Bio-Inspired Bioactive, Robotic, and Photosynthetic Hydrogels

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Our laboratory is focused on the design of synthetic functional systems that can emulate the most intelligent processes in supramolecular structures of plantae and animalia kingdoms. Three functional hallmarks of naturally occurring chemical systems are the photosynthetic machinery of green plants, the signaling pathways that rule the behavior of cells, and the motions of living creatures. All use hydrogels as the "material" environment in which evolutionary events have optimized their respective functions. In this lecture we will describe synthetic hydrogels inspired by green leaves that are based on light-harvesting supramolecular polymers and enzymes. These systems synthesize fuels such as hydrogen and hydrogen peroxide and also reduce carbon dioxide upon illumination with light within the solar spectrum. The lecture will also describe highly dynamic supramolecular polymer hydrogels that mimic extracellular matrices and effectively signal cells to promote regenerative signaling pathways. This particular work will highlight the use of hydrogels in promoting regeneration in the central nervous system, a goal that for many reasons has great societal impact to be explained in the lecture. Finally, the lecture will describe robotic hydrogels that exhibit by design mechanical actuation that mimics living creatures as a result of changes in temperature as well as exposure to light, magnetic fields, and electric fields.