From new methods for creating biofuels and determining cardiovascular risk to fridge-free food processing and a more efficient fuel injector, NC State researchers are developing innovative approaches to global challenges.

The Chancellor’s Innovation Fund is helping those researchers and others move their research to the marketplace. Each year since 2010, the fund has supported a new group of projects with the potential to yield marketable solutions to pressing problems.

Six research teams received funding from the 2014 Chancellor’s Innovation Fund:

‘CUT AND REPLACE’ GENE EDITING

The ability to edit select DNA sequences of interest — to add, delete, activate or suppress specific genes — is the holy grail of genetics research, including the molecular basis for many diseases.

Rodolphe Barrangou uses a system called CRISPR-Cas to take aim at certain DNA sequences in bacteria. CRISPR stands for “clustered regularly interspaced short palindromic repeats,” and Cas is a family of genes and corresponding proteins associated with the CRISPR system. Essentially, bacteria use the system as a defense mechanism and immune system against unwanted invaders such as viruses. Now, that same system is being harnessed by Barrangou and colleagues to quickly and precisely target certain genes for editing.

Barrangou, faculty member in food, bioprocessing and nutrition sciences, is working on a new set of genome editing tools that cuts the targeted DNA and sets the stage for precise genetic modifications. His work holds promise in manipulating relevant bacteria for use in food and biotechnology applications and in model organisms used in agriculture, biotechnology and medicine.

CREATING EXTREME BIOFUELS

Saltwater algae produce oil that can be converted to biofuels without using up valuable land and freshwater resources. The problem? It’s not cost-effective. NC State researchers Heike Sederoff, Amy Grunden, Robert Natelson and Kelly Zering have figured out a way to solve that problem with the help of extremophiles.

Extremophiles are organisms that live in extreme environments, like hot springs, acid lakes or polar ice caps. These organisms produce enzymes that are useful in industry — “extremozymes” that can work under extreme conditions and are used in detergents that help clean our laundry, or in food to make your cheese taste less bitter, or even to help dispose of deadly chemical weapons like sarin gas.

The researchers figured out a way to take the gene responsible for a particular enzyme’s production from the extremophile and put it in the algae. The algae then produce both the oil for biofuels and the extremozyme of interest. The cost of biofuel production is offset by the sale of the extremozyme and enables production of a commercially viable renewable liquid transportation fuel.

IDENTIFYING ‘VULNERABLE’ ARTERIAL PLAQUE

Engineering professors Xiaoning Jiang and Paul Dayton have developed a new ultrasound device that could help identify arterial plaque that is at high risk of breaking off and causing heart attack or stroke.

Existing state-of-the-art technologies are capable of determining if plaque is present in the arteries, but they can’t tell whether it’s vulnerable. That makes it difficult to assess a patient’s risk.

continued
“Our goal was to develop something that could effectively identify which plaques are vulnerable,” Dayton says. “The Chancellor’s Innovation Fund will enable us to test contrast-enhanced intravascular ultrasound imaging in preclinical models and further validate our technology for commercialization and eventual translation into patients.”

NO FRIDGE? NO PROBLEM

NC State food scientist Josip Simunovic is a pioneer in the field of aseptic processing, a system for rapidly heating and packaging food products in a sterile environment. His innovations, which have earned 10 U.S. patents, have made it possible for the food industry to deliver shelf-stable foods like soups and fruit snacks in packaging that preserves their flavor and nutritional value without requiring refrigeration.

Now, Simunovic is developing a prototype of a modular aseptic processing system that could be used by R&D labs and small-scale food processing companies for a fraction of the cost of an industrial-scale system.

Simunovic says the lower-cost system will give “insurgents” in the food industry the tools to develop a wide variety of innovative food products such as daring new hot sauces for an emerging generation of food enthusiasts.

TESTING THERMOELECTRIC TEXTILES

Half of the energy generated in the U.S. is lost as waste heat, much of it during manufacturing.

But what if wasted power could be harvested and be re-purposed to power other electronics in an industrial plant, like LED lighting? That’s the vision of textile researcher Jesse Jur and former research professor Mark Losego, now at Georgia Tech. They’re creating flexible thermoelectric textiles that harvest power from temperature differentials, such as those between heated pipes and cold air.

Textiles with embedded electronics are flexible enough to wrap around a pipe, stretch over walls and fit into nooks and crannies, generating DC voltage that could supplement other power sources. Thermoelectric textiles work with low-temperature heat loss — something that current technologies don’t do — and are less expensive to manufacture than existing designs.

The team, which recently added postdoctoral student Krishamraju Ankireddy, is developing a prototype for testing in the lab and with industry partners.

CLEANER CAR ENGINES

While the development of new technologies to replace fossil fuels is the focus of many researchers, NC State engineering professors Tiegang Fang and Greg Buckner are working on a simple change to the geometry of spray fuel injectors that they believe will offer a double dose of improvement for an American economy that consumes 385 million gallons of gasoline a day.

They are developing a new injector that optimally adapts both the direction and rate of fuel flow in an internal combustion engine and automatically changes the timing of when fuel is sprayed in the up-and-down cycle of a cylinder. They hope to increase engine efficiency by 10 percent, while also reducing emissions in a cleaner-burning engine.

Major car makers have shown interest in the first- and second-generation prototypes the researchers have made in their labs on Centennial Campus, but they would like to see a working engine before they commit to installing something in an upcoming model. That’s the next step in the researchers’ goal of making your engine less prone to pit stops.

NC State News Services contributed these profiles.