Workshop Training Series

Discover How BORC Can Transform Your Research

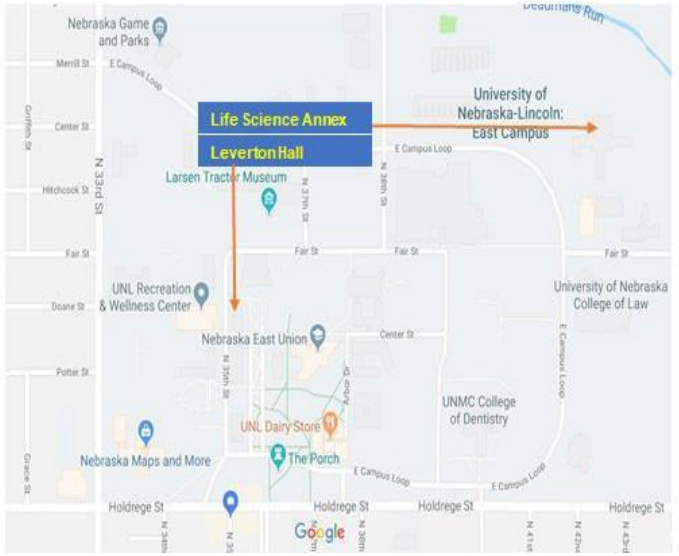
Jingjie Hao

Director of Biomedical and Obesity Research Core (BORC)

Nebraska Center for the Prevention of Obesity Diseases (NPOD)

About BORC

- The Biomedical and Obesity Research Core (BORC) is a comprehensive core facility within the Nebraska Center for Prevention of Obesity Diseases (NPOD).
- BORC offers state-of-the-art biomedical research services to investigators within the University of Nebraska system and to external users.
- BORC provides training for researchers on the core's available services.
- BORC supports research tool development programs that benefit the broader research community, contributing to scientific discovery and external funding opportunities.
- BORC operates from two locations: Leverton Hall and the Life Sciences Annex on the east campus of the University of Nebraska-Lincoln.
- BORC website: https://borc.unl.edu/



Services provided by BORC

Key Services:

1. BORC is equipped with advanced instruments that enable a variety of biomedical experiments, ranging from molecular biology to *in vivo* studies.
2. BORC provides workshops on instrument operation and cutting-edge scientific techniques. Additionally, manufacturers are invited to train users on new equipment.
3. BORC can perform biomedical assays on behalf of clients, ensuring high-quality results.

How to Access Services:

Services are managed online via iLab operation software. First-time users must register for an account at BORC iLab portal.

Fee structure

- The BORC is partially supported by the National Institute of General Medical Sciences of the National Institutes of Health (P30GM154608). Since Jan 1st, 2008, BORC has operated as a service center that has the authority to charge user fees to its users.
- BORC provides subsidies to NPOD members and the University of Nebraska System (NU) investigators.
  - NPOD members and Pilot Grant recipients receive a 40% (FY26) subsidy for service costs incurred in BORC.
  - NU investigators receive a 10% (FY26) subsidy of the actual cost.
  - External users are charged the full price.
  - Industry users will pay 140% of standard fees.
- BORC bills clients monthly.

Major equipment at BORC

- Molecular and Cell Biology
- Metabolic Study
- Animal Behavior Research
- Small Animal Imaging
- Biostatistics and Computational Services

Molecular and Cell Biology

- Bio-Rad QX200 ddPCR System
- BioTek Synergy™ H1m Plate Reader
- CFX Connect™ Real-Time PCR Detection System
- ClonePix 2® Mammalian Colony Picker
- Cytation C10 Confocal Imaging Reader
- DIGITAL Sonifier® UNITS Models S-450D
- FreeZone® 4.5 Liter Freeze Dry Systems
- GeoMx® Digital Spatial Profiler
- iCELLis™ Nano Bioreactor
- ImageStream®X MkII Image Flowcytometry
- Luminex MAGPIX® Multiplex Reader
- Malvern NanoSight NS300
- nCS1 Nano Particle Analyzer

Bio-Rad QX200 ddPCR System

Revolutionizing absolute quantification of nucleic acids

- **Absolute quantification** – No standard curve required
- **Unparalleled precision** – Reliable detection of small fold differences
- **Enhanced sensitivity** – Enrich rare targets, reduce background noise
- **Minimized PCR Bias** – Eliminates efficiency-related errors
- **Broad applications** – Suitable for research & clinical diagnostics

High-throughput | Reproducible results | Robust analysis

BioTek Synergy™ H1m Plate Reader

Versatile multi-mode microplate reader

- UV-Vis Absorbance
- Fluorescence Intensity
- Luminescence
- Fluorescence Polarization
- Time-Resolved Fluorescence

Applications:

- DNA/RNA, protein quantification
- ELISA
- Reporter gene expression (Luciferase assay)
- Biochemical & cell-based assays (absorbance, fluorescence, luminescence)

CFX Connect™ Real-Time PCR Detection System

High-performance Real-Time PCR for precise quantification of nucleic acids

- Dual-channel fluorescence detection for multiplexing
- Advanced optical technology for high sensitivity
- Advanced CFX manager software tools
- Fast cycling time and reliable performance

