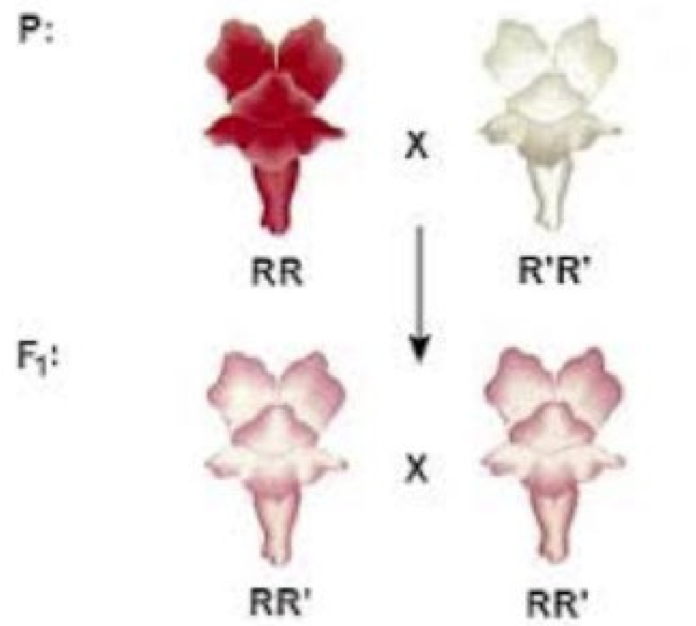
UNIT 3 | EXTENSIONS OF MENDELIAN GENETICS



Rafael Navajas-Pérez
www.rafaelnavajas.eu

UNIVERSIDAD DE GRANADA

ONE GENE

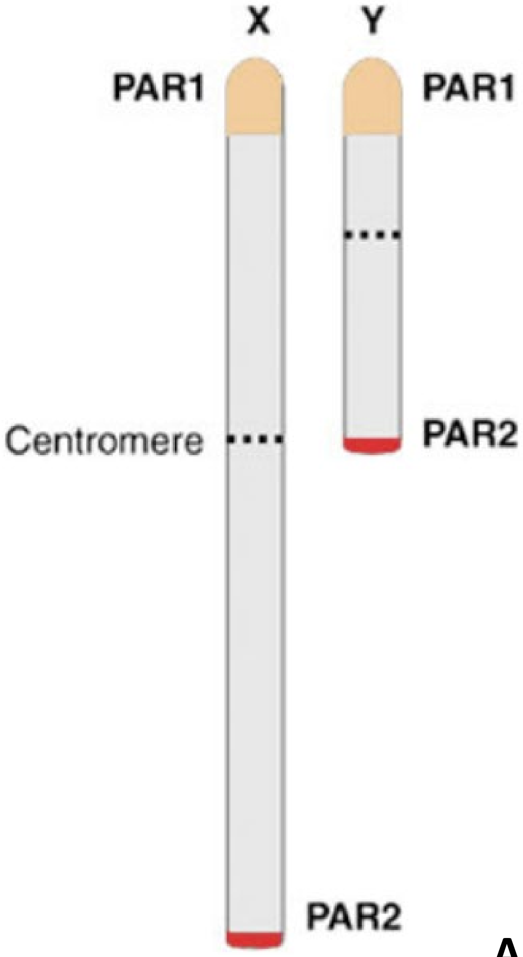
- **Sex-dependant traits:**
  - Sex-linked (chromosome X)
  - Holandric (chromosome Y)
  - Sex-limited
  - Sex-influenced

- **Incomplete dominance**
- **Codominance**
- **Allelic series**
- **Lethal genes**

