157h Engineering Nanoscale Hydrogel Particles Entrapping Bovine Hemoglobin as Temperature and pH Sensitive Oxygen Carriers

Andre Palmer and Jaqunda Patton

Two novel bovine hemoglobin-based oxygen carriers were synthesized via complexation of bovine hemoglobin within either temperature or pH sensitive nanoscale hydrogel particles. In this work, temperature and pH sensitive nanoscale hydrogel particles were engineered to respond to physiological conditions characterized by either changes in temperature or pH, with an alteration in oxygen affinity and particle size. Nanoparticles of uniform size distribution were synthesized via photo-polymerization of N-isopropylacrylamide (NIPA) or acrylamide (AAm) in the presence of bovine hemoglobin within liposomal reactors. Hemoglobin crosslinked within the polymer matrix of a nanogel particle was found to embody an oxygen carrier that prevents both dissociation of the hemoglobin tetramer into alpha-beta dimers and exposure of body tissues to acellular hemoglobin, while facilitating oxygen transport through the polymer matrix. The following physical properties of the hemoglobin entrapped hydrogel particles were characterized: oxygen affinity, cooperativity coefficient, methemoglobin level, particle size distribution, zeta potential, osmotic pressure, and encapsulation efficiency. Temperature sensitive pNIPA nanoscale hydrogel particles exposed to a reduction in temperature from 40oC to 29oC exhibited particle swelling, and an increase in oxygen affinity. Conversely, pH sensitive pAAm oxygen carriers exposed to a reduction in pH from 7.8 to 7.0 exhibited particle shrinkage, and an increase in oxygen affinity. Taken together, the results of this study illustrate the design and response of temperature and pH sensitive nanoscale oxygen carriers.