

Epistasis class 3

Polygenic Inheritance

Compiled by
Dr. Dipasree Roychowdhury
Department of Botany
Surendranath College

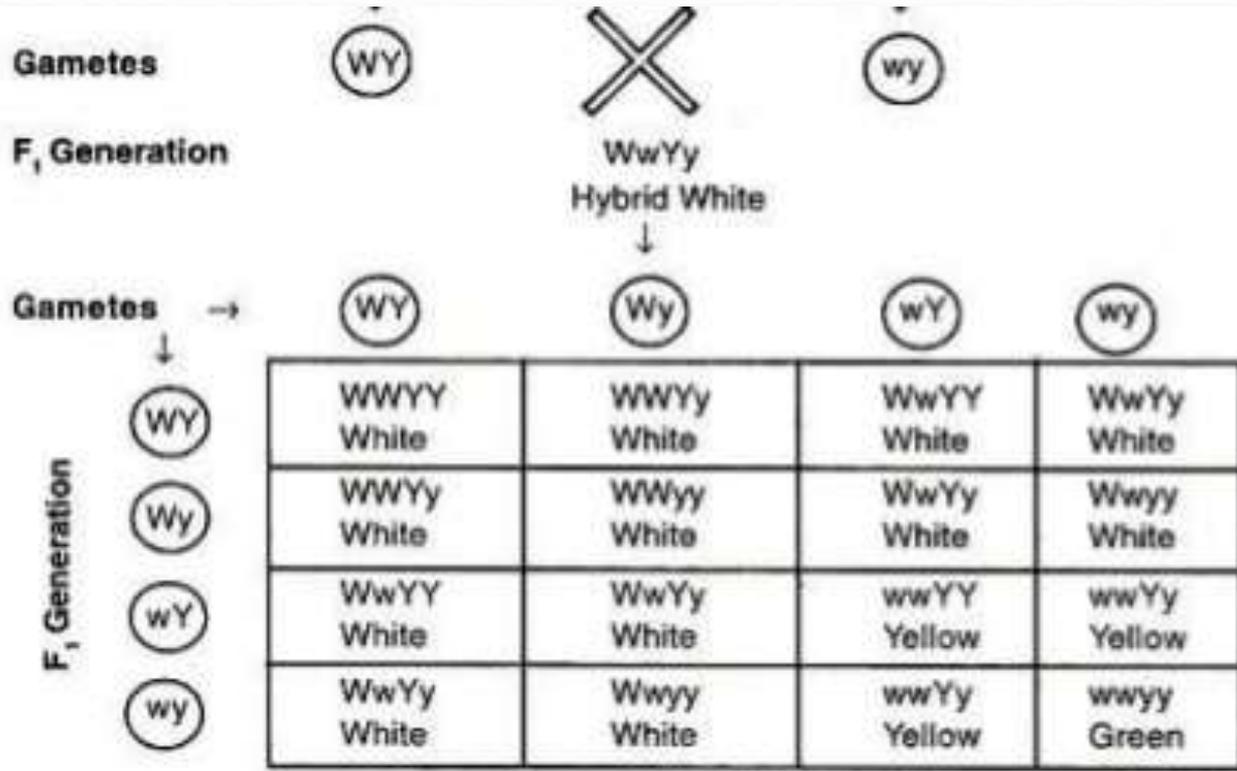
Dominant Epistasis



$WWyy$ x $wwYY$
 White Yellow

$W_Y_ : 9$
 $W_yy : 3$
 $wwY_ : 3$
 $wwyy : 1$

} 12



Duplicate Dominant Epistasis



	AB	Ab	aB	ab
AB	AABB [A]	AABb [A]	AaBB [A]	AaBb [A]
Ab	AABb [A]	AAbb [A]	AaBb [A]	Aabb [A]
aB	AaBB [A]	AaBb [A]	aaBB [A]	aaBb [A]
ab	AaBb [A]	Aabb [A]	aaBb [A]	aabb [a]

