Preface

Cytogenetics has experienced a renaissance in recent years with applications in genetics and genomics. Part of this revival has come from the use of fluorescent in situ hybridization (FISH) to address problems of chromosome structure, function, behavior, and evolution. In this volume, all of these topics are included. One set of contributions describes the diversity of chromosome structure. These studies illustrate that diverse accessions of a species have extreme differences in repetitive DNA arrays and organellar DNA insertions into nuclear chromosomes. In related species, significant diversity was documented with respect to chromosomal rearrangements. The fate of repetitive sequences is also explored in newly produced allopolyploids of wheat. A second set of contributions relate to new findings about centromere structure, specification and behavior. The volume also contains contributions about centromere behavior, neocentromeres and centromere function in interspecific hybrids. Centromere function is now known to have an epigenetic chromatin basis. Similarly, studies on chromatin organization of heterochromatin are also reported. Investigations of chromosome behavior make up a third set of contributions. FISH technology has now allowed studies of meiotic pairing and recombination that have not been possible previously. Several reports document recombination between diverged chromosomes from various species in addition lines or allopolyploids. New research on the mechanism of chromosome pairing, which is obviously required from meiotic recombination to occur, is also presented. The application of bacterial artificial chromosomes (BACs) derived from physical assemblies of various species has been used in genome sequencing projects. The use of FISH with these BACs onto chromosomes permits the coordination of the genetic, physical and the cytological maps. Physical and genetic maps have great utility but suffer from inherent inaccuracies. The ultimate test of genomic location of a fragment

of DNA is the visualization on the appropriate chromosome. Several studies in this volume address the use of these techniques for resolution of these issues. Further, the dissection of chromosome maps is also examined in studies of the gametocidal deletion system and the production of radiation hybrids for one of the three genomes of allohexaploid wheat. Lastly, studies of chromosomal evolution are included. Some studies noted above address evolutionary issues. An obvious and dramatic evolutionary change involves sex chromosomes, which are described in two studies.

The research reported in this volume illustrates the utility of incorporating cytogenetic tools into biological studies. Somatic chromosome identification is now becoming routine in selected species, and the utility of this technique will increase as it expands to other taxa. Individual genes or DNA fragments can be localized to chromosomes in combination with chromosomal identification techniques. This application bypasses the need for multiple generations of genetic analysis for the mapping of molecular markers to chromosomal positions. The identity of individuals with chromosomal changes can be determined in root tip metaphase spreads with subsequent growth of the individuals for further genetic and molecular analyses. These new techniques have also allowed examination of chromosomal behavior in meiotic and somatic preparations in ways that were previously not possible. They also allow studies of changes of chromosomal structure or transposable elements in different cells of a single tissue. The studies in this volume illustrate many of these applications and the diversity of new findings that they permit.

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