Development of Ultra-low Fouling Zwitterionic Materials: From Molecular Principles to Applications

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Abstract

An important challenge in many applications is the prevention of unwanted nonspecific biomolecular and microorganism attachment on surfaces. To address this challenge, our goals are twofold. First, we strive to provide a fundamental understanding of nonfouling mechanisms at the molecular level. Second, we aim to develop ultra-low fouling materials based on the molecular principles learned. As a result, we have shown that zwitterionic materials and surfaces are highly resistant to nonspecific protein adsorption and microorganism attachment from complex media. With zwitterionic coatings, hydrogels or nanoparticles, results show no capsule formation upon subcutaneous implantation in mice for one year, expansion of hematopoietic stem and progenitor cells (HSPCs) without differentiation, no anti-coagulants needed for artificial lungs in sheep, no antibodies generated against zwitterionic polymers, and environmentally benign marine coatings. Unlike poly(ethylene glycol) (PEG), there exist diversified zwitterionic molecular structures to accommodate various properties and applications. Furthermore, zwitterionic materials are super-hydrophilic while their PEG counterparts are amphiphilic. Currently, we are integrating immunology into our biomaterials research and translating our biomaterials to applications ranging from cancer immunotherapy to precision medicine.