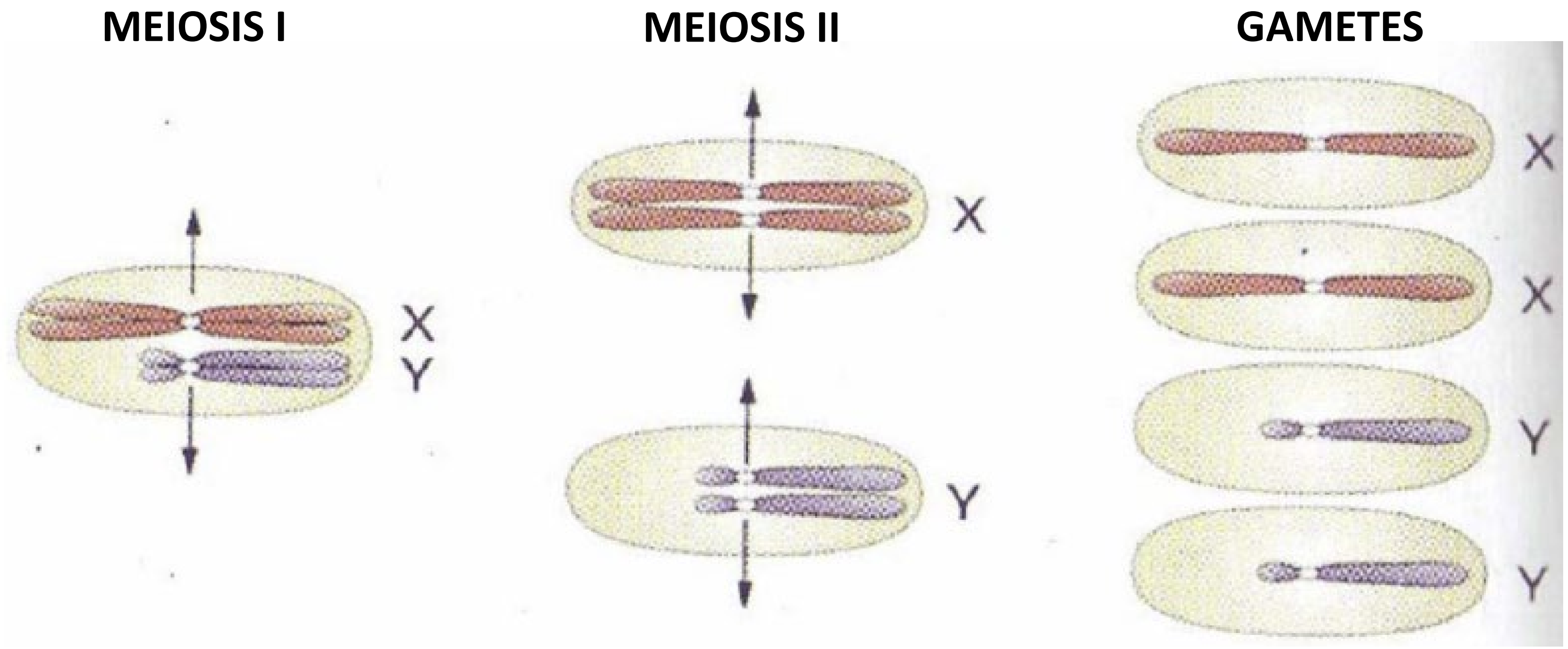
SEVERAL GENES

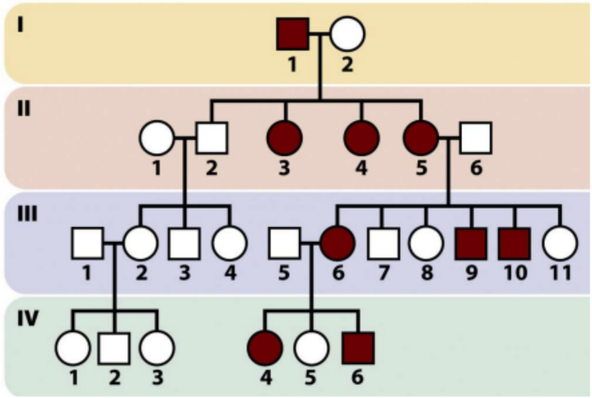
- **Gene interaction**
- **Duplicate interaction**
- **Dilution genes**
- **Epistasis**
  - Dominant
  - Recessive
  - Duplicate dominant
  - Duplicate recessive
  - Dominant-recessive

SEX IS INHERITED IN A MENDELIAN WAY



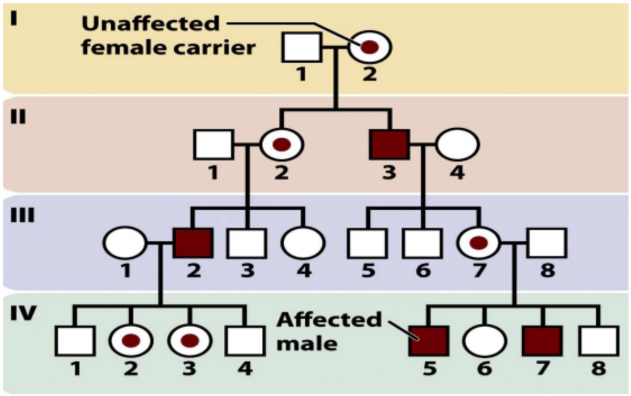
PAR: **P**seudo **A**utosomal **R**egion





