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Stimulus-Funded University Research Addressing Issues from Climate Change to Cancer, Creating Jobs and Training a New Generation of Scientists

The Association of American Universities (AAU), the Association of Public and Land-grant Universities (APLU), and The Science Coalition (TSC) today released highlighted examples of the important scientific work happening across the country as a result of the American Recovery and Reinvestment Act of 2009 (ARRA). The brief report summarizes just a handful of the thousands of projects benefiting from stimulus dollars.

Stimulus funding is fueling research projects at universities across America, and the United States will reap the benefits for decades to come. The investment in science and engineering provided by the ARRA is adding to the nation's collective body of knowledge and helping to fuel discovery and innovation in critical areas like biomedical research and alternative energy. It is also supporting employment and contributing to training our next generation of scientists, engineers, doctors and researchers.

The bulk of funding for research under the ARRA is being provided through the Department of Energy (DOE), the National Institutes of Health (NIH), and the National Science Foundation (NSF), although many other federal agencies also are providing stimulus funds for research.

Examples include the University of Washington's research into the effects of climate change on marine ecosystems. A University of Nevada, Reno biochemist is working to understand how plants adapt and thrive in warm, dry climates – knowledge that will be important as global warming may make such climates more widespread. ARRA-funded research at the University of Illinois at Chicago aims to help elderly and disabled people remain independent with robots that can comprehend speech altered by impairments. Stimulus grants to UCLA and Vanderbilt University will help develop future leaders in clean technology and global health research, respectively. Researchers at Emory University are taking a new approach to understanding the genes behind schizophrenia, while stimulus-funded research at Stanford University is studying the roots of pain in the brain – work relevant to pain management, addiction, cognitive development, depression and brain injury.

The attached summary is meant to be illustrative, not exhaustive. ARRA-funded research is happening in every state in the country. For more information, contact one of the people listed above or ARRAresearch@qga.com.

AAU, APLU, and TSC collectively represent more than 200 of the nation's leading academic research institutions. The associations advocated for inclusion of research funding in the ARRA because basic research produces both immediate and long-term economic impact, and will lead to solutions to many of the greatest challenges facing our country. Basic research is the foundation on which the U.S. will improve energy efficiency, reduce dependence on foreign oil, deploy 21st century technologies, save lives, and help bring down the cost of health care. In many communities, research universities are the largest employers and a vital component of the local economy.

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Examples of Research Funded by the American Recovery and Reinvestment Act
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The Impact of Climate Change on Marine Ecosystems

Stimulus funds through the National Science Foundation will help researchers at the **University of Washington** with two projects examining the effects of climate change on marine ecosystems.

Rebecca Woodgate, a senior oceanographer with the Applied Physics Laboratory, will lead an effort to investigate water flowing from the Pacific to Arctic oceans through the Bering Strait. Pacific water is a rich source of nutrients for Arctic ecosystems and brings heat and freshwater. It is important to understand how climate changes have affected the exchange of water in this, the only place where the Pacific and Arctic oceans meet.

The project will involve a year-round mooring in the strait from 2010-2013, serviced from a Russian research ship by a U.S. science team working with Russian collaborators. In addition to monitoring, researchers will make data available on a Web site, allowing students and the public to learn about the work.

Professor George Hunt will lead a retrospective study of seabird responses to large-scale and long-term environmental change in the Bering Sea. Environmental changes can affect the prey on which seabirds depend, changing how they forage and possibly hurting their ability to reproduce. Changes in the distribution or abundance of these birds may indicate how climate variability or fishing activity is affecting the marine ecosystem. Fisheries and wildlife managers will use Hunt's information to reduce seabird by-catch and better manage the ecosystems and seabirds of the Bering Sea and Aleutian Archipelago. Learn more

Robots to Help the Elderly Remain Independent

Miloš Žefran, an associate professor of electrical and computer engineering at the **University of Illinois at Chicago** (UIC), will lead a team to develop robots to help elderly people with limited mobility. The robots will be able to respond to a wide range of verbal language, including speech impaired by disability, as well as non-verbal gestures, and touch.

ARRA funding through the National Science Foundation will support the work of Žefran's team, which includes two other UIC engineers and a Rush University nursing specialist. At the project's core will be a novel adaptive and reliable recognition methodology called RISq -- Recognition by Indexing and Sequencing -- patented by Jezekiel Ben-Arie, professor of computer and electrical engineering and member of the research team.

