Washington State University researchers have developed a way to grow algae more efficiently—in days instead of weeks—and make the algae more viable for several industries, including biofuels. Their work was reported in the journal *Algal Research*.

Researchers would like to produce algae efficiently because of its potential environmental benefits. Oil from the algae can be used as a petroleum alternative and algae also can be used as food, feed, fiber, fertilizer, pigments, and pharmaceuticals. Growing and harvesting it in wastewater streams could also reduce the environmental footprint of many manufacturing processes. But its use in industry hasn’t caught on primarily because it requires a lot of time and water to grow. Generally, large ponds are required, and harvesting is labor intensive. Researchers have begun developing biofilm reactors to grow the algae, but the reactors aren’t efficient because of pH or temperature variations or a limited supply of carbon dioxide gas.

Led by graduate student Sandra Rincon and her advisor, Haluk Beyenal, professor in the Gene and Linda Voiland School of Chemical Engineering and Bioengineering, the researchers developed a unique biofilm reactor that recycles gasses and uses less water and lower light than typical reactors. The algae produced was full of the fats that make it suitable for biodiesel production and “fatter” than other biofilm reactors have produced. Because of a removable membrane, it was also easier to harvest than typical systems.

The system is unique because it allows the algae to simultaneously do photosynthesis like a plant while also “eating” carbon and respiring like an animal, said Beyenal. The researchers fed the algae glycerol, a cheap waste product of biodiesel production, and urea, another inexpensive chemical that serves as a nitrogen source for the algae. The system’s design means that carbon dioxide and oxygen are recycled in the system.

“The cell, in fact, becomes a very efficient factory in which the nutrients are supplied by the medium, but the cell metabolism meets its carbon dioxide requirements internally,” said Rincon.

The researchers have filed a patent application on the technology and are working to optimize the process.
WSU receives grant to study heart problems

Washington State University researchers have received a $1.57 million National Institutes of Health grant to understand the molecular-scale mechanisms that cause cardiomyopathy, or heart muscle disease. The four-year project could lead to improved diagnostics and new treatments for hereditary heart conditions. Cardiomyopathy affects as many as 1 in 500 people around the world and can often be fatal or have lifetime health consequences.

The researchers will be studying mutations in three important proteins that play a key role in healthy heart function. “Mutations in these proteins are found in patients with myopathy,” said Alla Kostyukova, assistant professor in the Gene and Linda Voiland School of Chemical Engineering and Bioengineering and leader of the project. “Our work is to prove that these mutations cause these problems and to propose strategies for treatment.”

Solution for wasteful methane flaring

Professors Su Ha and Jean-Sabin McEwen have developed a small reactor that inexpensively breaks water and methane into carbon monoxide and hydrogen, which can be used for energy and industrial products. They report their discovery in the journal ACS Catalysis. Methane, the primary component of natural gas, is a frequent byproduct of oil drilling. It is also a greenhouse gas 34 times more potent than carbon dioxide over the course of a century. Piping it from remote areas is expensive, so energy companies burn off about one-third of the gas they produce in bright flares that can be seen from space. McEwen and Ha’s solution involves breaking down the methane in the field.

Ordinarily, methane is such a tightly bonded molecule that breaking it apart requires a lot of water and temperatures of more than 1,800 degrees Fahrenheit. But McEwen and Ha found that they could use much lower operating temperatures and an inexpensive nickel catalyst in the presence of an electrical field to orient methane and water in a way that makes them easier to break apart.
Biobased material breakthrough

Washington State University researchers have developed a way to practically separate lignin from wood, a breakthrough that could provide new sources of lignin for advanced renewable fuel and advanced materials applications. The work was featured on the cover of the journal *Green Chemistry*.

Lignin is the second most abundant renewable carbon source on Earth. It is in all vascular plants, where it forms cell walls and provides plants with rigidity. Lignin allows trees to stand, gives vegetables their firmness, and makes up about 20–35 percent of the weight of wood. The material holds great promise as a precursor for biobased materials and fuels, but it is also notoriously difficult to break apart.

