

Prologue

Meiosis is a method of nuclear division leading to an orderly reduction of the chromosome number. It is coextensive with sexual reproduction and in the sexual cycle it compensates for fertilization. These statements provide us with a minimum definition of the process.

Cyril Darlington

Every living eukaryote either is, or at some time has been, a single cell. New cells arise only by the division of existing cells and this involves the division of both nucleus and cytoplasm. In eukaryotes nuclei divide in only two ways, by mitosis or by meiosis. Meiosis represents a unique form of cellular differentiation and, unlike mitosis, is most usually initiated only once in the life cycle of a eukaryote. Moreover, while mitosis is associated with uniparental, asexual, systems, it is meiosis that has made sex and biparental inheritance possible. It is then a unique and distinctive event in the life of an organism.

It is also a meticulously exact event normally involving both an accurate quantitative reduction in chromosome number, on the one hand, and a precise partitioning of genetic material, on the other hand. Meiosis thus fulfills two interrelated functions both of which are connected with the process of sexual reproduction. It ensure the production of a haploid phase in the life cycle of an organism (reduction) and, in one form or another, provides for the production of genetically distinct offspring (recombination). Deviations from this strict schedule of behaviour are, with few exceptions, eventually either lethal or sublethal since a precisely structured chromosome complement is an essential prerequisite for basic cell function during development.

Because meiosis is such a highly ordered process, the essential genes and proteins that control it can be reasonably anticipated to show considerable conservation throughout eukaryotes. While the meiotic mechanism does indeed display conservatism in its basic features it is not simply a unitary process but rather a complex of processes geared into a unitary sequence and its variations, as we shall see, involve considerably more than mere matters of detail. In animals the meiotic machinery is much more varied than in plants. On the other hand, the diversity of reproductive

mechanisms is far greater in plants, including as it does systems of self-fertilization, which are rarely found in animals, and hermaphroditism on a much more extensive scale. An understanding of the nature and mechanisms of meiosis is basic to the analysis of many biological problems for while its causes are rooted in cell biology its consequences lie ultimately in evolution.

The essential characteristics of meiosis have been understood in gross descriptive terms for almost a century but it is only within the last 20 years that information has become available on the ultrastructural and molecular aspects of the process. One of the aims of the present text is to present an overview of what we now know, and do not know, about meiosis. While we still lack a complete theory of meiosis the facts now available at least provide a basis for reformulating the unresolved problems in more specific terms and this is the second aim of this monograph.