Three Tulane Faculty Members Win Prestigious NSF CAREER Awards

August 11th, 2025

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Tulane University is celebrating a major milestone as three of its faculty members have been named recipients of the highly competitive National Science Foundation (NSF) CAREER Award. Mark Mondrinos (Biomedical Engineering), Samuel Punshon-Smith (Mathematics), and Alex McSkimming (Chemistry) each earned the honor for projects that push the boundaries of scientific understanding while advancing education and outreach in their respective fields.

Widely considered one of the most prestigious awards available to early-career researchers, the NSF CAREER Award supports faculty who exemplify the role of teacher-scholars through outstanding research, excellent education, and the

integration of both in their academic careers. It provides sustained funding (often for five years) to pursue innovative scientific inquiries while supporting the development of educational and outreach initiatives.

Mark Mondrinos: Engineering Sex-Based Models for Personalized Medicine

Assistant Professor Mark Mondrinos of the Department of Biomedical Engineering received the NSF CAREER Award for a project that tackles a longstanding issue in biomedical research: the underrepresentation of biological sex differences in preclinical models.

Historically, the development of drugs and therapies has largely relied on laboratory models that fail to distinguish between male and female cellular responses. This oversight can obscure important sex-based differences in how diseases develop and how treatments perform, potentially leading to less effective or even harmful outcomes.

Mondrinos’s project aims to fill this gap by creating new methods for culturing male (XY) and female (XX) cells using sex-specific hormone compositions, including carefully balanced levels of estrogen and testosterone. These culture systems will be used to build engineered tissue models of organs such as the retina and skin. The models can reveal how sex hormones influence disease mechanisms and drug responses at the cellular level.

“This award solidifies our group’s commitment to developing cell culture tools for investigating sex differences in health and disease,” said Mondrinos. “We hope that the research conducted for this award will allow us to develop distinct methods for culturing male and female cells that can catalyze a paradigm shift in human cell-based research throughout several sectors of biotechnology.”

The project goes beyond the lab, integrating research findings into biomedical engineering curricula and launching outreach programs aimed at middle and high school students. By highlighting how personal biological differences affect health outcomes, the program seeks to inspire a more comprehensive generation of future scientists.

“This award is a culmination of my commitment to research, teaching, mentorship, and outreach throughout every stage of my academic career,” Mondrinos said. “It would not have been possible to win this award without the hard work of my students and trainees, so the continuing opportunities to mentor, teach, and conduct outreach will be the most rewarding activities fostered by the NSF CAREER Award.”

Samuel Punshon-Smith: Unraveling Chaos in Fluids

In the Department of Mathematics, Assistant Professor Samuel Punshon-Smith received the CAREER Award for his project, “Dynamical Aspects of Random Fluid Motion.” His work centers on the complex and chaotic behavior of fluids, such as air and water, when subjected to random forces.

Understanding how fluids behave under these conditions is essential for advancing areas like climate modeling, oceanography, aerospace engineering, and environmental science. Yet fluid systems, particularly those involving turbulence and mixing, are among the most challenging problems in mathematics due to their nonlinear and high-dimensional nature.

Punshon-Smith’s research focuses on two key mathematical challenges: how random fluctuations impact a fluid’s ability to mix substances, such as pollutants or heat, and how to estimate quantities known as Lyapunov exponents, which measure the level of chaos in a system.

“A major goal is to successfully estimate Lyapunov exponents for infinite-dimensional systems like the Navier-Stokes equations, which describe the motion of viscous fluids,” Punshon-Smith explained. “A successful outcome of this investigation would be proving certain exponential bounds for advection-diffusion equations, resolving a long-standing open problem in the field.”

His previous NSF-funded work on Lagrangian chaos (the study of how individual particles move chaotically in a flow) laid the groundwork for this current project. Now, with the sustained support of the CAREER award, Punshon-Smith plans to push the boundaries of fluid dynamics theory while fostering a vibrant educational and collaborative community.

A significant part of his project involves mentoring graduate students, developing new courses on fluid mechanics and dynamical systems, and organizing interdisciplinary workshops.

“Receiving the NSF CAREER Award is a tremendous honor,” he said. “It allows me to focus on developing new mathematical tools and tackling some foundational open questions in my field.”

Alex McSkimming: Advancing Nitrogen Fixation Chemistry

In the Department of Chemistry, Assistant Professor Alex McSkimming received the NSF CAREER Award for his fundamental research into metal hydride chemistry—specifically, molecules that resemble key intermediates in the biological process of nitrogen fixation.

Nitrogen fixation is a natural process performed by certain bacteria that convert nitrogen gas from the atmosphere into ammonia, a form of nitrogen that plants can use. This process is vital for life and is the foundation of all agricultural productivity. Understanding how it works at the molecular level has been a long-standing goal in chemistry, with major implications for agriculture, sustainability, and energy efficiency.

McSkimming’s project focuses on studying small molecules that mimic the function of “metal hydrides,” intermediates that occur during enzymatic nitrogen fixation. By analyzing the behavior of these synthetic compounds, his team hopes to uncover insights into the chemical principles that enable this critical biological function.

“I have always been interested in the chemistry of nitrogen fixation from my early days in graduate school,” said McSkimming. “We aim to further the fundamental chemistry related to this important process and metal hydrides more generally.”

He emphasized that part of the thrill of the project lies in its unpredictability. “The great thing about science is you never really know where things will go. We're excited to see what things we uncover that we did not anticipate that well send us in brand new directions.”

While the focus of the project is research, the award will also support educational initiatives within the chemistry department. McSkimming plans to involve

undergraduate and graduate students in the lab, promoting hands-on learning and scientific curiosity through mentorship and collaborative experimentation.

When speaking of the the three winners, Dean Rajan notes, “These CAREER awards further affirm what we see every day at Tulane School of Science and Engineering: faculty who combine curiosity with uncommon care for students. From engineering sex-informed tissue models to unlocking the mathematics of turbulent flow to reimagining the chemistry of nitrogen fixation, Mark, Sam, and Alex are advancing knowledge while shaping the next generation of scientists. I am proud of their excellence and grateful for the example they set.” Together, these three CAREER Awards highlight the breadth and impact of Tulane's research enterprise, spanning fields from biomedical engineering to pure mathematics to fundamental chemistry. Their work exemplifies the university’s mission to advance knowledge and improve lives, locally and globally. As these faculty members embark on their five-year CAREER Award journeys, they bring with them a spirit of curiosity, collaboration, and a shared commitment to shaping the future of science.