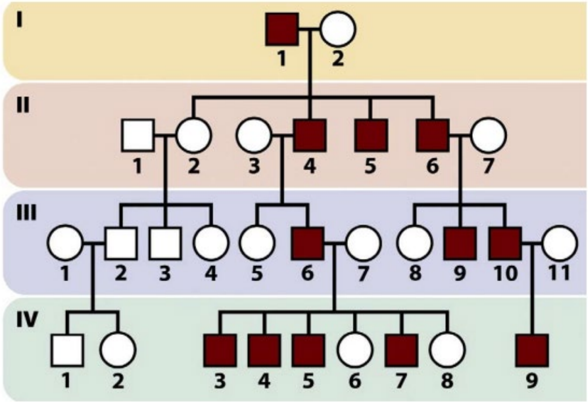
X-LINKED (DOMINANT)

- More females are affected
- Do not skip generations
- Affected males have an affected mother
- Affected females have either an affected mother or father
- Males do not pass it to their male offspring



X-LINKED (RECESSIVE)

- More males are affected
- Tend to skip generations
- Males do not pass it to their male offspring
- Affected males have carrier female offspring

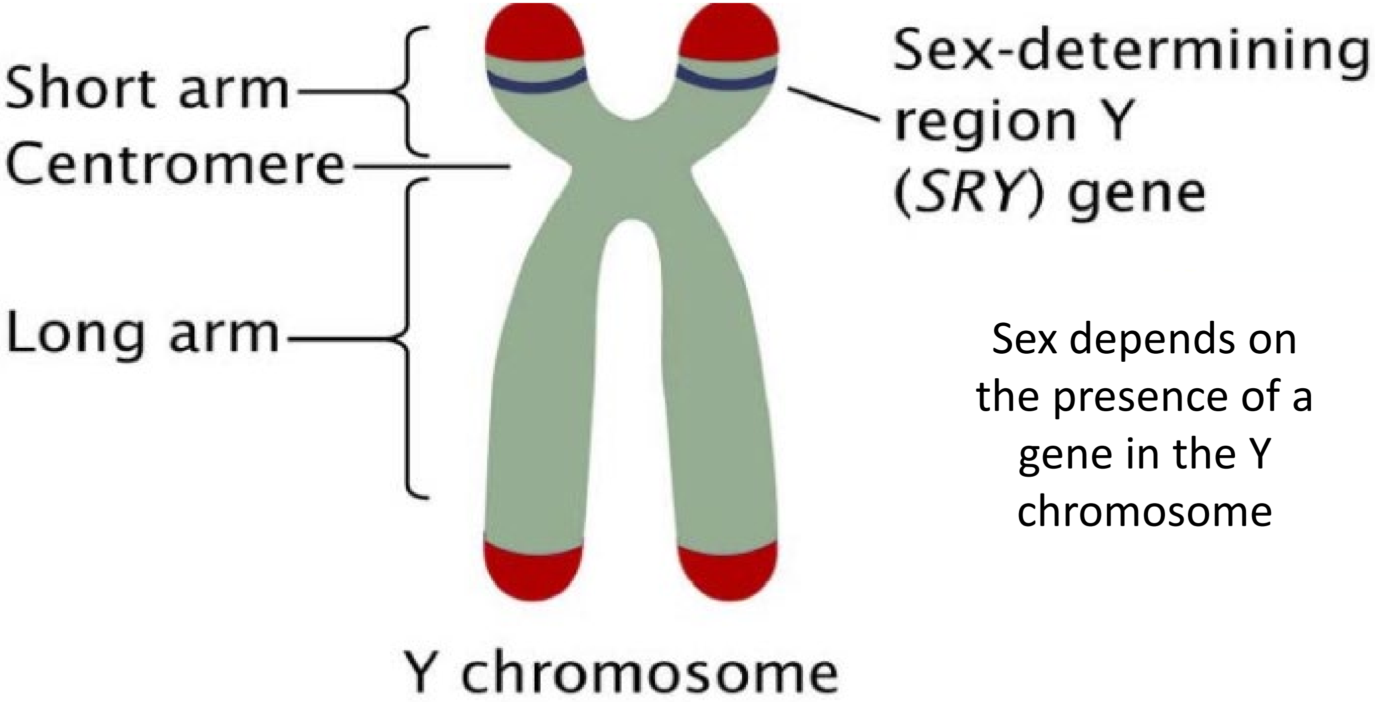


HOLANDRIC

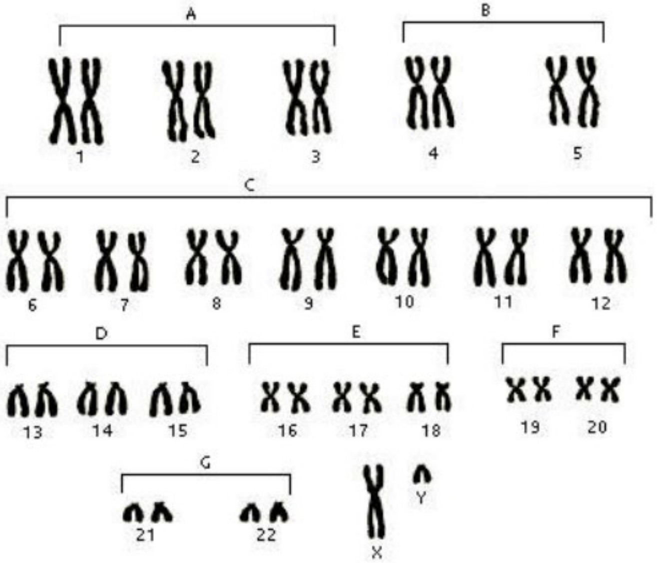
- Only males are affected
- Males pass it to their male offspring
- Do not skip generations

SEX-DETERMINATION SYSTEMS

(active Y)

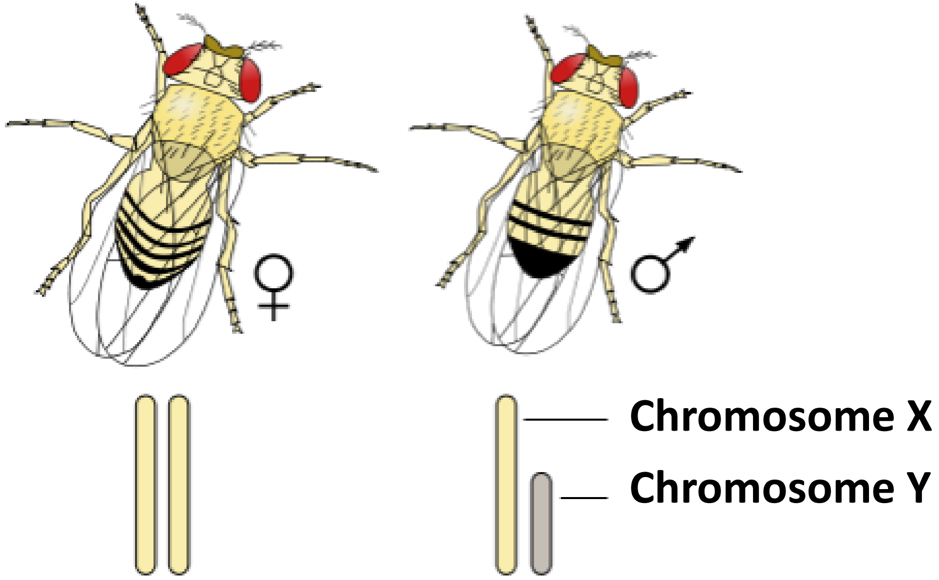


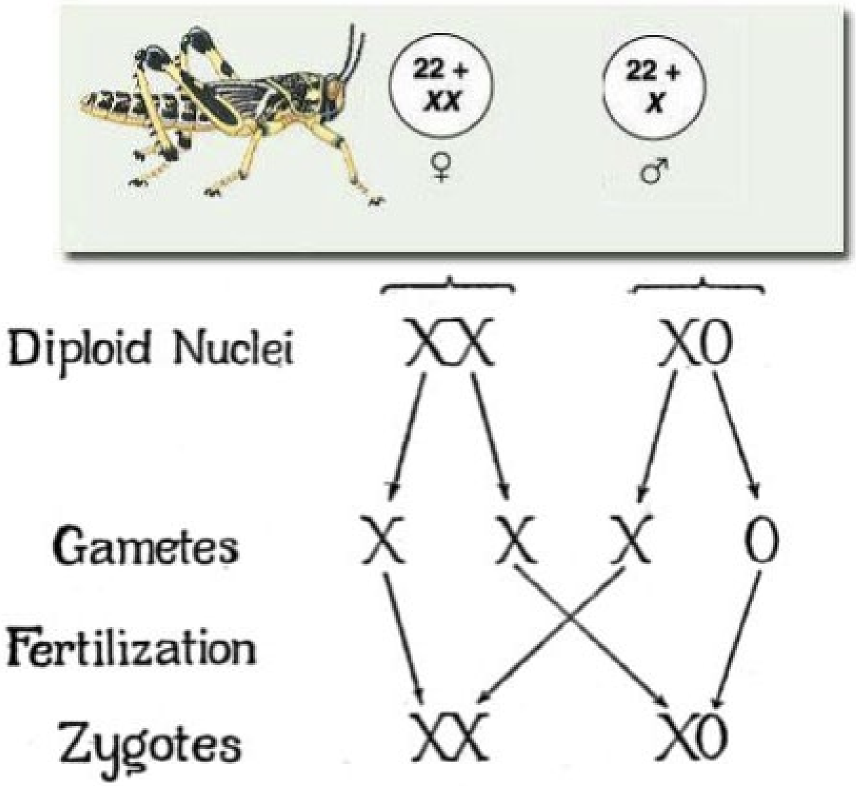
Sex depends on the presence of a gene in the Y chromosome



