ASSESSMENT AND EVALUATION

Discovery Learning Research Center
- Formative, summative, and project evaluation
- Qualitative and quantitative analysis
- Consultation and interpretation

CANCER PREVENTION

Oncological Sciences Center
- Cancer Prevention and Nutrition
  - Chemoprevention
  - Vitamins D and E as preventative agents
- International Breast Cancer and Nutrition Program
  - International consortium for culturally sensitive
    global prevention strategies for breast cancer
  - Biomarker discovery for early state colorectal cancer

CLIMATE CHANGE

Purdue Climate Change Research Center
- Coupled biogeochemical cycles – measuring/modeling
  the exchange of carbon and coupled elements among the
  Earth’s atmosphere, oceans and land ecosystems
- Climate change and extreme weather – severe weather
  prediction and predictability, including the effects of
  anthropogenic global warming and the impact of land use
  on severe weather
- Impacts, adaptation and resilience to climate change –
  developing tools and methods for assessing adaptation
  strategies and advising stakeholders
- Hydroclimatology – hydrologic impacts and feedbacks to
  climate change at a range of scales

CYTOMETRY

Bindley Bioscience Center
- Analysis and sorting of any particles between 0.2 to 100
  microns
- Cell cycle analysis

DATA AND INFORMATICS

Bindley Bioscience Center
- Research, development and application of computational
  tools/approaches for expanding use of biological,
  medical, behavioral or health data
- Data acquisition, storage, archival, analysis and
  visualization

Birck Nanotechnology Center
- Research, development and application of computational
  tools and approaches for understanding nanoscale
  physics and its application to nanotechnology
- Data acquisition, storage, archival, analysis and
  visualization
- Predictive science and uncertainty quantification for
  nanoscale physics and devices

- Predictive modeling and device simulation of vascular
  flow issues
- Micro-models of flow characteristics

Cyber Center
- Computer science - data management, information
  retrieval, security, privacy, networks, distributed systems,
  machine learning, computer graphics, mobile devices
- Computer technology – data forensics
- Social and human sciences – computational social
  sciences
- Bioinformatics
- Healthcare informatics
- Energy – security and privacy of advanced meters
  infrastructures

Network for Computational Nanotechnology
- Solutions for meeting requirements of data management
  guidelines as it relates to nanotechnology material

Regenstrief Center for Healthcare Engineering
- Healthcare data security

DRUG DISCOVERY AND DEVELOPMENT

Bindley Bioscience Center
- Screening – chemical compounds, yeast/bacteria
- High throughput cloning
- Recombinant protein production
- Custom designed high-throughput assays and
  experiments - preparation of samples for mass
  spectrometry, ELISA (lab-made/commercial kits)
- Porcine model testing – pharmacokinetic/
  pharmacodynamic (PK/PD), behavioral assessments,
  nutritional/biomarkers, surgical models with Vet Med,
  physiological data, imaging

Birck Nanotechnology Center
- Reel-to-reel coating of soft material for pharmaceutical
  drug delivery and bio applications
- Carbon nanotube production on a larger scale
- Advanced chemical film development
- High-volume manufacturing of nanoscale devices and
  materials
- Modeling and process design and control for lyophilized
  pharmaceuticals
- Wireless MEMS/NEMS sensors for temperature, pressure,
  and vapor flow control in freeze-drying manufacturing
  processes

Purdue Center for Drug Discovery
- Target discovery – focusing on oncology, neurological
  disorders, immune disorders, infectious disease,
  metabolic disorders, cardiovascular disorders
- Diagnostics/Imaging – design of imaging probes,
  identification of biomarkers and construction of
  biosensors for disease detection and diagnosis,
  diagnostics and surgery
Therapeutic development – formulations, in vivo studies, ADME/tox, PK/PD
• Translating discoveries into therapeutics
• Targeted drug delivery
• Complex multistep organic synthesis
• Multiphoton and confocal microscopy
• Whole animal functional and structural imaging (SPECT/CT, fluorescence and luminescence imaging)

EDUCATIONAL RESEARCH
Discovery Learning Research Center
• Interdisciplinary research in STEM learning
  o Learning spaces
  o Experiential learning
  o Connecting STEM research to STEM education
  o Informal learning
• Transforming educational research into practice
• Educational pedagogy, theory, and methods.
• Research space for testing or piloting new educational technologies and pedagogies
• Facilities, instrumentation, technology, and personnel to support learning research
• Links to and partnerships with K-12

