Chapter 5

Models for Meiosis

5.1 The meiosis process

In section 4.1, we introduced recombination as the process of crossing over between the two homologous parental chromosomes in the formation of an offspring gamete, and we have considered multilocus segregation probabilities under the assumption of no interference (section 4.7). In order to develop better models of multilocus segregation, it is necessary to consider the processes of *mitosis* and *meiosis* in greater detail. Mitosis is the normal process of cell division during somatic growth: meiosis is the process of gamete formation. Both processes involve chromosome duplication and separation, but only meiosis involves recombination. A chromosome is a doubled strand of helical DNA, with complementary bases on the two strands. Chromosomes of the shape often depicted in texts, or seen in an amniocentesis photograph, exist only just prior to mitosis or meiosis. These are actually doubled chromosomes. Each chromosome is thus two double strands of DNA. Each double-strand is known as a *chromatid*: the two chromatids of a single duplicate chromosome are known as *sister* chromatids. In the pair of chromosomes just prior to mitosis or meiosis, there are thus four chromatids, or eight strands of DNA in total. In our modeling here, we consider the four chromatids, or the *chromatid tetrad*, rather than all eight DNA strands.

Just after the previous mitotic division, each chromosome exists as a concentrated double-strand of DNA in the nucleus of the cell (Figure 5.1(a)). In the next stage, *interphase*, the chromosomes elongate (Figure 5.1(b)), and duplicate; at this stage the length of DNA in the nucleus of a cell is 2 meters. The DNA then re-concentrates to form the chromatid tetrad (Figure 5.1(c)). In mitosis, each chromosome divides to give two daughter cells (Figure 5.1(d)), each with a nucleus with the identical chromosome complement as the parent cell nucleus (Figure 5.1(a)). In the first meiotic division, however, one of each homologous pair of chromosomes must go to each daughter cell. In order to achieve this, the pair of chromosomes must become tightly aligned, and in so doing *chiasmata* occur, resulting in an exchange of DNA between two non-sister chromatids (Figure 5.1(e)).