RESEARCH CENTER FOR INTEGRATIVE AND COMPUTATIONAL BIOLOGY

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The aims of the research center for integrative and computational biology are (1) investigating the fundamental principles of various biological phenomena based on the integration of computational science and biology; (2) establishing new methodologies for integrative biology; and (3) providing new technology and knowledge to researchers. Our ultimate goal is to establish a new bioscience that includes methods originally utilized in different fields: informatics, mathematics, and biology.

I. Research activity

The research center for integrative and computational biology was founded in 2001 during a time of rapid progress in modern biology. The success of world wide genome projects has provided a huge amount of new information on genes, leading to expectations of advances in the development of new medicines for intractable diseases, the exploitation of new cultivated plants resistant to noxious insects, and so on. In addition, it is the object of present-day biology to research higher-order phenomena that are made up of complex interactions between many genes. To grapple with these challenges, it is necessary to decipher huge amounts of gene information and to reveal the fundamentals of the biological behavior of cells and organisms.

Mathematical and computational sciences have strong capacities for dealing with these challenges. Computational methods make it possible to process ever-increasing amounts of data. Hypothetical experiments (including the evolution of past organisms) based on mathematical or computational models make it possible to consider conditions which are impossible in real experiments. We continue to research higher-order phenomena in biology using mathematical and computational methods, as well as developing new methodologies for studying complex phenomena.

Figure 1. The laboratory room for computational studies

For example, integrative methods are especially important for understanding pattern formation in development. Morphological differences between species are an important research focus of current developmental biology. What is the mechanism responsible for the difference of morphogenesis between species? Theoretical studies are useful in identifying candidates for cell or gene interaction that are likely to be responsible for the systems in real organisms. This method gives us an integrative understanding of the behavior of complex systems in biology, including gene regulatory networks.

II. Collaborative activity

Interaction between researchers is essential to make the best use of mathematical and computational methods for experimental biology. Theoretical methods provide testable predictions which the experimental biologists are able to investigate before turning the results back over to the theoreticians for the next round of predictions. By repeating these predictions and tests, the integrative methods are continually developed. The Research Center for Integrative and Computational Biology has continued to encourage and enhance interaction between theoretical biologists and experimental biologists.

The center provides equipment such as cluster machines and Unix-based machines for computation and experiments. Members can also use computational equipment at the Research Center for Computational Science in Okazaki. The center also provides experimental equipment for collaborations with experimental biologists.

Figure 2. A cluster machine

Over the last five years we have organized four meetings, including two international meetings on systems biology and mathematical biology that had many participants studying biological systems using different methods, including physics, mathematics and computational science. The meetings enhanced interactions between researchers in many different fields and resulted in several collaborative research projects.