Center for Applied Structural Discovery

Mission
Develop new revolutionary techniques that reveal the structure and dynamics of biomolecules towards new visionary discoveries in medicine and energy conversion.

Overview
The intricate orchestration of biological activity on our planet is enabled by nature’s remarkable nanotechnology, composed of tiny molecular machines called proteins. Proteins carry out all of the essential tasks critical for survival, including normal metabolism and tissue repair, the response of our immune system to pathogens, and in plants and algae, the ability to capture and use energy from sunlight to produce the oxygen we breathe and the food we eat. Understanding how proteins perform their remarkable tasks requires a multi-faceted understanding of their structure, dynamics, and the physical and chemical processes that occur at the molecular and atomic scale. The emergence of new generations of state-of-the-art technologies that probe these processes promise hope that science and technology will emerge with a revolutionary understanding that enables building manmade technologies that mimic and improve on nature in order to solve pressing global challenges in healthcare and energy conversion.

Directed by Petra Fromme, the Center for Applied Structural Discovery (CASD) at Arizona State University’s (ASU) Biodesign Institute unites a team of complementary research professionals from a wide range of disciplines, including biology, chemistry, physics and engineering, to develop and apply groundbreaking technologies and methodologies to accelerate the rate at which we discover the structure and associated function of biomolecules. Breakthrough knowledge will accelerate progress on the path to technical innovations that improve human health and provide plentiful clean energy and food for future generations.
Center for Bioelectronics and Biosensors

Mission
We create new enabling tools for biomedical and environmental health research, develop wireless personal sensors for mobile health solutions, and explore fundamental phenomena of nature at the single molecule level for next-generation detection technologies.

Overview
A variety of sensors ranging from embedded systems to handheld devices may one day analyze your breath for the first telltale signs of disease, identify pollutants in drinking water, or keep society safe by detecting trace vapors and signatures of explosives. In the Center for Bioelectronics and Biosensors, our research can be divided up into several key themes. Some of the technologies are focused on the detection of harmful chemicals that are a threat to the environment and human health. Others look inside the body for markers or presence of disease. Still others focus on the detection of human-made threats.

In order to detect the presence of specific chemicals in the environment, or biomarkers in the body, extremely sensitive and selective sensors are required. An accurate and fail-proof early warning system for chemical and biological warfare agents and explosives also require sensors. In spite of many years of research, few systems can meet these challenges.

To achieve these goals, we utilize a multi-scale, multi-technology and system-level approach. We explore and integrate device and material functions from the nano- to micro- to macroscale. We hybridize different sensing platforms, including electrical, electrochemical, mechanical and optical signal transductions to achieve results that a single sensor alone cannot deliver. We use a system-level approach that optimizes devices from sample collection and sensing elements to signal processing and communication to deliver a complete solution to real-world problems.

Our research team can accomplish this because it involves a diverse group of researchers and students from bioengineering, electrical engineering, device physics, chemistry and biochemistry, and materials science. Among our collaborators are organic chemists and theoreticians from around the world, and industry that include researchers from Motorola, Intel, Dial, Biosensing Instruments among others.
Center for Biosignatures Discovery Automation

Mission
Discovery and understanding of microbial populations in harsh environments such as the oceans will enable insights into biogeochemical cycles, metabolic capabilities, and complex interactions that affect the health of our planet.

Overview
Diagnosing, understanding and predicting cell function or dysfunction is a key element toward gaining a better understanding of disease and other threats to human health. This knowledge is essential for developing the link between genomics, cell function and disease. Understanding these interrelationships will aid in the development of diagnostic tools to measure the health status across all dimensions of human health, from defects in single cells to alterations in the normal function of tissues and organs. Such knowledge could lead to the early diagnosis of major illnesses such as cardiovascular disease, cancer and stroke.

The Center for Biosignatures Discovery Automation serves as a headquarters to the Microscale Life Sciences Center (MLSC), a National Institutes of Health Center of Excellence in Genomic Science. Its researchers study different types of cell models to link cell genomics to metabolic and biochemical characteristics. By refining the MLSC’s microsystem-based platforms for measuring gene expression and physiological parameters, research can progress to include cell–cell interaction studies, in vivo tissue measurements and in vivo imaging for detection and monitoring.