A = Awned Rice, a = Awnless Rice

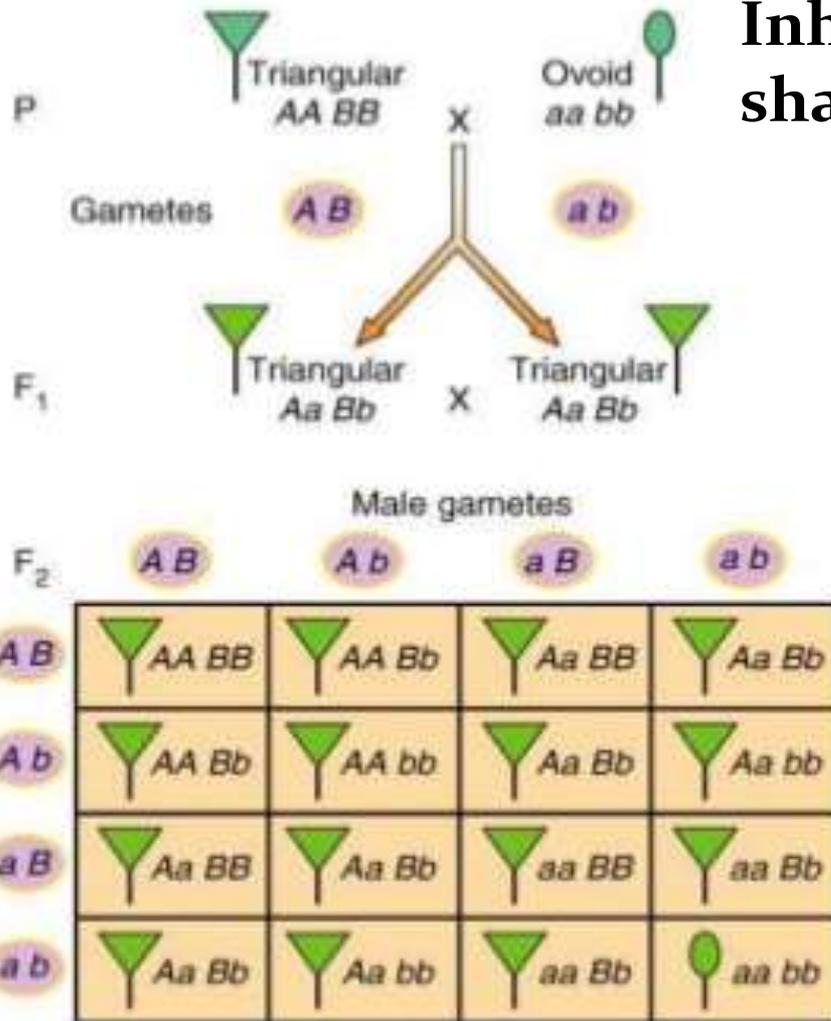


A_B_ : 9	} 15
A_bb : 3	
aaB_ : 3	
aabb : 1	

Duplicate Dominant Epistasis



Inheritance of capsule shape in Shepherd's Purse



Summary: 15/16 triangular, 1/16 ovoid

$A_B_ : 9$	} 15
$A_bb : 3$	
$aaB_ : 3$	
$aabb : 1$	

Recessive Epistasis

- BBEE and BbEe --> Black
- bbEE and bbEe --> Brown
- BBee, Bbee, or bbee --> Golden

