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Bioengineer Marley Dewey receives NIH award to study extracellular vesicles that support tissue repair

Researcher Marley Dewey, an assistant professor of bioengineering at UC Santa Barbara, has received a National Institutes of Health (NIH) research award to support her work on recently discovered extracellular vesicles that play an important role in tissue repair. The Maximizing Investigators Research Award (MIRA) for Early-Stage Investigators, given by the National Institute of General Medical Sciences, will provide $2.1 million in funding across five years for Dewey and her lab to learn more about how certain extracellular vesicles, called matrix-bound nanovesicles, might promote healing at the cellular level — work that could ultimately inform treatments for disease and injuries.

"We are thrilled for Professor Dewey and her new MIRA, an incredibly competitive grant mechanism bestowed on early-career researchers who have especially bold, creative ideas that will unlock new research directions for years to come," said Michelle O'Malley, interim chair of the Bioengineering Department and a professor of chemical engineering and bioengineering. "Marley's vision for studying and engineering extracellular vesicles is in perfect alignment with NIH's MIRA Award — applications from her work will lead to a better understanding of how cells repair tissues for accelerating wound repair and treating disease."

”This early-stage investigator award is super-impactful for my lab to get off the ground and to establish what my lab is going to be doing for the next five to 10 years, and longer,” Dewey said. “I’m excited that this will help my lab to grow and pursue directions that would be challenging for us to do otherwise.”

Research in Dewey’s lab is aimed at better understanding the extracellular matrix, a network that surrounds and connects cells in the body. This matrix contains extracellular vesicles, which are small packets that cells produce to communicate with each other in ways that can promote organ and tissue development. The vesicles, made of lipids, can contain anything from proteins to nucleic acids, among other bioactive signals. Dewey called them a cell’s version of email.

“These tiny nanoparticles have information,” she said, “and they send those messages off to another cell to use that information.” Extracellular vesicles may be especially effective in delivering therapeutic compounds such as growth factors, because cells recognize specific markers on the lipid envelope surrounding the compound. A growth factor injected without this cell-friendly packaging might get rejected as “spam.”

Dewey is particularly interested in matrix-bound nanovesicles (MBVs), which may promote organ and tissue repair. In her post-doctoral work at the University of Pittsburgh, where she was an NIH TL1 Clinical and Translational Science Fellow, Dewey began studying matrix-bound nanovesicles isolated from pig bladders, investigating the potential for using the vesicles to treat glaucoma and other optic-nerve damage. But few studies have compared MBVs with other types of extracellular vesicles, and even fewer have looked at MBVs derived from stem cells, which is the approach Dewey and her lab will take using their NIH award.

“One of the major roles of stem cells is signaling to other cells so that they can drive immune response, repair and homeostasis,” she said. “Stem cells can turn into all these different cell types to help with repair, but they are also huge signalers during that repair scenario. And one of the ways they do that is by secreting these extracellular vesicles.”

Dewey wants to answer fundamental questions about MBVs. Using super-resolution microscopy, she and her colleagues are examining where matrix-bound nanoparticles gather within the extracellular matrix. They also intend to isolate these extracellular vesicles from a variety of cell types and study the messages they're sending — and whether the message depends on the type of cell it comes from. Dewey is also interested in the way matrix-bound nanovesicles interact with their three-dimensional environment. With what she learns, she plans to design and print materials that can shepherd these vesicles and the signals they carry to promote the strongest, most effective healing response.

Wound repair has multiple steps that work in combination, depending on the nature of the injury, meaning that individual cells send out many signals to direct everything from an emergency response to long-term repair and healing. With a broken bone, for example, messages call the "cavalry" of immune cells that initiate both inflammation and repair. Cells also signal to each other to guide how new bone is formed, and how to build the vasculature to support the mending process.

"It's unlikely that a single type of vesicle can direct this complex repair process," Dewey said. "So, part of this project involves identifying and defining different vesicle populations that might be able to guide these very specific repair processes in different aspects of wound repair, whether the body is repairing vasculature, cartilage or fat or bone, and then putting them into a material that could help deliver those signals at specific times and locations."

Dewey and her colleagues also plan to use the award to pursue creative work that complements their research. Dewey grew up in an artistic family, and she began submitting her science-themed work to competitions while completing her doctorate in materials science and engineering at the University of Illinois Urbana-Champaign. A portion of the new grant will fund art-focused activities enabling students on campus to present their own art and learn more about communicating their work to the general public.

At a time when many people feel intimidated or even suspicious of science, Dewey said, "art seems to bridge that gap," allowing more people to interact with scientists, ask questions and learn about research.

Although the primary focus of her funded project is basic science, she said, "I'm hoping all the information we gather will help us to design better therapeutics in the future, because overall, my goal is always that the work we do in the lab will lead to an improvement in the lives of people. That was one of the things that really did draw me to the bioengineering field. It often feels like the impact can be very tangible."

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