Preface

Significant advances in molecular biology have been made since Watson and Crick described DNA and suggested its mode of replication. Certainly, molecular genetics has been one of the most exciting areas of science of this century. The worldwide food situation and the demands being placed on agriculture for increased production of high quality food have led to an intense interest in applying the scientific advances in molecular genetics, developed mostly with microbial systems, to plant and animal improvement for the betterment of mankind.

A transition appears to be occurring in the biological and agricultural sciences. In the biological sciences there is a shift from the investigation of model systems, principally procaryotic, to the study of applied systems such as economic crops. The intent is to apply the basic information generated over the past few decades to these higher plants. In the agricultural sciences, methods are being explored to reduce the complex economic crop plant to the cellular level. The intent is to manipulate and select for favorable phenotypes at the cellular level and then to regenerate complete plants that could be used in plant breeding programs. These transitions appear to be effecting a bridge that could result in a better utilization of the world's genetic resources. Researchers in the animal sciences might want to view these new approaches with plants as pilot systems that may provide future applications for the genetic engineering of animals. Indeed, the flow of information between plant and animal research is and will continue to enhance knowledge in the field.

With the foregoing ideas in mind, an interdisciplinary group of University of Minnesota faculty and graduate students commenced regular meet-

ings in 1973. Members from eight departments in three colleges (Agriculture, Biological Sciences, and Health Sciences) participated in discussions on the molecular genetic modification of eucaryotes. Annual workshops on the topic have ensued, and this book represents the updated proceedings of the first two held in 1974 and 1975. The basic goals of the workshops were to review the current state of knowledge and techniques potentially useful for the molecular genetic modification of eucaryotes and to consider such questions as the following: What existing molecular biological techniques might be useful in carrying out genetic modification of eucaryotes? What techniques need to be developed? In what ways might molecular biological techniques be applied to plant improvement? Can techniques developed for plant improvement be applied to animal breeding and the treatment of human disease? What fundamental questions of cell biology and genetics need to be answered to facilitate the application of these techniques? How can these techniques be used to answer fundamental questions of cell biology and genetics? What are the main obstacles in the culture of plant cells and tissues to the successful application of molecular biological techniques? What are the advantages and disadvantages of the various plant materials presently available?

The editors hope that this book will serve to collect in one volume some independent judgments on the potential of molecular genetic modification, assess some of the tools at hand for such research, expose the more obviously deficient areas of knowledge, and present additional data. The common thread of the workshops, and of this book, was the interfacing of molecular genetics, plant cell and tissue culture, and plant improvement. The workshops were not widely publicized beyond the University of Minnesota and were attended by approximately 150 persons each year. It is our hope that this book will make available to the larger scientific community the philosophy and information presented at the workshops. We anticipate that the readers of this volume may have as diverse interests as those faculty members involved in the University of Minnesota "Molecular Genetic Modification Discussion Group" who organized the workshops. Thus the book will be of interest to many geneticists, cell biologists, plant breeders, plant physiologists, plant pathologists, and biochemists. Throughout the book the usefulness of molecular genetic techniques is obvious in three aspects: as an alternative approach to currently available genetic methods, as a new approach to currently unfeasible ideas, and as an approach to the study of the basic biology of the eucaryotic genetic system.

Papers presented at the workshops are integrated into two sections reflecting aspects of cell biology and genetics. Specific topics in the cellular aspects section include cell and tissue culture, protoplasts, somatic cell fusion, cellular mutagenesis, regeneration of new plant types, and the ap-

plicability of these techniques to plant improvements. Specific topics in the genetic aspects section include viruses and viral integration; integration and expression of foreign genetic material in human cells, *Drosophila*, plant cells, and legumes; biophysical studies of DNA uptake by plants; and genetic engineering for plant protection against diseases. Four presentations are not included in this volume due to the prior commitment of the authors to publish their papers, or similar papers having been published elsewhere; these include "Differentiation and morphogenesis of cell cultures into plants" by T. Murashige, "Techniques for the insertion of eucaryotic DNA into bacterial and viral DNA's—biochemical tools for genetic modification" by R. W. Davis, "Isolation of ovalbumin synthesizing polysomes—methods for the isolation of a gene" by R. T. Schimke, and "Molecular biology of nitrogen fixation" by R. C. Valentine.

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