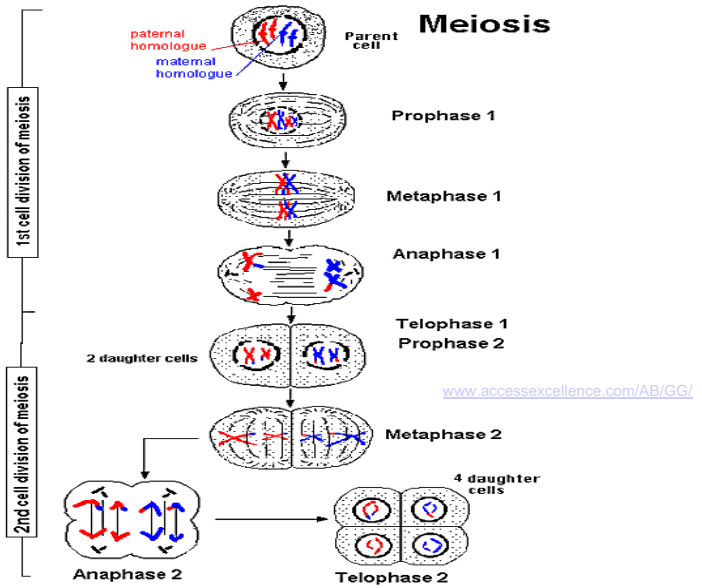
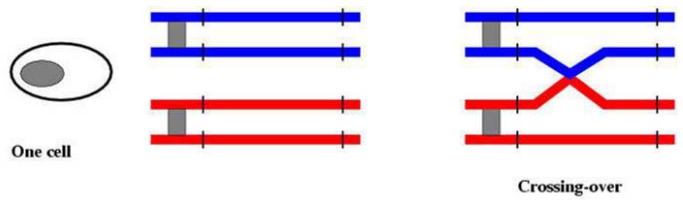
Meiosis

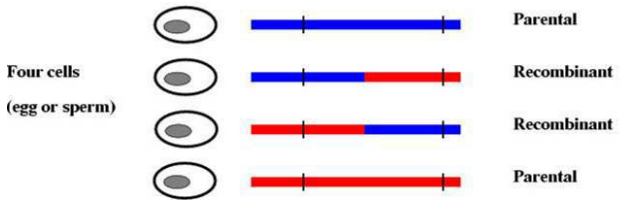
- Meiosis is the process of cell division that leads to the formation of gametes.
- Meiosis starts with a diploid cell, with pairs of homologous chromosomes (one maternal, one paternal), and produces four haploid cells, with only a single chromosome from each pair.
- As a result of crossovers, chromosomes passed from parent to offspring are mosaics of the two parental chromosomes.

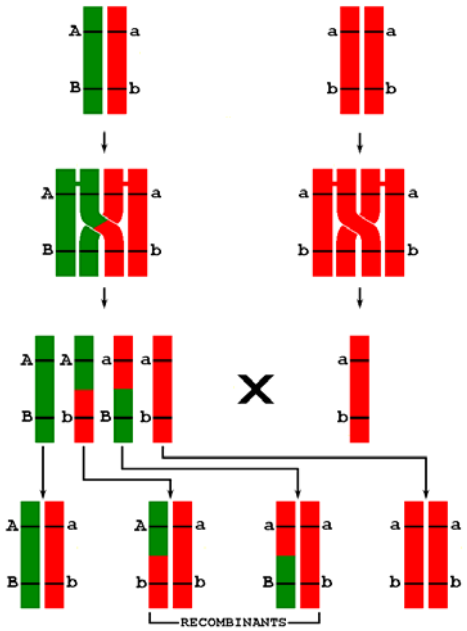
Meiosis



Recombination







Genetic mapping

- The phenomenon of crossover during meiosis, and the resulting varying degree of recombination between loci, provide means of measuring distances along chromosomes.

Genetic markers

- Genetic markers are regions of DNA that tend to differ among individuals and are easily assayed.
- Unlike protein coding genes, markers often have no known function; they are simply convenient landmarks on chromosomes.
- Markers form the basis of genetic maps against which new genes are mapped.
- Genetic markers which have several different DNA variants, or alleles, are termed polymorphic.

Genetic and physical maps

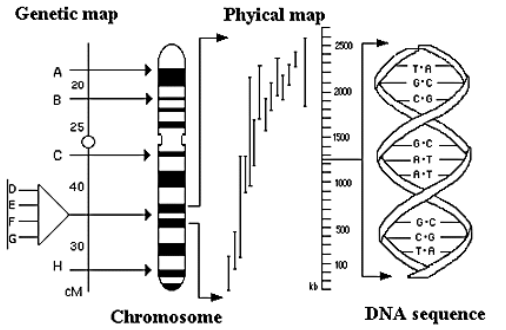
- Genetic distance: expected number of crossovers between two loci, per chromatid, per meiosis.
  Unit: Morgan (M) or centiMorgan (cM).
- Recombination fraction: the proportion of recombinant gametes between two loci.

- Physical distance: number of nucleotide base pairs (bp).

Genetic and physical maps

- In general,
  genetic distance ≠ physical distance.
- A rough correspondence
  1cM ~ 1 million bp (1Mb).
- The intensity of the crossover process varies by sex, individual, chromosome, position on the chromosome, temperature.

Genetic and physical maps



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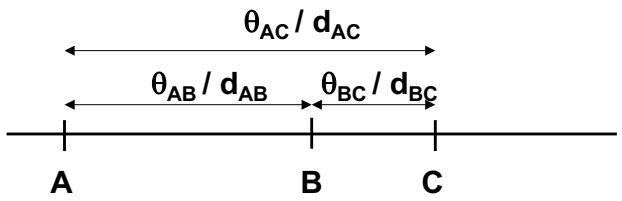
Recombination fractions vs. genetic distances

- Problem: the recombination fraction is not a metric.
- Unlike genetic map distances, recombination fractions are not additive.
- A recombination event between two loci could result from any odd number of crossover events.

Recombination fractions vs. genetic distances



$\theta_{AC} \neq \theta_{AB} + \theta_{BC}$

but

$d_{AC} = d_{AB} + d_{BC}$

Map functions

- To relate the recombination fraction to the genetic distance, one can specify a stochastic model for meiosis.
- The model will yield a map function, M

$$\theta = M(d).$$

- For short distances, $\theta \approx d$.