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Genetics and Genomics (GEGE2X01)

Course Notes

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Contents

Linkage and gene mapping

- Genetic mapping links observable phenotypes to genotypes.
- Linkage and genetic mapping leads to:
    - Identifying genes and biological processes underlying inherited traits;
    - Functional genomics to discover why genes cause phenotypes;
    - Genetic tests for diseases and potential cures; and
    - A scaffold to inform the assembly of whole genome sequences.
- Linked genes are located close enough together on the same chromosome that they are often inherited together.
    - Also called syntenic genes.
    - Genes far apart on the same chromosome can be unlinked.
    - In the diagram below for example, a-b and d-e could be linked:
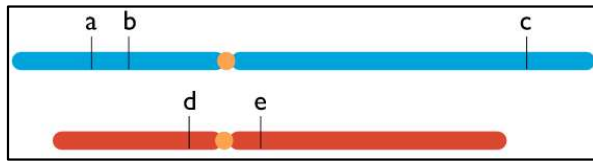

- Fun fact: one of the first genetic maps was created for Drosophila.
- Linkage maps show relative locations, not physical locations.
    - Like a railway map, not an absolute map like a street directory.
    - The challenge is connecting linkage and absolute maps.
- Recombination is when alleles of linked genes can separate.
    - Also called crossing over.
    - Occurs during prophase I of meiosis.
    - Between chromatids of homologous chromosomes:
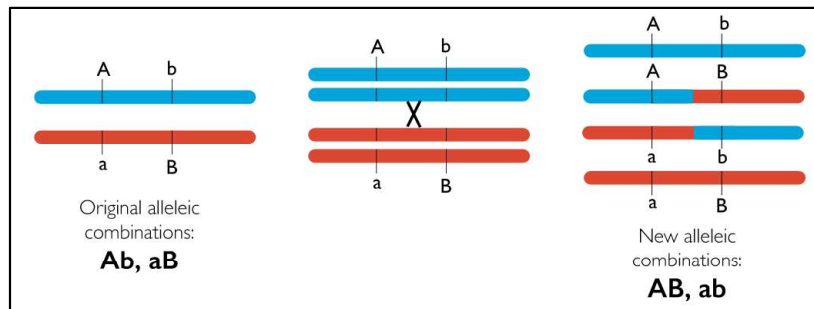
    - Ab and aB are referred to as parental. AB and ab are referred to as recombinant.
- Crossing over occurs at the chiasma (plural chiasmata).
- Determination of genetic linkage:
    - Unlinked genes assort independently according to Mendelian ratios.
      For a dihybrid cross, this gives a 9:3:3:1 ratio.
      For a test cross, this gives a 1:1:1:1 ratio.

- o Linked genes don't assort independently:
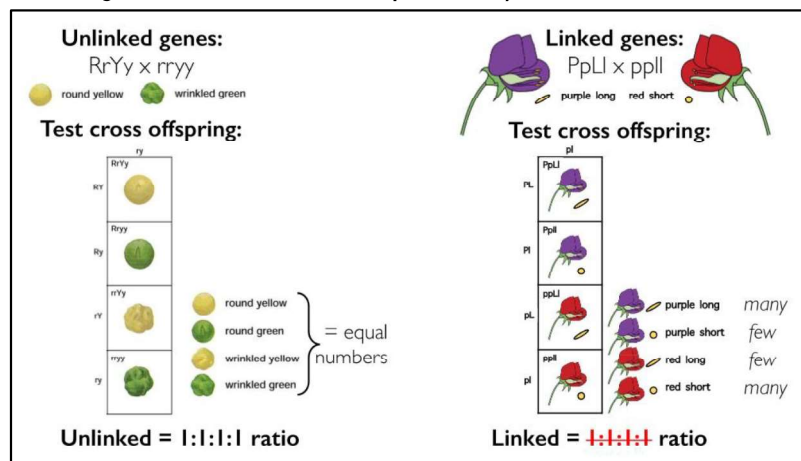
In this example, purple-long and red-short are linked.