B_E_ : 9

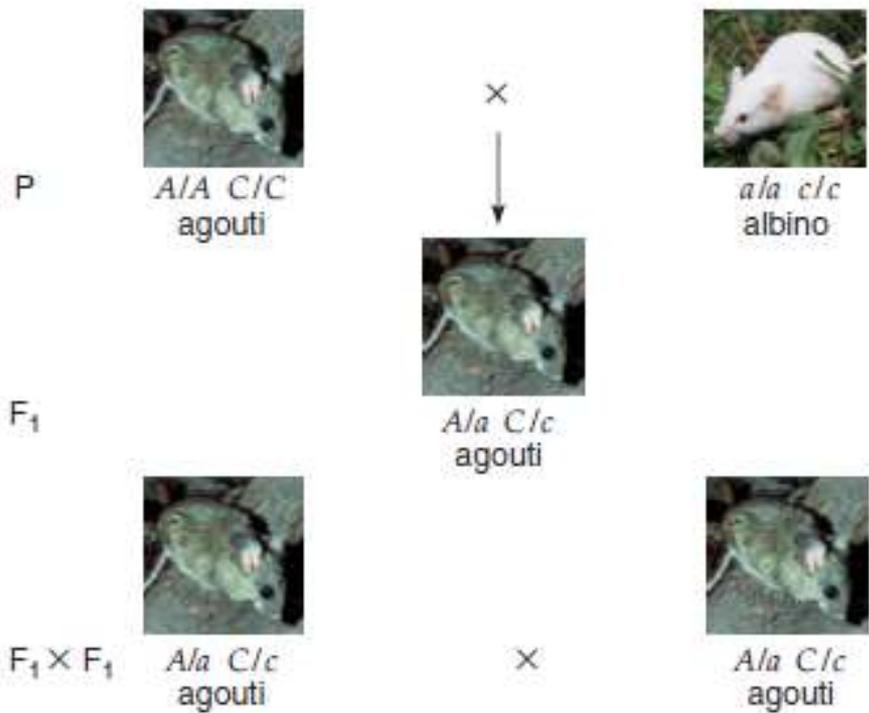
bbE_ : 3

B_ee : 3

bbee : 1

4

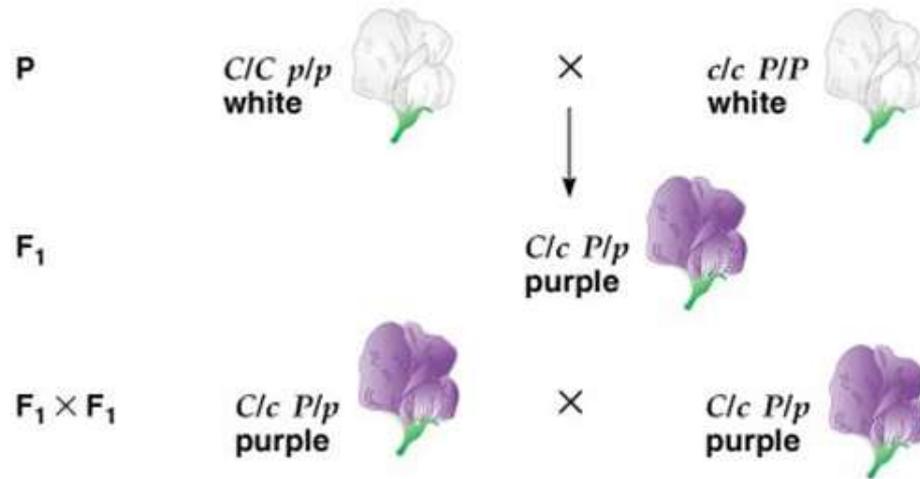




F ₂ ratio for <i>A/a</i> × <i>A/a</i>	F ₂ ratio for <i>C/c</i> × <i>C/c</i>	Combined F ₂ ratios	F ₂ phenotypic proportions
$\frac{3}{4} A/-$	$\frac{3}{4} C/-$	$\frac{9}{16} A/- C/-$	$\frac{9}{16}$ agouti 
	$\frac{1}{4} c/c$	$\frac{3}{16} A/- c/c$	$\frac{3}{16}$ albino
$\frac{1}{4} ala$	$\frac{3}{4} C/-$	$\frac{3}{16} ala C/-$	$\frac{3}{16}$ black 
	$\frac{1}{4} c/c$	$\frac{1}{16} ala c/c$	$\frac{1}{16}$ albino
			$\frac{4}{16}$ albino 

Duplicate Recessive Epistasis

Inheritance of flower colour in sweet pea



Complementary Factor (9:7)

F ₂ ratio for $C/c \times C/c$	F ₂ ratio for $P/p \times P/p$	Combined F ₂ ratios	F ₂ phenotypic proportions
$\frac{3}{4} C/-$	$\frac{3}{4} P/-$	$\frac{9}{16} C/- P/-$	$\frac{9}{16}$ purple 
	$\frac{1}{4} p/p$	$\frac{3}{16} C/- p/p$	$\frac{7}{16}$ white 
$\frac{1}{4} c/c$	$\frac{3}{4} P/-$	$\frac{3}{16} c/c P/-$	
	$\frac{1}{4} p/p$	$\frac{1}{16} c/c p/p$	

