

Preface

This reference book is intended to provide information for students, instructors, and researchers on a range of topics in plant cytogenetics, including classical cytogenetics of plant genomes and chromosomes from structural or functional perspectives, modern molecular cytology and cytogenetics in the twenty-first century, recent methods, and laboratory exercises suitable for undergraduate or graduate instruction. The book is divided into three sections, each with chapters contributed by leading international scholars in the field. Our hope is that these chapters will supplement the many excellent review articles on plant cytogenetics published in the last 10 years and will provide a lasting contribution as a reference book on this important topic.

The first section, “Structure, Variation, and Mapping in Plant Cytogenetics,” covers classical cytology, chromosome aberrations, plant B chromosomes, and cytogenetic mapping by conventional or modern DNA or chromatin-fiber-based techniques. The role of plant chromosomal rearrangements, such as deletions, insertions, and rearrangements, is described, and research tools are explored. The production, detection, and impact of aneuploidy in plants are reviewed in relation to gene dosage and breeding through introgressions. In addition, the supernumerary B chromosomes are reviewed, and their potential research applications examined. This section ends with two chapters on the use of cytogenetics to map plant genomes, from historical cytology with G-banding to fluorescence in situ hybridization (FISH) on chromosome spreads. High-resolution FISH-based mapping using DNA or chromatin fibers highlights the state of the art in plant cytogenetic mapping.

The second section, “Function, Organization, and Dynamics in Plant Cytogenetics,” covers the basic elements of chromosomes, their behavior in meiosis, and the epigenetic landscape as surveyed by analysis of DNA methylation and histone modifications. Chapters on plant centromeres and plant telomeres are followed by a chapter on meiotic chromosomes, with emphasis on prophase of meiosis I. The last chapter in this section reviews epigenetic code in plants and a comparison of plants and nonplant eukaryotes.

The third section, “Methods, Informatics, and Instruction in Plant Cytogenetics,” provides breadth to the book by covering several major methods used by leading

laboratories as well as including chapters on informatics and laboratory exercises for aspiring or practiced instructors. The techniques for chromosome microdissection and descriptions of their use in several plant genetic applications are covered in the first of four chapters in this section. The next chapter provides detailed methods for the use of antibodies in plant cytogenetics, including immunolocalization and the chromatin immunoprecipitation (ChIP) technique. The next two chapters cover advanced methods in FISH, including extended DNA fiber-FISH and in situ PCR. A chapter on plant cytology in genome databases addresses the growing role of online resources and databases in our access to and comprehension of plant cytogenetics in relation to classic genetic and modern genomic resources. Finally, a chapter for instructors is included to encourage the development or continuation of laboratory courses in plant cytogenetics, an activity deemed important for training future plant cytogeneticists. The chapter includes several modular exercises that can serve as a resource for instructors of new or ongoing courses.

Overall, the book is designed to cover many foundational topics in plant cytogenetics, while reviewing modern research and new techniques that represent the current growth and momentum in the field today. Inclusion of methods and instruction provides a distinct advantage to this reference book. We hope it will stimulate new research and facilitate the hands-on transmission of plant cytogenetic knowledge to students and teachers alike.

Finally, we would like to acknowledge the extraordinary editorial assistance of Dr. Anne B. Thistle. We are deeply appreciative of her dedication and attention to detail.

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