

Genetics 320 (EEB/MCB) Exam One Solutions

(1) [15 points] Scientists studying pond scum at ASU have found an organism with four sexes. Suppose the parents are P1 = AAAa, P2 = AAaa, P3 = AAAA, and P4 = Aaaa.

(a) What is the probability of getting an AAAA offspring?

This can only occur one way, namely all parents contribute A.

$$(3/4)(1/2)(1)(1/4) = 3/32$$

(b) What is the probability of getting an AAAa offspring?

Four pathways: "a" for parent one (P1), or from P2, or from P3 or from P4, A from all others in each case

$$P(a \text{ P1, A others}) = (1/4)(1/2)(1)(1/4) = 1/32$$

$$P(a \text{ P2, A others}) = (3/4)(1/2)(1)(1/4) = 3/32$$

$$P(a \text{ P3, A others}) = 0$$

$$P(a \text{ P4, A others}) = (3/4)(1/2)(1)(3/4) = 9/32$$

$$\text{hence Prob (AAAa)} = (1+3+9)/16 = 13/32$$

(c) Given that the offspring is AAAa, what is the chance that Parent four (P4) contributed the a allele? *Hint: Think about conditional probability!*

P(P4 gives a | AAAa offspring)

$$= P(P4 \text{ gives a \& AAAa offspring}) / P(\text{AAAa offspring})$$

noting that P(P4 gives a & AAAa offspring) = (3/4)(1/2)(1)(3/4) = 9/32 gives

$$P(P4 \text{ gives a \& AAAa offspring}) / P(\text{AAAa}) = 9/32 / (13/32) = 9/13$$

(2) [5 points] Recall the ABO blood group locus. Suppose we examine 10 offspring from a cross of Ai and Bi. What is the probability that only A and AB offspring are recovered?

Cross yields (1/4) Ai, (1/4) AB, (1/4) iB, (1/4) ii. Hence, prob (offspring AB) = 1/2. Prob(only AB in 10 offspring) = (1/2)^10 = 1/1024

(3) [5 points] The probability that any particular pair of human autosomes fails to disjoin properly in meiosis, resulting in a trisomic (three copies of that chromosome) is 1/500. Given that there are 22 pairs of autosomes, what is the probability that a trisomic offspring is not produced. *Hint: remember BOTH parents*

$$\text{parent 1 normal} = \text{parent 2 normal} = (499/500)^{22} = 0.957$$

$$\text{Prb(Both are)} = 0.957^2 = 0.916$$

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(4) [25 Points] 1000 Gametes from an individual are scored, with the following numbers seen:

ABc	360	aBC	105
AbC	55	aBc	45
Abc	95	abC	340

(a) What are the parental gametes?

ABc, abC

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

A - B. recombs = Ab, aB = (55+95+105+45)/1000 = 0.3

A - C. recombs = AC, ac = (55+45)/1000 = 0.1

B - C. recombs = BC, bc = (95+105)/200 = 0.2

(c) What are the double-recombinant gametes?

abc, ABC

(d) Formally show which locus is in the middle

AcB / aCb

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

Expected(# dcos) = 1000 * (0.1)*(0.2) = 20

(f) What is the probability that no double crossovers are observed in our sample of 1000 (assuming no interference)

Prob(double) = 0.1*0.2 = 0.02.

