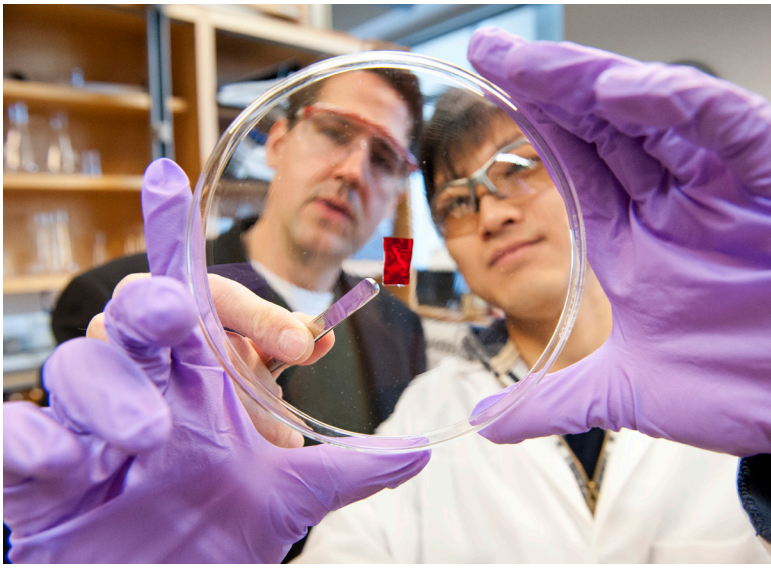
The long-term objective is to develop reliable, predictive models for optimized drug/carrier systems. This focus on synergies between the bioactive compound and its delivery for a suitable carrier solution creates a new paradigm for drug and nutrient delivery. The focus of our research falls into the following themes:

### Proteins, Peptides & Antibodies

Develop robust capabilities to deliver peptides, proteins, and antibodies to targeted cells and tissues. The team is tackling the challenge of protecting protein-based biologics from protease degradation and deliver them to targeted cells and tissues, and also to specific intracellular compartments. These approaches open up opportunities in "undruggable" targets such as targeting K-Ras and in enhancing the efficiencies of protein-based therapies such as in lysosomal storage diseases.

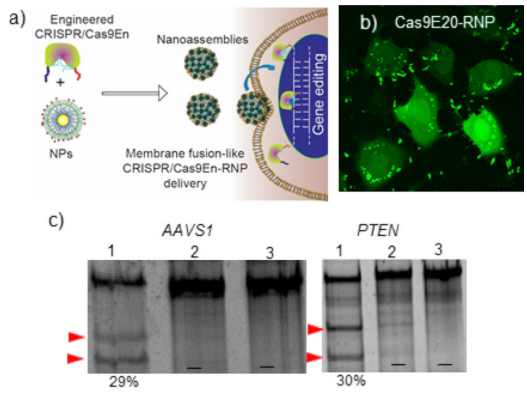


Thayumanavan group has developed a novel first-principle strategy to shrink-wrap proteins, protect them proteases, deliver to cells, and trigger the traceless of proteins in response to a specific intracellular trigger. Image shows the delivery of proteins to activate molecular homing in the nucleus (J. Am. Chem. Soc. 2017, 139, 5676).



### Nucleic Acid Delivery

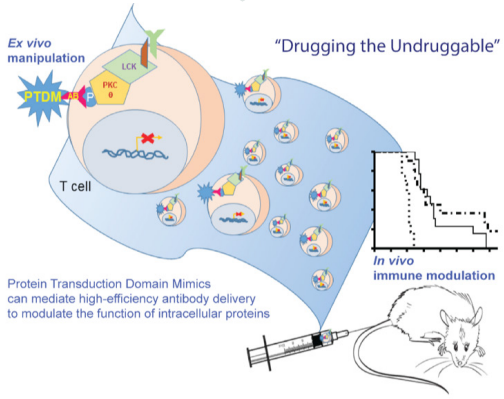
Focused on developing platform technologies for the delivery of nucleic acids inside cells. This team is particularly focused on developing efficient delivery vehicles that exhibit high transfection efficacies and low toxicities. The aim here is to develop toolkits that impact gene expression, gene knockdown and genome editing. An example involves the delivery of Cas9 coupled to guide RNA to target DNA modification of specific genes.




Rotello group has developed an efficient and direct cytoplasmic/ nuclear delivery of Cas9 protein complexed with a guide RNA (sgRNA) through the co-engineering of Cas9 protein and carrier nanoparticles. This construct provides effective (~30%) gene editing efficiency and opens up opportunities in studying genome dynamics (ACS Nano, 2017, 11, 2452–2458)

## Cell Based Therapies

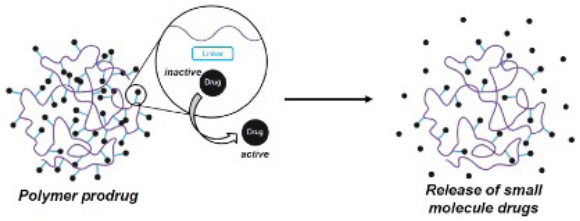
Develop and utilize novel delivery technologies to modify cells that are used for a variety of therapies. Examples include ongoing work to modify bacteria to invade tumor tissue and deliver payloads designed to kill or arrest the growth of the tumor. Additionally, strategies are being developed to use delivery technologies to modify cells of the immune system for adoptive transfer into a syngeneic host. The aim is to develop efficient *ex vivo* approaches to manipulating cellular responses and utilize them in a variety of therapeutic approaches.




Minter and colleagues have developed humanized, lymphocyte transfer model of graft-versus-host disease and demonstrated that polymer:antibody complexes can be readily introduced with high efficacy into hard-to-transfect human peripheral mononuclear blood cells, eliciting a biological response sufficient to alter disease progression (Mol. Ther. 2016, 24, 2118-2130).

## Small Molecule Delivery

Understand the self-assembly of carrier molecules and utilize them to develop efficient delivery vehicles for small molecules and nutraceuticals. These molecules are non-covalently encapsulated in carriers or developed in a pro-drug format. Strategies for controlled release and targeted delivery to specific cells and tissues are being developed. Impact areas include oncology, liver diseases such as NASH, and food-based products such as nutraceuticals.




Emrick and colleagues have developed a polymeric pro-drug that exhibits reduced drug uptake in healthy tissues and enhanced drug accumulation in tumors using BALB/c mice bearing 4T1 tumors. These pro-drugs has no apparent innate or adaptive immune system response (Mol. Pharm. 2016, 11, 1715-1720).

