

1) [25 Points] 1000 Gametes from an individual are scored, with the following numbers seen:

ABC	105	aBC	50
ABc	5	aBc	340
AbC	360	abC	5
Abc	40	abc	95

(a) What are the parental gametes?

AbC, aBc

(b) What are the recombination frequency between all pairs of loci?

A-B: Recomb gametes = AB, ab, freq = (105 + 5 + 5 + 95)/1000 = 0.210

A-C: Recomb gametes = Ac, aC, freq = (5 + 40 + 50 + 5)/1000 = 0.100

B-C: Recomb gametes = BC, bc, freq = (105 + 40 + 50 + 95)/1000 = 0.290

(c) Formally show which locus is in the middle, (i.e., which gene order gives the observed double crossovers).

If the order is bAC/Bac , then double crossovers are abC and ABc, which correspond to the rarest gametes in the samples (the double crossovers)

(d) What is the expected number of double crossovers (assuming no interference)

$$1000 * 0.21 * 0.10 = 21$$

(e) Compute the coefficient of coincidence and the interference.

$$\text{COC} = \text{Obs/Exp} = 10/21 = 0.48, \text{ inter} = 1 - \text{COC} = 0.52$$

(f) Suppose there is 95% interference. What is the probability that no double crossovers are observed in our sample of 1000 ?

$$\text{95\% interference} = \text{5\% of expected DCO, or } 0.05 * 0.21 * 0.1 = 0.00105, \\ \text{Pr(no)} = (1 - 0.00105)^{1000} = 0.35$$

NAME: _____ KEY _____

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(2) [25 points] Consider the following collection of 100 tetrads from a single cross.

A	B	C	D	E
pro +	pro +	pro +	pro ad	pro ad
pro +	pro ad	+ ad	+ ad	+ +
+ ad	+ +	pro +	pro +	pro +
+ ad	+ ad	+ ad	+ +	+ ad
60	12	24	1	3

Which tetrad(s) are tetratypes? **B, D, E**

Which are non-parental ditypes? **NONE**

What is the recombination frequency between the proline and adenine loci?

$$= (1/2)(12+1+3)/100 = 0.08$$

Which tetrad(s) show second division segregation for adenine? **B, C, E**

What is the recombination frequency between the adenine locus and the centromere?

$$= (1/2) (12+24+3)/100 = 0.195$$

Which tetrad(s) show second division segregation for proline? **C, D, E**

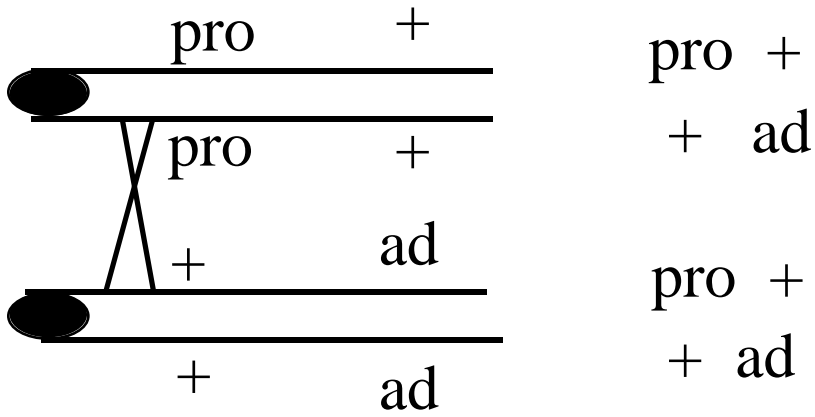
What is the recombination frequency between the proline locus and the centromere?

$$= (1/2) (24+1+3)/100 = 0.14$$

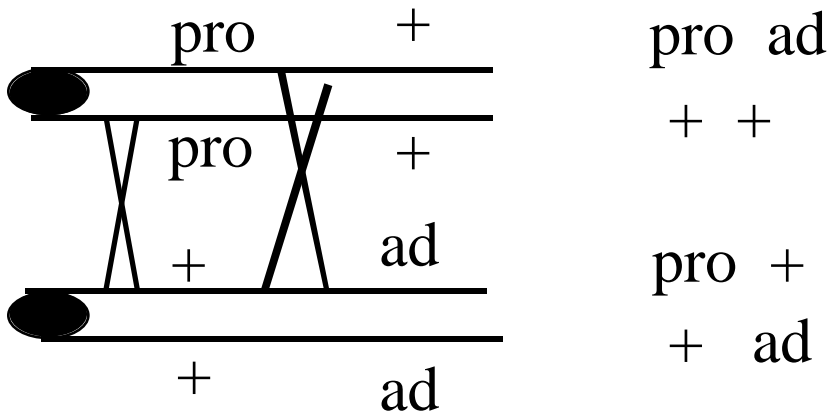
What is does the resulting gene map look like?

