

Iowa State research: exploring solutions to society's grand challenges

Iowa State and the university's faculty are committed to purposeful research, whether it's foundational research that contributes the building blocks to greater exploration and understanding, or translational research that directly leads to new innovations and technologies that benefit society. Most research at Iowa State is defined by grand societal challenge themes that are a core component of the university strategic plan. Many projects within the institution are shaped and framed to address at least one of these challenge themes:

- Promoting healthy lives (plants, animals, people, communities)
- Building sustainable human and natural ecosystems
- Creating next-generation materials and manufacturing technologies
- Advancing data-driven discovery and secure cyber systems
- Developing global citizens and vibrant societies

Iowa State received external funding for 755 new research projects during the 2020 fiscal year. Here are just a handful of examples of how the research conducted at the university is helping find solutions to these grand challenges for the betterment of the state, the nation and the world.

Grand challenge: Promoting healthy lives

Project name: Investigating Obesity-Induced Altered Ovarian Intracellular Signaling

Lead Principal Investigator: Aileen Keating, associate professor, Animal Science – Reproductive Physiology/Reproductive Toxicology

Sponsor: National Institute of Environmental Health Sciences (NIEHS)

Award amount: \$460,000 funded with a total of \$2.4 million expected over five years

Global obesity rates are rapidly increasing and obesity has been demonstrated to contribute to human females' susceptibility to a variety of health hazards including diabetes, cardiovascular disease, cancer and compromised reproductive capabilities. Obesity's adverse impacts on reproduction include reduced fertility and lower conception, implantation and birth. In addition, obese mothers run increased risks for poor oocyte (or egg) quality, miscarriage and offspring birth defects. In this NIEHS-funded five-year study, Aileen Keating and her team will use mice as animal models for humans to test the central hypothesis that obesity increases the likelihood of ovotoxicity through ineffective repair of DNA damage, altered ovarian chemical biotransformation and induction of oxidative stress. This hypothesis will be tested in three developmental states – in utero, pre-puberty and adulthood. When complete, the study will generate novel biological information and insight that could significantly improve female fertility and general well-being in girls and women.

Grand challenge: Building sustainable human and natural ecosystems

Project name: Reuniting the Three Sisters: Enhancing Community and Soil Health in Native American Communities

Lead Principal Investigator: Christina Gish Hill, associate professor, American Indian Studies Program

Sponsor: USDA National Institute of Food and Agriculture (NIFA)

Award amount: \$300,000

The Americas' original intercropping system (the practice of growing two or more crops in close proximity) is the Native American practice of growing maize (or corn), common beans and squash together. Native Americans have commonly referred to these crops as the "three sisters" because they have a sisterly relationship of caring for each other: the beans – as a legume – contribute nitrogen to help feed the other crops; the squash provides shady ground cover, preventing weeds and protecting the plants from animals; and the tall stalks of maize provide a platform for the beans to climb to gather moisture during the night that drips down to nurture the other plants. The Three Sisters Intercropping practice deeply resonates with the cultures of many Native American nations, but it may also provide significant agronomic benefit by enhancing soil health. The goals of the research team, led by Christina Gish Hill, are to work with Native collaborators toward the holistic revitalization of indigenous agriculture and food systems and to explore what indigenous practices, like Three Sisters Intercropping, can reveal about improving soil health in modern agroecosystems. The project is also relevant to ongoing state-federal food and agriculture research and extension, as it directly addresses three priorities in the 2014 Farm Bill: 1) Food safety, nutrition and health; 2) Bioenergy, natural resources and the environment; and 3) Agriculture economics and rural communities. The research team also hopes to promote healthy food and sustainable agriculture in Native communities through citizen science.