Applications:

- SYBR®Green/EvaGreen & duplex experiments
- Real-Time PCR assay optimization
- Gene expression analysis
- High-resolution melt (HRM) studies
- Pathogen detection & genotyping

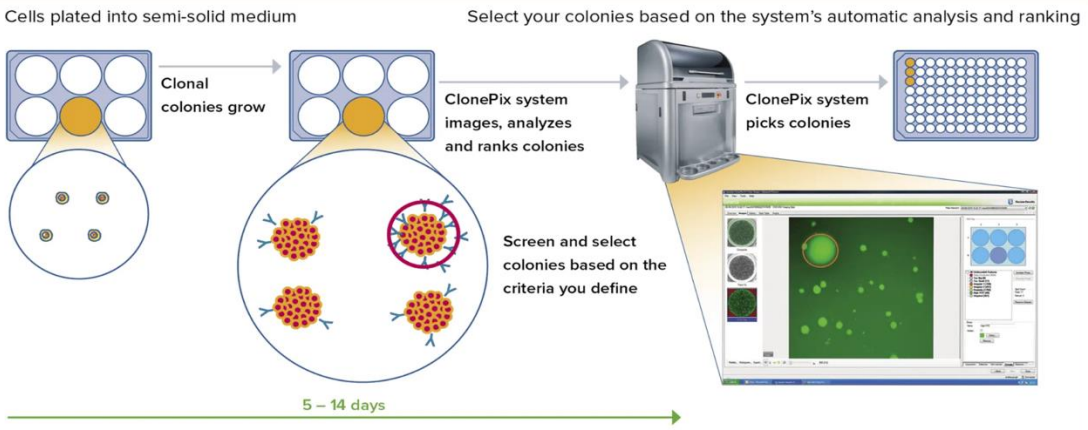
ClonePix 2® Mammalian Colony Picker

Automated selection for high-value clones

- Fully automated selection – Reduces time and labor
- Monoclonal verification – Screen and identify top producers in weeks
- Multiple detection methods – White light & fluorescence imaging
- Sterility maintenance – UV sterilization & pin-washing system
- Integrated plate storage – 10-plate capacity for source & destination
- Discrete colony formation – Semi-solid CloneMedia™ for optimized growth
- Animal-free media – Chemically defined for enhanced productivity

Applications:

- Antibody discovery
- Cell line development
- Hybridoma & CHO cell screening
- Stem cell research



Cytation C10 Confocal Imaging Reader

High-content imaging and multi-mode detection

- Confocal and widefield imaging for high-resolution analysis
- Automated live-cell imaging with environmental control
- Multi-mode detection: fluorescence, luminescence, absorbance
- High-throughput screening with plate and slide compatibility
- Advanced software for image analysis and quantification

Applications:

- Live-cell imaging
- Whole organism imaging
- Cell-based assays
- High-content screening
- 3D cell culture analysis
- Fluorescence and brightfield imaging

DIGITAL Sonifier® UNITS Models S-450D

The Branson 450 is an ideal sniffier for:

- Cell disruption and lysing
- Nano particles production
- Chip assay
- Emulsification
- Homogenization
- Processing DNA and proteins

FreeZone® 4.5 Liter Freeze Dry System

Reliable preservation for biologicals, pharmaceuticals, and food

- Efficient lyophilization for long-term sample preservation
- Precise temperature and vacuum control for optimal drying
- Versatile applications in biological and pharmaceutical research
- Compact and user-friendly design for easy operation
- Reliable system for maintaining sample integrity

Applications:

- Milk
- Antibiotics
- Proteins
- Plasma
- Cell lines
- Viruses
- Microorganisms

GeoMx® Digital Spatial Profiler

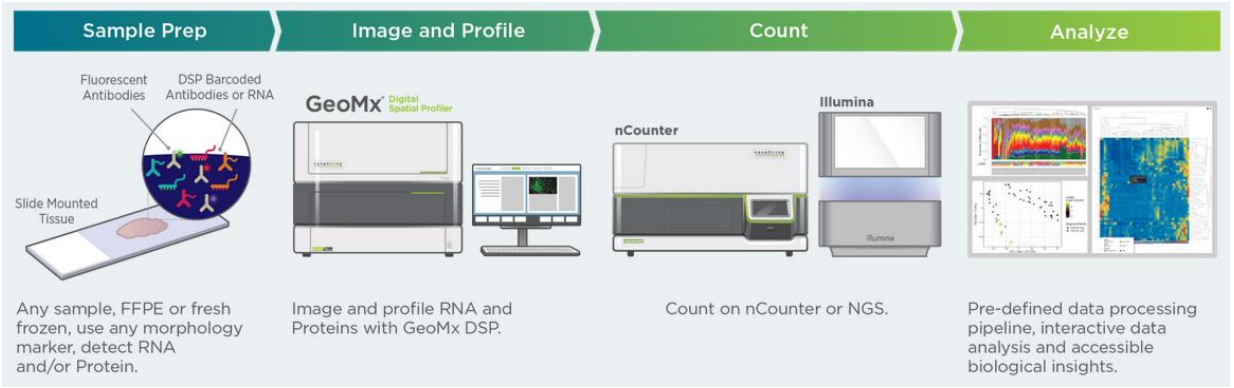
The GeoMx® Digital Spatial Profiler (DSP) is a cutting-edge tool designed for high-plex spatial and molecular analysis of RNA and protein within tissue samples.

