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Biosynthetic Polypeptides as Templates in Materials Design

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Biosynthetic routes to protein-based polymeric materials offer important opportunities for the production of well-defined macromolecular templates, owing to the control of sequence and molecular weight inherent in the biosynthesis of proteins. In particular, the biosynthesis of polypeptides with controlled presentation of functional groups in multiple positions, coupled with their subsequent chemical modification with biologically relevant ligands, will permit the production of well-defined, bioactive macromolecules that may provide insight into biological binding events in which multivalent binding is important. Modification of the well-defined macromolecules with ligands such as saccharides has application in the study of events such as toxin neutralization and mediation of the immune and inflammatory responses. In this work, alanine-rich polypeptides of both random coil and helical conformations, equipped with glutamic acid residues to impart chemical versatility, have been produced via biosynthetic strategies. Analysis via spectroscopic and calorimetric methods indicates that the polypeptides adopt helical, beta-sheet, or random-coil conformations that can be controlled with variations in temperature, pH, and salt concentration; the conformational behavior of the polypeptides is not compromised upon chemical modification with saccharides. The binding of these macromolecules to bacterial toxins has been characterized via immunochemical and spectroscopic methods; results indicate that specific architectural features of the glycopolymer scaffold cause changes in the binding of these molecules to multivalent receptors. Given the chemical flexibility in the design of such scaffolds, they can be modified with many different moieties in addition to saccharides, so multiple opportunities exist for their application in areas where control of active side chains is important, such as in biomaterials, electronic devices, and bioinorganic structures.