

# Physics Colloquium

with

## Megan T. Valentine

Associate Professor of Mechanical Engineering, UCSB

**Thursday, December 7, 2017**  
**4:10PM in Lewis Lab. 316**

*“Soft, Strong, Resilient: How mussels use multiscale structures, fiber reinforcement, and dynamic bonding to adhere to rocks underwater”*

Using marine mussels as a model organism, we explore the role of geometry and internal interfaces in controlling biological adhesion. We observe the dynamics of mussel plaques as they debond from glass using a custom built load frame with integrated dual view imaging capabilities. We previously found that the shape of the holdfast improves bond strength by an order of magnitude compared to other simple geometries and that mechanical yielding of the mussel plaque further improves the bond strength by  $\sim 100\times$  as compared to the strength of the interfacial bonds. Moreover, we determined that a porous, heterogeneous network within the plaque gives rise to novel modes of load transfer within the material. Here, I will present new work exploring how cyclic loading of the holdfast affects plaque debonding. We find that multicycle loading decreases small-strain stiffness, but does not compromise the critical strength or maximum extension, as compared to plaques that are monotonically loaded to failure. Strain-dependent plastic damage, observed using scanning electron microscopy, does not appear to be reversible or repairable on hours-long timescales. However, our results suggest that a redundancy of load-bearing mechanisms contributes to plaque toughness in repeated loading. These experiments provide new insight into the physical origins of biomaterials properties, and suggest new avenues for design of biomimetic systems with enhanced properties.

*Megan T. Valentine received her B.S from Lehigh University ('97), M.S. from UPenn ('99) and Ph.D. from Harvard ('03), all in Physics. She completed a postdoctoral fellowship at Stanford in the Department of Biological Sciences, where she was the recipient of a Damon Runyon Cancer Research Postdoctoral Fellowship, and a Burroughs Wellcome Career Award at the Scientific Interface. In 2008, she joined the faculty at the University of California, Santa Barbara, where she is now an Associate Professor of Mechanical Engineering. Her interdisciplinary research group investigates many aspects of biophysics and biomechanics, from regulation of intracellular transport, to shape control of cell division, to design of novel bioadhesives. In 2013, she was awarded an NSF CAREER Award for her work on neuron mechanics, and in 2015 was awarded a Fulbright Award to study adhesion mechanics in Paris, France. She is an Associate Director of the California NanoSystems Institute, and a co-leader of an IRG on Bio-inspired Wet Adhesion within the UCSB Materials Research Laboratory, an NSF MRSEC.*