Key features:

- Multi-Omic: Analyze RNA and protein with any sample types, such as formalin-fixed paraffin-embedded (FFPE), fresh-frozen tissue sections, core needle biopsy, slide mounted tissue, cell lines, and tissue microarray, making it adaptable to various research needs.
- Whole-Slide Imaging: Allows for comprehensive imaging with up to four fluorescent stains to accurately guide the selection of regions of interest (ROIs).
- Wide Dynamic Range: The platform supports up to 6 logs (base 10) of dynamic range, ensuring precise digital quantitation.
- Preservation of Samples: The non-destructive processing preserves tissue integrity for potential further analysis.

Scientific applications:

- Tumor microenvironment and immune landscape mapping
- Neuroscience and developmental tissue profiling
- Biomarker identification and spatial gene expression
- Drug target validation and response characterization
- Translational research and precision medicine



iCELLis™ Nano Bioreactor

The iCELLis™ bioreactor system is an automated, single-use, fixed-bed bioreactor that provides excellent cell growth conditions for adherent cells.

Key features:

- Enables consistent and controlled culture conditions
- Fixed-bed bioreactor with pre-installed calibrated probes and single-use technology
- Unique waterfall system for optimal oxygenation and CO_2 stripping
- Provides high surface area for adherent cell growth
- Significant decrease in operational costs vs. classical 2D flatware

Applications:

- Gene therapy and vaccine development
- Viral vector production (AAV, lentivirus, etc.)
- Recombinant protein manufacturing
- Adherent cell culture scale-up
- Bioprocess optimization and development

ImageStream®X MkII Image Flowcytometry

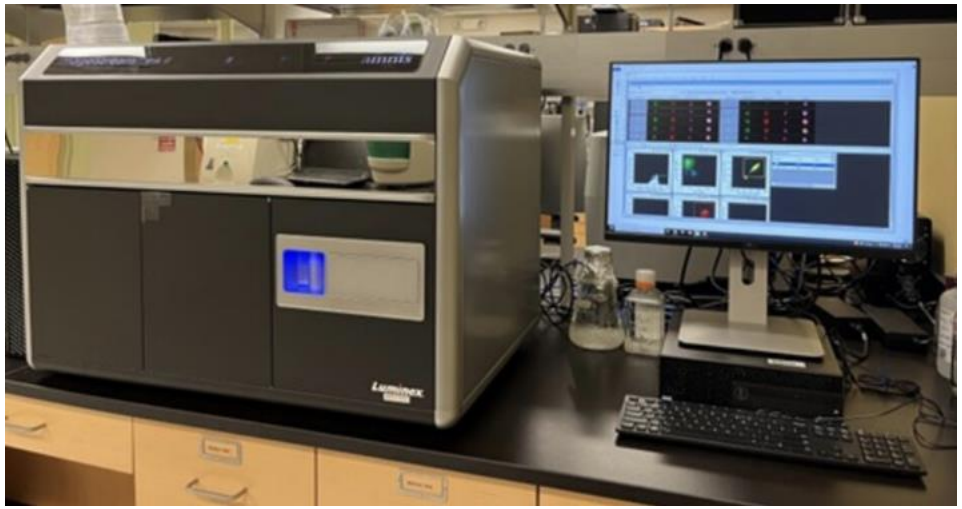
Combines the speed and quantification of flow cytometry with the detailed imagery of microscopy.

Key features:

- High-throughput image-based analysis of cells in flow
- Captures multiple images per cell: brightfield, darkfield, fluorescence
- Quantifies spatial and morphological features with single-cell resolution
- Compatible with suspension cells and complex samples
- Multiparameter analysis with up to 12 fluorescence channels

Applications:

- Immune cell phenotyping and activation
- Apoptosis and cell cycle analysis
- Nuclear translocation and co-localization studies
- Rare event detection
- Cell signaling and internalization assays



Luminex MAGPIX® Multiplex Reader

Compact and cost-effective multiplexing for biomarker analysis

- Simultaneously detects up to 50 analytes in a single sample
- Uses magnetic bead-based technology for robust performance
- Fluorescence-based detection for high sensitivity
- Compact and easy-to-use design
- Reduces sample volume and assay time

Applications:

- Cytokine profiling
- Protein biomarker detection
- Immunoassays
- Gene expression analysis (nucleic acid assays)
- Disease research and drug discovery

Malvern NanoSight NS300

Nanoparticle tracking analysis (NTA) for direct visualization and measurement of particle size and concentration (10 – 2,000 nm) in liquid suspension.