Led by Xiao Zhang, associate professor in the Voiland School, the researchers used a new type of solvent to separate the lignin from wood without altering its key properties. The researchers were able to extract lignin from poplar and Douglas fir samples in high yields. The lignin products have high purity and distinct characteristics.

The researchers are working to understand the solvent’s precise mechanism for separating the lignin. They are exploring new applications for this type of lignin and are in discussion with industry partners regarding scaling up production.

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Learning from Muslim countries

A new study co-led by researchers at WSU aims to understand why significantly more women study engineering in some predominantly Muslim countries than in the United States.

Funded by a two-year, $589,200 National Science Foundation grant, the study seeks to identify the mechanisms that motivate women to pursue engineering in Jordan, Malaysia, Saudi Arabia, and Tunisia, where participation rates by women are as high as 50 percent. In the United States, approximately 15–20 percent of engineering students are women.

“The U.S. government, industry, and professional societies have allotted tremendous resources to increase women’s participation in engineering—with minimal impact,” said Julie Kmec, professor of sociology and Edward R. Meyer Distinguished Professor of Liberal Arts at WSU and one of the study’s two principal investigators.

The researchers hope the work leads to greater understanding of the constraints that shape women’s participation in engineering and new ways to increase the number of women studying engineering in the United States. Nehal Abu-Lail, Linda Voiland professor in the Voiland School of Chemical Engineering and Bioengineering at WSU, is a coprincipal investigator on the project.
NSF career awards
Jean-Sabin McEwen and Steven R. Saunders

McEwen and Saunders, assistant professors in the Voiland School, received National Science Foundation Career Awards, which provide significant research support to young faculty beginning their careers. McEwen and Saunders are improving catalysts, which are crucial in a wide variety of industries including fuel and energy production, environmental cleanup, and pharmaceutical production.

McEwen is developing a model for predicting behavior of low-temperature exhaust catalysts in real-world conditions. The researchers will investigate the applicability of the emerging area of “single-site” catalysis to low temperature automotive exhaust catalysis. In collaboration with Tufts University researchers, the team will use a comprehensive model they developed to predict exhaust gas reactions. The work could also improve the possibility of using earth-abundant rather than expensive and precious metals, such as platinum, in efficient automotive catalysis.

Saunders is developing better methods of preparing catalysts so they are more efficient and last longer. Researchers would like to have better control over catalysts, particularly at the nanoscale. Traditional methods of preparation lack sufficient control over the size of the nanoparticles that are created, resulting in catalysts that don’t perform as well as they could. Saunders’ team is working with molecules that can be switched on or off through physical or chemical stimuli, such as heat or the introduction of carbon dioxide, as a way to control the shape, size, synthesis, and deposition of metallic nanoparticles to be used as catalysts. They have shown that catalysts prepared using switchable molecules are more resistant to size and shape changes and can perform at higher temperatures for longer periods of time. The NSF projects also have related educational and outreach programs that target high school students and aim to increase interest in higher education opportunities in science, technology, engineering and math fields, especially among women and underrepresented minorities.

ACS fellow award
Yong Wang, Voiland Distinguished Professor

The American Chemical Society Industrial and Engineering Chemistry Division fellow award honors a chemist or engineer from an academic, industrial, or government laboratory based on innovative contributions to the areas in which they have published within applied chemistry or chemical engineering.

NSF graduate research fellowships
Jake Gray and Jenny Voss

Gray, who holds a WSU bachelor’s degree in engineering, will study renewable and carbon-neutral hydrogen production from formic acid using electric field assisted catalysis. Voss, who has a WSU bachelor’s degree in chemical engineering, is studying the catalytic conversion of carbon dioxide and hydrogen into long-chain alcohols. Only two thousand students from all disciplines nationwide receive this fellowship every year.