## Combinations and Interfaces

CBD recognizes enormous opportunities at the interface of these cargo classifications. For example, combination of small molecule encapsulation with antibodies provide opportunities in developing innovative and impactful alternates to antibody-drug conjugates (ADCs) (*Bioconjugate Chem.* 2015, 26, 2198–2215). Similarly, combining the delivery of proteins and nucleic acids present opportunities in novel cell-based therapies, including in genome editing strategies such TALEN and CRISPR (see examples in 'cell-based therapies' and 'nucleic acid delivery'). CBD investigators are collaboratively targeting these opportunities at the interface of different technology platforms and cargoes.

For more information, visit umass.edu/cbd

## Training at the Institute

70% of the new jobs created in Massachusetts Life Sciences are forecasted to be at organizations focused on biotechnology research & development. IALS will be a key contributor to devloping the current and next generation workforce to fill these new jobs, providing access to cutting-edge equipment to develop product candidates, the technical and 'soft' skills needed in the growing life sciences and advanced manufacturing industries. These contributions will advance UMass' educational and economic development missions of training researchers skilled in the discovery, development, and manufacture of medical devices and biomolecules, and life science entrepreneurship.

# Center for Personalized Health Monitoring

The Center for Personalized Health Monitoring (CPHM) accelerates the development, commercialization and clinical translation of low-cost, multi-function wearable wireless sensor systems and mHealth technologies for precision healthcare delivery, wellness optimization and biometric monitoring.

## Our Mission

- Conduct basic and translational research across the technical roadmap for advanced precision health monitoring,
- Train the future and current workforce in key skills needed for the emerging digital health industry,
- Develop and integrate new technologies in collaboration with industry and clinical partners that pave the way to commercialize innovations and promote economic development

The Center for Personalized Health Monitoring gathers critical expertise from polymer science and engineering, nursing science, computer science, kinesiology, psychological and brain sciences, and engineering to provide convergent solutions to challenges in health monitoring at every step of product development– from design, manufacturing, and system integration, to data analytics and outcome validation. CPHM seeks to tackle real-world problems in the emerging field of digital healthcare, wearable sensor technologies, and personalized, precision healthcare delivery, interfacing closely with provider networks, hospitals, and industry across the Massachusetts Commonwealth, and the world.

A wide-range of critical problem-focused research areas include:

- On-Body Biomarker Sensing
- Biomedical Devices & Device Manufacturing
- Healthy Aging
- Fall Prevention & Detection
- Technologies of Addiction Prevention
- Sexual Health Equity
- Sleep Monitoring & Measurement
- Health Self-Management
- Environmental Sensing & Design
- And more!

In addition, CPHM provides an industry collaborative facility wherein industry can work directly with our staff and researchers, and utilize cutting-edge UMass Core Facilities to validate current and develop next-generation digital health technologies and products. We custom create validation methods of health monitoring technologies to the specific needs of the wearable activity sensor industry.

Our group offers solutions for improvements in accuracy of digital devices at the human-device interface, in clinical workflow, and home-health integration, as well as, develops specific algorithms to interpret and apply sensor data, opening the door for major new discoveries and advances in digital health and wearable health technologies.

**Developing Wearable Technology for Monitoring Fatigue**
Walker and Ganesan are looking to develop a better understanding of the possible impacts of fatigue on oculomotor function (eye movements) among breast cancer survivors by utilizing and assessing the accuracy of a new type of technology used to measure eye movements called computational eyeglasses.

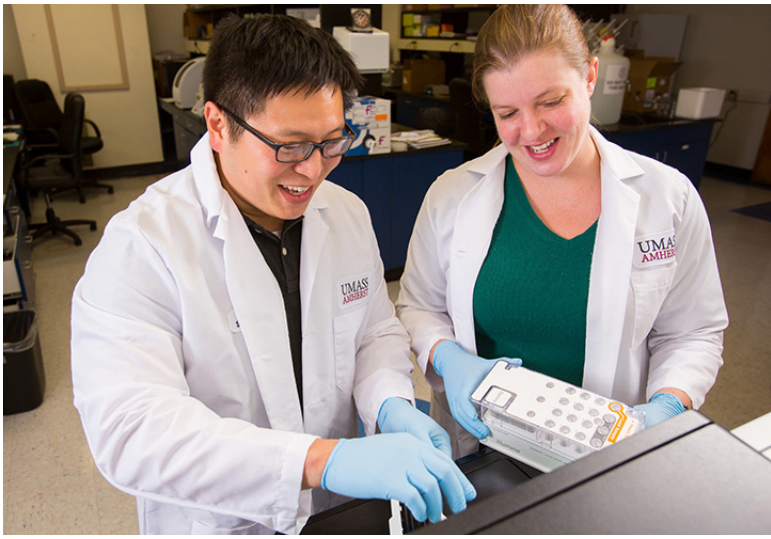
**For more information, visit umass.edu/cphm**

# Models to Medicine Center

The Models to Medicine Center (M2M) harnesses campus research strengths in life sciences to foster translational applications, create synergistic ties with industry, and improve the training of future life scientists, especially those who will join the workforce in the commonwealth.

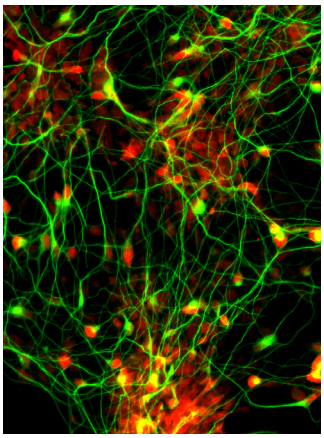
## Our Mission

M2M aims to translate fundamental science into new targets, leads, and disease models. Faculty within the center leverage mechanistic insights into molecular pathways implicated in cell health and in disease pathology to identify novel drug targets and therapeutic candidates.



### Biomaterials for Devices and Regenerative Medicine (BDRM)

Understand, manipulate and design *in vitro* model systems at the cellular, molecular, and tissue levels for applications in disease and regenerative medicine. Combines expertise in cellular engineering, tissue engineering, molecular self-assembly, mechanics, high-throughput screening, biopolymer materials, and materials design principles.



**Linking Mechanics to Proper Tissues and Organ Function**
Sun and Jiménez labs use manufacturing tools to create biomimetic models of model human development.

