

Genetics and Genomics (GEGE2X01)

Course Notes

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University of Sydney 2018

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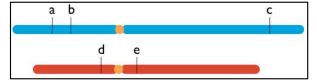
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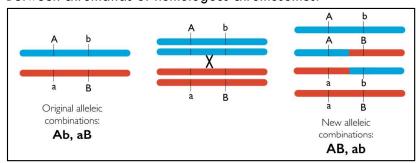
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Linkage and gene mapping

- Genetic mapping links observable phenotypes to genotypes.
- Linkage and genetic mapping leads to:
 - o 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.
 - o Also called syntenic genes.
 - O Genes far apart on the same chromosome can be unlinked.
 - o 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.
 - O 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 ratio.

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Unlinked genes:

RrYy x rryy
round yellow wrinkled green

Test cross offspring:

PpLI x pplI
purple long red short

PpLI x pplI
purple

Linked genes don't assort independently:

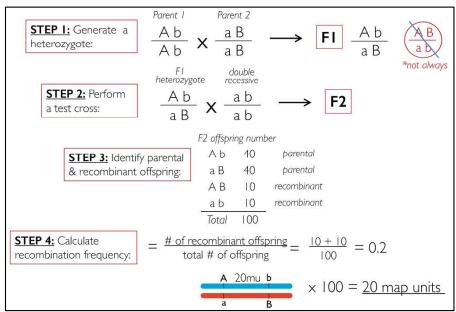
In this example, purple-long and red-short are linked.

• Recombination frequency is a measure of genetic distance.

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

- \circ 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.
 - 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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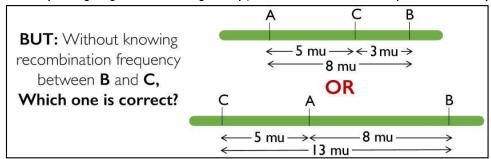


^{*}not always is crossed-out because often this combination of alleles is lethal.

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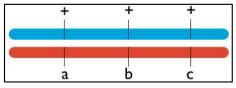
• When putting together a linkage map, the recombination frequencies usually add up.



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

	Progeny		Ratio	
	Phenotype	Number	Exped	t 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
0.53	Total	1184		

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



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

