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NSF grant supports Marley Dewey's work to restore coral reefs

Corals aren't loners. Tiny creatures called coral polyps gather by the hundreds — and sometimes, hundreds of thousands — to create the ecosystems known as coral reefs. These living structures formed from the calcium carbonate that each polyp secretes host abundant wildlife, draw visitors to their beauty, and protect coastal communities from waves and storms.

But rising ocean temperatures, acidity, overfishing, and other impacts have threatened coral reefs, and more than half of reefs have died off since the 1950s. Many previous efforts to restore damaged reefs have proved unsuccessful in reversing the damage.

Now, UC Santa Barbara assistant professor of bioengineering Marley Dewey is bringing in a wider community as she studies how to repair coral, as part of a $750,000 CAREER award from the National Science Foundation. The CAREER Award is the agency's most prestigious grant for early-career faculty, and along with providing funding, the award validates academic excellence and serves as a key step on the path toward tenure.

With the award, Dewey's work will be aimed at understanding how to better grow coral in order to repair damaged reefs. And she'll bring that work into the community through local exhibits on coral reefs, supporting graduate students learning to communicate about science, and developing curriculum for local K-12

students integrating science and art.

“We’re delighted that the NSF is recognizing Marley Dewey’s extensive research on this critical ecosystem and her commitment to making science accessible and meaningful to the community,” said Catherine Klapperich, professor and chair of the Department of Bioengineering. “Art and science are overlapping and complementary disciplines, and the CAREER award is an affirmation of her creativity in research, outreach, and dissemination.”

Dewey, who has a background in both bioengineering and visual art, said that this combined approach aims to both accelerate biotechnology for coral restoration and inspire future scientists with the urgency and promise of coral reef repair. “My goal is to get broader participation in STEM by integrating art and science, forming a bridge between some of these complex concepts around coral and something accessible like art, which everyone can understand and appreciate.”

One thing that Dewey appreciates — and is leaning on in her research — is the similarity between bone and coral. Both materials are packed with calcium-rich minerals and tiny holes, called pores, that allow them to form the scaffolding of living structures, whether that’s a reef or a human body.

Because of these parallels, coral has inspired biomaterials for bone repair. As part of her research, Dewey has been investigating how to take what’s known about bone repair and translate it into new techniques and materials to repair coral reefs.

Bone repair relies on many of the properties of bone cells, including their stiffness, their mineral content, and the size of the pores, or small openings, in bone structure. These pores allow nutrients to move from one cell to another and, depending on how they’re organized, can help bone grow stronger. “Pore alignment and pore size are really important for human health,” Dewey said. “Different cells have different responses to pore size, and it seems like a universal property that cells can sense and understand porosity.”

Dewey wants to learn whether coral polyps respond to the size, shape, and arrangement of pores on the surface in which they grow. She also plans to look closely at how stiffness, chemical composition, and other properties of coral polyps affect how they grow and attach themselves to undersea surfaces. With her findings, she and her colleagues will develop new strategies to support and accelerate coral

growth.

In the ocean, coral polyps might attach themselves to the sea floor, rocks, and even shipwrecks. But while the reefs they form have been studied for years, there are still many uncertainties around how coral hangs on, and how to encourage new polyps to grow as part of restoration efforts.

While coral and bone have much in common, the way each cell type attaches to its surroundings may be different. “Cells in your body don’t actually stick to a material, they stick to proteins stuck on these materials, such as those in the extracellular matrix, or ECM,” she says. When trying to replicate tissue or bone in the lab, some of these ECM proteins need to be added to the substrate that the cells are being grown on, but, Dewey said, “we don’t know if coral needs that or not.”

Dewey and her colleagues will also consider what surfaces might be welcoming hosts for coral. “Certain materials we’re already avoiding,” she said. “Some people will use zip ties to tie coral to the bottom of the ocean, but research suggests that these actually harm the coral microbiome, likely because of the way the plastic degrades.” So she’ll consider a range of options, including natural and synthetic materials that include compounds known to enhance bone growth, and the chemical impacts of each on how coral grows.

This work ultimately seeks to define aspects of materials, such as the type of material, pore size, and stiffness, that allow for coral cell attachment, mineralization, and growth, Dewey said. The hope is that these design rules can be used by other researchers, as well as by Dewey and her collaborators, to develop materials that promote coral repair and restoration.

Dewey’s effort to unite engineering and art draws on two interests that once seemed to be taking her life in different directions. “For most of my life, I was doing art,” she said. “Sometimes when my mom would tell friends' parents that I went into engineering, they were shocked.”

But as a graduate student at the University of Illinois Urbana Champaign, Dewey began taking scanning electron microscope (SEM) images of structures within the collagen materials she was studying, and realized she could re-color the images herself with Photoshop. She went on to enter and win several “Art of Science” competitions with false-colored SEM images of composite materials used for bone repair.

With her coral research, she envisions continuing to turn SEM and other imaging techniques into visually stunning prints, along with creating 3D-printed diagrams of coral and bone “so that students can physically touch these materials and see how similar these two materials actually are.”

The art and research that emerges from Dewey’s lab seeks to be a part of interactive community outreach exhibits at two local nature education facilities, UCSB’s Research Experience and Education Facility and the Santa Barbara Maritime Museum.

With her award, she will also work with local K-12 teachers to integrate art and science in the classroom, reviving a previous workshop presented by the UCSB Materials Research Laboratory. These connections will extend to UCSB undergraduate and graduate students, through a new summer bootcamp on communicating a scientific topic through storytelling and art.

“Some students don’t realize that there’s this other side of science,” Dewey said. “I’m not just solving equations or on my computer or mixing chemicals together. There’s an art that comes with what we do in the lab.” By making the art visible, Dewey hopes to help more students understand the science behind coral restoration and imagine a place for themselves within it.

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