C_P_:	9
C_pp:	3
ccP_:	3
ccpp:	1
} 7	

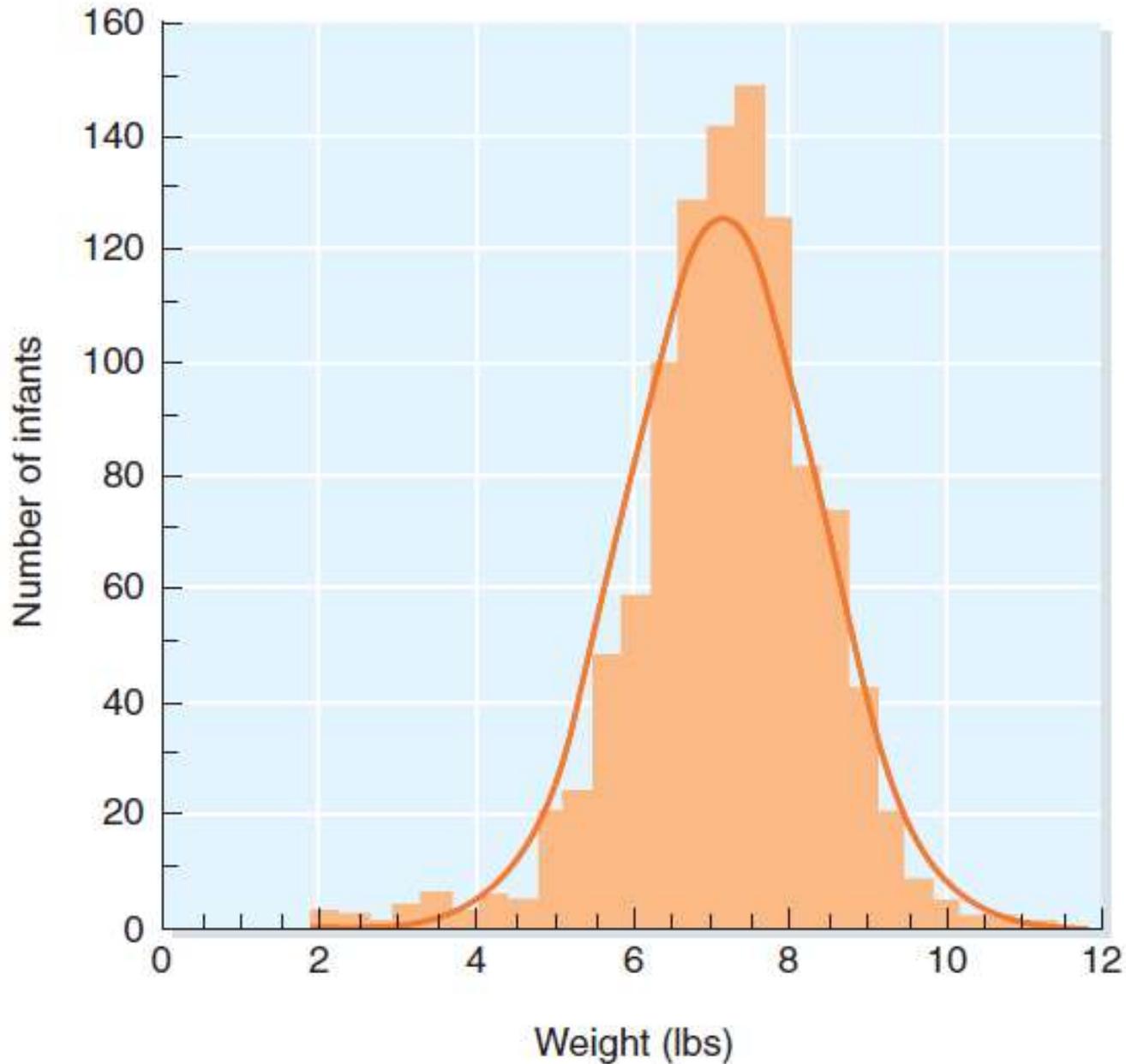
Table 13.3 Summary of Epistatic F₂ Phenotypic Ratios from an F₁ A/a B/b × F₁ A/a B/b Cross in Which Complete Dominance Is Shown for Each Allele Pair

F ₂ Phenotypic Ratio from an A/a B/b × A/a B/b Cross				
Gene Interaction	A/- B/-	A/- b/b	a/a B/-	a/a b/b
None	9	3	3	1
Recessive epistasis <i>a/a</i> epistatic to <i>B</i> and <i>b</i>	9	3	4	
Dominant epistasis <i>A</i> epistatic to <i>B</i> and <i>b</i>	12		3	1
Duplicate recessive epistasis (complementary gene action) <i>a/a</i> epistatic to <i>B</i> and <i>b</i> ; and <i>b/b</i> epistatic to <i>A</i> and <i>a</i>	9	7		
Duplicate dominant epistasis <i>A</i> epistatic to <i>B</i> and <i>b</i> ; and <i>B</i> epistatic to <i>A</i> and <i>a</i>	15			1