Prob(no doubles in 1000) = [1-0.02]¹⁰⁰⁰ = 1.68 x 10⁻⁹

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

coc = Obs (dco)/ Exp(dco) = 0, Interference = 1-coc = 1

(5) [5 Points] In a cross of **AaBbCCddEE** x **AaBbCcDdEe**,

(a) What is the probability of an **AaBbCcDdEe** offspring?

$$= (1/2)(1/2)(1/2)(1/2)(1/2) = 1/32$$

(b) What is the probability of an **aabbccdde** offspring?

$$= 0$$

(6) [10 Points] Silkworm females show no recombination, while recombination is normal in males. Consider two loci, A & B, with a (male) recombination fraction of $c = 0.1$. In a cross of an **AB/ab** female and an **Ab/aB** male,

(a) What is the probability of an **AABB** offspring?

$$\Pr(\text{AABB}) = \Pr(\text{AB father}) * \Pr(\text{AB mother}) = (0.1/2) * (1/2) = 0.025$$

(b) What is the probability of an **AaBb** offspring?

$$\begin{aligned} \Pr(\text{AaBb}) &= \Pr(\text{AB/ab}) + \Pr(\text{Ab/aB}) \\ &= \Pr(\text{AB dad}) * \Pr(\text{ab mom}) + \Pr(\text{AB mom}) * \Pr(\text{ab dad}) + \\ &\quad \Pr(\text{Ab dad}) * \Pr(\text{aB mom}) + \Pr(\text{Ab mom}) * \Pr(\text{aB dad}) \\ &= 0.05 * 0.5 + 0.5 * 0.05 + 0.45 * 0 + 0 * 0.45 = 0.05 \end{aligned}$$

(7) [10 Points] The U and A loci are linked on the X chromosome, with alleles **U/u** and **A/a**. The *wilbur* phenotype occurs when an individual has even a single capital letter allele (i.e. **A** and/or **U**), while the dreaded *sparky* phenotype arises when both **A** and **U** are lacking. Suppose a *sparky* female is mated to a *wilbur* male (much to Wilma's disgust). All of their sons are *sparky*, while only 20 percent of the females are *sparky*.

(a) What can you say about the genotype of the wilbur male?

This is an error, as the male gives only one type of X chromosome

(b) What is the recombination fraction between A and U?

see (a)

(c) Suppose a *sparky* male is crossed to a *wilbur* female, and 30 percent of the males are *sparky*, as are 30% of the females. What is the genotype of the *wilbur* mother?

Sparky males always give ua gametes to their daughters, Y to their sons. Hence, to be a sparky son or daughter, the mother must also give an ua gamete, so that 30% of maternal gametes are ua. Thus (since these are > 1/4), these must be parental gametes. Hence, the mother is AU/au.

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(8) [25 points] A cross was made between a proline-requiring strain (pro + / pro +) and a adenine-requiring strain (+ ad / + ad), and among 100 ordered tetrads from a pro+ / +ad F₁, five distinct types were recovered (numbers of each type are given below in bold)

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
58	19	20	1	2

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

**Types C, D, E show proline 2nd div seg, freq(2nd DS) = (20+1+2)/100 = 23%.
rec freq(pro-cent) = (1/2)(0.23) = 0.115**

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

**Types B, C, E show adenine 2nd div seg, freq(2nd DS) = (19+20+2)/100 = 41%.
rec freq(ad-cent) = (1/2)(0.41) = 0.205**

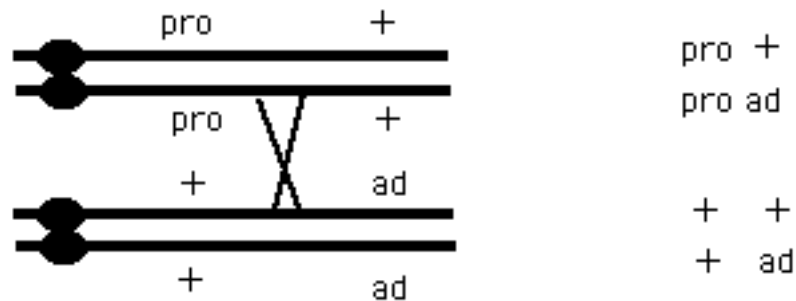
What is the recombination frequency between the proline and adenine loci?

Tetratypes are Types B, C, E; There are no NPD. Hence, rec fre = (1/2)(19+2+1)/100 = .11

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 B.



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