### Cellular Dynamics

Understand fundamental cellular processes and gain insight into the dysfunctions that result from defects in these processes. Areas of expertise include cell division and chromosome segregation, molecular motor proteins, cytoskeleton regulation and dynamics, cell growth and renewal, and cancer cell biology.

### Contraception, Reproduction Assistance Technologies and Embryology (CREATE)

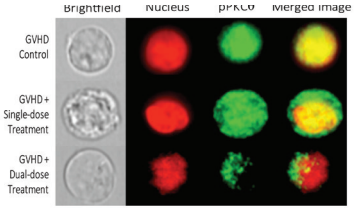
Focused on understanding the mechanisms underlying reproduction and embryonic development and the effect of the environment in those processes, as well as, environmental factors and toxins that disrupt developmental processes, either in the embryo or later in life, can result in a range of reproductive disorders.

### Engineering Models & Mechanisms in Cancer (EM$^2$C)

Broad expertise using *in vitro* models mimicking the complexity of tumors *in vivo*, working with animal tumor models, analyzing human tissues and evaluating the epidemiology of cancer risk.

### Infection & Immunity

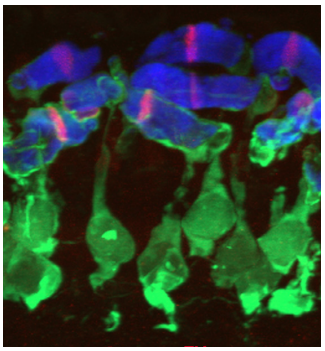
Develop and use models of diseases of people and domestic animals including autoimmune disease (aplastic anemia and multiple sclerosis) and malignant disease. Study diverse aspects of microbial biology including protein folding, DNA replication, mechanisms of quorum sensing and chemotaxis, production of and response to antimicrobial agents, identification of virulence factors as well as pathways that lead to symbiosis, and novel biochemical pathways that may serve as drug targets.




**Novel Cell-Based Therapies**
Reduce GVHD severity in a humanized mouse model by altering the nuclear localization of PKC0, a key pro-inflammatory protein. Bone marrow samples were collected 19 days after disease induction with human peripheral blood mononuclear cells.

## Mechanisms of Neural Function & Dysfunction

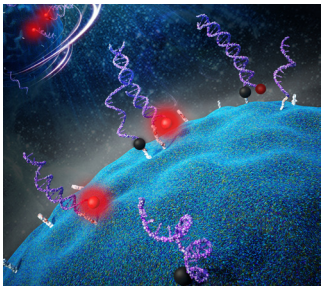
Focused on understanding the mechanisms underlying reproduction and embryonic development, the formation and function of the nervous system, and related disease processes. Employs a range of *in vitro* and *in vivo* model systems that allow the use of forward and reverse genetics, epigenetics, genomics, pharmacology, physiology, and behavioral assays to probe gene function in normal and disease states.



**Retinal Degeneration**
The Jensen lab has generated zebrafish models of macular degeneration. A novel transgenic zebrafish line allows sophisticated analyses of photoreceptor outer segment renewal.

## Membranes in Biology & Medicine

Seek to understand and engineer membrane processes, materials, and proteins, with a variety of fundamental and translational goals. Includes develops novel systems for high-throughput screening for drugs targeting membrane proteins, and novel molecules for delivering drugs across membranes. Also developing tools to overcome the challenges of membrane protein studies and determining mechanisms of membrane proteins that are potential antibiotic targets.



**Touching Cells at the Molecular Level**
Lipid-based approach to immobilize DNA probes on the outer membranes of live cells, to measure transient membrane lipid encounter events and cellular mechanotransduction.

## Microbiome, Microbes & Infectious Diseases (MMID)

Seeks to understand, manipulate and design microbial systems at the molecular, cellular and community levels for translational applications in human health and disease. To achieve this goal, MMID faculty combine expertise in genomics, microbiology, synthetic and systems biology, host-microbe interactions, infectious diseases, biocolloids, surface science and computational modeling. Through extensive collaborations within MMID, these capabilities have been integrated to seek innovative solutions to unsolved problems in human health and disease.

## mUscleMASS

Studies the biology of skeletal and cardiac muscle during development, aging, and pathogenesis with a variety of expertise in all aspects of muscle biology, including: molecular, cellular and structural biology, energetics and muscle physiology, from the interactions of myosin and actin to single biophysics to human MRI studies. The theme's primary interests center on atrophy and contractile alterations with exercise and aging.

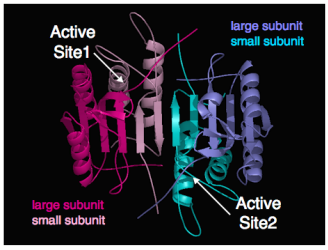
## Plant and Microbial Innovation

Combines expertise in functional genomics, systems and computational biology, with cellular imaging, biochemistry, microbial and plant physiology, evolution and genetics to address key problems in renewable energy, climate change, sustainability, and food security.

**Reproductive Structure**
Design to Accelerate Breeding: The Bartlett Lab has resolved genetic determinants of flower architecture that can be manipulated to advance crop improvement.

## Protein Homeostasis

Improves understanding leading to new targets for small molecule modulators, and hence new therapeutic strategies against many of these diseases. Targeting protein homeostasis components also affords the opportunity to develop new anti-infectives, either by intervening with the protein homeostasis components of the pathogen, or targeting components of the host network that are hijacked by a pathogen.




**Programmed Cell Death**
Hardy explores how caspases are controlled at the structural and biochemical level. Caspases are the main player in regulating the apoptosis in both normal and cancer cells during programmed cell death.

For more information, visit umass.edu/m2m

# Industry Partners: Working with Us

## Collaboration with Industry and Start Up Community

IALS seeks to become the catalyst for applied life science programs on campus and enable industry/academic alliances. To achieve this IALS is creating a 'portfolio' of translational life science projects based on faculty and student strengths in basic sciences on this campus and from collaborators. This project portfolio is regularly evaluated by a group of expert industry advisors that form Industry Advisory Boards (IABs) for each of the three centers and for IALS overall, and also by a group of Business Innovation Fellows that provide business guidance to prioritized portfolio projects. Prioritized projects are also eligible for resourcing, and are advanced towards the development of product candidates.