Key Applications:

- Protein aggregation
- Exosomes and microvesicles
- Liposomes and other pharmaceutical nanoparticles

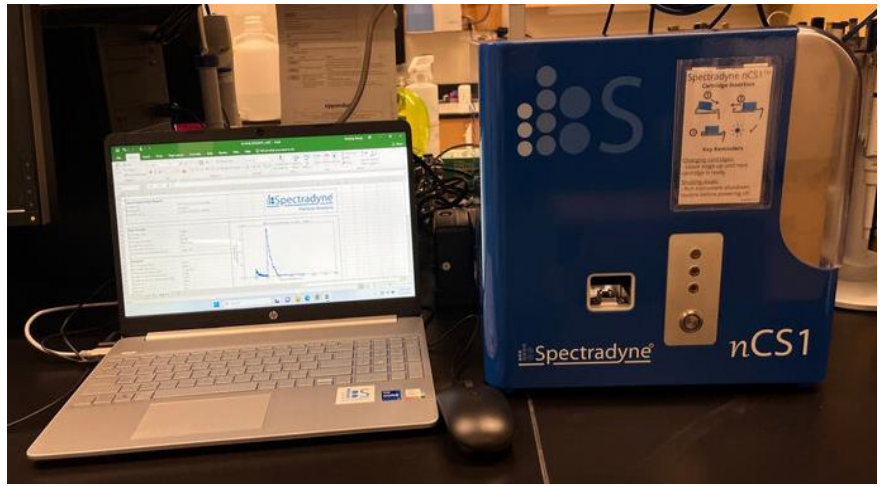
nCS1 Nano Particle Analyzer

Single-particle analysis of extracellular vesicles and nanoparticles

- Label-free analysis of size, concentration, and fluorescence
- High-resolution detection from 50 nm to 200 nm
- Single-particle quantification without ensemble averaging
- Simultaneous measurement of size and fluorescence intensity
- User-friendly software for data visualization and interpretation

Applications:

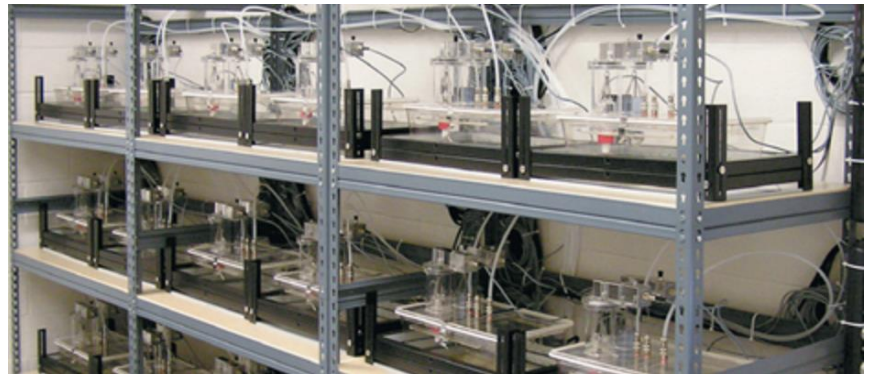
- Extracellular vesicle characterization
- Exosome quantification and profiling
- Nanoparticle tracking and size distribution
- Virus particle analysis
- Quality control in nanomedicine and therapeutics



Metabolic Study

- Metabolic Cages (TSE Systems)
- XFe-24 Extracellular Flux Analyzer
- Vitros250 Chemistry Analyzer
- Agilent GC-MSD

Metabolic Cages (TSE Systems)



A multi-modular platform enabling automated, synchronized analysis of metabolic, behavioral, and physiological parameters in mice.

Currently our system is configured with 12 cages, the system monitors metabolic performance, locomotor activity, and feeding and drinking behavior.

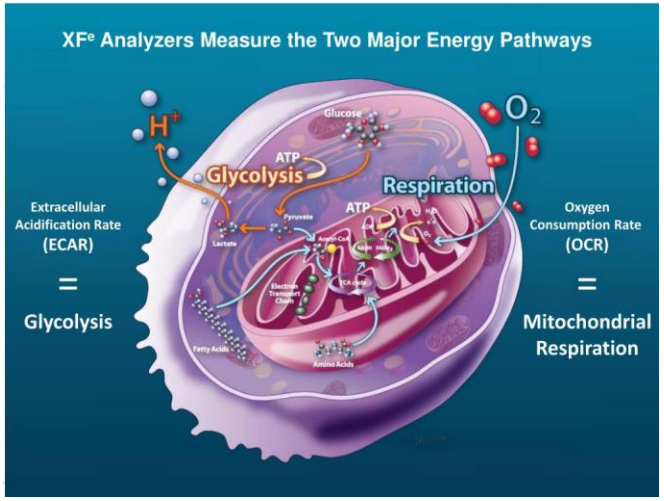
Calorimetry:

Parameter	Description	Unit	Remarks
Flow	Flow	l/min	
Temp	Temperature	°C	Measurement in the box.
O2	Concentration	%	Reference and per box.
CO2	Concentration	%	Reference and per box.
dO2	Difference	%	Reference O2 - Box O2.
dCO2	Difference	%	Reference CO2 - Box CO2.
VO2	O2 consumption	ml/(kg x h) or ml/h	
VCO2	CO2 production	ml/(kg x h) or ml/h	
RER	Respiratory Exchange Rate		VCO2/VO2
H	Heat	kcal/(kg*h) or Kcal/h	Also possible in W/kg

XFe-24 Extracellular Flux Analyzer

Real-time measurement of cellular metabolism

- **Glycolysis**: Cells generate ATP via glycolysis independent of oxygen, producing lactic acid and protons. The Seahorse XFe Analyzer measures glycolysis by measuring the extracellular acidification rate (ECAR) of cells.
- **Respiration**: Mitochondrial consume oxygen when oxidizing fatty acids or other substrates to generate ATP. The Seahorse XFe Analyzer measures mitochondrial respiration by measuring the oxygen consumption rate (OCR) of cells.



