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Designer Biopolymers

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Edited by
Ayae Sugawara-Narutaki
Yukiko Kamiya

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Nature has evolved sequence-controlled polymers, such as DNA and proteins, over its long history. The recent progress of synthetic chemistry, DNA recombinant technology, and computational science, as well as the elucidation of molecular mechanisms in biological processes, drive us to design ingenious polymers that are inspired by naturally occurring polymers, but surpass them in specialized functions. The term “designer biopolymers” refers to polymers which consist of biological building units, such as nucleotides, amino acids, and monosaccharides, in a sequence-controlled manner. This book particularly focuses on the self-assembling aspect of designer biopolymers. Self-assembly is one common feature in biopolymers that is used to realize their dynamic biological activities and is strictly controlled by the sequence of biopolymers. In a broad sense, the self-assembly of biopolymers includes a double-helix formation of DNA, protein folding, and higher-order protein assembly (e.g., viral capsids). Designer biopolymers are now going beyond what nature evolved: researchers have generated DNA origami, protein cages, peptide nanofibers, and gels. This book illustrates the latest interdisciplinary work on self-assembling designer biopolymers. As shown by this book, the self-assembly of biopolymers has a great impact on a variety of research fields, including molecular biology, neurodegenerative diseases, drug delivery, gene therapy, regenerative medicine, and biomineralization. Designer biopolymers will help researchers to better understand biological processes, as well as to create innovative molecular systems. We believe that this book will provide readers with new ideas for their molecular design strategies for frontier research.

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