IALS is also developing new business models for establishing win/win industry/academia collaborations based on the concept of risk-sharing. These models are being developed with a group of 'Entrepreneurs-in-Residence', and by the Business Innovation Fellows in collaboration with the Isenberg School of Management and its Berthiaume Center for Entrepreneurship. Furthermore, IALS also provides an interface between industry and faculty/students.

Overall, these capabilities position UMass Amherst as a regional resource for applied life sciences, novel industry relationships, and economic development in Massachusetts.

## What are IALS 'Collaboratories'?

Collaboratories are research laboratory spaces for industry partners. IALS has space for up to 16 industry partners which can include start-up companies emerging from faculty research projects, to partnerships with more established companies that seek space on campus to develop medical devices, healthcare/life science-related product candidates. Collaboratory occupants will have access to 30 IALS Core Facilities. Spaces are adaptable to individual needs, and flexible to accommodate both basic and specialized equipment.

If you are interested, please visit umass.edu/ials/industry-engagement

# Industrial Sabbatical Program

## Nationally-Renowned Expertise, Just a Few Steps Away.

- ✓ Collaborate with IALS faculty.
- ✓ Access to cutting-edge IALS facilities, managed by highly-specialized core facility directors.
- ✓ Attend special seminars and guest lecture series in IALS-associated departments.
- ✓ Participate in laboratory module courses.
- ✓ Make use of the state-of-the-art IALS Collaboratories in the Life Science Laboratories.

## Connect. Explore. Make a Difference.

- ✓ Short-term faculty appointment in your department of choice.
- ✓ Guest lecturing opportunities through:
  - Departmental seminar series
  - IALS seminar series and events
  - Graduate courses–such as Drug Design (Biochemistry) and Frontiers of Biotechnology (Chemistry)
- ✓ Mentor a Biotechnology Training Program (BTP) student as part of the student's on-campus internship.
- ✓ Explore Amherst and Northampton. Take advantage of the cultural, artistic, and intellectual resources of the five-college area, and the charms of a small town.

# Enx Labs–a Collaboratory Expierience

## *Design, Test, Learn and Innovate*

Dr. Uzodinma Okoranyanwu founded Enx Labs, formerly known as Allnano, in March of 2015. He recently took occupancy in IALS collaboratory space, embedded in the Life Science Laboratories at UMass Amherst. The company develops electronic instruments used in molecular diagnostics, energy storage, and environmental monitoring.

With the rising cost of technology and the need for biomedical research to improve human health, the collaboratory space, combined with IALS and its core facilities, provides affordable and scalable infrastucture, and a network of researchers to collaborate and create groundbreaking initiatives that change the way we live and innovate.

For Enx Labs, Dr. Okoranyanwu is now able to build, measure, and optimize his technologies, in this all-inclusive environment. To fail fast and learn, while having access to cutting-edge resources, this all-in-one location is indispensable to his company's mission and growth.

IALS Advantages for Enx Labs:

- 3D printed prototyping using ADDFab
- Circuit board fabrication in Sensor Integration
- Gold standard characterization in Roll-to-Roll
- Access to world-class microbiologists and polymer science researchers at UMass Amherst
- Flexible electronics expertise
- Vertical integration and growth of experimentation
- Validation of technologies in Exercise Intervention and Outcomes
- IALS seed grant funding
- Opportunity for subsidies through the UMass Core Facilities State Voucher Program

"Part of the attraction to IALS is the presence of talent. I am surrounded by many people with a variety of backgrounds.The core facilities allow me to create everything from 3D prototypes to simulating processes. I couldn't have asked for a better place."–Uzodinma Okoroanyanwu, PhD - Founder, Enx Labs, Inc.

# IALS Business Innovation Fellows Program

## *Bringing Science, Engineering, and Business Together*

The IALS Business Innovation Fellows program brings together teams of MBA students from the Isenberg School of Management and resources from the Berthiaume Center for Entrepreneurship with teams of UMass Amherst scientists and engineers to support the development of research-based ventures and IALS industry collaborations.

The mission of the program is to facilitate the translation of basic research projects into product candidates, industry partnerships, and start-up companies. Accordingly, Fellows work to:

- Develop business concepts that build upon campus research and capabilities.
- Apply business and entrepreneurial tools and methods to facilitate and accelerate venture development by UMass Amherst entrepreneurs and innovators.
- Help to set new venture priorities, assess market opportunities, secure resources, and integrate business considerations with technology development efforts.
- Contribute to a culture of collaboration between the business school, life science and technology researchers, and industry experts.

## Services

Projects are grounded in state-of-the-art hypothesis-driven entrepreneurship and a commitment to helping founding teams start and build compelling businesses. For example, Fellows have helped new venture teams to:

- Identify and assess initial markets and customers segments.
- Apply for SBIR funding and other resources.
- Develop financial projections.
- Prepare for high-stakes presentation and pitch opportunities.

**For more information, visit umass.edu/ials/isenberg-ials-innovation-fellows-program**

# UMASS CORE FACILITIES

IALS offers more than 30 core facilities, available to both internal and external users. These turnkey facilities are a significant resource for faculty research and student training in the Massachusetts and New England region, while representing a novel interface for government and industry partners. These facilities enable faculty, students, and industry collaborators to access a broad array of equipment to enhance their R&D capabilities, address both basic and translational questions, deliver technologies and product candidates more rapidly, and become more competitive in obtaining state, federal, foundation, and private funding. These facilities, many housed in the Life Science Laboratories, will advance the University's objectives of becoming a destination and partner of choice as well as the Institute's goals of supporting high-quality research and advancing translational programs towards novel drug targets, drug delivery technologies, personalized healthcare devices, nutraceuticals, and other technologies that enhance human health and well being.

The overall core facility infrastructure was made possible by a grant from the Massachusetts Life Science Center and operational support from UMass Amherst.

For more information visit umass.edu/ials/core-facilities, or email the Director of Core Facilities at UMassCores@umass.edu.

## Advanced Manufacturing/ Engineering/Materials

*From concept to characterization, design to delivered product, these resources help in building your next medical device, precision manufactured component, and wearable or embedded sensors.*

### Advanced Digital Design and Fabrication (AddFab)

3D printing and related digital manufacturing capabilities to support the translation of new technologies in biosensors and medical devices from lab bench to human testing. The mission of ADDFab is to institutionalize the Center for Surgical Technology Innovation and commercialization in partnership with UMass Medical School.

### Atomic Force Microscopy (AFM)

The mission of the Scanning Probe Microscopy Core is to provide analytical and high resolution scanning probed based microscopy. This includes Atomic Force Microscopy (AFM) related techniques such as tapping mode, contract mode or conductive AFM as well as force measurements.

