Genetics Problem Set 2
Feb 15, 2010
(concepts from chapter 3, text)

1. You are interested in the mode of transmission of coat color in mice. You start by crossing a true breeding gray mouse with a true-breeding white mouse. The offspring are all gray. After letting these gray offspring interbreed you note a total of 114 gray mice and 31 white mice from several litters.

a. Propose a mechanism to explain the results. Diagram the crosses and compare the observed results with the expected. (indicate parental, F1, and F2 generations; show possible gametes and zygotic combinations)

Because of the F_1 (all gray) and F_2 (~3 gray : 1 white) approx. ratios, this looks like a genetic trait in which one gene controls this aspect of fur color. Two alleles exist in which gray is dominant to white. P: WW x ww (gray, white) → F_1: Ww (white) → F_2: 1 WW, 2 Ww, 1 ww

b. Describe the phenotypes and ratios of the F3 generations

① WW x WW (gray gray) → All gray
② Ww x Ww → 3 gray : 1 white
③ ww x ww → all white

c. Suggest a molecular mechanism for gray and white fur color.

Since white is recessive the "W" gene may encode a gray pigment. W allele allows the pigment. w allele somehow restricts the making of gray pigment.

2. In fruit flies (*Drosophila melaogaster*) a *recessive* mutant allele *w*, results in white eyes, whereas the normal, wild-type eye color is red. A second *recessive* mutant allele, *b*, results in black body color, whereas the normal, wild-type body color is gray.

a. Diagram a cross of a true-breeding gray-bodied, white-eyed fly with a true-breeding black-bodied, red-eyed fly. P: BB ww (gray/white) x bb WW (black/red)

b. Show the Parental and F1 genotypes. Bb Ww (Gray/red)

c. Use a Punnett square to show F1 gametes and F2 zygotic combinations. See next page

d. Determine the expected ratio of F2 phenotypes.

Expect 9 : 3 : 3 : 1
Gray/red : Gray/white : black/red : black/white

a - b

P₁ BB ww × bb WW

↓ (Bw) (bW)

F₁ Bb Ww

c.

	BW	Bw	bW	bw
BW	BBWW	BBWw	BbWW	BbWw
Bw	BBWw	BBww	BbWw	Bbww
bW	BbWW	BbWw	bbWW	bbWw
bw	BbWw	Bbww	bbWw	bbww

d.

- ● 9/16 gray / Red eyed
- ▲ 3/16 gray / white eyed
- ⊡ 3/16 black / red-eyed
- • 1/16 black / White eyed

B ? W ? x bbww → 100% both dom body
gray/red

Genotype was BBWW

e. A test cross involving one of the gray-bodied, red-eyed F2 flies gave 100% gray-bodied, red-eyed flies. What was the genotype of that particular fly?

BBWW

3. A 5-factor cross was performed using a plant with genotype AAbbccDDEE.

a. What should the genotype of the other parent plant be?

aaBBCCddee

b. Show the possible gametes formed by Parents.

AbcDE aBCde

c. Show the genotype of the F1 plant.

AaBbCcDdEe

d. How many different gametes can be produced in the F1 plant? n = 5

2^5 = 32 gametes

e. How many entries would a Punnett square have showing all the F2 genotypes?

32 x 32 = 1024 entries

f. How many different (unique) genotypes would you expect in the F2 generation?

3^5 = 243 genotypes

g. How many different (unique) phenotypes would you expect to see in the F2 generation?

2^5 = 32 phenotypes

h. Use the forked line method to show the expected ratio of F2 phenotypes.

See next page.

i. What is the probability of having all 5 recessive phenotypes in the same plant.

