Mayfield senior is pioneering advancement in energy, technology and math

Sophia Sánchez–Maes: Pioneering work on algae as energy source

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Sophia Sánchez–Maes just turned 17, but you’d never guess it by looking at her résumé. The Mayfield senior has already racked up more than 90 credit hours at New Mexico State University, discussed her research on the future of algae as a biofuel with President Obama, and won countless prestigious awards in math.
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By fifth grade, she was doing seventh grade math.

"The summer after sixth grade, I decided I wanted to keep doing math because I liked it, so I took Algebra I," she said.

She blew through all of the high school math classes on a very accelerated track, often taking two or three advanced classes at once. By the time she was a sophomore, she was taking dual-credit courses at NMSU.

"As a junior, I took Finite Math, Proofs, and Modern Algebra — which is the theory of groups and rings and fields, all proof-based," she said. "This year, my senior year, the upper-division math that I really wanted didn't fit into my schedule, and the other one was cancelled due to under-enrollment. But the department head, Dr. (Joe) Lakey, stepped up, and told me that he'd tutor me in something that was interesting to me. He thought that I was deficient in analysis, so he tailored a curriculum to help me develop that."

Improving Biofuels

During the summer of 2013, after her sophomore year, Sophia was working as a photonics research intern in Albuquerque at the University of New Mexico's Center for High Technology Materials. While she was there, she began formulating a theory to help satisfy the world's energy demand.

"I'd heard a lot about algae, and the potential that biofuels held," she said. "I'd heard about fuels that are enriched by corn, but it's so inefficient and ineffective — we spend a lot of energy to make that happen, and we're using corn that could otherwise be used to feed mouths. That's a problem. Algae, on the other hand, kind of seemed like the golden crop. It didn't have any of those problems whatsoever."

Sophia discovered that algae can thrive on land unsuitable for other forms of agriculture.

"Here in New Mexico, especially, we had a lot of promise," she said. "We have exorbitant sunshine. We're short on water, but algae can thrive in saline water, or wastewater — and we've got that."

During her junior year, she participated in the Supercomputing Challenge. With two teammates, Ian Rankin and Ahmed Muhyi, the trio created a computational model of the growth dynamics of green microalgae.

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"We had to create a mathematical model as well as a computational model to make that happen, and we did," Sophia said. "It ran thousands and thousands of simulations to figure out what was optimal to produce the most growth in certain conditions.

"One of the biggest problems with algae biofuel is that it took more energy to make than the biofuels would contain," she said.

The team took third place at the Supercomputing Challenge, and Sophia set her sights on making algae biofuel production more efficient. Working with researchers at NMSU, she began studying an "extremophile" algae native to Yellowstone National Park called Galdieria sulphuraria.

"The ultimate goal was to minimize production costs, to make algae biofuel competitive at the pump," Sophia said. "I used a process called thermogravimetric analysis to determine whether this specific algae would be a good source of fuel, and found that, by my measurements, it was better than any other algae except for Chlorella."

Sophia then pioneered a chemical method called hydrothermal liquefaction, which mimics high pressure, high heat conditions in the center of the Earth.

"We're basically pressure-cooking the algae inside a soup. So the water is part of the reaction, rather than an impediment," she said. "With this method, we've been able to get back in the black, as far energy gain goes. We're no longer running that deficit, which is a big deal."

Working with the National Science Foundation's Engineering Research Center, Sophia discovered that her algae can also treat wastewater better than other algae.

"In every city in the U.S., approximately 33 percent of energy is spent treating wastewater, which is kind of obscene," said Sophia. "Traditionally, part of the treatment and filtration process is done with anaerobic bacteria, which extract the impurities like phosphorous and nitrogen from the wastewater. My algae can remove those better than anaerobic bacteria, and thrives in wastewater. This also eliminates the cost of nutrients for growing the algae, because it's feeding itself off of the contaminants."

**Awards and achievements**

For her work, Sophia was named a National Science Foundation Young Scholar.

On March 23, she was able to share her work with President Obama at the White House Science Fair.

"(Sophia is) helping to bring the world closer to using algae as a clean, renewable, and even inexhaustible energy source," Obama said, speaking at the event in the East Room of the White House. "And it's already being tested in her hometown, the process that she's developing. It is amazing."

Sophia has also earned the Hispanic Heritage Foundation's Gold Award in Engineering and Mathematics, and recently won the National Center for Women in Technology Award for computing.

She has received full-ride scholarships to M.I.T. and Princeton. Yale has offered her their Questbridge Scholarship, a comprehensive package worth more than $250,000. She hasn’t decided on a college yet, but the offers continue to roll in. Columbia University has offered her a full-ride, plus $10,000 for her research as a science research fellows. Only 10 Columbia students per year are asked to participate in the program.

Sophia is also a two-time Junior Olympian in cross country, and has done extensive cancer research, examining how cancer cells metastasize — which she's not ready to talk about yet, "because I'm still working on it."

She received the National Merit Scholarship, and is a finalist for the Gates Millennium Scholarship, offered by the Bill and Melinda Gates Foundation.

After graduating in May, Sophia will spend the summer working at NASA's Jet Propulsion Laboratories in Pasadena, Calif.

"I'm going to be working with the Thermal Team to develop code for the Mars Rover," she said. "A lot of the equipment on the Mars Rover is older equipment, and there are time delays between NASA sending data up and the Rover putting that information into use. The goal of my project will be to create a sort of 'real-time' Mars Rover, using the power of high-performance computing to improve a lot of those functions."
At today's City Council meeting, Mayor Ken Miyagishima is expected to issue a proclamation, declaring today "Sophia Sánchez-Maes Day" in Las Cruces.

Her father, Jim, said that the family is genuinely grateful for the Las Cruces Public Schools system and its dual-credit program, which has provided Sophia with the resources she has needed to excel.

"LCPS and NMSU have really been amazing," said Maes. "When Sophia needed to take courses that were beyond what they offered, she would go in and negotiate with them, and they would give her credit for the courses. Because of that kind of flexibility, and LCPS working with NMSU, Sophia has been able to accomplish what she has."

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