### Device Characterization

Provides gold-standard verification of wearable and point-of-care devices and other medical devices. This lab offers a full suite of mechanical testing capabilities to fully characterize materials, manufacturing processes, and their fabricated devices.

### Device Fabrication

Class 1000/100 cleanroom designed to have CMOS processing technologies to serve as a key enabler towards

personalized healthcare and preemptive medicine. Specifically, we aim to develop smart and miniature devices, circuits and systems with biomedical applications such as biosensing, DNA sequencing and smart implanting. This facility supports both discovery-based research and translational research that leads to the development of new research tools for life sciences.

## Electron Microscopy

Equipped with several Transmission (TEM) and Scanning (SEM) Electron Microscopes as well as related sample preparation equipment for the use of the UMass community as well as external customers. The Center serves both materials and life-sciences communities and most of the instruments options are focused on analytical capabilities such as Energy Dispersive X-Ray Spectroscopy (EDS) and Electron Energy Loss Spectroscopy (EELS).

## Electronic Materials

Equipped with a set of state-of-the-art analytical instruments for characterization of optical, electronic, electrical and electrochemical properties of materials and devices. A glove box-based line of instruments enables solution-based fabrication of such electronic and optoelectronic devices as polymer and perovskite solar cells, field-effect transistors, light-emitting diodes, thermoelectric elements, etc. in inert atmosphere.

## High Frequency Sensor Development

Provides world-class measurement capability for frequencies into the Terahertz range. It will be used for high-frequency spectral analysis of materials and for testing high-speed communications technologies.

## Nanofabrication Cleanroom

Provide nanofabrication tools and services to researchers, students, and off-campus clients on a fee for services basis. Supports research and development through provision of technologies for the fabrication of micro and nano devices and complements the activities planned for the Device Fabrication and the Roll-to-Roll Core Facilities.

## Roll-to-Roll Fabrication and Processing

Provides a unique set of custom, moving web-based tools for the translation of advanced materials and nanomanufacturing processes to industrially relevant scalable platforms for the development of next generation life science innovations in biosensors, diagnostics, and platforms for personalized health monitoring. Custom R2R coating, lithography and printing tools (inkjet, aerosol jet, nano-emboss, photonic cure, atomic layer deposition (ALD)) utilizing nanomaterials advances for precision patterning and integration of novel compositional coatings having unprecedented functionalities will impact specified applications in biosensing, printed electronics, microfluidics, detection and monitoring of disease, and control of electro-magneto-optical imaging and detection systems. Combined with additional web-based tools for vacuum sputter deposition, reactive ion etching, wet chemistry, and interlayer alignment, the R2R Facility provides access to an emerging set of tools found nowhere else.

## Sensor Integration

Facilities for integration of optical and electronic components into compact systems. Equipment is available for packaging and modifying prototype integrated circuits and for prototype circuit board fabrication.

## X-Ray Scattering

The facility provides access to X-Ray Scattering instrumentation as well as data analysis and interpretation support. The facility houses several instruments dedicated to the structural analysis of crystalline materials, the determination of highly-periodic morphologies in self-assembled systems over a large length scale range.

**For more information, visit umass.edu/ials/core-facilities**

# Human Health

*Evaluating the human condition and interventions that aim to improve quality of life.*

## Human Magnetic Resonance Center

Whole-body MR system for the noninvasive study of human tissue structure and function using MR imaging and spectroscopy. Research performed in this center advances our understanding of biological and cognitive function in the living organism, and as such provides a unique opportunity to develop and test new hypotheses, as well as translate information gained from basic science to human health. Neuroimaging, including fMRI of brain; proton, phosphorus and carbon spectroscopy of various tissues, structural imaging, MR elastography, and other state-of-the-art research equipment and techniques are available.

## Human Testing Center

### Exercise Intervention and Outcomes

Hosts a wide variety of equipment that allow for gold-standard assessment of human health outcome measures including: muscular strength, body composition (e.g. lean and fat mass, and bone density), bioenergetics, as well as the ability to harvest blood and tissue samples. Additionally, the core hosts an exercise training facility with Noldus Viso video capture system where research teams can work closely to monitor the dose-response relationship between exercise prescription and improvements in health outcomes all in a highly-controlled private setting. Housing intervention and outcome assessment tools in one location provides an ideal setting to assess both pharmaceutical and behavioral impacts on human health and performance.

### Human Motion

Designed and equipped to assess all aspects of human motion the core is home to state-of-the-art equipment that allow for the assessment of human motion (i.e. kinematics, kinetics and muscle activity) and segmental and/or muscle coordination (with and without robotic assistance/ interaction). Additionally, we have the ability to synchronize many types of 3rd party devices with the system, making the core an ideal place to assess new wearable technologies that target human movement and muscle activity.

### Living Science

The Living Science Core is a space where human participants can reside for long periods of time during which both physical activity level and behavior can be assessed in a unique manner. Houses a Noldus Viso video capture and assessment system so researchers can assess both quality and duration of activity while removing the researcher from the room, there by allowing participants the opportunity to act more 'naturally' in this home-like setting. Additionally, the core is equipped with an Oxycon Mobile metabolic system that can be used to assess whole body energy expenditure and macronutrient utilization, for short durations (i.e. 1-2 hours). This is a great setting for manufacturers to bring both wearable and embedded sensing platforms to either develop or validate algorithms that aim to capture features of physical activity. The core maintains several research grade activity monitors allowing for comparison to industry standards when developing new devices.

### Room Calorimeter

Unique to New England and only 1 of 26 such facilities in the world, the Room Calorimeter Core is home to two whole room calorimeter chambers. The advantage of whole room calorimeters over other devices that assess human energy expenditure through indirect-calorimetry (i.e. $O_2$ and $CO_2$) is that participants do not have to wear any head mounted apparatus allowing for a more comfortable experience thereby allowing for much longer periods of assessment. The two chambers in the core differ in that the large chamber (30 m3) is configured with a bed, toilet, desk, television, pass-through for

food/medication, and Noldus Viso video surveillance system allowing for 24hr+ stays. The smaller 'flex' chamber can be configured for both resting metabolic rate assessment or short duration exercise testing. Both chambers can be equipped with a port such that blood can be drawn while the participant remains in the chamber. Additionally, data from both a bicycle ergometer or treadmill can be collected in synchrony with the metabolic data from either of the chambers. This facility is the ideal setting for industry partners to develop or validate the next generation of wearable sensors that aim to accurately assess energy expenditure, or to identify the metabolic impact of dietary or pharmacological intervention.

