Core Instrumentation Service Facilities

advancing biotechnology research and education

Supporting core service facilities for biotechnology research by faculty, student, government, and industry scientists. Developed by the Office of Biotechnology and the Office of the Vice President for Research.

April 2015
Still growing and reaching higher is a good way to describe the core instrumentation service facilities of the Office of Biotechnology at Iowa State University.

Developed under the oversight of the Office of the Vice President for Research, these fee-for-service facilities support research from single molecules to whole tissues.

Personnel in the core facilities can assist university, industry, and government researchers at every stage of their research projects.

Facility personnel teach a hands-on course in molecular biology techniques and, in most facilities, researchers can be trained to operate the instruments themselves.

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Cells and Cell Images

Confocal and Multiphoton Facility

The Confocal and Multiphoton Facility at Iowa State University features equipment that provides both confocal and multiphoton capabilities in a single instrument. This system is one of the few instruments in the world with both a white light laser and an optical parametric oscillator (OPO).

Confocal/Multiphoton System

Confocal microscopes remove out-of-focus fluorescent light, allowing clearer imaging of the sample's structures and components. The Leica SP5 X MP confocal/multiphoton microscope system in the Molecular Biology Building allows real-time optical sectioning of fixed and living specimens. Users easily can switch between the confocal and the multiphoton mode that allows users to image deeper into their samples than is possible with confocal systems.

New technology

New technology on the confocal/multiphoton system includes a white light laser tunable to any wavelength between 470 and 670 nm, an infrared laser, high sensitivity detectors, and an optical parametric oscillator. The system has an acousto-optical beam splitter which enables researchers to precisely set the emission wavelengths for capture, rather than be limited to preset emission ranges determined by fixed filter sets. The optical parametric oscillator expands the range of the multiphoton laser to include the red and high red ranges, enabling use of essential fluorophores such as mCherry and Alexa Fluor 660. High sensitivity detectors allow visualization of structures with low fluorescence.

Other features

The system also has a resonant scanner which enables video rate scanning at speeds up to 16,000 lines per second, a 405 laser, and an Argon laser. The system has fluorescence resonance energy transfer (FRET), fluorescence recovery after photobleaching (FRAP), time lapse, hyperspectral signal separation, colocalization, deconvolution, region of interest scanning, brightfield, and differential interference contrast (DIC). User-friendly software for 3D reconstruction is available.

Researchers can work with live cells over long time periods by using live cell equipment, including a heated stage with microcontainment or macrocontainment system, active gas regulation, cell cultivation chamber, and microinjection system.
Flow Cytometry Facility

Iowa State University’s Flow Cytometry Facility offers life scientists a powerful technology for investigating all aspects of cell biology and for isolating cells of interest. Flow cytometry is an indispensable tool for deciphering complex cellular processes and interactions in a variety of animal, plant, and microbial systems. It enables detection and quantitative analysis of specific cellular and sub-cellular elements in a complex mixture of cells.

Flow Cytometry Capabilities
The Flow Cytometry Facility’s data acquisition and cell sorting instruments can provide many types of cell-related information, including intracellular and cell surface receptor densities, genome size, chromatin structure, cell cycle kinetics, cellular metabolic functions, cell viability and concentration, intracellular protein products, and more. Cell life and tissue localization can be tracked in vivo. Fluorescence in situ hybridization (FISH) techniques that provide information on the mRNA expression level of a specific gene can be used in conjunction with flow cytometry to provide quantitative gene expression information on a cell-by-cell basis. Necrotic versus apoptotic-mediated cell death can be distinguished using flow cytometry.

It is also possible to sort individual cell populations via flow cytometry, enabling researchers to separate and further characterize subpopulations of cells.

