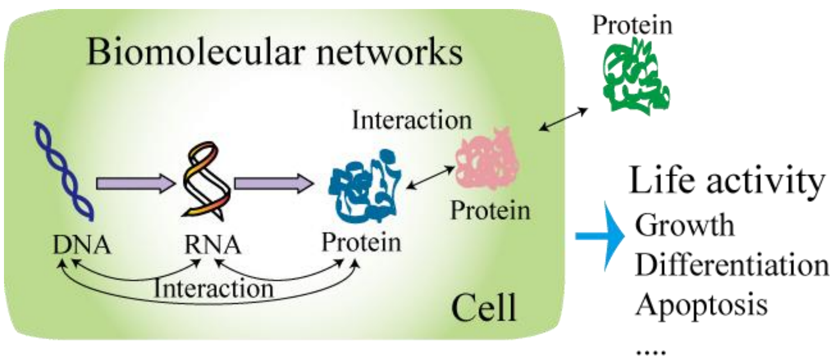
～Bioanalytical chemistry laboratory～

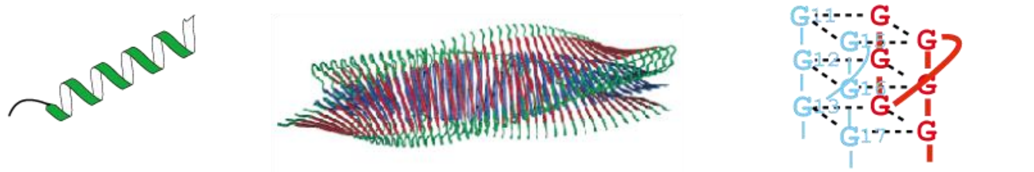
Biomolecules (proteins, nucleic acids, etc.) have a variety of functions and properties and are responsible for regulating numerous vital activities through their mutual interactions within organisms. These interactions are complicated and are controlled precisely and dynamically by the amounts of those molecules, their activities, and their binding characteristics.

The projects of our group are generally directed at constructing systems for analyzing these biomolecular interactions, particularly protein- and/or peptide- interactions, through chemical approaches. At present, most of our work is centered on the three projects described below. These studies will provide us with useful clues for facilitating the development of systems that will enable us to control biomolecular interactions and regulate cellular events, as well as to characterize biomolecular interaction networks.



1. Construction of designed "middle molecules" with secondary structures for analyses

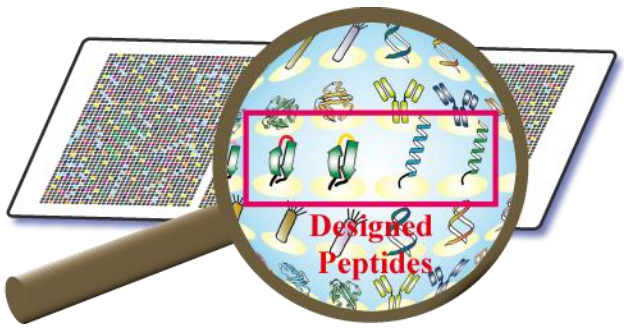
The structural characteristics of biomolecules, such as proteins and nucleic acids, generally determine their functions. The polymerization of hundreds and/or tens of monomers to each other in natural systems results in the generation of elaborate molecular structures that have a variety of associated functions. In order to obtain molecules that have unnatural functions for technological applications, the development of artificial molecules is necessary. The combination of natural, compact and simple secondary structures is one of the most effective ways to develop these artificial molecules. We are attempting to develop “middle molecules” (neither low nor high molecules) having novel functions by combining DNAs, which have a simple function and can be theoretically designed, with proteins, which have elaborate functions and complicated structures. This concept may be one of the promising ways to create useful *de novo* designed molecules for application in the field of nanobiotechnology.



α-helix structure β-strand structure G-quadruplex structure

2. Developing microarrays for various high-throughput analyses

The elucidation of the genome sequences of a variety of organisms has been successfully completed. In a post-genome-sequencing era, 'omics' studies and next-generation studies of cellular events are becoming increasingly effective for understanding vital biological phenomena. Microarrays (biochips) are promising and powerful assay systems for supporting these studies. To date, we have constructed and designed a variety of peptide microarrays with various secondary structures. Initially, the peptide arrays we designed were applied to the protein-analysis system. Since then we have shifted our focus to the design of a peptide array system for use in cellular assays.



3. Analyzing biomolecular interactions in cells

Recreating intracellular environments in a test tube is difficult. However, being able to analyze and directly measure the interactions among the proteins in a cell would dramatically increase our understanding of the real interactions and functional mechanisms associated with proteins. Within this context, by examining the process of self-assembly of amyloid beta peptide (Aβ), a protein implicated in the pathogenesis of Alzheimer's disease, we constructed a novel functional protein that could co-aggregate with Aβ and give fluorescent changes for monitoring the aggregation in cells by fusing fluorescent and luminescent proteins to the protein. Future research will focus on a protein-protein interaction that is associated with a serious physiological activity and we are currently attempting to construct a system for examining the intracellular interactions between these two proteins more closely.