The center also houses a portion of the work conducted by NEPTUNE, a project to construct a cabled underwater observatory in the northeast Pacific Ocean with high bandwidth and power for real–time oceanographic observations and experiments. The research team is developing sensing devices and other instruments to gain knowledge of the biological, chemical and physical environments at microbial levels on the sea floor and in the overlying water column.
Mission
Breaking through the current bottlenecks in fundamental mitochondrial biochemistry, drug design and therapeutic compounds by focusing on improved diagnoses and treatments for diseases caused by impaired energy metabolism.

Overview
The health of every living organism is dependent on metabolism, a basic process of life that captures and releases the energy contained in foods we eat to help fuel the body. Within nearly every cell type in the body are tiny, pill-shaped structures called mitochondria. These are the powerhouses for the cells, allowing proper growth, enabling the organs and muscles of the body to function effectively, and providing us with the energy needed for good health. Defects in mitochondrial function can result in serious, often fatal, diseases.

The Center for BioEnergetics, directed by Sidney Hecht, focuses on improved diagnoses and treatments for diseases caused by impaired energy metabolism. The majority of these diseases is degenerative and affects children and young adults. In addition to impacting children, mitochondrial impairment has been implicated as a factor in aging. It is associated with Parkinson's disease, atherosclerotic heart disease, stroke, Alzheimer's disease and cancer. On the other end of the spectrum, optimal mitochondrial function has been linked with peak physical performance, such as that exhibited by top athletes.

Due to widely ranging symptoms and early lack of understanding of the root cause of these symptoms, mitochondrial diseases have historically been classified into discreet groupings of diseases, such as Friedreich's Ataxia, that are relatively rare. This meant little effort has been put into drug discovery and treatment. Yet, together, the more than 40 mitochondrial diseases comprise a significant human and health care burden.
Center for Evolution and Medicine

Mission
To establish evolutionary biology as an essential basic science for medicine, worldwide.

Overview
The ASU Center for Evolution & Medicine is a university-wide Presidential Initiative whose mission is to establish evolutionary biology as an essential basic science for medicine, worldwide. This should not be necessary; all health professionals should already learn evolutionary biology the same way they learn other basic sciences. Unfortunately, few do.

The Center, led by Randy Nesse, will bring leading scientists to ASU to join existing faculty in research that demonstrates the power of evolutionary biology to address problems in medicine and public health. The new courses and degrees they create will begin to meet the growing demand for such experiences, and will educate a generation of future researchers and health professionals. Many of these experiences will be at ASU, and some will be in conjunction with the new Mayo medical school, but others will be available online open access worldwide, providing the authoritative content that has long been needed to bridge the gap between evolutionary biology and medicine.
**Mission**
Protecting human health and critical ecosystems by detecting, minimizing and ultimately eliminating harmful chemical and biological agents through early detection and engineering interventions.

**Overview**
More than half of humanity’s health problems are dependent, either directly or indirectly, on environmental factors. We can be exposed to harmful substances through the food we eat, the water we drink, the air we breathe, and the soil on which we stand. Today, our society faces the risks of environmental pollution, communicable diseases, endocrine disruptors in consumer products, and the potential of aerosolized biological agents.

The Center for Environmental Security, led by Rolf Halden, is working to protect human health and critical ecosystems by detecting, minimizing and ultimately eliminating harmful chemical and biological agents through early detection and engineering interventions. It sits at the link between the environment, human health and security to meet critical real-world needs to promote public safety. The center works on a regional, national and global scale.

The Center for Environmental Security team is made up of more than 30 scientists, undergraduate and graduate students, research technicians, postdoctoral researchers. Together, they are harnessing human exposure assessment technologies and intervention strategies to characterize environmental threats, improve public health and reduce the human and financial cost of disease of environmental origin.

The center was established in late 2012 with funding from the Piper Charitable Trust’s Health Solutions, ASU's Security and Defense Systems Initiative (SDSI), the Fulton Schools of Engineering, and ASU’s Office of Knowledge Enterprise Development.
Center for Infectious Diseases and Vaccinology

Center Director, Roy Curtiss

Mission
Our center’s research efforts seek to understand the mechanisms of host–pathogen interactions leading to disease as well as latency and induction versus evasion/suppression of mucosal, systemic and cellular immunities.

Overview
Infectious disease causes 35 percent of deaths worldwide, and is the world’s biggest killer of children and young adults. Our researchers are focused on basic bacterial and viral infectious disease processes as well as the design and use of vaccines and protein therapeutics to combat infectious diseases. These include newly emerging pathogens and potential biological warfare agents. We are devising new and effective ways of producing advanced vaccines and therapeutics, methods include the use of recombinant attenuated bacteria and viruses as well as genetically modified plants, and transferring this technology to the developing world to help fight diseases.