Sorting Flow Cytometer
The sorting flow cytometer located in the Molecular Biology Building uses the power of multi-color flow cytometry and a highly sensitive analysis platform to categorize a variety of unique cell subpopulations. Operated by facility personnel, this instrument allows researchers to identify cells of interest and simultaneously isolate and collect these target events for further study. Data acquired on the instrument is loaded onto a network server where customers can retrieve data files for analysis from their office/lab.

Data Acquisition Flow Cytometers
The Flow Cytometry Facility operates two data acquisition flow cytometers. One instrument located in the Molecular Biology Building combines a patented optical design, digital electronics, and a novel sample injection system supporting carryover of less than 0.1%. This instrument is uniquely suited for rare event analysis.

A second data acquisition flow cytometer in the Veterinary Medicine Complex satellite facility is configured to detect seven fluorescent parameters. This instrument can be operated by trained users. The facility also maintains a user-operated bench-top magnetic cell separation instrument within the satellite facility that can be used to perform sterile bulk sorts.
Hybridoma Facility

At Iowa State University’s Hybridoma Facility, researchers can obtain monoclonal or polyclonal antibodies against their protein of choice that are ready to be used in their research projects. The facility develops monoclonal antibodies beginning with mouse immunization through all the steps to cryopreservation of cell lines.

Services Provided
The Hybridoma Facility serves researchers who need monoclonal or polyclonal antibodies but do not have the appropriate equipment or are not experienced in antibody production techniques. A wide array of procedures can be customized to meet the researcher’s individual requirements. These techniques are provided on an individual charge basis and include animal immunization, cell fusion and hybridoma culture maintenance, cell culture and maintenance of other cell lines used in biotechnology and virology labs, large-scale mammalian cell culture (bioreactor), blood sera collection, antibody purification and isotyping, cryopreservation and cryostorage of cell lines (-140 degrees centigrade), and ELISA (enzyme-linked immunosorbent assay) tests.

The hybridoma projects are usually screened and selected by the client. However, the facility can do the screening and/or training of lab personnel when needed.

Polyclonal Antibodies
Polyclonal antibody production in rabbits is available only for on-campus clients. Polyclonal services include the purchase and care of rabbits through the Laboratory Animal Resource group on campus, blood collection and processing of sera, adjuvant addition, and injection of antigen. Procedures are administered according to an approved protocol and timetable.

Timetable for Hybridoma Production
A hybridoma project usually requires three to five months for completion. The following timetable is typical.

<table>
<thead>
<tr>
<th>Weeks</th>
<th>Description</th>
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<tbody>
<tr>
<td>4-6</td>
<td>Mouse immunization</td>
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<tr>
<td>2</td>
<td>Selection of primary hybridomas after cell fusion</td>
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<td>2</td>
<td>Expansion and freezing of primary hybridomas</td>
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<td>2</td>
<td>Cloning and screening clones</td>
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<td>4</td>
<td>Bioreactor and ascites fluid production</td>
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Image Analysis Facility

The Image Analysis Facility at Iowa State University provides two-dimensional (2D) and three-dimensional (3D) imaging resources for researchers who are interested in sample measurement or visualization.

Image Analysis Services
Services of the Image Analysis Facility include 2D image analysis such as morphometry, particle analysis, densitometry, and more. The 3D image analysis services include volumetric sample measurement. Other related services offered by the facility are reconstruction, image editing instruction, and photomicroscopy.

Microscopes
The Image Analysis Facility offers an upright microscope with fluorescence. An inverted microscope with an automated scanning stage and recomposition software for capturing images of large samples at high resolution is available in the Confocal and Multiphoton Facility. The facility also has a stereo microscope, digital cameras for all microscopes, and a copy stand.

Laser Capture Microdissection
A laser capture microdissection system identifies and retrieves individual cells from tissue sections. The retrieved cells can be used for assessment and analysis of RNA, DNA, protein, and other biochemical properties.

Computer Software
Software in the facility includes Imaris software for 3D reconstruction and image analysis and IPLab for 2D image analysis.