### Sleep Monitoring Laboratory

The sleep center is equipped for overnight sleep studies to assess sleep and sleep physiology. The center has three bedrooms that can be used for polysomnography, the gold standard for sleep measurement. On-line sleep monitoring from a central control room allows for sleep stage specific manipulations.

## mHealthLab

Designed as a testbed to help explore the future of digital healthcare that combines data from disparate sources (wearable sensors, environmental sensors, physician visits, etc). The goal is to use this testbed to understand how data from these sources can help develop a proactive and dynamic health-care system that leverages data from sensors to predict behavior, intervene in a timely manner, and reduce cost. The facility will involve hundreds of students streaming data via phones and wearable wristbands and a real-time analytics back end system that combines data from disparate sources and provides real-time inferences on behavior.

## Nutriceutical Formulation

Equipment for isolation of bioactive food components, production of delivery systems such as emulsions and powders, and several food processing operations including concentration by reverse osmosis, ultrahigh and HTST pasteurization, and spray drying. Instruments are available to characterize liquid and dried delivery systems and test their biological efficacy. Space is also available for standard food production operations.

# Off-Campus Core Facilities

*UMass Amherst partners with its sister campuses to offer over 90 core facilities state-wide. Two facilities with direct collaboration include:*

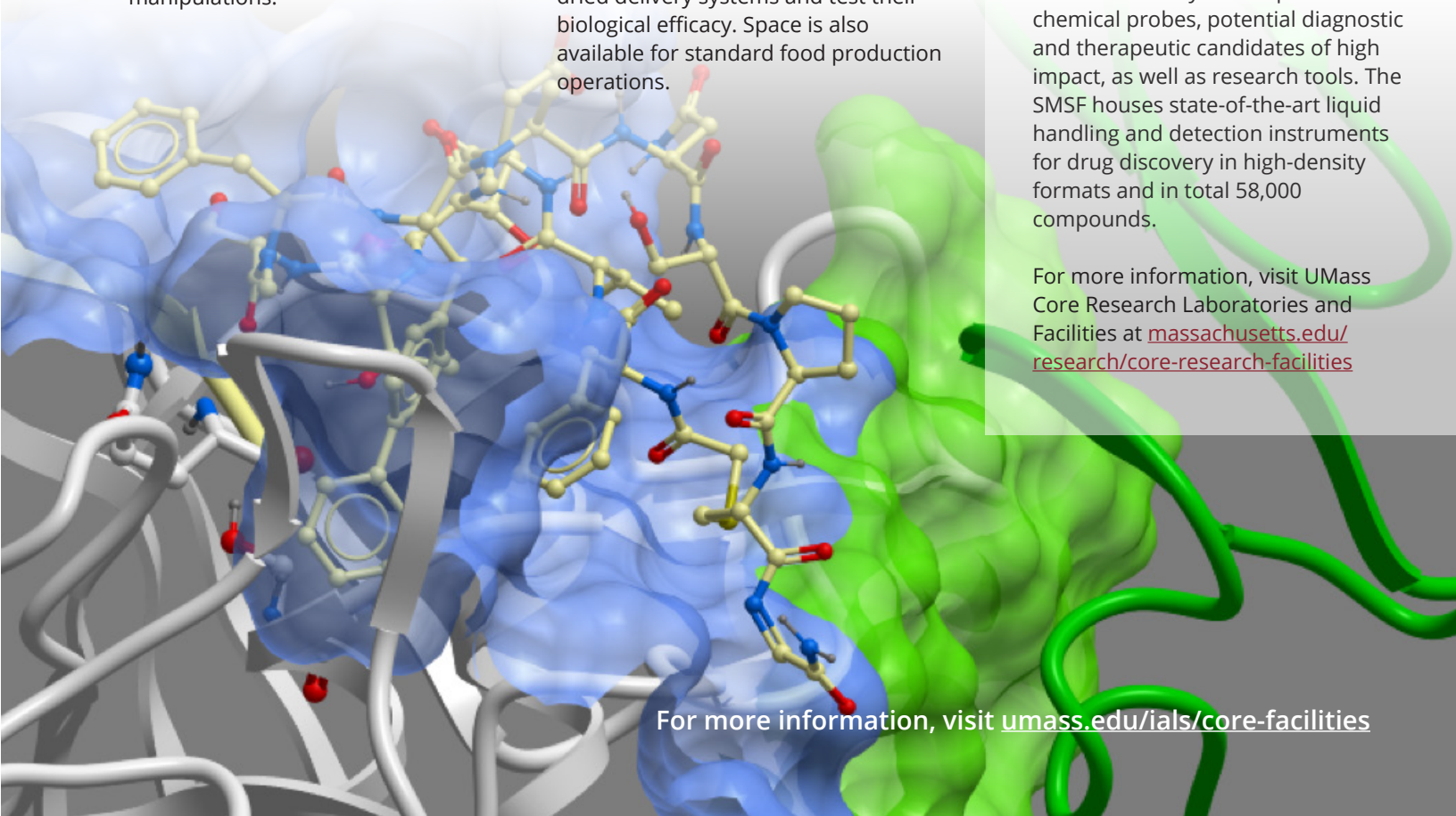
## Massachusetts Green High-Performance Computing Center

Provides world-class computational infrastructure, indispensable in the increasingly sensor and data-rich environments of modern science and engineering discovery.