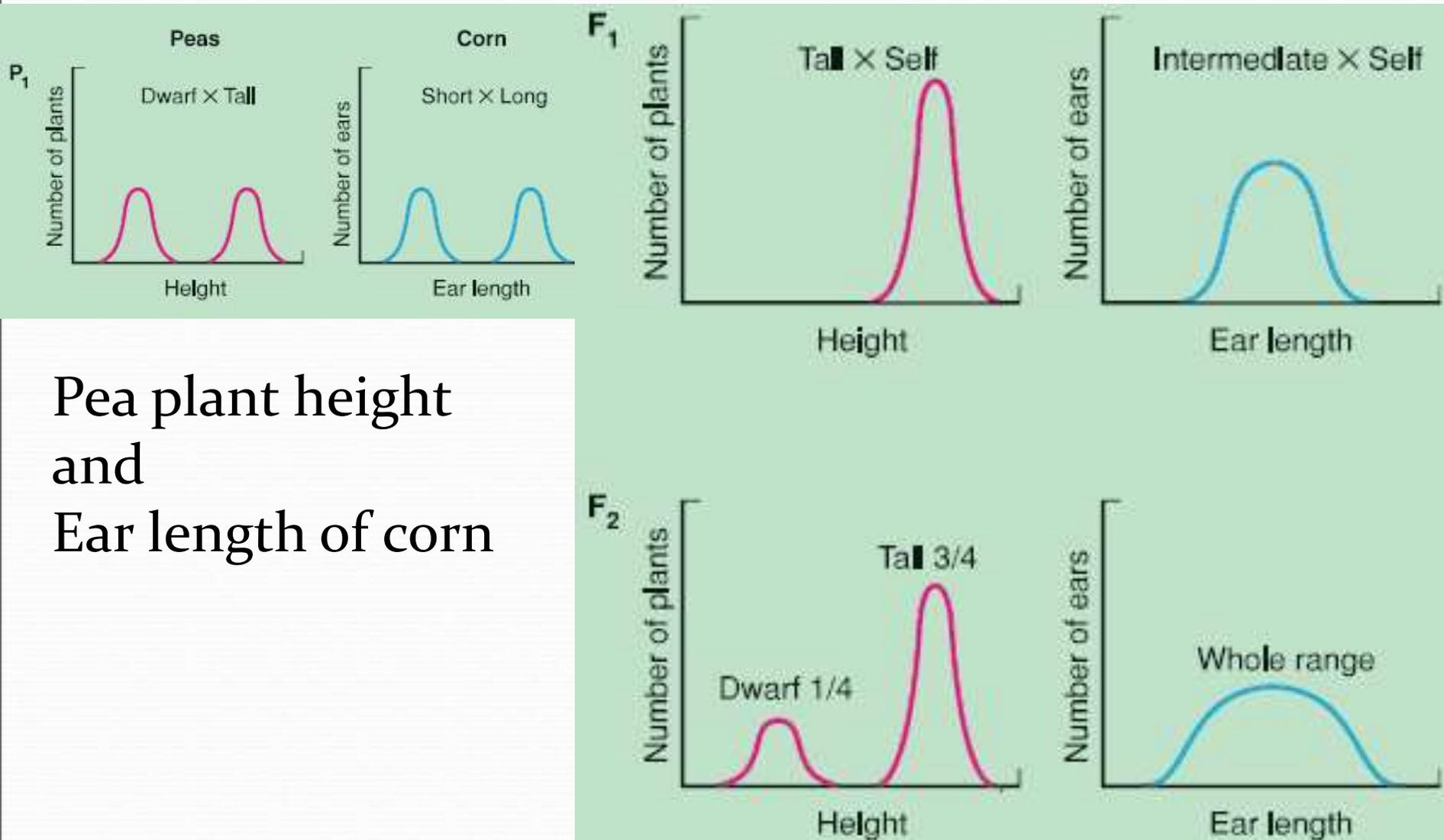
Discontinuous v/s continuous traits

- Traits such as colour of Pea, coat colour of mice, colour of summer squash, etc. with only a few distinct phenotypes, are called **discontinuous traits/ qualitative traits**.
- Many traits (probably most), such as human birth weight and adult height, protein content in corn, and the number of eggs laid by *Drosophila*, **exhibit a wide range of possible phenotypes**.
- Traits such as these, with a continuous distribution of phenotypes, are called **continuous traits/ Quantitative traits**.

Distribution of birth weight of babies (males + females) born to teenagers in Portland, Oregon, in 1992.



