

Chapter 3

Mendel's First Three Postulates:

1. Unit factors occur in pairs.
 2. Dominance/Recessiveness
 3. Segregation
-
-

Terms:

Genes -- Mendel's unit factors

Alleles

Locus

Genotype

Homozygous, Heterozygous

Phenotype

Autosomal

Monohybrid Cross

Trait = Coat Color --

Alleles: B = black, b = brown

black = BB or Bb; brown = bb

P₁: black X black
 (Bb) (Bb)

Gametes: B , b B , b

Punnett Square

	B	b
B	BB	Bb
b	Bb	bb

F₁ Genotypic Ratio: 1/4 BB : 2/4 Bb : 1/4 bb

F₁ Phenotypic Ratio: 3/4 black : 1/4 brown²

QUESTION: You have several pair of black coated individuals. How can you develop a line of true-breeding (= pure-bred) black coated individuals?

Possible genotypes of black-coated individuals:

BB and Bb

What genotype can you cross with your black Coated individuals to determine the genotypes?

ANSWER: brown -- bb

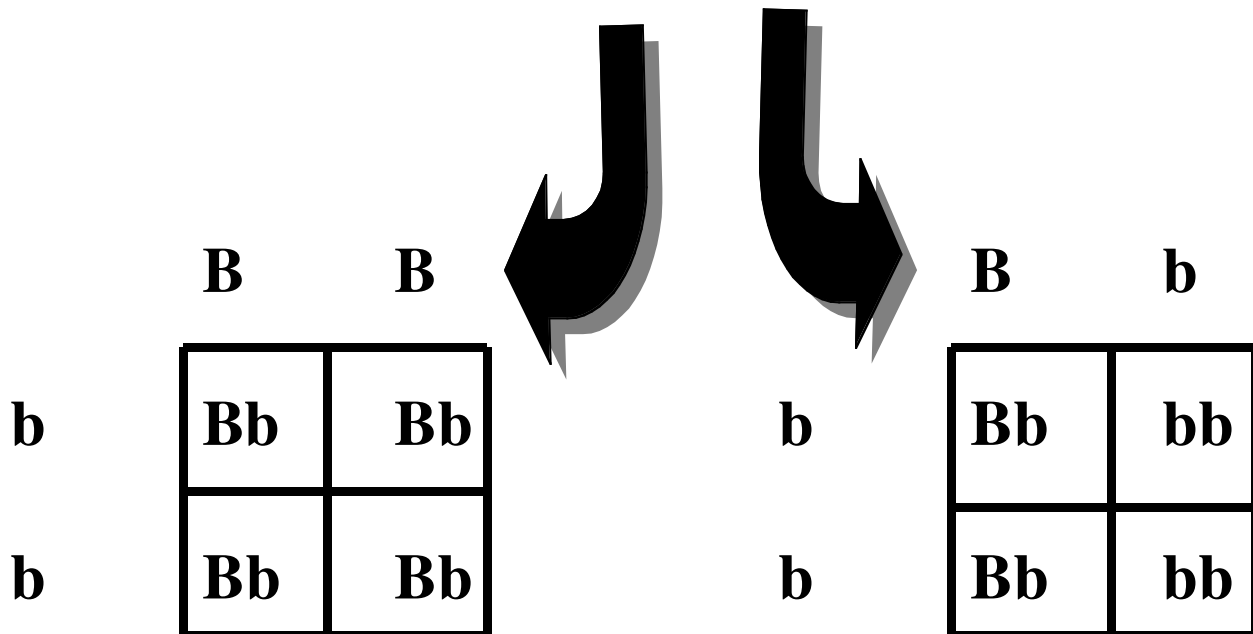
This is known as a “*Test-Cross*”

Test-Cross

black X brown

Possible genotypes: BB or Bb bb

Gametes: B, B OR B, b b



F₁ Genotypic Ratio
All Bb

F₁ Genotypic Ratio
1/2 Bb : 1/2 bb

F₁ Phenotypic Ratio
All Black

F₁ Phenotypic Ratio
1/2 black : 1/2 brown⁴

DIHYBRID OR TWO-FACTOR CROSS

MENDEL'S FOURTH POSTULATE:

During gamete formation, segregating pairs of unit factors assort independently of each other.

Feather color of parakeets:

Y = Yellow pigment on outside of feather shaft

y = no pigment on outside of feather shaft

B = melanin granules in center of feather shaft

b = no melanin granules

Problem: You cross a white parakeet with a true-breeding green parakeet. You then allow the F_1 generation to breed. What will be the F_2 genotypic and phenotypic ratios?