Accomplishing our goals requires the creation and evaluation of novel bio–manufacturing systems for cost–effective production of vaccines and therapeutics and the development and implementation of new strategies for translation of this research into health benefits for the developing world.

Our center’s research efforts seek to understand the mechanisms of host–pathogen interactions leading to disease as well as latency and induction versus evasion/suppression of mucosal, systemic and cellular immunities. By identifying and characterizing protective antigens from established and emerging pathogens, and by modifying them to enhance induction of optimal immune responses, researchers are able to evolve mechanisms for producing and delivering vaccines using plants and attenuated live bacteria and viruses.
Mission
The expertise of the Center for Innovations in Medicine is built on a history of innovation. Our efforts focus on the improvement of medical diagnostics and treatment, and the prevention of disease.

Overview
Today’s medical science creates effective treatments for diseases and injuries by building on existing discoveries and knowledge. This incremental, improvement-focused approach is a useful means of meeting the urgent needs of patients diagnosed with life-threatening diseases.

Equally important, however, is research that attempts to transform our understanding of disease. In many cases, innovation requires that we put aside what we think we know and start fresh.

This is the tactic used by our center. With such an unconventional approach, the possibilities are limitless, from creating a single vaccine that prevents virtually all types of cancer to treating oncoming illness before experiencing any of the symptoms. This methodology allows us to approach problems in ways that have never been attempted before.

The expertise of the Center for Innovations in Medicine is built on a history of innovation. Our efforts focus on the improvement of medical diagnostics and treatment, and the prevention of disease. One innovation, called "immunosignature technology," is designed to measure a person's immune response to cancer and other diseases, essentially giving patients and their doctors an early answer on the course of treatment. CIM efforts have led to a spinout, HealthTell, that garnered a "Start-Up of the Year" award in 2012 at annual Governor's Celebration of Innovation.

Like all research, the ultimate importance lies in our potential to save lives and improve the quality of life.
Mission
Using nature’s design rules as an inspiration in advancing biomedical, energy and electronics innovation through self-assembling molecules to create intelligent materials for better component control and for synthesis into higher-order systems.

Overview
The field of biomimetics represents one of the most exciting transdisciplinary research areas of the 21st century. With nearly 4 billion years of research and development, nature has identified appropriate and long lasting solutions to many of the research problems scientists are trying to solve.

We are developing a world-class Center for Molecular Design and Biomimetics at the Biodesign Institute at ASU. The center, led by Hao Yan’s research team, has built a variety of 2-D and 3-D structures at a scale 1,000 times smaller than a human hair, and now, he wants to push their efforts to build ever smaller, and design at the scale of individual atoms, molecules and chemical bonds, which Yan has dubbed “angstrom level control.”

The inspiration behind the new center is to move beyond DNA nanotechnology and develop new bio-inspired tools, built molecule by molecule, to solve current challenges in medicine, energy and electronics. Such a field could spawn the growth of entirely new industries.

The center will use nature’s design rules as an inspiration in advancing biomedical, energy and electronics innovation through self-assembling molecules to create intelligent materials for better component control and for synthesis into higher-order systems.
Center for Personalized Diagnostics

Mission
The mission of the Virginia G. Piper Center for Personalized Diagnostics is to drive the discovery and development of biomarkers for the early detection of diseases.

Overview
Promising advances in the area of personalized medicine have shown us that life-threatening diseases are as distinct in character as the individuals they afflict. The Virginia G. Piper Center for Personalized Diagnostics has been established with an eye toward overcoming the health care challenges posed by disease variance.

Our Center is developing new diagnostic tools to pinpoint the molecular manifestations of disease based on individual patient profiles. The strategy promises not only to improve therapeutic care, but also to greatly reduce treatment costs by allowing for early disease detection.

The Piper Center's research team is led by Dr. Joshua LaBaer, one of the foremost investigators in the rapidly expanding field of personalized medicine and former director of the Harvard Medical School's Institute of Proteomics (HIP). LaBaer's efforts involve leveraging the Center's formidable resources for the discovery and validation of biomarkers—unique molecular fingerprints of disease, which can provide early warning for those at risk of major illnesses, including cancer and diabetes. This work is carried out in conjunction with the Partnership for Personalized Medicine, a multi-institution effort that includes the Translational Genomics Research Institute (TGen) in Phoenix and the Fred Hutchinson Cancer Research Institute in Seattle.