Product rule

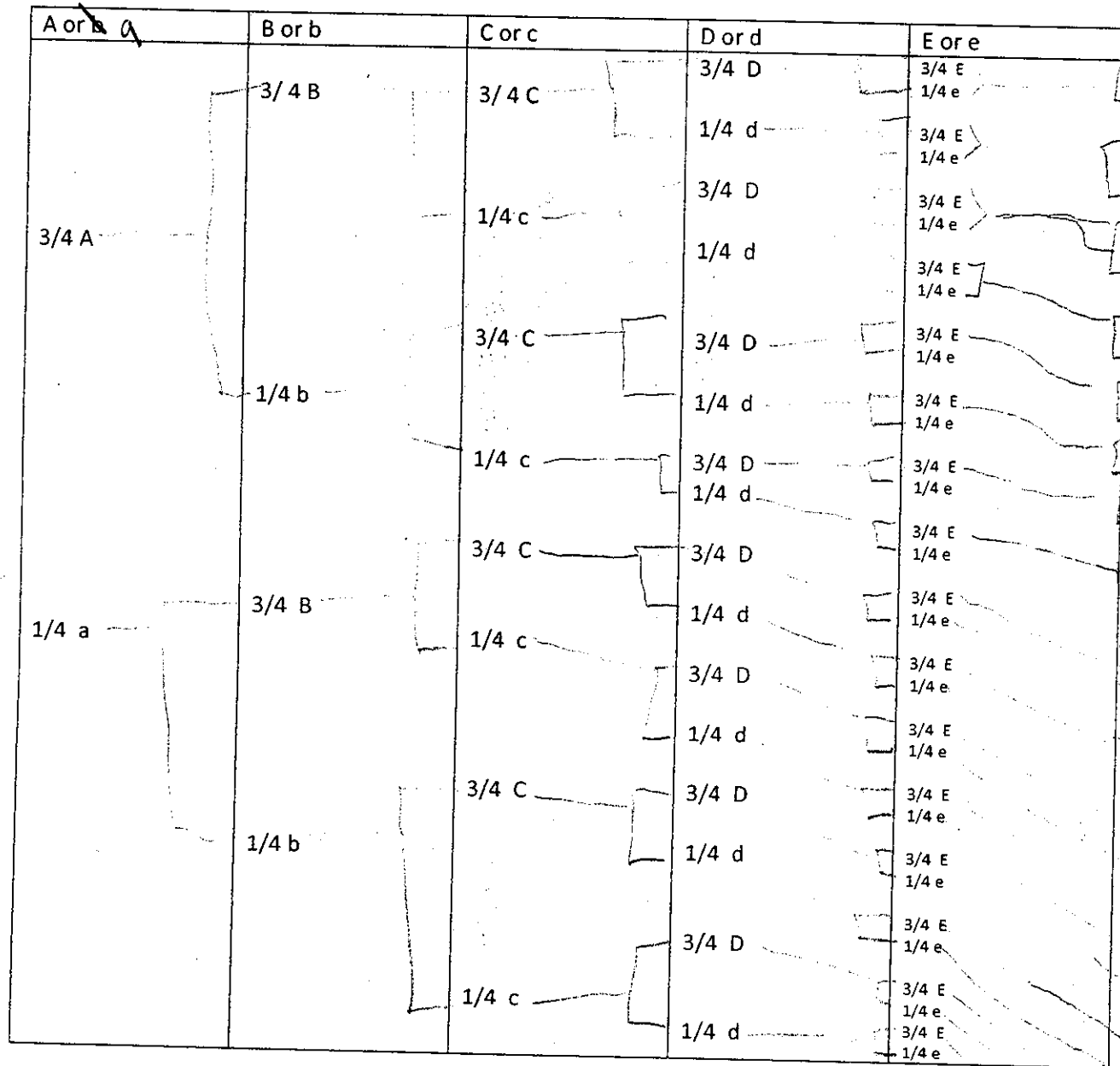
aabbccddee

$\frac{1}{4} \cdot \frac{1}{4} \cdot \frac{1}{4} \cdot \frac{1}{4} \cdot \frac{1}{4}$ =

$\frac{1}{1024}$

3.h

(32)



