

Math 186, Winter 2020, Prof. Tesler
Homework #2, Due Wednesday January 22, 2020

Larsen & Marx **Sixth Edition:**

2.5# 2, 4, 7, 9, 14, 20, 22, 23, 29 (For #20, see the solitaire game on the Ch. 2.5 class slides)

2.6# 4, 19, 22, 27, 29, 36, 44, 53

and the problems below: H-201, H-202

Problem H-201. See the slides on Mendel's Laws for the terminology in this problem.

- (a) In pea plants, the gene for height comes in two alleles, T=tall, t=short, and the gene for seed shape comes in two alleles, R=round, r=wrinkled. The height and shape genes are inherited independently since they are on different chromosomes. A pea plant with genotype Ttrr is crossed with a pea plant with genotype TtRr. Compute the proportion of offspring expected to have each genotype, and the proportion expected to have each phenotype. (Hint: 6 genotypes have nonzero proportions.)
- (b) Flower color in pea plants can be purple (dominant) or white (recessive). Two plants with purple flowers are crossed. These original plants form the *P generation* (parental). Their offspring form the *F1 generation* (first filial generation). Some plants in the F1 generation have purple flowers and others have white flowers.
 - (i) What are the genotypes of the plants in the P generation?
 - (ii) If a plant in the F1 generation has purple flowers, what is the probability that it is heterozygous for the flower color trait?

Problem H-202. A portion of mouse chromosome 1 is shown on the next page, using coordinates in cM (centimorgans). Maps like these are constructed by experimentally determining the recombination rates (r) between pairs of genes, and converting those to distances (d) in cM as described on the class slides.

- (a) What is the maximum possible recombination rate for genes on the same chromosome? How does this compare to the constant recombination rate of $1/2$ for genes on separate chromosomes?
- (b) What is the distance and the recombination rate (to at least 3 significant figures) between *D1Ncv1* and *Sox17* on the map shown on the next page?
- (c) Show that $r(d) = \frac{1}{2}(1 - \exp(-2d))$ and $d(r) = -\frac{1}{2}\ln(1 - 2r)$ are inverse functions.
- (d) A chromosome has genes A, B, C in that order. Let $y = d_{AB}$, $z = d_{BC}$, $y + z = d_{AC}$.

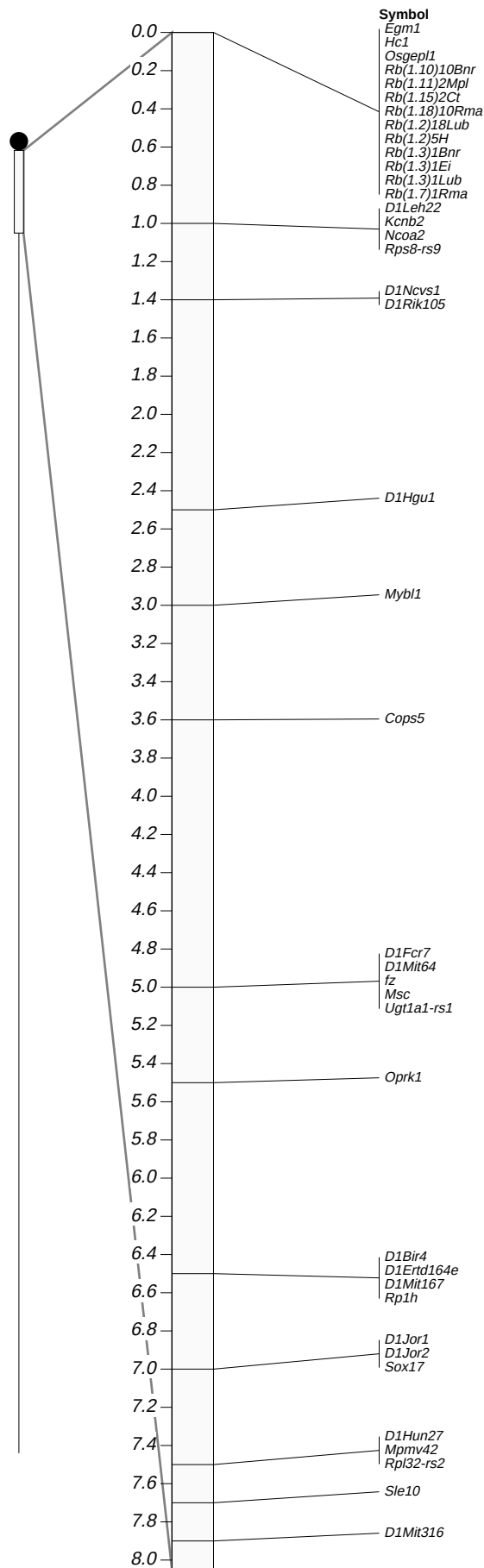
— A ————— B ————— C —

Prove that $r(y + z) = r(y) + r(z) - 2r(y)r(z)$, where $r(d)$ is the function given above.

Hint: start by expanding the right side of the equation, and simplify until you get the left side.

In class, we showed that recombination probabilities satisfy $r_{AC} = r_{AB} + r_{BC} - 2r_{AB}r_{BC}$. Transforming r to $d(r)$ converts this to an additive relation, $d_{AC} = d_{AB} + d_{BC}$. So recombination rates aren't additive, but they may be converted to distances, which are additive.

MGD: Chromosome 1: 0.0 - 7.9 cM



This map was obtained from the Mouse Genome Database (MGD), Mouse Genome Informatics, The Jackson Laboratory, Bar Harbor, Maine. Jan. 19, 2004.

<http://www.informatics.jax.org/searches/linkmap.cgi>