Assays:

- Mitochondrial stress test
- Glycolysis stress test
- Fatty acid oxidation assay
- Cell energy phenotype test

Applications:

- Obesity/Diabetes
- Cancer Biology
- Immunology
- Neurodegeneration

Vitros® 250 Chemistry Analyzer

An automated clinical analyzer that uses micro-slide technology for high-precision, water-free testing. It can measure up to 36 analytes across various sample types, including serum, plasma, urine, CSF, and cell culture medium.

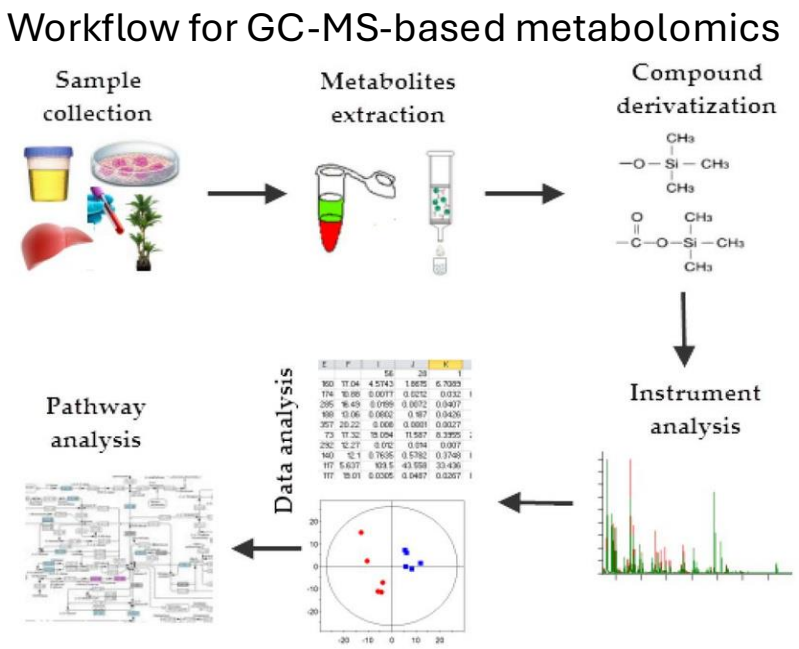
Representative panel of supported assays

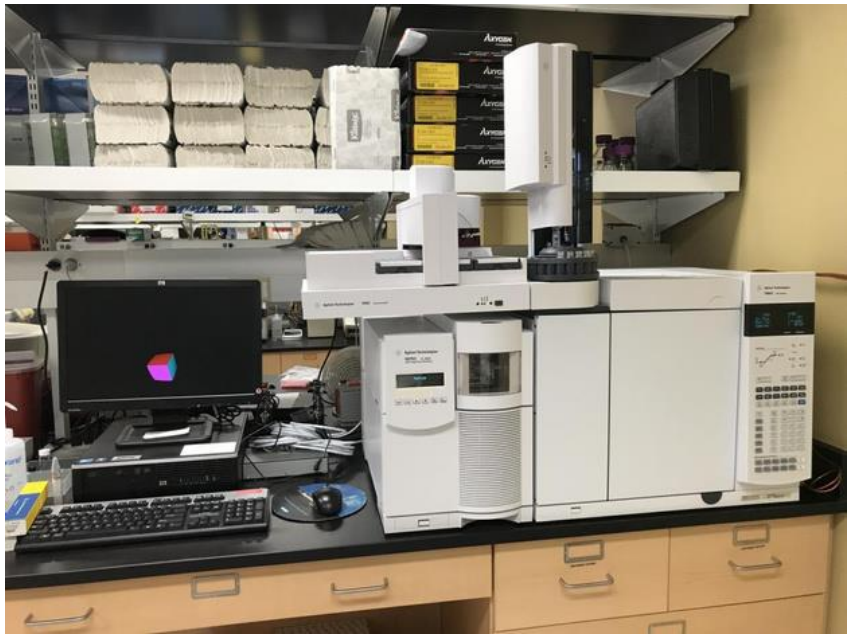
- ✔ Albumin
- ✔ Alkaline phosphatase (ALP)
- ✔ Alanine aminotransferase (ALT)
- ✔ Aspartate aminotransferase (AST)
- ✔ Amylase
- ✔ Bilirubin (Total)
- ✔ Bilirubin (Direct)
- ✔ Blood urea nitrogen (BUN)
- ✔ Calcium
- ✔ Chloride
- ✔ Cholesterol (Total)
- ✔ Creatinine
- ✔ Creatine kinase (CK)
- ✔ C-reactive protein (CRP)
- ✔ Gamma-glutamyl transferase (GGT)
- ✔ Glucose
- ✔ High-density lipoprotein (HDL)
- ✔ Iron
- ✔ Lactate dehydrogenase (LDH)
- ✔ Low-density lipoprotein (LDL)
- ✔ Magnesium
- ✔ Phosphorus
- ✔ Potassium
- ✔ Sodium
- ✔ Total protein
- ✔ Triglycerides
- ✔ Uric acid
- ✔ Carbon dioxide (CO_2)
- ✔ Anion gap
- ✔ Albumin/globulin ratio
- ✔ Globulin (calculated)
- ✔ Hemoglobin A1c
- ✔ Osmolality (calculated)
- ✔ Non-HDL cholesterol
- ✔ Calcium/Phosphorus ratio

