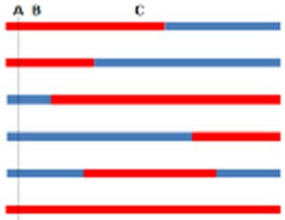
Calculating recombination distances between 2 genes

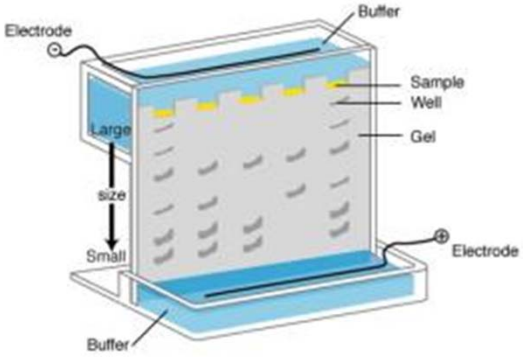
Can use linkage to develop a "map" of chromosomes

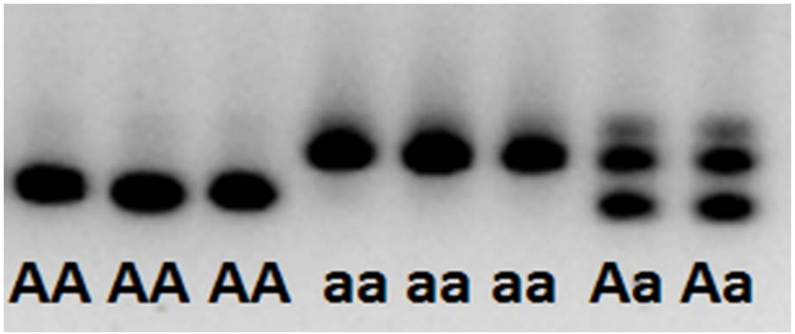
- Chromosomes are linear
- Neighboring variants tend to stay associated
  - "Parental" combination more common than "recombinant" combination in gametes
- Range: full association (0% recombination) to no association (50% recombination)
- … but how do we know what variant is at "A"?

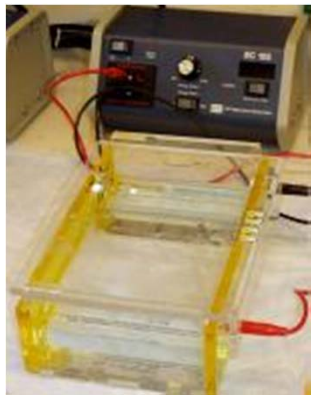


“Genetic markers”

- Reference point in the genome with 2+ alleles
  - Don’t necessarily know ahead of time where it is
- May be “molecular”: assay via molecular bio
  - a: sequence GTGAAAAGCTATGTAGT
  - A: sequence GTGGCTATGTAGT







“Genetic markers”

- Reference point in the genome with 2+ alleles
  - Don’t necessarily know ahead of time where it is
- May be “phenotypic”: red vs. white eyes

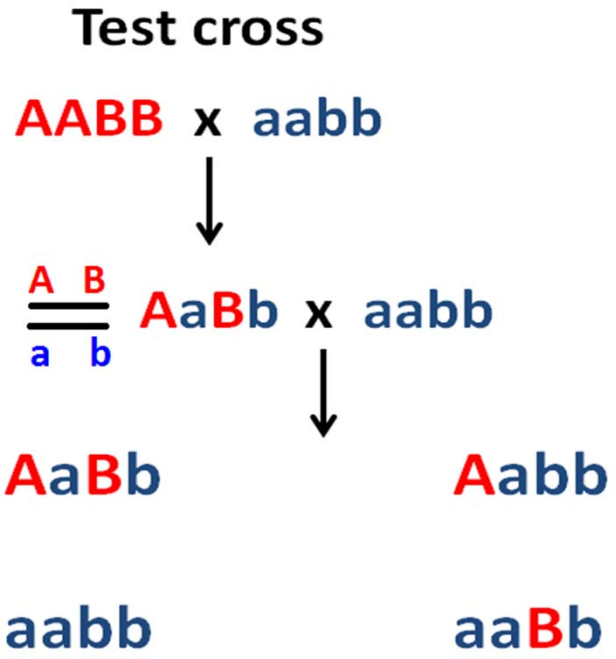
AA, Aa

aa

Sequence difference
at an “eye color gene”
makes it so **aa** individuals
have white eyes