P_1	green	X	white
	YYBB		yybb
Gametes:	YB		yb
F_1 genotypic ratio:		all YyBb	
F_1 phenotypic ratio:		all green	

Allow F_1 to breed:

F_1	green	X	green
	YyBb		YyBb
Gametes	YB , Yb , yB , yb		

	YB	Yb	yB	yb
YB	YYBB	YYBb	YyBB	YyBb
Yb	YYBb	YYbb	YyBb	Yybb
yB	YyBB	YyBb	yyBB	yyBb
yb	YyBb	Yybb	yyBb	yybb

F₂ Genotypic Ratio

- 1: YYBB**
- 2: YYBb**
- 1: YYbb**
- 2: YyBB**
- 4: YyBb**
- 2: Yybb**
- 1: yyBB**
- 2: yyBb**
- 1: yybb**

F₂ Phenotypic Ratio

- 9: Green (Y-B-)**
- 3: Yellow (Y-bb)**
- 3: Blue (yyB-)**
- 1: white (yybb)**

Leghorn Chickens

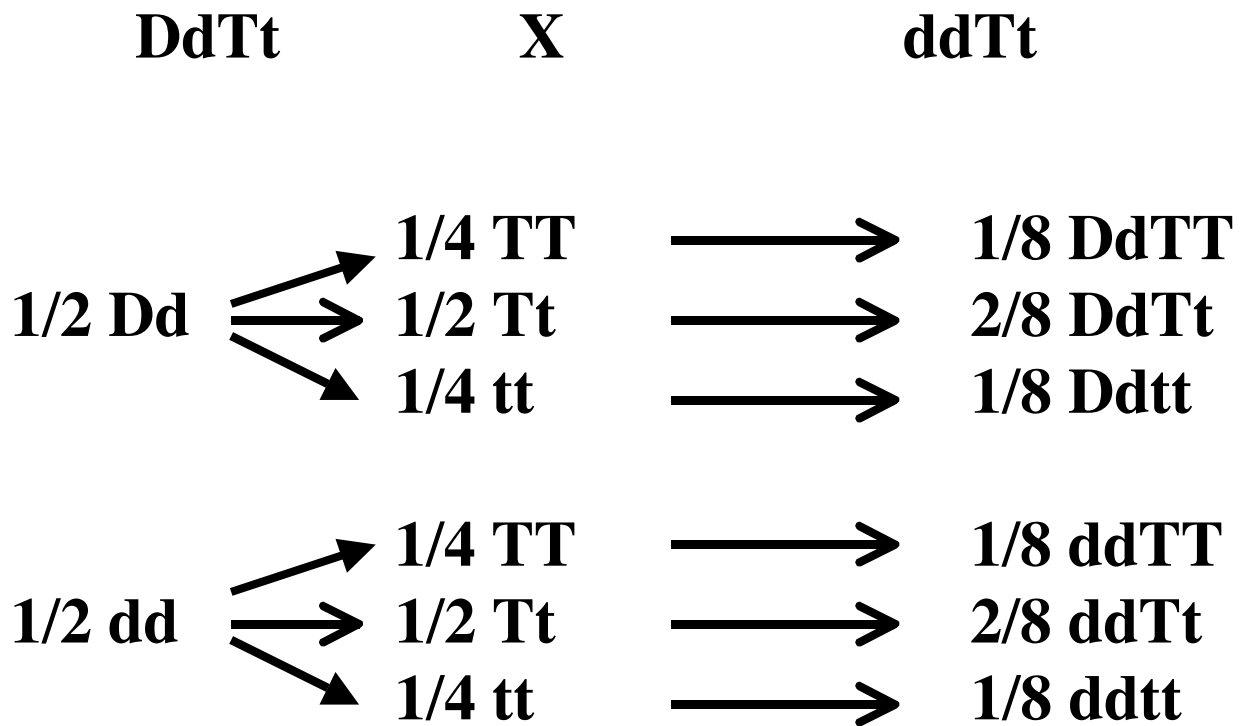
White Plumage **D**

Colored Plumage **d**

Feathered Shanks **T**

Clean Shanks **t**

Problem: Determine the genotypic ratio resulting
From the following cross:



