Biohybrid Actuators: Engineered Neuromuscular Tissues for Medicine and Machines

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Biological materials dynamically sense and adapt their form and function to changing environments, but these capabilities have not been fully replicated in the synthetic materials traditionally used by engineers. This is perfectly showcased in the contrast between synthetic and biological actuators – force produced by skeletal muscle far exceeds the capabilities of abiotic competitors in efficiency, robustness, and dynamic adaptation. A complex feedback loop of sensory and motor neuron signaling, moreover, enables precise responsive control of force production and locomotion. We have engineered mesoscale models of the human motor control system in the lab that offer deep insight into the biochemical, mechanical, and electrical signaling mechanisms that govern system function. The system is modular, tunable, and biohybrid: constructed from both biological materials and smart synthetic materials. Our biohybrid actuators enable studying neuromuscular tissues in healthy and diseased states, serving as high-throughput personalized testbeds for new translatable therapies. They can also be deployed as responsive actuators in engineered devices, enabling machines capable of dynamic adaptation to changing environments.