Crossing Over in *Sordaria*

Background

Sordaria fimicola is an ascomycete fungus that can be used to demonstrate the results of crossing over during meiosis. *Sordaria* is a haploid organism for most of its life cycle. It becomes diploid only when the fusion of the mycelia of two different strains results in the fusion of the two different types of haploid nuclei to form a diploid nucleus. The diploid nucleus must then undergo meiosis to resume its haploid state.

Meiosis, followed by mitosis, in *Sordaria* results in the formation of eight haploid ascospores contained within a sac called an ascus (plural, asci). Many asci are contained within a fruiting body. When ascospores are mature the ascus ruptures, releasing the ascospores. Each ascospore can develop into a new haploid fungus. The life cycle of *Sordaria fimicola* is shown in Figure 1.

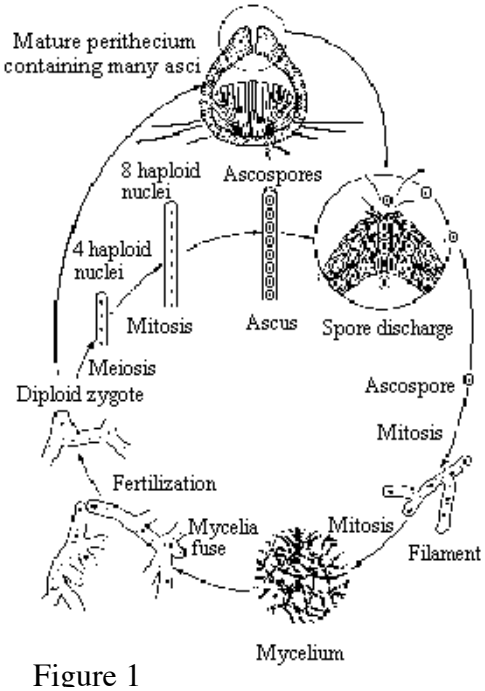
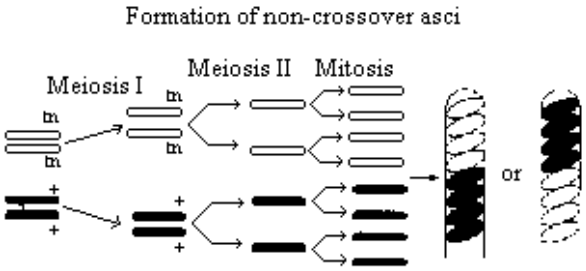


Figure 1

To observe crossing over in *Sordaria*, one must make hybrids between wild-type and mutant strains of *Sordaria*. Wild-type (+) Sordaria have black ascospores. One mutant strain has tan spores (tn). When mycelia of these two different strains come together and undergo meiosis, the asci that develop will contain four black ascospores and four tan ascospores. The arrangement of the spores directly reflects whether or not crossing over has occurred. Below, no crossing over has occurred.



If crossing over occurs, it will occur in the region between the gene for spore color and the centromere. The homologous chromosomes then separate during meiosis I. Meiosis I (MI) will result in two cells, each containing both genes (1 tan, 1 wild-type); therefore, the genes for spore color have not yet segregated. Meiosis II (MII) results in segregation of the two types of genes for spore color. A mitotic division will result in the formation of 8 spores with an arrangement different than seen above.

The frequency of crossing over appears to be governed largely by the distance between genes, or in this case, between the gene for spore coat color and the centromere. The probability of a crossover occurring between two particular genes on the same chromosome (**linked genes**) increases as the distance between those genes becomes larger. The frequency of crossover, therefore, appears to be directly proportional to the distance between genes.

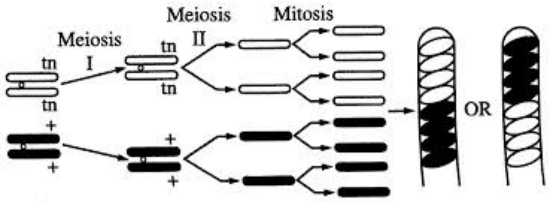
A **map unit** is an arbitrary unit of measure used to describe relative distances between linked genes. The number of map units between two genes or between a gene and the centromere is equal to the percentage of recombinants. Customary units cannot be used because we cannot directly visualize genes. However, due to the relationship between distance and crossover frequency, we may use the map unit.

Objectives:

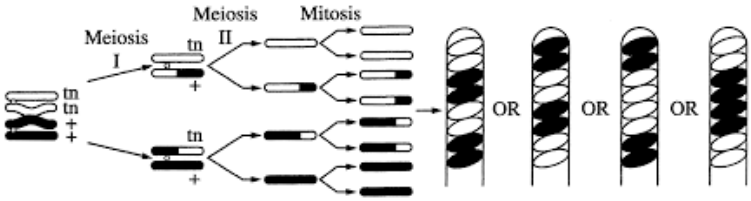
To determine the map unit distance of a gene to centromere based on the crossover frequency.

Procedure

1. Using the cards provided, examine **at least 50** hybrid asci. Count the number of non-crossover asci. Count the number of crossover asci. Determine the total number of asci counted. Record the data.



Non-Crossover Asci



Crossover Asci

2. Based on your counts, determine the percentage of asci showing crossover.
3. Divide the percent showing crossover by 2. This is your gene to centromere distance. (The percentage of crossover asci is divided by 2 because only half of the spores in each ascus are the result of a crossover event.)

Data

# of Non-crossover Asci	# of Crossover Asci	Total Asci	% Showing Crossover	Gene to Centromere Distance

Analysis

1. A similar technique can be used to determine the distance between two genes on a single chromosome. In this activity, a color mutation was used as the gene of interest. What is the benefit of using a color mutant gene for learning about map units?

2. Published results indicate that the map distance from the centromere of the gene for spore color in *S. fimicola* is 26 map units (corresponds to 52% crossover frequency). How close are your results to the published results? Calculate your percent error.

$$\% \text{ error} = \frac{|\text{Accepted} - \text{Measured}|}{\text{Accepted}} \times 100$$