"We'll start by observing interaction between human helpers and the elderly," Žefran said. Learn more

Nurturing a New Generation of Global Health Research Leaders

A National Institutes of Health ARRA-funded award to **Vanderbilt University** will enable the expansion of the international clinical research fellowship program coordinated through the Vanderbilt University Institute for Global Health. As a result of the grant, 23 additional research fellows will be able to participate in a year of mentored clinical research training in the developing world.

The initiative encourages participants to enter the field of global health-related clinical research. The grant is funding 13 new research fellows, and allowing 10 advanced research fellows to continue their projects for a second year.

"We're seeking a new generation of global health research leaders," said Dr. Sten Vermund, director of the Institute for Global Health at Vanderbilt University Medical Center and principal investigator for the Clinical Research Training Scholars and Fellows Program. "The clinical research that our new fellows will oversee will help the global economy to prosper while benefiting Americans worldwide, including military personnel and travelers abroad." Learn more

Employment and Training for Future MD

Morgan Hawkins graduated from the **University of Southern California** in 2008 with a bachelor's in biological sciences, $30,000 in student loan debt, and a desire to go to medical school. Thanks to an ARRA-funded grant from the National Institutes of Health, the 23-year-old native of South Los Angeles is back at USC working as a research and laboratory technician, gaining critical training and employment as he saves for his graduate studies.

Hawkins is working in the lab of Susan Forsburg, a professor of molecular and computational biology at USC College. He and two graduate students are studying the genetic roots of miscarriages by exploring related genes in the model organism S. pombe, a type of yeast.

More than half of miscarriages result from gross chromosomal abnormalities in the developing fetus, Hawkins said. Understanding the genetics of model organisms such as S. pombe is a common strategy for gaining insight into human processes. Learn more

Understanding Resistance to Infectious Disease

Why are some individuals of a species more adept at fighting infection than others, and what evolutionary forces maintain this variation? How is the immune system interconnected with other components of host physiology? **Cornell University** Associate Professor of Entomology Brian Lazzaro is trying to find the answers to these questions. Lazarro began work Aug. 1 on stimulus-funded research of infectious disease resistance. Using fruit flies as a model, he will study connections between the immune system and other physiological processes in determining resistance to infectious disease.

His two-year study is funded by a stimulus grant from the National Institutes of Health and has allowed Lazzaro to hire a full-time technician and add a graduate student to help conduct the research. Learn more

Fighting Lung Disease Caused by Smoking

Emily Scott has always worried about smokers' health. As a young girl, the assistant professor of medicinal chemistry at the **University of Kansas** would hide her grandfather's cigarettes from him — fearful that his smoking could cut his life short.

Today, Scott uses advanced research to continue her fight against disease caused by smoking. Her research is directed at understanding how a particular lung enzyme works — the cytochrome P450 enzyme that breaks down nicotine. Ultimately, she hopes to detect ways to stop the enzyme from producing a carcinogen during its nicotine processing. With that knowledge, she might be able to design

a drug to halt DNA damage that smokers inflict on their lungs — harm that often develops into lung cancer.

Scott's research is being supported by stimulus funding from the National Institutes of Health. This new award builds on nearly $1.4 million she had earned previously from the National Institutes of Health for the same line of investigation. The new grant will allow Scott to make a new hire and buy U.S.-made scientific instruments.

"To understand how this enzyme works, my lab has previously used a technique called X-ray crystallography to essentially take before and after snapshots of the cytochrome P450 enzyme — that is, still shots before and after foreign chemicals like nicotine bind to it," said Scott. "This grant will support application of a new technique, nuclear magnetic resonance, which will essentially allow us to obtain a video of the cytochrome P450 as it binds different chemicals. It's like the difference between looking at before and after pictures of a car crash and watching a video of that car crash when trying to figure out what happened." Learn more

Getting to the Roots of Pain in the Brain

Last year, Sean Mackey an associate professor of anesthesia and pain management at the **Stanford University** School of Medicine, applied for a grant to continue studying the roots of pain in the brain, but funding was unavailable. Now, with the benefit of stimulus funding from the National Institutes of Health, he will be able to expand his work. Mackey is using functional magnetic resonance imaging (fMRI) to control brain activities in real time. According to Mackey, the research not only will help in pain management but may also shed light on addiction, cognitive development, depression and brain injury. Further, the funds will enable him to hire two full-time employees, in addition to providing faculty salary support for him and his collaborators in radiology, psychiatry and psychology.

