Abstract

**Elucidating Meiotic Recombination and Crossover Interference using Polymer Physics Modelling**

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The formation of an egg or sperm cell during meiosis involves the pairing, recombination, and segregation of homologous chromosomes. Proper segregation and genetic variability requires the formation of genetic crossovers between the homologs. The observed genetic crossovers arise at sites that are genomically separated---a phenomenon called crossover interference. We use a polymer physics model of two confined flexible polymers to determine how the physical properties and biological structure of chromosomes influence the locations of linkages that colocalize the homologs and evolve into recombination sites. We calculate the statistics of our model to determine the evolving probability distributions for colocalization of homologous loci as pairing progresses. Modeling chromosomes as linear flexible polymers predicts that colocalization is favored at close proximity to existing linkages, contradicting crossover interference. However, we extend our model to include the cohesin-induced loop structure of meiotic chromosomes through a couple different methods, resulting in reduced density in linkages occurring at small genomic distances from each other and an average distance between linkages to be around 110 kilobases. This prediction agrees with the genomic scale of the experimentally observed crossover interference (approximately 100 kilobases). Our model predicts a competition between the physical behavior of flexible polymers and the biologically relevant structure that inhibits the formation of crossovers through the misalignment of loci. Through this analysis, we predict that crossover interference is the result of the looped structure and the chromosomal organization that occurs during early Prophase I.