Agilent GC/MS

High-resolution analysis of cellular metabolism

Gas chromatography–mass spectrometry (GC-MS) is a powerful technique for analyzing small and volatile molecules such as steroids, fatty acids, and hormones. It separates complex mixtures, quantifies analytes, and detects trace levels of organic contaminants with high sensitivity and specificity.



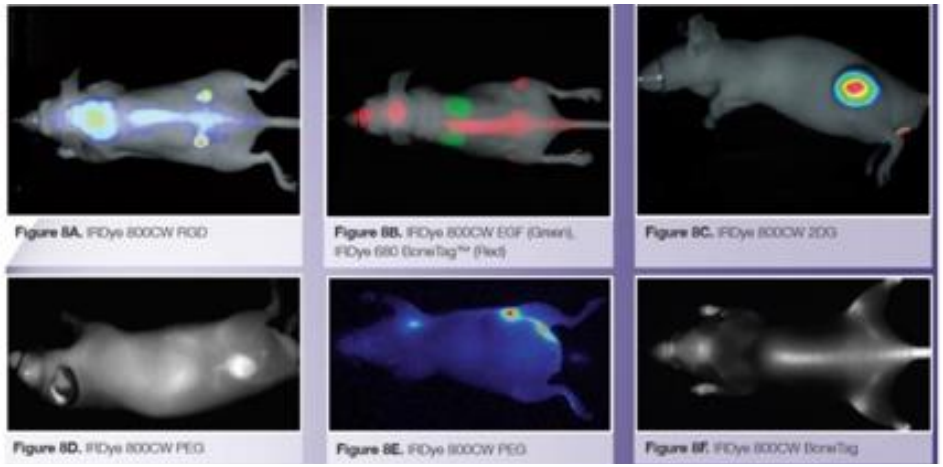


Small Animal Imaging

- iBox Scientia Small Animal Imaging System
- LI-COR Odyssey CLx
- UltraFocus DXA X-Ray

iBox® Scientia™ Small Animal Imaging System

Enables non-invasive, in vivo fluorescence imaging of small animals using visible and NIR light. It is designed to detect fluorescent protein markers (e.g., GFP, RFP) and fluorophore-conjugated probes, making it ideal for cancer research, stem cell tracking, and drug delivery studies.



Applications:

- Tumor growth and metastasis tracking
- Stem cell migration and engraftment
- Biodistribution of fluorescently labeled compounds
- Gene expression and promoter activity in transgenic animals
- Inflammation and immune response studies

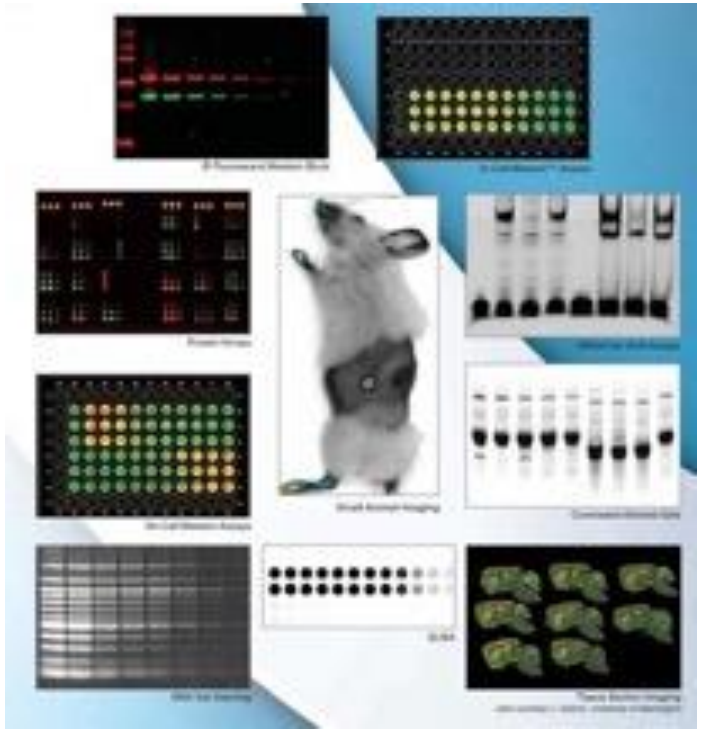
- Excitation and emission filter sets to accommodate a wide range of fluorophores
- Multiplexing capability allows simultaneous detection of multiple targets
- Integrated anesthesia system with isoflurane vaporizer and nose cones

LICOR ODYSSEY® CLx

A high-sensitivity imaging system for precise qualitative and quantitative analysis across diverse applications.