"It's a wonderful opportunity," Mackey said. "We expect the resources from this grant will ultimately benefit a number of groups beyond our lab. There's much interest in real-time fMRI across the campus." Learn more

Developing Cancer-Fighting Drugs

West Virginia University Chemistry Professor George O'Doherty and his team of student researchers have been developing new methods to synthesize complex carbohydrates for nearly 13 years. This type of synthesis is vital in the creation of new pharmaceuticals because altering the configuration of molecules as Dr. O'Doherty and his team do, often produces different biological activity.

"If you're lucky, you make a cancer drug," he said. "But what we are really trying to do in my lab is develop methods for making carbohydrate-containing drugs, which will enable any medicinal chemist to create new pharmaceuticals."

Now, with the help of ARRA funding from the National Institutes of Health, he and his team intend to demonstrate that a well-known heart drug called digitoxin could be transformed into a cancer-fighting drug by modifying its sugars. The grant will keep research funding in place for two years and largely

cover the hiring or retention of O'Doherty's research group – eight graduate students, four postdoctoral students, three undergraduates and one visiting scientist. Learn more

Designing Smart Concrete

Since "dumb as a box of rocks" is a none-too-kind description, the idea of a material like concrete being "smart" may seem counter-intuitive. With a stimulus-funded grant from the National Science

Foundation, a **University of Minnesota, Duluth**, engineering professor is exploring a new approach to monitoring the health of structures like bridges, roads, and buildings.

Dr. Xun Yu is using carbon nanotubes embedded in concrete to detect cracking or mechanical stress—in effect using the concrete itself as a monitor. These carbon nanotubes may also improve the strength and toughness of concrete pavement, especially in cold weather conditions. The grant also will be used to enhance the curriculum for undergraduate engineering students at UMD, and to introduce nanotechnology, sensors, and transportation to high school students to spark their interest in science and engineering. Learn more

Research Vessel to Enable Exploration of New Regions of World's Oceans

Recovery Act funding from the National Science Foundation is enabling the construction of the Alaska Region Research Vessel (ARRV) – a 242-foot, ice-capable vessel that will support scientific research in high-latitude waters. The ARRV will be operated by the **University of Alaska Fairbanks**. Bids for shipyard construction are due in September 2009 and the vessel is expected to be ready for use in 2014.

As the first vessel in the U.S. academic research fleet capable of breaking up ice 2.5 feet thick, the new ship will open up the ice-choked waters of the Alaska region to scientists from all over the world. With its ability to penetrate the polar and sub-polar regions, the ARRV will allow the study of such issues as sea-level rise and climate change and the effects of both on the coastal and arctic ecosystems.

The ARRV will allow researchers to collect sediment samples directly from the seafloor, host remotely operated vehicles, and use a suite of flexible winches to raise and lower testing equipment throughout the water column. The ship also will be able to transmit real-time information directly to classrooms all over the world. It will accommodate 26 scientists and students at a time, including those with disabilities. Learn more

Training Future Clean-Tech Leaders

As the country presses forward in developing green energy and Los Angeles strives to become a hub of clean technology, **University of California, Los Angeles** Associate Professor Diana Huffaker noticed there was one thing still missing: a program to train the future leaders of environmental industry in L.A.

So she created it — and, working with about 20 other professors, won support for it through a stimulus-funded grant from the National Science Foundation. The Clean Energy for Green Industry Fellowship, designed to develop leaders in environmental energy, will grant Ph.D. students a $33,000 stipend for pursuing coursework in the science, business and policies of clean technology.

"Over the course of the five-year program, we'll graduate 33 Ph.D.s with expertise in energy storage, energy harvesting and energy conservation," Huffaker said. "They'll be in existing Ph.D. programs, such as chemistry or engineering, and for our fellowship they'll take a series of five classes, including lab research and policy. The program is the first of its kind in the L.A. basin." Learn more

Understanding Drugs to Minimize their Misuse

Why do so many more people struggle from addiction to certain painkillers than from others? ARRA funding is supporting research that will answer important questions about prescription opioid abuse and help lead to the development of other opioid analgesics with reduced potential for misuse and abuse.

The grant from the National Institutes of Health will enable **University of Kentucky** researcher William Stoops to study the pharmacological effects of tramadol, a synthetic opioid that does not appear to be

abused at the same rate as other natural, semi-synthetic and synthetic analgesics derived from opium alkaloids. Stoops is an assistant professor in the UK College of Medicine's Department of Behavioral Science and the UK Center for Drug and Alcohol Research. The grant will support four current faculty and three staff members as well as fund three positions for either current staff or to-be-hired staff. Learn more

New Strategies for Uncovering Schizophrenia Genes

An ARRA grant from the National Institute of Mental Health is enabling Dr. Brad Pearce, an epidemiologist in **Emory's** Rollins School of Public Health, and several Emory colleagues to examine the genes missing in DiGeorge syndrome. People with a specific deletion on chromosome 22 (DiGeorge syndrome) have a high risk for schizophrenia.