Ratio	Phenotypes
243/1024	ABCDE
81/1024	ABCDe
81/1024	ABCdE
27/1024	ABCde
81/1024	ABcDE
27/1024	ABcDe
27/1024	ABcdE
9/1024	ABcde
81/1024	AbCDE
27/1024	AbCDe
27/1024	AbCdE
9/1024	AbCde
27/1024	AbcDE
9/1024	AbcDe
9/1024	AbcdE
3/1024	Abcde
27/1024	aBCDE
27/1024	aBCDe
27/1024	aBCdE
9/1024	aBCde
27/1024	aBcDE
9/1024	aBcDe
9/1024	aBcdE
3/1024	aBcde
27/1024	abCDE
9/1024	abCDe
9/1024	abCdE
3/1024	abCde
9/1024	abcDE
3/1024	abcDe
3/1024	abcdE
1/1024	abcde

4.

a. How many <u>different</u> gametes can be formed in a mouse with the following genotype? **UuWwXxYyZz** (n=5 heterozygous gene pairs). For example UwxYZ could be found in one gamete...how many other *unique* gametes. $2^5 = 32$ (31 others besides UwxYZ)

b. What is the probability that two mice with the genotype above will produce offspring with the same genotype (UuWwXxYyZz)?
$\frac{1}{2}\ \frac{1}{2}\ \frac{1}{2}\ \frac{1}{2}\ \frac{1}{2}$ $\frac{1}{32}$

5. When performing a testcross on a maize plant giving <u>all red kernels</u> (dominant trait) you note on the offspring plant the development of ears of corn with both red and white kernels (on the same ear).

a. What, specifically, might you hypothesize about your original maize plant with red kernels? (show the genotypes in the cross and resultant offspring) It was heterozygous for alleles of the gene controlling kernel color
Ww

b. You count 2 rows of kernels. The results are: 15 red : 35 white. Later you count a whole ear of corn noting 240 red: 260 white.

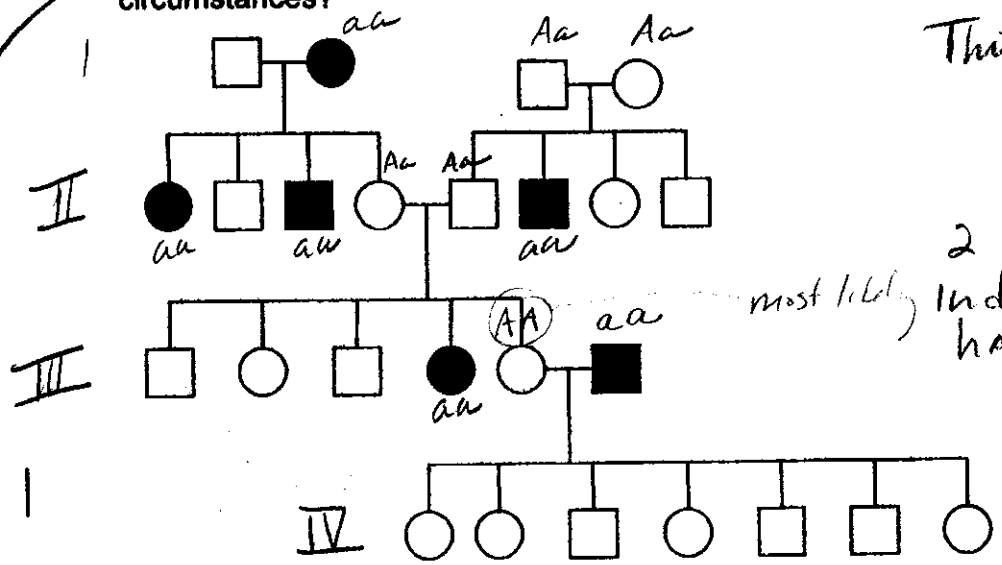
What is your null hypothesis? Perform the X^2 analysis on both sets of data. What do you note about the value (o-e) in both data sets? (i.e. how far from the expected value were you in each case)? In each case what is your p value? Decide whether you would reject or fail to reject your null hypothesis in each case. See next page.