Cen - pro - ade

Draw the crossover(s) that occur at the 4-strand stage to give tetrad type C.



Draw the crossover(s) that occur at the 4-strand stage to give tetrad type E.



(3) [10 Points] The dreaded sparky phenotype is determined by two X-linked loci, wherein **aabb** (female) or **abY** (male) individuals display this hideous phenotype, while all other genotypes at these two loci display the much more attractive Wilbur phenotype.

a) In a cross between a sparky female and a Wilbur male, what fraction of the resulting male offspring are sparky ?

All males get an ab gamete from their mother and hence all are sparky.

b) Suppose a Wilbur male and female are crossed, and five percent of the male offspring are sparky . What is the genotype (and linkage phase) of the female?

5% are ab (recombinant gamete). Female is Ab/aB

c) For the cross in part b), what is the **a-b** recombination frequency?

$$c = 2 * 0.05 = 0.10$$

(4) [15 Points] Members of the dreaded Sun Devil species have a distinct feature of nose hair several feet long. Two linked genes influencing nose hair are known. The color locus has two alleles, with **R** (red nose hair) completely dominant to **r** (green nose hair). Likewise, a second locus gives either straight hair, or curly hair, with the straight-hair allele **H** completely dominant to the curly hair allele **h**. A green curly hair female is crossed to a red straight hair male. Unfortunately, Sun Devils have large litters, and the following offspring frequencies were observed:

Frequency	Phenotype	Gamete type from Father
40%	Red, curly hair	____ R h ____
10%	Red, straight hair	____ R H ____
40%	green, straight hair	____ r H ____
10%	green, curly hair	____ r h ____

(a) Fill in the gamete types (in the above table) from the father for the above genotypes

(b) What is the genotype (including correct phase) of the male?

Rh/ rH

(c) What is the recombination frequency between these loci?
20%

(5) [15 Points] Consider the offspring from a cross of a male AB/ab and a female Ab/aB, where the A and B loci are linked with recombination frequency $c = 0.15$.

(a) What are the parental gametes for the male? What is the frequency of each?

AB, ab each $0.5*(1-0.15) = 0.425$

(b) What are the recombinant gametes for the female? What is the frequency of each?

AB, ab each $0.5*(0.15) = 0.075$

(c) What is the probability of getting an AABB offspring?

=Pr(AB from mom)*Pr(AB from Dad) = $0.425*0.075 = 0.03$

(d) What is the probability of getting an AABb offspring?

**=Pr(AB from mom)*Pr(Ab from Dad) + Pr(Ab from mom)*Pr(AB from Dad)
= $0.075*0.075 + 0.425*0.425 = 0.186$**

(6) [10 Points] Consider a tetraploid and recall that gametes in tetraploids are formed by choosing (at random) two of the four parental gene copies.

(a) If a parent is AAAa, what is the probability of an AA gamete? An Aa gamete?

Pr(AA gamete) = Pr(1st is A)*Pr(2nd is A | first is A) = $(3/4)(2/3) = 6/12 = 1/2$

Pr(Aa gamete) = $1 - \text{Pr(AA gamete)} = 1/2$

Alternatively, Pr(Aa gamete) = Pr(1st is A)*Pr(2nd is a | first is A) + Pr(1st is a)*Pr(2nd is A | first is a) = $(3/4)*(1/3) + (1/4)*1 = 1/2$

(b) If a parent is AAaa, what gametes are possible and what are their frequencies?

AA, Aa, aa

Pr(AA gamete) = Pr(1st is A)*Pr(2nd is A | first is A) = $(1/2)(1/3) = 1/6$

Pr(aa gamete) = Pr(1st is a)*Pr(2nd is a | first is a) = $(1/2)(1/3) = 1/6$

Pr(Aa gamete) = $1 - \text{Pr(AA gamete)} - \text{Pr(aa gamete)} = 2/3$

Alternatively, Pr(Aa gamete) = Pr(1st is A)*Pr(2nd is a | first is A) + Pr(1st is a)*Pr(2nd is A | first is a) = $(1/2)(2/3) + (1/2)(2/3) = 2/3$