In addition to 2D image analysis, the Image Analysis Facility provides a 3D reconstruction and analysis system. This system is often used with files generated by a confocal system to enhance visualization of samples from research projects.

With the ever-increasing capabilities of computers, the availability of free image analysis software, and cost-efficient research budgets, the Image Analysis Facility strives to assist and educate users in the proper implementation of image analysis software techniques and methodologies in their research. The facility also serves as a reference and focal point for researchers who need support with image analysis projects.

Assistance with reporting image analysis work in publications, dissertations, and other formats is also available.

Equipment in the facility is available to researchers for an hourly charge for other types of projects when not in use by the facility.
Microscopy and Nanolmaging Facility

Iowa State University’s Microscopy and Nanolmaging Facility (MNIF) provides instrumentation, technical assistance, and training in electron and light microscopy, cryo-preservation, cytochemistry, autoradiography, in situ hybridization, tomography, X-ray microanalysis, image analysis, and photomacropy.

Electron Microscopy
Electron microscopy instrumentation includes a scanning transmission electron microscope (STEM) and a scanning electron microscope (SEM).

STEM
The 200 kV STEM provides <1.4Å resolution and has elemental analysis, cryo-imaging, tomography, and image analysis systems. The microscope includes a light-element energy dispersive x-ray spectrometer (EDS) and integrated software package for computerized control.

The digital microscope and analytical system allow elemental analysis of the composition and structure of specimens with a nanometer resolution. Special features include a darkfield/brightfield detector, hi-angle tilt holders for tomography, cryo-preparation system and holder for cryo-TEM imaging, and two digital cameras for image recording, as well as image analysis software.

SEM
The SEM offers 35Å resolution with digital imaging capability and image analysis. The microscope operates at either high or low kVs and at either high or low pressures to allow observation of both fixed and fresh specimens.

Light Microscopy
Light microscopy instrumentation includes a compound microscope with six optical modes, including fluorescence, and color and B/W digital cameras. This microscope has an Apotome for creating thin optical slices.

Specialized Rooms and Instruction
The facility also houses a stereomicroscope, dissecting microscopes, and compound microscopes. Microscopes with digital cameras have image analysis capabilities.

Facility personnel instruct an individual module training program for researchers to help them process and visualize their research materials and identify the appropriate methods and instruments for their objectives.

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24-hour access after training

Web
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Genome Informatics Facility

Iowa State University’s Genome Informatics Facility provides bioinformatics services for investigators within academia, industry, and government.

Quality Analysis
Quality analysis starts with understanding the nuances of the biological question and the assumptions made by informatics tools. Facility staff members are available to work closely with researchers to provide the best solution for biological enquiry.

Building Infrastructure
The mission of the Genome Informatics Facility is to build and maintain an infrastructure that enables the application of strong bioinformatics analysis with a measurable impact on the ability of Iowa State University investigators to both publish their work and obtain new funding.

Consulting and Data Analysis
The Genome Informatics Facility serves as a centralized resource for providing expert and timely bioinformatics consulting and data analysis solutions. The facility offers services to investigators both within and outside Iowa State University on both grant-funded and fee for service projects for management and analysis of large-scale biological datasets produced by high-throughput genomics experiments.

Available Services
Genomics Information Facility personnel collaborate with faculty and scientists from Iowa State University and other institutions. The facility develops computational resources that are available to the university research community and to potential off-campus collaborators and customers.

Next-Gen Sequence Analysis
The Genome Informatics Facility provides bioinformatics support and leadership in the field of Next-Generation sequence analysis.

Mentoring and Grant Support
The facility manager supervises and mentors postdoctoral scholars and graduate students in sequence analysis. The manager also collaborates with researchers, faculty, and staff on proposals to granting agencies.

Specific Services
Specific services offered include:

- Assembly and annotation
- SNP/InDel calling
- RNA-seq analysis
- Metagenomics
- Introgression/Trans-gene mapping
- Novel gene discovery
- Personalized GBrowse for data visualization
- Access to high performance computing resources

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DNA Facility

The DNA Facility at Iowa State University performs DNA sequencing, synthesis, and related services to support research.