Grand challenge: Creating next-generation materials and manufacturing technologies

Project name: Development of hand-specific model and systematic tool for next-generation gloves used for firefighters and other emergency responders

Lead Principal Investigator: Guowen Song, associate professor/Norma Scott Lloyd Chair in Textiles and Clothing

Sponsor: Federal Emergency Management Agency (FEMA)

Award amount: \$1.5 million

A chain – as the old saying goes – is only as strong as its weakest link. And when it comes to personal protective equipment (PPE) for firefighters, all too often that weakest link is the gloves they wear to safeguard their hands. A recent survey indicated that 30% of male and 62% of female firefighters have experienced ill-fitting gloves, making them susceptible to potentially dangerous and debilitating heat hazard and cold-injury threats. An interdisciplinary research team at Iowa State – involving the departments of Apparel, Events and Hospitality Management, Mechanical Engineering, Mathematics, Industrial Design and Kinesiology – is working with PPE industry partners and fire departments to help innovate new and better glove technologies and solutions. The purpose of this project, led by Guowen Song, is to develop a fundamental tool that includes a hand-specific thermoregulation model, a hand-glove manual performance model and a hand-form instrumented mannequin to systematically simulate the physiological responses of hands – and the protective performance of gloves – to cold or burn injury. The model will predict performance for both the whole hand and fingers based on different thermal environmental conditions, glove materials, design features and anthropometric parameters. The result will be a greater understanding of hand-specific physiology, textile materials, and glove design and engineering, and whole-glove performance, that will eventually lead to the development of better glove materials and designs that enhance firefighter safety. The findings and developed approach can be applied to improve PPE performance for military, healthcare workers (HCWs), industrial and agricultural workers, as well as high-risk occupation workers.

Grand challenge: Advancing data-driven discovery and secure cyber systems

Project name: Building Drug Intelligence Networks to Combat the Opioid Crisis in Rural Communities: A Collaborative Intelligence-led Policing Strategy

Lead Principal Investigator: Andy Hochstetler, professor, Sociology

Sponsor: DOJ National Institute of Justice

Award amount: \$725,000

Rural communities in the U.S. are facing a host of challenges from the opioid crisis that has emerged and expanded rapidly over the past two decades. High rates of addiction and its associated problems dampen investments that offer the potential to sustain rural economies and improve quality of life, thus undermining both the social and economic vitality of these communities. The DOJ National Institute of Justice is funding a three-year program – led by Iowa State’s Andy Hochstetler in tandem with his Sociology department colleagues David Peters, Kyle Burgason and Jeff Bouffard – focused on providing rural communities with better access to data-driven opioid intelligence that is critical for evaluating and implementing potential strategies for lessening the impact of opioid hazards. One part of the project is to develop collaborative relationships between police departments aimed at encouraging actionable intelligence efforts for small, rural communities. Another end result of the project will be a Microsoft Excel-based tool that can help rural communities make more strategic decisions by simulating the impact potential policy responses – increased arrests, job creation, anti-poverty programs, for instance – might have on opioid hazard-related factors such as volume of prescriptions and opioid mortalities.

Grand challenge: Developing global citizens and vibrant societies

Project name: The World is Amazing: Communicating Awe and Wonder about Science

Lead Principal Investigator: Michael Dahlstrom, interim director and professor, Greenlee School of Journalism and Communication

Sponsor: Howard Hughes Medical Institute

Award amount: \$75,000

Science communicators face a significant and often difficult challenge of distilling complex subject matter and making it relevant to a mass audience. Findings suggest that feelings of awe and wonder can lead to positive and profound effects on decision making, pro-social attitudes and general well-being. To this point little research has been conducted exploring the connection between science comprehension and the feelings of awe and wonder. Michael Dahlstrom received funding from the Howard Hughes Medical Institute to support the first phase in a multi-year research agenda to explore the communication of awe and wonder to legitimize it as a consequential outcome of science communication. Dahlstrom and his team will conduct a series of in-depth interviews with science communications professionals who have a proven track record of creating communication products designed to instill awe and wonder in public audiences. Through qualitative analysis, Dahlstrom will synthesize the communicators’ collective experiences into factors, insights and recommendations that can help guide other communications professionals in creating the awe and wonder needed to make complex scientific subject matter more attainable and understandable to a public audience.