ENERGY
Bindley Bioscience Center
• Direct catalytic conversion of plant biomass to liquid hydrocarbon transportation fuels

Birck Nanotechnology Center
• Design of electro-thermal energy conversion devices and systems (automotive and co-generation applications)
• Thermal interface characterization (e.g. Carbon nanotubes)
• Bulk and thin film thermoelectric measurement
• Microcooling modeling, technology, and applications
• Photovoltaics, thermophotovoltaics modeling and applications
• Thermal imaging with submicron spatial, 800ps time and 0.1C temperature resolution
• Vibration-based and strain-based energy harvesting MEMS devices

Global Sustainability Institute
• Control science approaches to design of metabolic pathways in plants for drop-in biofuels
• Energy efficient technology development for buildings
• Re-designed engines to improve fuel consumption and reduce carbon emissions by 50% from medium/heavy-duty vehicles
• Fundamental studies of combustion processes in gas turbines
• Photovoltaics with improved performance using modeling and simulation
• Novel and improved catalysts for energy applications designed using discovery informatics
• Forecasts of electricity consumption, prices, and resource requirements for the State of Indiana
• Inspiring future leaders in energy in the Duke Energy Academy at Purdue for high school students and teachers

ENGINEERING AND MICRO/NANO DEVICES
Birck Nanotechnology Center
Bio-Nano Sensors
• Sensors for measuring biological movement at the cellular scale
• Sensors for measuring very low level changes in biological fluid dynamics
• Graphene-based sensors for biological and chemical applications
• Wireless electronics and sensing interfaces

Cleanroom Design and Building Controls
• Cleanroom, laboratory, and facility design, particulate control, cleaning protocols
• Advanced building monitoring and management systems

Laser Machining and Nanomanufacturing
• Laser machining of physical micro models
• Laser nanomanufacturing

Micro- and Nanofabrication
• Semiconductor and MEMS device fabrication in an ISO 3, 4, and 5 (Class 1, 10, & 100) cleanroom
  o Optical, electron-beam, and nano-imprint lithography (feature sizes down to 6 nm)
  o Wet and dry chemical and mechanical etching (aspect ratios > 40:1)
  o Physical and chemical vapor deposition (metals, insulators, magnetic materials)
  o Thermal processing
• Specialty processes including atomic layer deposition (ALD), molecular beam epitaxy (MBE), and rapid thermal processing
• A wide variety of processing expertise: MEMS, microfluidics, photonic materials, sensors, Carbon nanotube devices, RF devices, advanced transistor structures and materials

Nanoelectronics, RF electronics, MEMS sensors Modeling and Fabrication
• Spin-electronics devices, low band-gap devices, graphene/2D materials
• RF MEMS tuners, sensors, actuators for a wide variety of applications including condition monitoring, energy harvesting, radiation detectors, reconfigurable electronics, tunable RF/microwave /millimeter-wave filters, and RF switches
• RF nanodevices and circuits
• Nanostructures, nanomechanics, nonlinear dynamics and vibration
• Power electronic materials and devices
• Nanoscale plasma modeling and design for nano-scale actuators and RF electronics
• Kudsen force modeling and applications
• Micropropulsion modeling and MEMS devices
• Rarefied gas dynamics modeling and experiments with applications to micro/nano-fabrication, MEMS/NEMS sensors, micropropulsion, and manufacturing of bio/pharmaceuticals.
• Wireless harsh-environment sensors for condition monitoring
• Implantable wireless sensors
Nanotechnology and Fabrication Safety
- Processing safety protocols
- Solid (particle), liquid, gaseous chemical hygiene
- Nanoparticle containment
- Incorporating safety into equipment installation, cleanroom design, laboratory design, and facility design (Prevention through Design - PtD)
- Advanced emergency response procedures

Photonics Modeling and Device Modeling, Fabrication, and Characterization
- Meta materials, negative refractive index materials and devices
- Raman spectroscopy and ellipsometry of thin films
- Femtosecond pump-probe optical and thermal characterization

cPRIMED
- Unique software and computational modeling capabilities that will revolutionize the design of products, devices, and systems
- Multi-scale modeling that will link atomic-, nano-, meso-, and macro-scale material properties to ultimate device and structure performance
- Multi-scale development strategy that will couple in general ab-initio methods to larger scale, yet atomistic device models in NEMOS