Why might the same ear of corn give you data with different "goodness of fit" in these 2 cases. In the first case we had a smaller sample of the ear of corn so the reason we reject Ho probably reflected more variation related to small sample. When we increased the sample size we reduced chance variation & ended up failing to reject Ho

6. For the following pedigree, individuals with a suspected genetic disorder are shown in dark gray. Predict the mode of inheritance of the phenotype and note the most probable genotypes of each individual. Assume that one gene controls the phenotype (the disease) and alleles are *A* and *a* for the 2 alleles for the gene. Would any in generation V (the offspring of

b.

generation IV) be expected to have the disorder? If yes, under what circumstances?



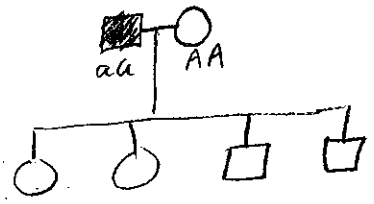
This is a recessive trait. 2 unaffected individuals have affected offspring in 2 different generations

most likely

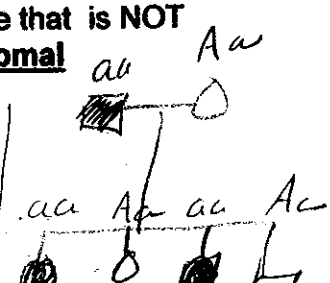
Since none of the Chidren in IV are affected it's likely their Mom was AA and they are heterozygotes. The could pass the trait to generation V if the mated with another heterozygote

7. **A man with an unusual genetic disorder marries an unaffected woman and they have 4 children together. For a and b below, sketch a pedigree for the family showing the parents and children. Show the expected number of affected children in each case. More than one correct answer may be possible.**

a. **The disorder is recessive and is controlled by a gene that is NOT on one of the sex-determining chromosomes (<u>autosomal recessive</u>)**

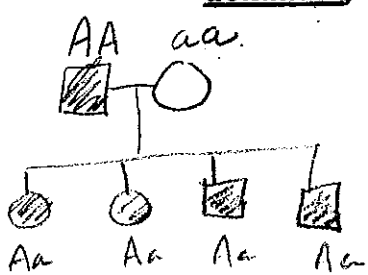


none expected

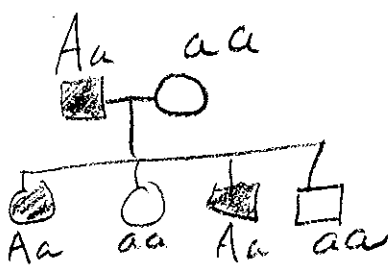


50% expected to be affected

b. **The disorder is dominant and is controlled by a gene that is NOT on one of the sex-determining chromosomes (<u>autosomal dominant</u>)**



100% Affected



50% Affected

#5) Test cross gives 2 phenotypes suggesting Plant showing the dom. phenotype is heterozygous

a. Ww x ww → ½ Ww red
red white ½ ww white

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* Null hypoth = Difference in O-E values is due to chance alone

1st count

15 + 35 = 50

Expect 1:1

25 : 25

$\chi^2 = \frac{(15-25)^2}{25} + \frac{(35-25)^2}{25}$

$\chi^2 = 4 + 4$

$\chi^2 = 8$

df = 1

$p > .01$ - reject null hypoth

$|O-E| = 10$

2nd count

240 + 240 = 500

Expect 1:1

250 : 250

$\chi^2 = \frac{(240-250)^2}{250} + \frac{(240-250)^2}{250}$

$.4 + .4$

$\chi^2 = 0.8$

$.2 < p < .5$

fail to reject

$|O-E| = 10$

↖ Absolute deviation is same - but sample 2 is much larger (10x) reduces impact of