Key Applications:

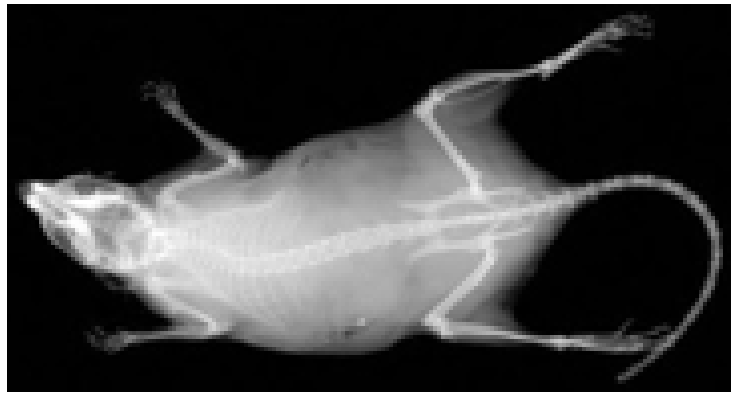
- **Protein Detection:**
  - Coomassie-Stained Gels
  - Membrane and Slide Arrays
  - Two-Color Infrared Western Blots
  - In-Gel Western Blots
- **Nucleic Acid Detection:**
  - Mobility Shift Assays
  - DNA Gel Staining (Syto®60)
  - Nucleic Acid Arrays
- **Small Animal Imaging**
- **Cell-Based Assays:**
  - In-Cell Western™
  - On-Cell Western
- **Microwell Assays:**
  - ELISA/FLISA
  - Protein Arrays
  - RNAi Analysis



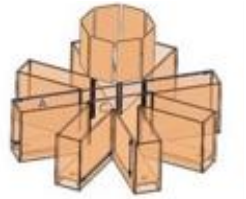
UltraFocus DXA X-Ray

High-resolution imaging and body composition analysis

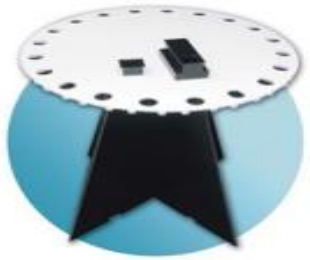
- Fully shielded cabinet for safe, high-throughput pre-clinical imaging
- Combines digital x-ray and dual-energy x-ray absorptiometry (DXA) in one system
- Enables bone density, lean mass, and fat mass quantification
- Suitable for small animal models such as mice and rats
- Ideal for studies in metabolism, osteoporosis, and aging research
- User-friendly software with automated region-of-interest (ROI) analysis



Animal Behavior Research



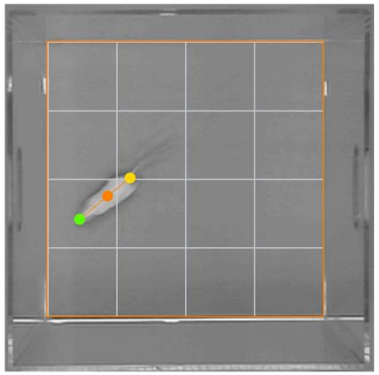
- ANY-maze Open Field
- Barnes Maze
- Grip Strength System
- Morris Water Maze
- ROTOR-ROD System
- Place Conditioning Preference
- SR-LAB Startle Response System
- The Radial Arm Maze
- Treadmill

ANY-maze Open Field

Designed for assessing rodent behavior in open-field experiments. This system can evaluate locomotion, exploration, and anxiety-related behavior.

Key features:

- Tracks X-Y movement, distance, speed, and zone occupancy
- Detects rearing, jumping, and other behaviors with high precision
- Integrated photobeam arrays and customizable arena setup
- Equipped with video tracking software for analysis and reporting



Barnes Maze

Designed for spatial learning and memory assessment in rodents.

Key features:

- Circular maze with multiple holes; only one leads to an escape box
- Animals must locate the escape hole using spatial cues to avoid a brightly lit, open surface
- Non-aversive alternative to the Morris water maze
- Quantifies learning and memory via latency, path length, and error rate
- Ideal for testing effects of drugs, aging, and genetic modifications on cognition

Grip Strength System

Designed for assessment of neuromuscular function in rodents.

Key features:

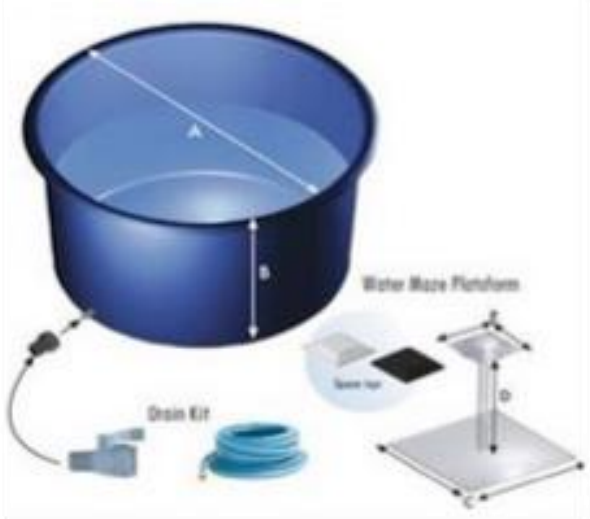
- Evaluates motor function, strength deficits, and neuromuscular disorders in rats and mice
- Measures peak force exerted by forelimbs or hindlimbs using precision force gauges
- Available with single or dual sensor models for separate or simultaneous limb assessments
- Force values recorded manually or via software
- Highly accurate readings (±0.25% full-scale), displayed in grams, kilograms, or newtons

Morris Water Maze

Tests spatial learning for rodents that relies on distal cues to navigate from start locations around the perimeter of an open swimming arena to locate a submerged escape platform. Spatial learning is assessed across repeated trials and reference memory is determined by preference for the platform area when the platform is absent. Reversal and shift trials enhance the detection of spatial impairments.