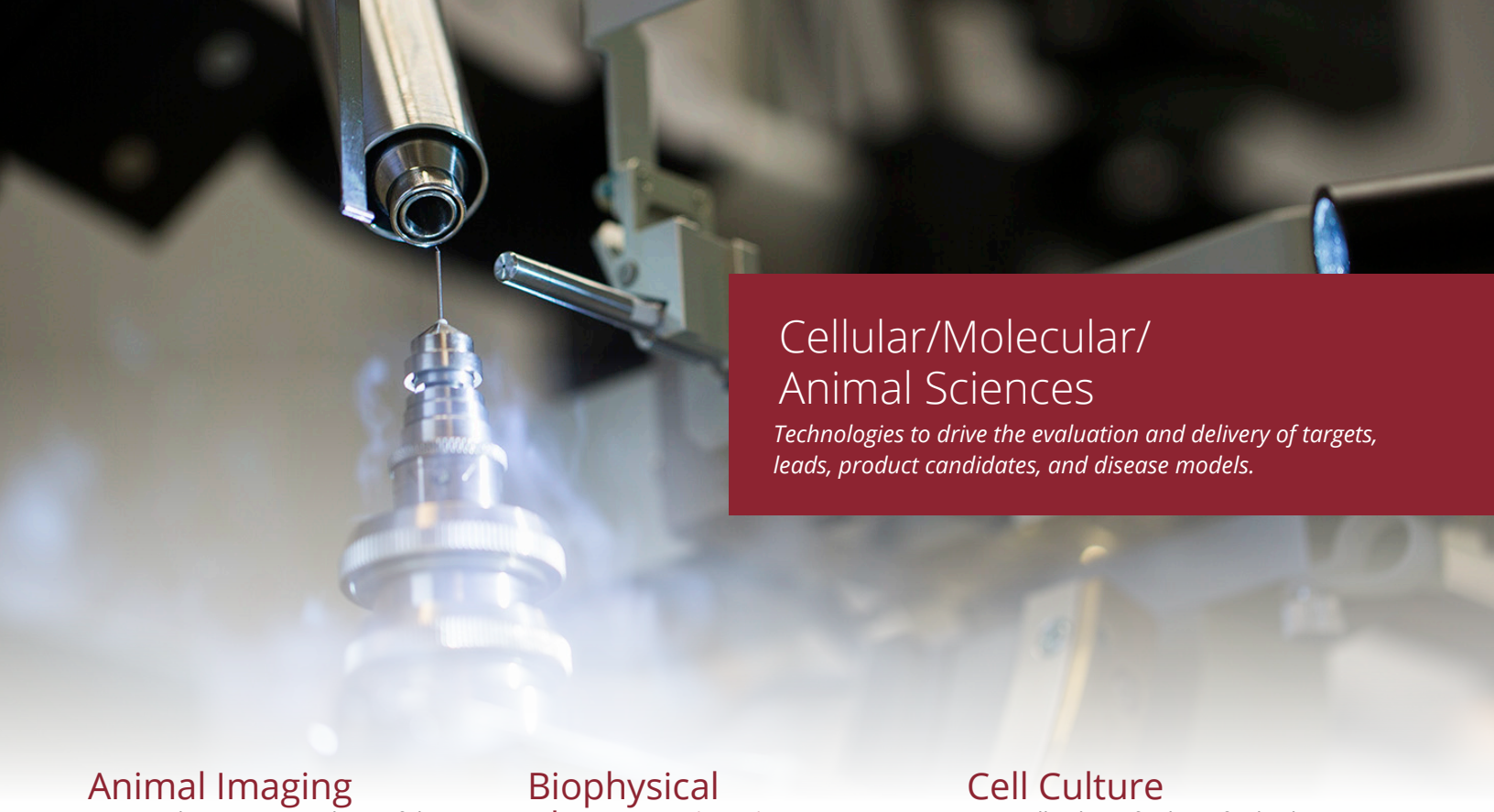
## Small Molecule Screening Facility (High-Throughput Screening)

Provides investigators with a platform for assay development and screening of unique, small drug-like molecule libraries occupying novel chemical space in a variety of readout systems for the discovery of exceptional chemical probes, potential diagnostic and therapeutic candidates of high impact, as well as research tools. The SMSF houses state-of-the-art liquid handling and detection instruments for drug discovery in high-density formats and in total 58,000 compounds.

For more information, visit UMass Core Research Laboratories and Facilities at massachusetts.edu/research/core-research-facilities



For more information, visit umass.edu/ials/core-facilities



# Cellular/Molecular/ Animal Sciences

*Technologies to drive the evaluation and delivery of targets, leads, product candidates, and disease models.*

## Animal Imaging

Designed to assist members of the research community on UMass and the other five college campuses to conduct research using live animal imaging technologies. Equipment is capable of fluorescence and luminescence imaging independent of or concurrent with CT imaging.

## Animal Modeling

Provides transgenic, gene targeting, and other services to the research community. The core performs microinjections of DNA into fertilized embryos to generate transgenic mice. Uses cutting-edge technologies, including CRISPR/Cas9 genome editing, to generate gene knock-out or knock-in mice or other animal models. In addition, provides mouse surgery service and training, such as patient-derived xenograft (PDX), tail vein injection, and catheterization. The core is able to customize services as requested to support development of animal models of human diseases in a timely and cost-efficient manner.

## Biophysical Characterization

The facility supports basic research into mechanistic cellular biochemistry and endows us with the ability to pursue potential targets for drug discovery. Academic and industry users are able to characterize the nature of the structural interactions, to determine thermodynamic and kinetic parameters for the interactions, to screen multiple small molecules to identify lead compounds for further study, to canvas conditions for single crystal formation, to determine crystal structures, and to build up models of complexes using shape sensitive scattering methods.

## Bioproduction/ Separation

The facility offers equipment for expression, separation, and isolation of biomolecules allowing users to culture cells including bacterial, yeast, insect, plant, and mammalian cells, and then separate biomolecules of interest including proteins, nucleic acids, natural products, and metabolites. Academic and industry based users can culture a variety of cell types at a range of scales up to 50L.

## Cell Culture

Two cell culture facilities for both biological and bio-engineering approaches. Biosafety cabinets, incubators and general wet lab supplies.

## Computational Modeling

Provides consultative and collaborative service in computational and molecular modeling. Allows scientists who are unfamiliar with computational methods and high-performance computing to apply these techniques in their research. Work directly with researchers to develop, implement and perform biomolecular modeling, simulation and analysis. Contribute to manuscript and grant application preparation as necessary. Provide hands-on training in molecular visualization, docking, comparative modeling and molecular dynamics simulation.

## Flow Cytometry

Designed to assist members of the research community at UMass and the surrounding areas to conduct research using flow cytometry and associated technologies. The equipment and services provided by

the facility are unmatched on campus and in the five-college area with the nearest comparable facility 60 miles from campus.

Independent users have 24/7 access to analysis and imaging cytometers (training is available in house). Highly-trained personnel provide florescence associated cell sorting (FACS), available by appointment.

The core also provides assistance with research design, data acquisition, and data analysis upon request.

## Genomics Resource

The GRL maintains next-generation sequencing capabilities, with a short turn-around time for data production as well as sequencing with capacity to sequence a human genome in less than a day. Equipment is also available for library preparation. The GRL provides service to both academic and industry based users.