DNA Sequencing

Standard Sanger Sequencing
DNA can be sequenced as plasmid, lambda, cosmid, or BAC DNA, or as PCR products (direct sequencing). Data can be downloaded directly from the facility’s server, and a four-color data printout is provided. Custom primers can be used with all types of templates.

High-Throughput Sanger Sequencing
Samples can be submitted in a 96-well format. Twelve sets of 96 samples can be processed in a 24-hour period.

Next-Gen Sequencing
The facility provides short-read (50-250 bases) Illumina sequencing and offers library preparation service for all applications.

Access to Roche 454 sequencing is made possible through an instrument-sharing agreement between Iowa State University and the University of Iowa.

DNA Synthesis
DNA oligomers can be synthesized in two scales, 50-nmol and 200-nmol. The facility can make modified oligomers such as the fluorescent primers used in genotyping applications. Primer design is available for primer walking sequencing projects.

Automated Genotyping
The facility processes microsatellite and AFLP markers using a DNA analyzer and associated software to electrophorese samples and analyze the results. Each sample can have as many markers as the client can identify.

DNA Template Preparation
The facility performs plant genomic DNA preparation and also offers a seed grinding service. Plasmid template preparation in 96-well format also is available.

Quantitative Real-Time PCR
The DNA Facility has two quantitative, real-time PCR instruments for gene expression studies, validation of microarray data, allelic discrimination, SNP analysis, and screening for GMOs.

Nucleic Acid Sizing and Quantification
A Bioanalyzer instrument analyzes and quantifies DNA, RNA, and protein. Each chip can be used to assay from one to twelve samples. Trained users run their own samples.
Macromolecular X-Ray Crystallography Facility

The Macromolecular X-Ray Crystallography Facility provides the Iowa State University research community and off-campus clients with x-ray data collection and crystal screening services.

X-Ray Diffraction
The Macromolecular X-Ray Crystallography Facility has a rotating anode generator for single crystal x-ray diffraction studies.

Crystallization and Crystallography
For crystallization, the facility houses stereomicroscopes and temperature and vibration controlled chambers. Training is offered in crystallography techniques, and computers with crystallography software installed are available.

Specific Services
Facility services are provided on a fee basis and include consultation on protein purification, crystallization, and crystal optimization, as well as assistance with crystal screening, data collection, data processing and structure determination and analysis.

The following outline is used for general planning of a crystallography project:

**Protein purification**
Concentrated protein >95% pure

**Crystallization**
3D, mountable crystals

**Crystal screening**
Search for high quality, high resolution crystals

**Data collection**
Using facility or synchrotron equipment

**Structure determination**
Processing, phasing, refinement, modeling, analysis, deposition

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Protein Facility

**Iowa State University’s Protein Facility provides expertise for the analysis, characterization, and synthesis of proteins and peptides. After training, users can operate many instruments themselves.**

**Circular Dichroism**
Researchers who want to detect and quantitate the chirality of molecular structures can access the Protein Facility’s circular dichroism (CD) spectroscopy services.

**HPLC**
Microanalytical, analytical, and preparative high performance liquid chromatography (HPLC) purification of proteins and peptides can be accomplished.

**Mass Spectrometry**
A matrix-assisted laser desorption/ionization time-of-flight (MALDI-TOF) mass spectrometer can be used for determining the molecular weight of proteins, peptides, glycoproteins, oligosaccharides, oligonucleotides, and polymers. A quadrupole-TOF tandem mass spectrometer is also available for obtaining peptide sequence information.

**Peptide Synthesis**
The facility can do both large- and small-scale peptide synthesis, including phosphopeptides, peptides with unusual amino acids, and multiple antigenic peptides (MAP).