Discontinuous v/s continuous traits



Pea plant height
and
Ear length of corn

Polygenic Inheritance

- **Quantitative characters** are controlled by a large number of individual genes called **polygenic system**.
- Inheritance could be explained by **multiple factor hypothesis**.
- For a given quantitative trait there could be **several genes**, which are **independent** in their **segregation** and had **cumulative effect** on the phenotype.
- Eg. Inheritance of Wheat Kernel Colour

Inheritance of Wheat Kernel Colour

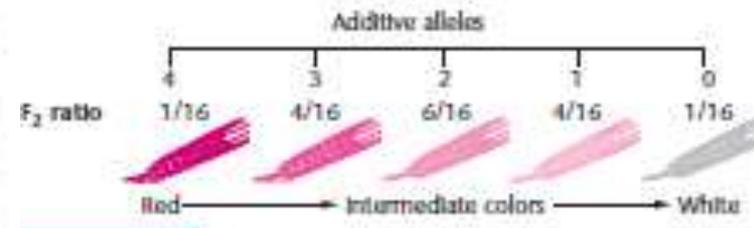
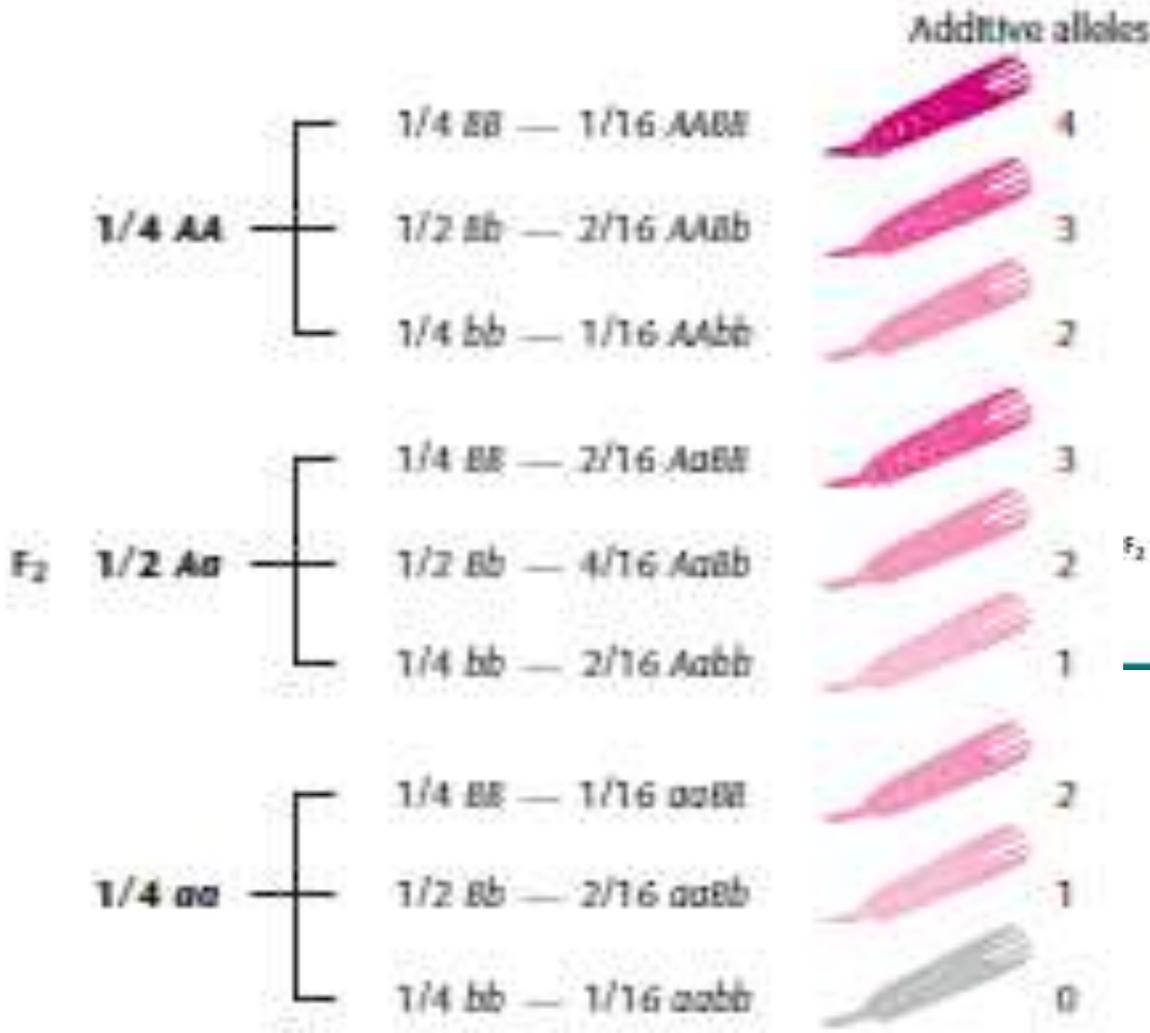
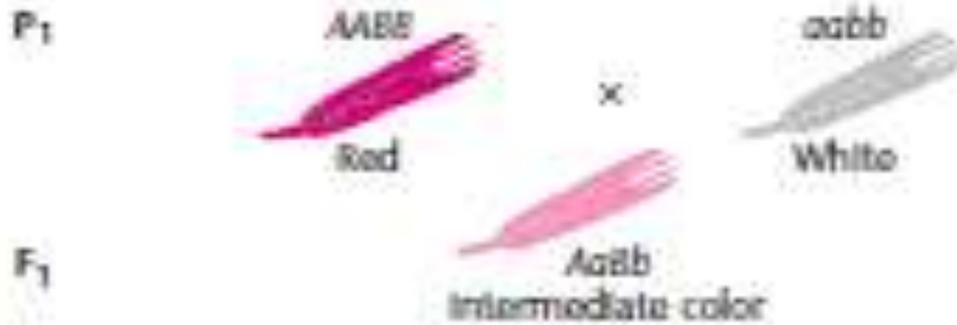