## Light Microscopy

The facility provides expertise and access to nine different imaging modalities for visualizing cellular and biomaterial samples. The core facility houses state-of-the-art equipment including a two-photon microscope, a resonant scanning confocal microscope, a spectral confocal microscope, a high-content microscope for automated imaging and analysis, a spinning disk microscope, a single molecule imaging microscope, a patch clamp rig, and a laser capture microdissection instrument. In addition, cell culture facilities will be available nearby as well as other routine needs for biological imaging. This core facility is one of a few designated Nikon Centers of Excellence and will provide a unique opportunity for trainees to get experience on the different microscopes as well as interact with the professionals from Nikon.

## Mass Spectrometry

A broad range of instrumentation and expertise to serve the life science community in academia and industry. Capabilities and techniques available include proteomics, small molecule and metabolite qualitative and quantitative determination, characterization of mixtures by LC-MS, protein structural/dynamics and ligand-binding using hydrogen/deuterium exchange, molecular imaging of tissue and other materials, structural and stoichiometry studies using native MS. MALDI-TOF/TOF and ICP-MS with molecular imaging capabilities.

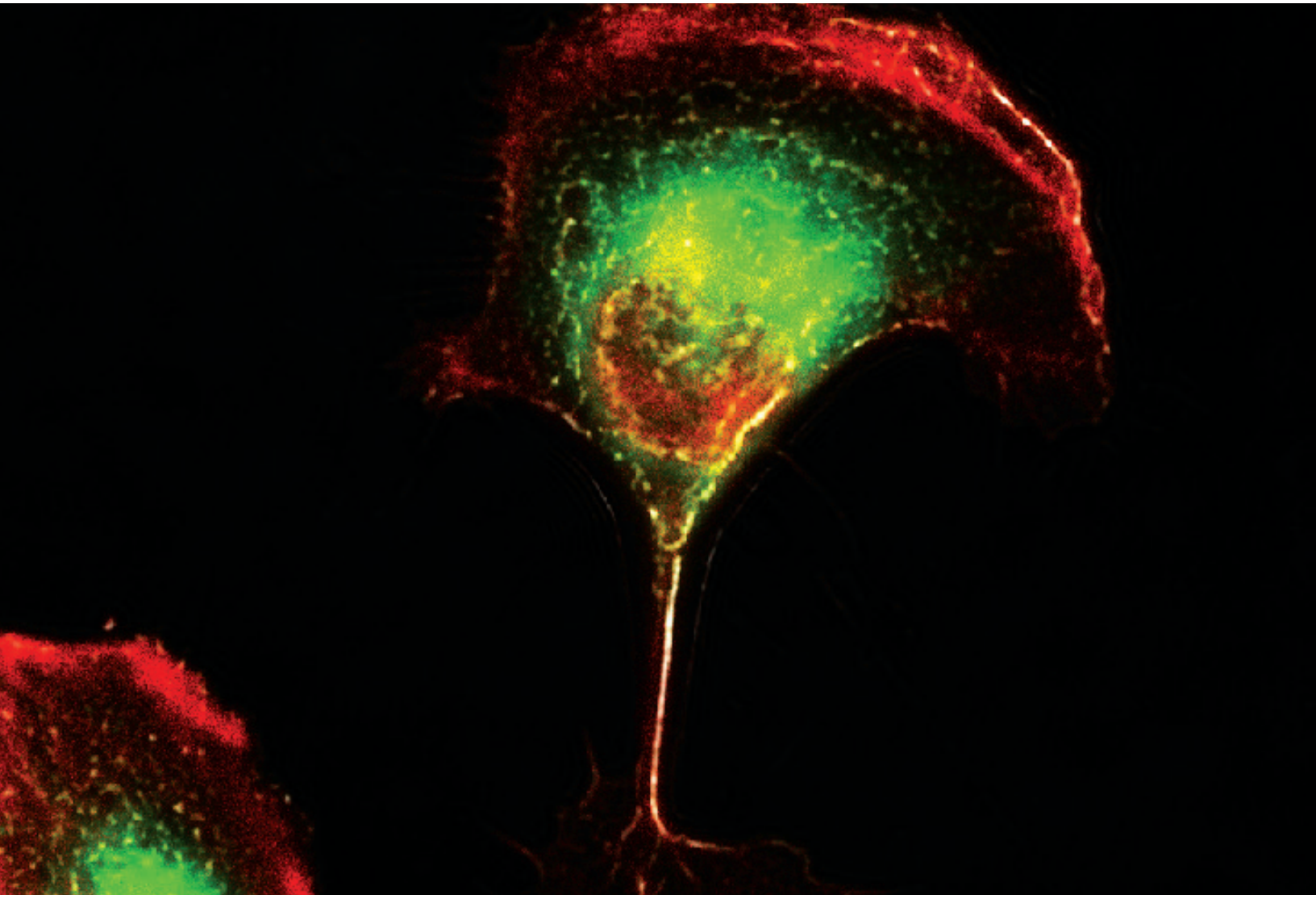
## Nuclear Magnetic Resonance (NMR)

Houses high-field NMR spectrometers that serve to elucidate the structure, dynamics, interaction, and organization of molecules. Researchers across the disciplines of chemical science, materials science, biological science, and natural products research community rely on NMR spectroscopy for the structure and behaviors of their molecules. The facility serves approximately 40 UMass Amherst research groups, liberal arts colleges and community colleges across Western New England, and industrial research partners throughout the US.

A significant portion of core equiment has been purchased through MLSC grant funding support.

MASSACHUSETTS LIFE SCIENCES CENTER

For more information, visit umass.edu/ials/core-facilities



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Fluorescent image of a normal mammalian cell that has been labeled with concanavalin A/AlexaFluor488 conjugate to label the endoplasmic reticulum and phalloidin/AlexaFluor568 conjugate to label the cytoskeleton. This image is one of 2400 that were acquired during an algorithm-driven cell morphology profiling assay in collaboration with UMassMed. The coordinates of individual cells in each of the wells were detected at 10x and then 25 random cells that met specific criteria were automatically imaged at 60x. The data was collected in the Nikon Center of Excellence Light Microscopy Facility in IALS on a new Nikon microscope with 6-lasers and a resonant scanning confocal head using the JOBS automation module with high-content analysis.

Photo: James Chambers, Light Microscopy-Nikon Center of Excellence