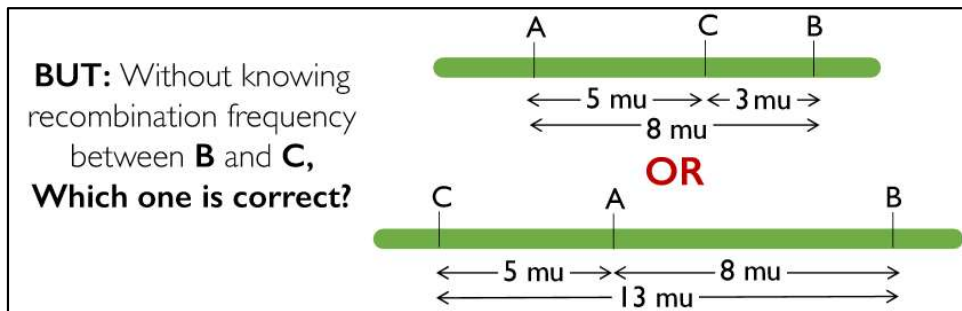- Recombination frequency is a measure of genetic distance.
  - o

  $$r = \frac{\text{\# of recombinant offspring}}{\text{total \# of offspring}}$$

  - o A recombination frequency of 0.01 = 1 map unit (m.u.), also known as centimorgans (cM).
- Recombination frequency can be used to determine arrangement of genes along a chromosome.
  - o Recombination is more likely when genes are far apart, therefore leading to more recombinant progeny.
  - o Genes greater than 50 m.u. apart are effectively unlinked.
- Example 1: Test cross:
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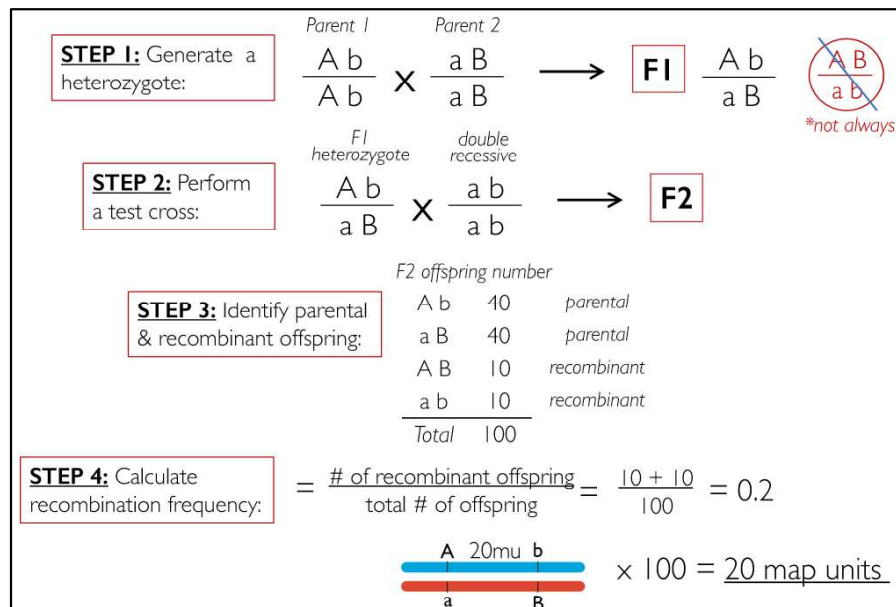
 *not always is crossed-out because often this combination of alleles is lethal.

- When putting together a linkage map, the recombination frequencies usually add up.

BUT: Without knowing recombination frequency between **B** and **C**, **Which one is correct?**

A   C   B

←— 5 mu —→←3 mu→
←———— 8 mu ————→

OR

C   A   B

←——— 5 mu ——→←———— 8 mu ————→
←———————— 13 mu ————————→

- Example 2: Three-gene test cross to determine recombination frequency between B and C.

	Progeny		Ratio	
	Phenotype	Number	Expect	Observed
	+ + +	502	1	most
	pr + +	5	1	least
	+ vg +	57	1	intermediate
	pr vg +	36	1	intermediate
	+ + bl	34	1	intermediate
	pr + bl	65	1	intermediate
	+ vg bl	3	1	least
	pr vg bl	482	1	most
	Total	1184		

  - First step: determine the parental and recombinant types:
    - Parental are those in the original cross: + + + and *pr vg bl*.

+   +   +

a   b   c
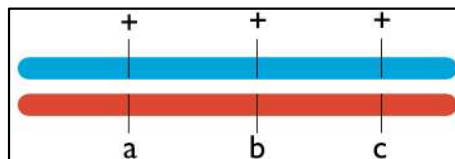
    - Most of the recombinants types have one crossing over event. This happens less often than parental types.

+   +   c

a   b   +

+   b   c

a   +   +