Cyber Center
- Computer engineering – high-performance computer, software engineering, visualization
- Electrical engineering and civil engineering – smart grid technologies
- Industrial engineering – human factors

iNEMO
- Development of software (quantum mechanical based simulation tools) that works in the area of nanoelectronics for the understanding of electron flow through nano-scale devices

Nano-Engineered Electronic Device Simulation Node (NEEDS)
- SPICE-compatible compact models in Verilog-A format with supporting resources
- Environment for developing compact models
- Hosting of seminars and training materials in support of creating new compact models for circuit simulation.

Network for Computational Nanotechnology
- Development and hosting of scientific research codes
- Development and hosting of seminars, courses, and teaching materials
- Access to backend computational resources through simulation tools and workspace

Oncological Sciences Center
- Cross-training in clinical oncology and engineering/physical sciences
- Microfluidic approaches to isolation of rare blood cells
- Intracellular chemosensors for drug targets and drug efficacy
- Nanoparticle delivery systems for anti-cancer agents
- Mathematical modeling of large scale data

Regenstrief Center for Healthcare Engineering
- Healthcare Engineering
  - System design tools – improve care coordination, human factors in care coordination
  - System analysis tools – modeling and simulation, enterprise-management, financial engineering, knowledge discovery in databases
  - System control tools – scheduling, resource optimization
  - Patient-centered Care – health communications, health literacy, improving patient engagement, family support in patient self-care

ENTREPRENEURSHIP
Burton D. Morgan Center for Entrepreneurship
- Manage Deliberate Innovation For Faculty (DIFF) Director program, which guides research proposal opportunities and collaborations
- Technology realization, rapid prototyping, transfer and commercialization direction from early stage discovery to commercialization or startup formation
- Entrepreneurship and innovation education/certification
- Business plan/model development such as capital source analysis, market research, and business planning
- Entrepreneurial leadership development for faculty interested in interdisciplinary research programs, centers, and partnerships that may lead to translational activities
- Entrepreneurial resources aimed at funding, grant writing, regulatory requirements, mentoring, etc.

ENVIRONMENT
Center for the Environment
- Risks from emerging pollutants – persistence, fate, transport, toxicology of new chemicals in the environment
- Biodiversity and ecosystem functioning on managed landscapes – protecting biodiversity and monitoring and preserving ecosystem services
- Environmental decision-making and behavior
- Resilience to natural disasters
- Design for the environment – improve product design to reduce environmental impacts and increase profitability
- Environmental education

IMAGING
Bindley Bioscience Center
- Advanced light microscopy – 2D, 3D high resolution, high speed, confocal, multiphoton, super resolution
- Tomographic animal imaging – SPECT/CT, optical imaging
- Image processing and analysis

Birck Nanotechnology Center
MOLECULAR ANALYSIS

Bindley Bioscience Center

Biophysical Analysis
• Aggregation studies
• Stability
• Kinetic parameters
• Quantification of interactions – protein-protein, DNA/RNA-protein, small molecule-DNA/RNA/Protein, nanoparticles/copolymers/viruses

Biological Mass Spectrometry
• Protein identification
• Peptide fingerprinting
• Quantification (label and label-free)
• Top down/bottom up analysis – accurate mass determination
• Post translational modifications – phosphorylation, acetylation, oxidation, unique (adenylation/ubiquitination) glycosylation
• Applications to structural biology interface and domain mapping
• Sample preparation – liquid extraction, solid phase extraction
• Instrument method development
• Data analysis – quantitation, comparative sample profiling
• Biochemical pathways analysis
• Metabolite analysis – global profiling and accurate quantitative comparisons

Birck Nanotechnology Center
• Elemental, compound, and structural analysis
• Analysis of energetic materials (oxygen-free sample preparation)

WOMEN’S HEALTH

Oncological Sciences Center
• International consortium for culturally sensitive global breast cancer prevention strategies
• Nutrition research and cancer prevention

Women’s Global Health Institute
• Bone health
• Breastfeeding promotion through interactive web-based monitoring systems
• Communication improvement device for Parkinson’s patients
• Cancer and obesity
• Biomarker discovery for early detection of breast cancer
• Nanoparticle delivery system for ovarian cancer