At the Piper Center's 8000-sq. ft., state-of-the art research facility, our translational research will deliver benefits for clinical diagnoses, the development of custom-tailored drugs and individualized therapies for a range of diseases.
Center for Sustainable Health

Mission
Our mission is to sustain health through the prevention and early detection of disease to improve health outcomes at lower costs.

Overview
The Center for Sustainable Health (CSH) was established in 2009 at Arizona State University’s Biodesign Institute thanks to the generous financial support of the Virginia G. Piper Charitable Trust.

We believe that health systems must shift their current focus from expensive and ineffective late-stage disease response toward more outcome-based and cost-effective prevention and early intervention strategies. In light of rapidly aging populations and increased incidence of lifestyle diseases such as cancer, diabetes, heart disease and neurodegenerative diseases, behavioral interventions have become a high priority for health systems around the globe.

In addition to our original focus on the role of molecular diagnostics for early detection through our Global Biosignatures Network, recent advances in information technology and sophisticated but inexpensive data capture devices, such as biosensors, promise to dramatically improve our ability to detect, diagnose and prevent disease.

Through our Project HoneyBee, we leverage our extensive experience in the careful validation of biomarkers for clinical application with a parallel methodology aimed at the utilization of physiological metrics obtained from wearable biosensors to address key clinical problems. To accomplish this goal, we enlist ASU’s considerable multidisciplinary resources, while partnering with health systems such as the Mayo Clinic and Banner Healthcare in the United States and with Chang Gung University and Hospital system in Taiwan.
Swette Center for Environmental Biotechnology

Mission
We manage microbial communities that provide services to society. Most of the services make our society more environmentally sustainable. The microbial services also make humans healthier – directly and indirectly.

Overview
Research in the Swette Center seeks to gain deep understanding of the microorganisms and how they work together in microbial communities. The researchers apply the most advanced tools of molecular microbial ecology, chemistry, microscopy, and mathematical modeling so they think like the microorganisms. Armed with this deep understanding, the researchers then apply advanced engineering methods to create systems that work for the microorganisms so that they work for us. This approach establishes a win–win partnership between the uniquely talented workers – the microorganisms – and the wise managers – the environmental biotechnologists.

The Center organizes it research through collaborative teams. Some teams are applications based, such as microbial electrochemical cells, photobioenergy and bioremediation. Other teams are more methods based, such as mathematical modeling and molecular microbial ecology. One more hallmark of the Center is that we link fundamental research with practical application. The second part of our strategy is that we partner with key practitioners, the ones who will put the fruits of our research to good use. We have on–going partnerships with the leading environmental engineering consulting firms, such as CDM–Smith and CH2M–HILL. Likewise, we work closely with technology companies to test and commercialize systems based on our research work. Good examples include our spinout company ARBsSource, as well as APTwater, OpenCEL and Siemens Water Technology.
Center for Single Molecule Biophysics

Center Director, Stuart Lindsay

Mission
The Center uses nanotechnology to study the physical processes on which life is based using the simplest model systems — those that exist on the level of a single molecule or several molecules.

Overview
Single molecule biophysics lies at the confluence of molecular medicine and nanotechnology. The Center uses nanotechnology to study the physical processes on which life is based using the simplest model systems — those that exist on the level of a single molecule or several molecules. By doing this, we can gain a better understanding of gene regulation, molecular signaling and molecular transport in cells that will lead to improved biosensors and other new technologies.

The Center seeks to better understand the physical basis of life by studying the individual molecules that comprise living cells. Researchers at the Center are using scanning probe methods to measure and manipulate individual molecules. Our premise is that single molecules are simple enough to be modeled accurately with computer simulations, yet complex enough to reflect the variations that are important to their function.

The Center is also dedicated to advancing the latest techniques for research on the single molecule scale and to translating discoveries into new tools and new applications that are relevant to promoting health and combating disease. With a clearer understanding of the individual components that comprise integrated living systems, researchers are better able to grasp the many complex interactions between gene products (molecules) that cause disease. By learning from nature’s repertoire of experiments on its own "nanomachines" researchers at the Center are figuring out how to craft components for machinery of undreamt-of complexity and sophistication.