Table 22.1 Genetic Explanation for the Number and Proportions of F₂ Phenotypes for the Quantitative Trait Red Kernel Color in Wheat

Genotype	Number of Contributing Alleles for Red	Phenotype	Fraction of F ₂
<i>RR CC</i>	4	Dark red	1/16
<i>RR Cc</i> or <i>Rr CC</i>	3	Medium red	4/16
<i>RR cc</i> or <i>rr CC</i> or <i>Rr Cc</i>	2	Intermediate red	6/16
<i>rr Cc</i> or <i>Rr cc</i>	1	Light red	4/16
<i>rr cc</i>	0	White	1/16

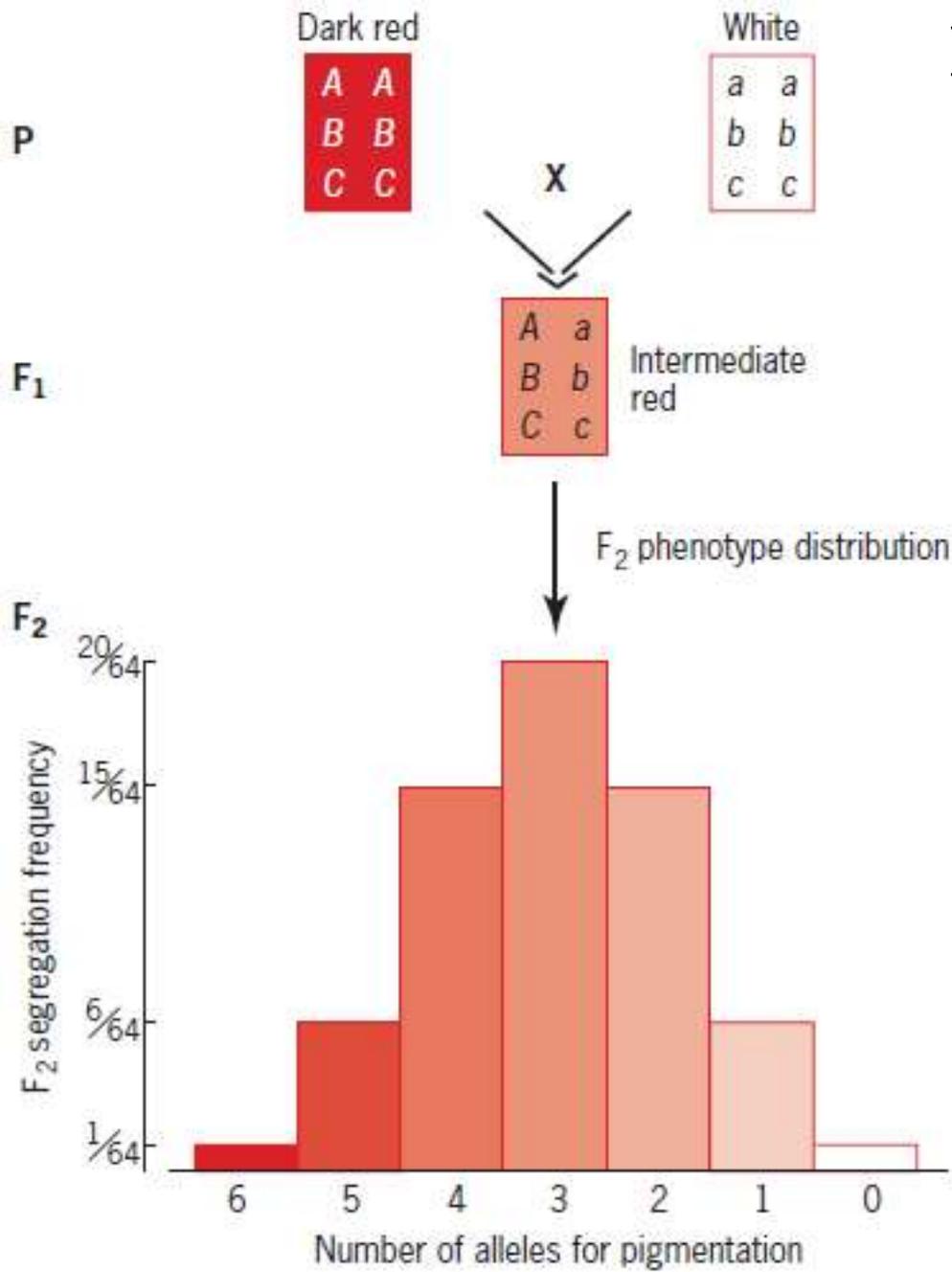
Inheritance of Wheat Kernel Colour

Parents	Dark red			White
Genotypes	$R_1R_1R_2R_2$	x		$r_1r_1r_2r_2$
		↓		
F ₁	$R_1r_1R_1r_1$		Medium Red	
	R_1R_2	R_1r_2	r_1R_2	r_1r_2
F ₂	R_1R_2	R_1r_2	r_1R_2	r_1r_2
	$R_1R_1R_2R_2$ [DR]	$R_1R_1R_2r_2$ [MDR]	$R_1r_1R_2R_2$ [MDR]	$R_1r_1R_2r_2$ [MR]
	$R_1R_1R_2r_2$ [MDR]	$R_1R_1r_2r_2$ [MR]	$R_1r_1R_2r_2$ [MR]	$R_1r_1r_2r_2$ [LR]
	$R_1r_1R_2R_2$ [MDR]	$R_1r_1R_2r_2$ [MR]	$r_1r_1R_2R_2$ [MR]	$r_1r_1R_2r_2$ [LR]
	$R_1r_1R_2r_2$ [MR]	$R_1r_1r_2r_2$ [LR]	$r_1r_1R_2r_2$ [LR]	$r_1r_1r_2r_2$ [W]