Key features:

- Visual cue navigation: Relies on external cues for orientation and learning
- Measures latency, swim path, distance traveled, and target quadrant time
- Supports acquisition, reversal, and probe trials to detect subtle cognitive impairments
- Commonly used in aging, neurodegeneration, and drug studies



ROTOR-ROD System

Assesses motor coordination, balance, and motor learning in rodents. It tracks how long animals maintain balance on a rotating rod to evaluate neuromuscular function.

Key features:

- Tests motor performance and learning in rats and mice
- Quantifies latency to fall as a measure of motor coordination
- Ideal for evaluating drug effects, neurological deficits, and recovery
- Supports repeated trials to assess motor learning

Place Conditioning Preference

Assesses the positive (rewarding) or negative (aversive) motivational effects of objects (e.g., food pellets, novel toys) or experiences (e.g., brain stimulation, drug in toxication, drug withdrawal, foot shock, illness, wheel running and copulation).

Key features:

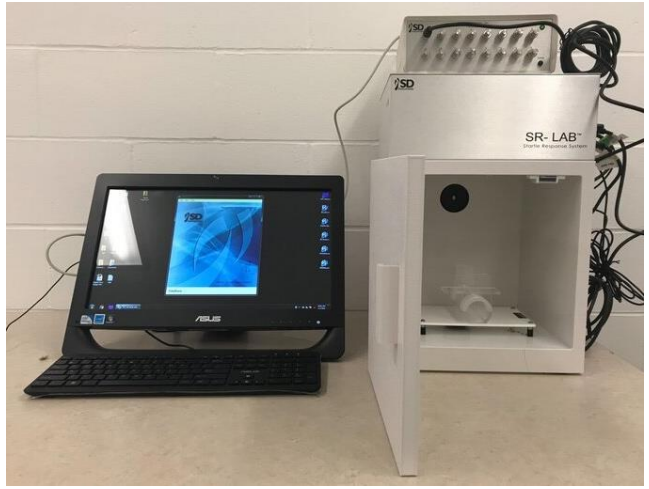
- Two-compartment chamber with different contexts (e.g. wall color, bedding, flooring)
- Alternating drug vs. vehicle exposure during conditioning
- Free movement during test to measure time spent in each compartment

SR-LAB Startle Response System

Measures rodents' reflexive responses to sudden intense stimuli, commonly acoustic but can also be tactile or light.

Key features:

- Simple acoustic pulse trials with varying intensities (e.g., 90–120 dB)
- Prepulse inhibition paradigm: weak leading stimulus reduces response to following strong pulse
- Habituation tests: response decline over repeated trials
- Stimulus presentation in randomized order; quiet background noise maintained (≈ 65 dB)
- Used to study brainstem circuitry and higher-order modulation in models of neuropsychiatric disorders



The Radial Arm Maze

Assesses spatial working and reference memory in rodents. Rodents navigate 8 arms from a central hub to locate food rewards. Efficient performance requires remembering which arms were previously visited.

Key features:

- Tracks working memory (repeat entries) and reference memory (correct choices)
- Measures latency, arm entries, and errors
- Requires training over multiple days
- Used in studies of learning, aging, and cognitive impairment

Treadmill

Rodents run on a motorized belt under controlled speed, incline, and duration settings to assess endurance, fatigue, and locomotor capacity.

Key features:

- Adjustable speed, incline, and shock grid (if applicable)
- Measures running distance/time and exhaustion latency
- Suitable for training protocols, disease models, and drug interventions
- Offers reproducible and quantifiable measures of physical performance

Services Provided at BORC

- Cell Based Assays and Biochemical Assay
- Chemistry Panel Analysis
- DNA & RNA extraction
- Gene Cloning and Subcloning
- Genotyping
- Real Time PCR and Digital Droplet PCR

Research Tool Development Program

The BORC supports two Research Tool Development Programs annually. The eligible applicants may be either NPOD internal investigators or other UNL investigators. The proposed projects are expected to benefit research for multiple labs. Applications are accepted on a rolling basis. The applications must include the following information in three pages (maximum, word or PDF format)

- Application title
- PI contact information
- Rationale and objectives of the proposed project
- Experimental plan
- A justification for funding request

Biostatistics and Computational Services

Expert support for study design, data analysis, and high-performance computing

Biostatistics Coordinators:

- Dr. Reka Howard
- Dr. Indranil Mukhopadhyay

Services:

- Experimental Design
- Sample size and power calculations
- Data Analysis
- Development of analysis plans
- Development of statistical tools
- Implementation (R and SAS)

Computational resources:

- Dr. Hongfeng Yu

Thanks!