**Protein and Peptide Sequencing**
The Protein Facility provides N-terminal protein/peptide sequence analysis (Edman degradation) of proteins in solution or electroblotted onto polyvinylidene difluoride (PVDF) membrane.

**In-gel Digestion and Peptide Mass Fingerprinting**
The facility offers in-gel digestion of protein samples from 1D or 2D gels. Gel spots can be digested with a variety of enzymes, and the resulting peptides can be analyzed to identify the protein.

**SDS-PAGE / Electroblootting**
The facility conducts sodium dodecyl sulfate polyacrylamide gel electrophoresis (SDS-PAGE) of proteins for purity and molecular weight estimation. Gels can be electroblotted to nitrocellulose or to PVDF for immunodetection and protein/peptide sequencing, respectively.

**2-D Gel Electrophoresis**
The facility does two-dimensional electrophoresis by separating proteins in the first dimension according to charge (isoelectric focusing), followed by separating the focused proteins in the second dimension according to their molecular weight.

**Other Services**
The Protein Facility also has equipment for phosphor imaging and the imaging of visible and fluorescent stained gels or blots. Software for the analysis of 1D and 2D gels is also available.
Materials Analysis and Research Laboratory

The Materials Analysis and Research Laboratory at Iowa State University offers chemical and physical characterization of a wide variety of materials to support university research and teaching programs. For outside agencies, the laboratory also conducts research on unusual material evaluation problems.

Microscopy
The lab has a field emission scanning electron microscope, with low vacuum and environmental imaging capabilities. It is also equipped with secondary electron and backscattered electron detectors, an energy-dispersive x-ray spectrometer, a 1000°C heating stage, and a motorized stage (x-y).

Light microscopes are available for reflected light, transmitted light, and stereo imaging.

X-ray Diffraction
The lab operates two x-ray diffractometers. One has a diffracted beam monochromator and a sample spinner. The other is a research grade instrument for studying the underlying structure of solids, including phase identification, quantification, and structure refinement.

X-ray Fluorescence
An x-ray fluorescence spectrometer is equipped with a 60-specimen sample changer for automated operation. It provides excellent sensitivity for the determination of all elements from boron through uranium. Specimens can be introduced into the spectrometer as bulk solids (powders, pellets or fused disks) or as liquids or semi-solids.

Thermal Analysis
The lab offers high resolution thermal gravimetric analysis that can test samples in inert gases from ambient to 1200°C, with a 25 position autosampler.

Image Acquisition, Processing, and Analysis
Both of the scanning electron microscope x-ray analyzers are equipped for recording digital images, and one can record movies. A charge-coupled device camera can capture images through the light microscopes or from a camera stand. Software is available for image processing and analysis.

Sample Preparation
The lab is equipped with extensive equipment for preparing samples. Equipment includes cutoff saws, grinders, polishers, sputter coaters, evaporators, sample presses, etc.

Network and Computer Support
The laboratory operates its own local area network for exchange of data within the laboratory. Results are available for immediate retrieval through Web and FTP servers.
Iowa State University’s W. M. Keck Metabolomics Research Laboratory houses analytical instruments for high-throughput chemical analysis of small molecules (metabolites) in biological samples. This facility houses seven different analytical platforms to analyze diverse and complex sets of metabolites with a variety of chemical and physical properties.

Gas Chromatography (GC-MS)
The laboratory houses four gas chromatography mass spectrometry instruments with electron impact and chemical ionization methods.

Liquid Chromatography – Mass Spectroscopy (LC-MS)
A liquid chromatography/mass spectrometry instrument, the ion-trap in the laboratory, has several ionization capabilities, including electrospray ionization (ESI) and atmospheric pressure chemical ionization (APCI).

Fourier-Transform Ion Cyclotron Resonance Mass Spectrometry
The laboratory has expanded to include a Fourier-transform ion cyclotron resonance (FT-ICR) mass spectrometry instrument. The FT-ICR instrument is a high-end mass spectrometer that provides ultra high-accuracy mass measurements to the sub-parts per million level. This instrument has built in MALDI (matrix assisted laser desorption ionization) capabilities.

