Preface

Johann Gregor Mendel (1822–1884), a monk in the Augustinian monastery at Brün, Austria (now Brno, the Czech Republic), conceived and delivered to the scientific world in 1865 the science of genetics using a garden pea. His results were presented in a clear-cut and straightforward fashion, and they were fairly easy to understand. Unfortunately, the invaluable treasure was buried in libraries until 1900, when three scientists, Carl Correns (Germany), Hugo de Vries (the Netherlands), and Erich von Tschermak (Austria), independently unearthed Mendel's Laws of Heredity. Three years later, Walter Sutton and Theodor Boveri (1903) proposed that the hereditary particles are borne by chromosomes and developed the chromosomal theory of inheritance (Sutton–Boveri Hypothesis), creating the science of cytogenetics. The pioneering cytogenetic investigations in maize, *Datura*, and *Drosophila* during the early twentieth century showed that an individual has a fixed number of chromosomes. The genes are located on the chromosomes and are inherited precisely by cell divisions (mitosis and meiosis). Alteration in the genetic material induces mutations. Since its inception, cytogenetics has exploded in many disciplines, involving organisms ranging from virus to mammals. The dawn of the twenty-first century saw the sequencing of the entire genomes of bacteria, many crops, animals, and humans.

Plant cytogenetics has been progressing at an extremely rapid pace since the author composed the first edition of *Plant Cytogenetics* that was published by CRC Press in 1993. The second edition that was published in 2003 contained several changes such as the mode of reproduction in plants and transgenic plants and this was updated in all the chapters. It has been more than a decade since the second edition saw the light of day and was widely accepted by plant cytogeneticists. The time is right to update this book (third edition) in an encyclopedic fashion that includes new chapters on Mendelian genetics and the role of cytogenetics in plant breeding. Mendel's original paper in English was added in Appendix A. All chapters have been updated with new, important information.

The book's introduction flows directly into the stream of classical and modern cytogenetic techniques after extensive exposure to Mendelism and major chronological discoveries in the science of cytology, genetics, cytogenetics, and molecular genetics. The handling of plant chromosomes assembled in Chapter 2 has undergone monumental progress. Precise identification and nomenclature of plant chromosomes from classical aceto-carmine and Feulgen staining techniques have progressed to Giemsa banding, fluorescence *in situ* hybridization, genomic *in situ* hybridization, fiber fish, and sorting and karyotyping of chromosomes by flow cytometry. Several protocols for determining nuclear DNA content by flow cytometry have been formulated and perfected. Chapter 3, Methods in Plant Cytogenetics, a new chapter, describes Mendelian genetics including gene interaction and expression, test of independence, and classical mapping of qualitative traits on the chromosomes. Chapter 4 (Cell Divisions—Mitosis and Meiosis) and Chapter 5 (Genetic Control of Meiosis) describe mitosis and meiosis in the higher plants. The mode of reproduction (sexual, asexual, and sex chromosomes, incompatibility-self, and cross pollination) in plants is described in Chapter 6. Chapter 7 includes chromosome nomenclature based on the kinetochore position on chromosomes, karyotyping by aceto-carmine, and Giemsa C- and N-banding methods. Chromosome numbers of some economically important plants are presented in Appendix B.5. Chapter 8 discusses extensively chromosomal aberrations (structural and numerical changes). Utilization of primary, secondary, and tertiary gene pools for crop improvement depends on the comprehension of genomic relationships between the cultigen and allied species and genera. Established genomic relationships based on classical taxonomy, cytogenetics, and verified by biochemical and molecular methods are presented in Chapter 9. The cause of morphological aberrations generated through cell and tissue cultures and genetic transformation are described in Chapter 10. The dazzling progress achieved

since 1986 in producing genetically modified crops by private and public institutions is briefly discussed in Chapter 11. Finally, Chapter 12 summarizes the relationship of cytogenetics in plant breeding.

I have provided an adequate literature review; it covers publications from ancient time to the present.

I am optimistic that this book will be accepted by plant cytogeneticists and will encourage students to receive training in the exciting field of plant cytogenetics, particularly in wide hybridization.