American Heart Association graduate fellowship
Thu (Lily) Ly

Ly is conducting research on mutations in a heart muscle protein that are linked to dilated cardiomyopathy and hypertrophic cardiomyopathy. She received the fellowship after presenting her preliminary research at the 61st Biophysical Society annual meeting earlier this year in New Orleans, Louisiana.
Summer program offers student research opportunities

This summer, 90 students from across the nation participated in WSU’s summer undergraduate research program where they worked with award-winning professors in cutting-edge facilities. For many, the experience opened their eyes to the world of possibilities research offers.

Raquel Murillo, a junior in chemical engineering, worked with Professor Nehal Abu-Lail to study a multidrug resistant strain of Escherichia coli (E.coli). The research project focused on how the bacteria’s cell membrane interacts with antibiotics at a nanoscale level.

“Professor Abu-Lail is known around the world for her research,” said Murillo. “There is nothing like the experience of being around someone who can truly mentor you. She is a great mentor and has constantly provided me with information and resources that helped with my research.”

“Raquel has shown great work ethic. She is reliable, persistent, inquisitive, and disciplined,” said Abu-Lail. “It has been great to have her as part of our laboratory team.”

Abu-Lail received a grant from the National Science Foundation to develop the summer undergraduate research program.

Chemical car heads to nationals

Voiland School chemical engineering students competed at the national Chem-E-Car race in Minneapolis, Minnesota this fall. The students earned the right to compete in the national competition after success at the spring regional competition. This year’s Chem-E-Car team, which included 12 students, used a zinc air battery and an iodine clock reaction for their car. At this spring’s regional competition, three undergraduate students, Bardya Banihashemi, Marisa Gliege, and Kyle Groden, also presented their research on catalysis and fuel cells.

First cohort chosen for PNNL-WSU research

Washington State University and the U.S. Department of Energy’s Pacific Northwest National Laboratory have selected the first group of students for the PNNL-WSU Distinguished Graduate Research Program. The program is available to students who have been accepted into a WSU graduate program and are pursuing research in clean energy, smart manufacturing, sustainability, national security, or biotechnology. Voiland School students who are participating in the first cohort include Jenny Voss, Christina Louie, Trent Graham, and Austin Winkelman. The students will complete their coursework at WSU and collaborate with nationally recognized PNNL scientists on their thesis projects.
Major gift advances WSU thermodynamics research

Washington State University recently announced the creation of the Alexandra Navrotsky Institute for Experimental Thermodynamics (AlexInstitute), made possible by a $1 million gift from Alexandra Navrotsky, Distinguished Interdisciplinary Professor of Ceramic, Earth, and Environmental Materials Chemistry at University of California, Davis. Navrotsky recently made a similar gift to UC Davis.

The new institute will be part of the Gene and Linda Voiland School of Chemical Engineering and Bioengineering. Navrotsky’s gift will create an endowment to support experimental thermodynamics research. The endowment will be used to advance the careers of aspiring scientists, including two of Navrotsky’s former Ph.D. students who recently joined WSU’s chemical engineering and chemistry faculty. The endowment will support research, purchase new equipment, and provide supplemental funding to help attract and retain outstanding Ph.D. program graduate students or postdoctoral scholars, with preference given to women.

“This transformational and generous gift is a testament to the importance of advancing research and the development of new ideas,” said WSU President Kirk Schulz. “We are both honored and grateful to receive this gift from Alexandra Navrotsky, which helps grow the University’s reputation and attract top graduate students.”

Learn how you can support the Voiland School at https://voiland.wsu.edu/giving-to-the-voiland-school/.

Voiland School: A growing program

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Did you know?

49% of our undergraduates participated in research and 56% participated in a professional experience while at WSU.
David Ensor (’63, Chem. Eng.) wanted to have a big impact. His support led to the establishment of the Gene and Linda Voiland School of Chemical and Bioengineering’s Ensor Lectureship, which brings world-class researchers to WSU. The annual lectureship, established in 2016, will feature emerging research in chemical engineering, bioengineering, aerosol technology, and nanotechnology. In the past year, Ensor lecturers have included Professors Gabor Somorjai from University of California, Berkeley, and Bruce Gates from University of California, Davis, who are leading researchers in the field of catalysis and surface science.