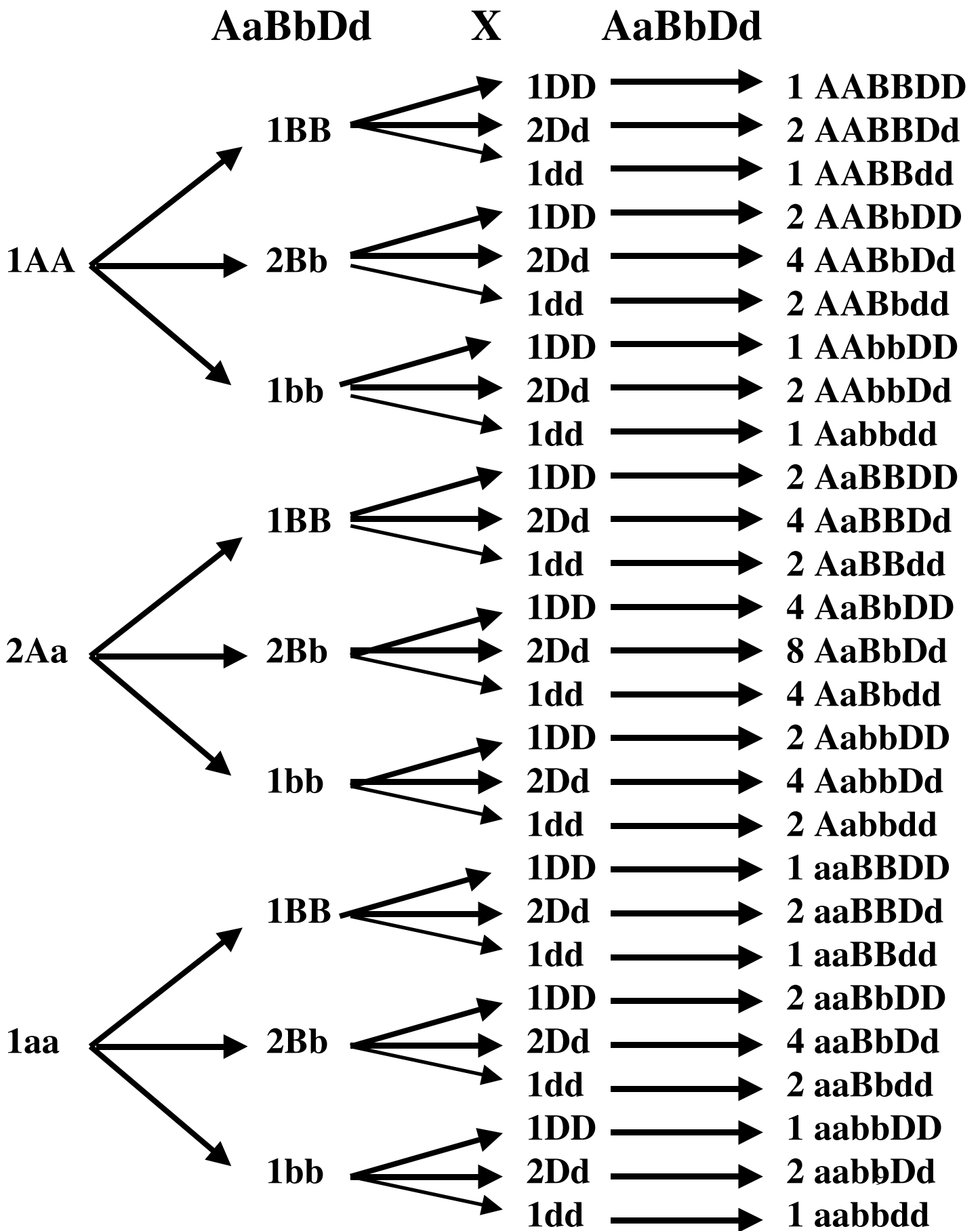


Table 3.1 -- Crosses between organisms heterozygous for genes exhibiting independent assortment.

# Het. gene pairs	# Diff. gametes	# Diff Genotypes	#Diff. phenotypes
n	2ⁿ	3ⁿ	2ⁿ
1	2	3	3
2	4	9	4
3	8	27	8
4	16	81	16
5	32	243	32
6	64	729	64
7	128	2187	128
8	256	6561	256

Chi-Square Statistic -- Testing whether deviations from the expected ratio is due to chance.

Example with parakeets:

Y-B- = green Y-bb = yellow

yyB- = blue yybb = white

You cross several green parakeets and obtain the following 1,000 offspring:

750 green

100 yellow

95 blue

55 white

Do these data fit the expected 9:3:3:1 Mendelian ratio?

Chi-Square Statistic

$$\chi^2 = \frac{(\text{observed} - \text{expected})^2}{\text{expected}}$$

o	e	(o-e)²/e
750	9/16 X 1000 = 562.5	62.5
100	3/16 X 1000 = 187.5	40.8
95	3/16 X 1000 = 187.5	45.6
55	1/16 X 1000 = 62.5	0.9
		χ² = 149.8

Degrees of freedom (df) = number of classes - 1
= 4 - 1 = 3

Look at Figure 3.12 on pg. 63 to test for significance.