The team will study people with DiGeorge, patients with "typical" schizophrenia and people at high risk of developing schizophrenia. The project is a good example of newer research that looks for the genes behind complex diseases such as schizophrenia and autism. Scientists are beginning to shift their efforts away from genome-wide association studies. Rapid sequencing technologies are allowing scientists to investigate rare variants like DiGeorge syndrome, which can substantially increase disease risk. Learn more

Unlocking the Mysteries of Plant Cellulose

With the aid of stimulus funding from the Department of Energy, **Penn State University** researchers aim to answer the question of how we can produce food, fuel and fiber more efficiently and sustainably. The university's new Center for Lignocellulose Structure and Formation, one of 16 Energy Frontier Research Centers funded through the ARRA, will support the study of the molecular biology of cellulose. Understanding this will aid in developing better methods for converting plant biomass into fuel.

According to Virendra Puri, one of the Penn State researchers involved, "Once we unlock the mystery of how the materials go together – how they are intertwined – and we can learn to take them apart, then the possibilities are vast." With enormous agricultural and forest-based feedstocks, the United States is uniquely and competitively poised to capitalize on technical advancements relating to lignocellulosic materials.

The new center will collaborate with researchers at **North Carolina State University** and **Virginia Polytechnic Institute and State University**. Learn more

Understanding How Plants Adapt and Thrive in Warm, Dry Climates

Warmer, drier climates may become more widespread in the future due to global warming, making stimulus-funded research at the **University of Nevada, Reno** all the more important. Biochemist John Cushman is investigating how plants thrive in these warmer, drier conditions by studying the molecular,

genetic and biochemical pathways in the common ice plant. The ice plant improves water use efficiency up to 10 times relative to most plants.

Cushman's National Science Foundation-supported research explores a photosynthetic adaptation to water limitation on molecular and biochemical levels. CAM (crassulacean acid metabolism) is a process by which plants take up and store carbon dioxide during the night and refix it slowly during the day, reducing water loss and improving the water use efficiency of photosynthesis so that plants are better able to thrive in hot, dry climates.

"If we can get a better understanding of how this metabolic process is regulated or controlled, we might be able to someday alter the biochemistry of crop plants to make them survive with less water," Cushman said.

The grant will enable several postdoctoral students, graduate students and lab personnel to work on certain aspects of the project, as well as provide undergraduate research training opportunities. Learn more

Developing a New Class of Molecules for Biomaterial and Biopharmaceutical Use

A **Syracuse University** professor is using Recovery Act funding from the National Science Foundation to expand his study of a new class of water-soluble molecules that can spontaneously self-assemble to form new kinds of materials for use in the biomaterials and biopharmaceutical industries. Ultimately, these materials might be used as a "molecular factory" to make new drugs or as biodegradable implants for tissue regeneration.

Until now, only soap molecules were thought to be able to self-assemble in water. However, SU Assistant Professor of Chemistry Yan-Yeung Luk and his research team recently discovered a new kind of molecule that also can self-assemble in water using a different mechanism than soap. Unlike soap, Luk's new molecule does not contain an oily substance; instead it self-assembles in a microenvironment that repels water molecules. The repelling action enables the positively and negatively charged components of the new molecule to connect. When the molecules are assembled, they can be used to support polymer coatings and the formation of a new kind of hydrogel. Because of its unique structure, this hydogel can function like living tissues. Learn more

Software to Allow Researchers to Better Catalog and Use Natural History Data

A Recovery Act-funded grant to the **Tulane University** Museum of Natural History will allow the redesign of a leading computer program the institution developed to help researchers around the world catalog natural history collections.

The GEOLocate program is currently used by 800 researchers and institutions worldwide and is considered a critical tool for computerizing data on natural history collections. The grant from the National Science Foundation will enable the software program to be updated based on Web services, online mapping and integration with other natural history software applications.

Using GEOLocate, a researcher can input general label information on where a specimen was found such as "Mississippi River at Hwy. 190 Baton Rouge" and receive the precise longitude and latitude coordinates of its location. Such information is critical in enabling researchers around the globe to study climate change, species migration, extinction patterns and threats to the animal kingdom, says Hank Bart, director of the Tulane Museum of Natural History. Learn more

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