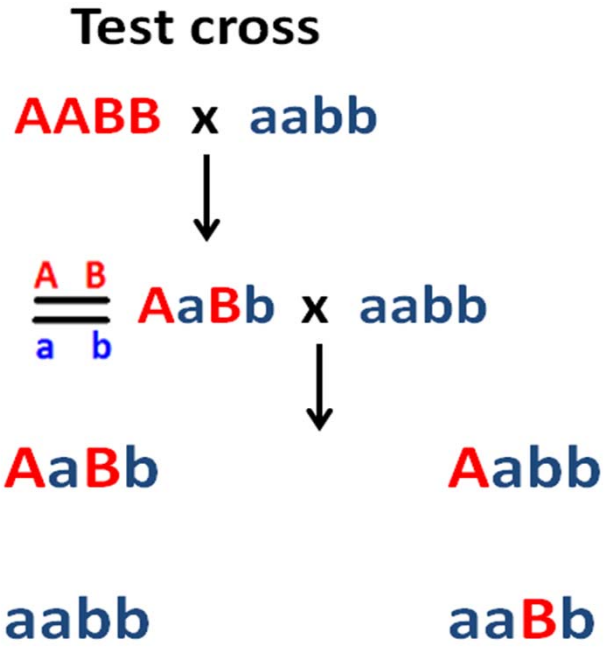
Use crosses (or pedigree) and inferred genotypes to make map

- Identify “recombinants” and “parentals”
- If A and B are linked, what are fractions of all?
- If A and B are unlinked, what are fractions of all?



Use crosses (or pedigree) and inferred genotypes to make map

- What would proportions be if “sort of” linked?
- What does the fraction recombinant tell you?



Fly cross

- Cinnabar (bright red) eyes (cn) x Vestigial wings (vg)

Fly cross

- Cinnabar (bright red) eyes (cn) x Vestigial wings (vg)

- Offspring: all have normal eyes and wings
  - Is cinnabar form dominant or recessive?
  - Is vestigial form dominant or recessive?
  - What is the genotype of this fly?

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Fly cross

- Cinnabar (bright red) eyes (cn) x Vestigial wings (vg)

- Offspring: all have normal eyes and wings

$$\frac{cn \quad vg^{+}}{cn^{+} \quad vg}$$

- Cross F1 females above to cn-vg males. What is the males' genotype?

Fly cross

- Cinnabar (bright red) eyes (cn) x Vestigial wings (vg)

- Offspring: all have normal eyes and wings
- Cross F1 females to cn-vg males.

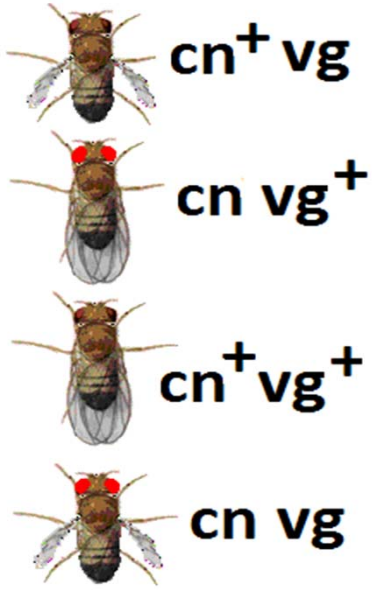
$$\frac{cn \quad vg^{+}}{cn^{+} \quad vg} \times \frac{cn \quad vg}{cn \quad vg}$$ **Test cross**

- What are parental and recombinant offspring?

Fly cross

$$\frac{cn \quad vg^{+}}{cn^{+} \quad vg} \times \frac{cn \quad vg}{cn \quad vg}$$

Test cross



- What if there is total linkage between the cn and vg genes?
- What if cn and vg are “unlinked”?
- What if linked but not totally so?

The fraction recombinant reflects the distance between the genes

- % recombinant is called "map units" (mu)
  - In Drosophila, often called centiMorgans (cM)
  - Recombinant fraction ranges from 0% to 50% (= 0-50cM)
- Gives an idea of distance between genes
  - Developed before we had "genome sequences" and known physical distances in base-pairs
  - In humans, average 1.3cM ~ 1 million bases
- Can determine linear order of genes

What if saw these numbers?

$$\frac{cn \quad vg^+}{cn^+ \quad vg} \times \frac{cn \quad vg}{cn \quad vg}$$

Test cross

$cn^+ vg$ 92

$cn\ vg^+$ 88

$cn^+ vg^+$ 9

$cn\ vg$ 11

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