Capillary Electrophoresis
Researchers can access a capillary electrophoresis instrument with ultraviolet (UV) and laser induced fluorescence.

High Performance Liquid Chromatography
The W. M. Keck Metabolomics Research Laboratory also has several high performance liquid chromatography instruments equipped with an ultraviolet-diode array (UV-DAD), fluorescence, and evaporative light scattering detectors (ELSD). The laboratory also possesses quaternary pump HPLC.

Microplate Reader
A multi-mode microplate reader in the laboratory has the ability to assay optically active molecules via luminescence, fluorescence, fluorescence polarization, and ultraviolet-visible (UV-Vis) absorbance that is monochromator-based.

Sample Analysis
Analysis of samples for on- and off-campus researchers is offered for a fee.

After training, on-campus researchers may choose to analyze their own samples.
Plant Transformation Facility

The Plant Transformation Facility at Iowa State University offers research partnerships for the genetic transformation of plants. The target crops are maize (corn), soybeans, and rice. Brachypodium distachyon serves as a model organism for grasses, cereals, and biofuel crops. The facility also offers consulting and other transformation-related services.

Maize Transformation

The facility uses either the Agrobacterium or biolistic delivery systems for transformation of corn immature zygotic embryos. Transformed products available are maize callus, plantlets, or seed.

Soybean Transformation

The facility uses an Iowa State University proprietary method (US patent 7,473,822) for Agrobacterium-mediated transformation using soybean half-seed explant from mature seed. Transformed seed is the product.

Rice Transformation

Agrobacterium-mediated transformation is the method used to transform rice callus cultures derived from mature embryos. Transformed rice plantlets will be delivered to the customers.

Brachypodium distachyon Transformation

Brachypodium distachyon (common name purple false brome) is a model organism for functional genomics research in temperate grasses, cereals, and dedicated biofuel crops such as switchgrass. The target tissue for Agrobacterium-mediated transformation is callus cultures derived from immature embryos. Transformed plantlets are the available product.

Transformation-Related Services

The Plant Transformation Facility also provides instrumentation, technical assistance, consultation, and training. Facility personnel instruct a graduate course (GDCB 542D) on plant transformation and transgenic plant analysis every spring semester.

Transformation Methods

The methods for genetic transformation are Agrobacterium-mediated and biolistic systems. Agrobacterium tumefaciens is a common soil bacteria that has a natural ability of delivering DNA into plant cells. The biolistic BioRad PDS1000/He device bombards the targeted tissue with gold particles coated with the genetic material to be introduced.

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Besides the core facilities that are administered by the Office of Biotechnology, Iowa State University has many more facilities that support research related to biotechnology. For more information, contact the Office of Biotechnology or visit www.biotech.iastate.edu/biotechnology-service-facilities.

Animal Gene Transfer Facility (1)  
Atmospheric Air Quality Laboratory (2)  
Atomic Force Microscopy (3)  
Biomolecular Nuclear Magnetic Resonance Facility (3)  
Center for Crops Utilization Research (CCUR) (4)  
Chemical Instrumentation Facility (5)  
Comparative Pathology Core Services (6)  
Doubled Haploid Facility (7)  
Environmental Engineering Research Laboratory (8)  
Fermentation Facility (4)  
Genomic Technologies Facility (9)  
Grain Quality Laboratory (4)  
Materials Preparation Center (10)  
Molecular Printing Facility (3)  
Microfabrication Facility (11)  
Nutrition and Wellness Research Center (12)  
qPCR Consultation Service (6)  
Sensory Evaluation Unit (12)  
Ultrahigh Resolution Biological Microscopy Lab (3)  

For Iowa State University online campus map  
www.fpm.iastate.edu/maps/

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