DR = Dark Red, MDR = Medium Dark Red,
MR = Medium Red, LR = Light Red and W = White

Fig. 12.1. Inheritance of kernel colour in wheat.

Inheritance of Wheat Kernel Colour



P₁ Red $AA BB CC$ × White $aa bb cc$

F₁ Intermediate color $Aa Bb Cc$ × Self

	<i>ABC</i>						
<i>ABC</i>	6	5	5	5	4	4	3
<i>ABc</i>	5	4	4	4	3	3	2
<i>AbC</i>	5	4	4	4	3	3	2
<i>aBC</i>	5	4	4	4	3	3	2
<i>Abc</i>	4	3	3	3	2	2	1
<i>aBc</i>	4	3	3	3	2	2	1
<i>abc</i>	3	2	2	2	1	1	0

Phenotype Red → White

Number of color-producing alleles 6 : 5 : 4 : 3 : 2 : 1 : 0

Ratio 1 : 6 : 15 : 20 : 15 : 6 : 1

Polygenic Inheritance (Skin colour)

Gene 1	d^1d^1	d^1D^1	d^1D^1	D^1D^1	D^1d^1	D^1d^1	D^1D^1
Gene 2	d^2d^2	d^2d^2	d^2D^2	D^2d^2	D^2d^2	D^2D^2	D^2D^2
Gene 3	d^3d^3	d^3d^3	d^3d^3	d^3d^3	D^3D^3	D^3D^3	D^3D^3
Total number of dark-skin genes	0	1	2	3	4	5	6
							
	Very light			Medium			Very dark
# of light "d" alleles	6	5	4	3	2	1	0
# of dark "D" alleles	0	1	2	3	4	5	6

Number of individuals