SEX-DETERMINATION SYSTEMS

(X:A ratio)



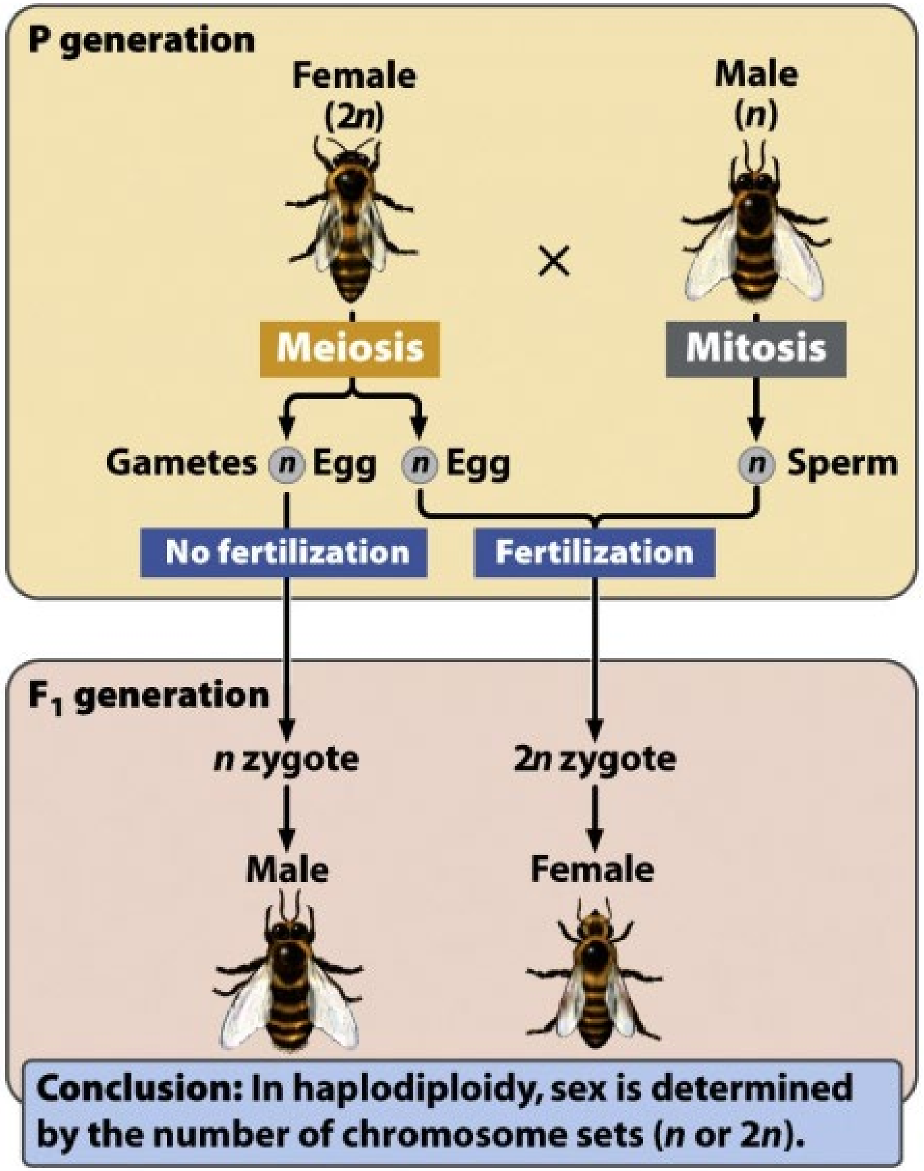


Sex depends on the ration between number of X chromosomes and set of autosomes:

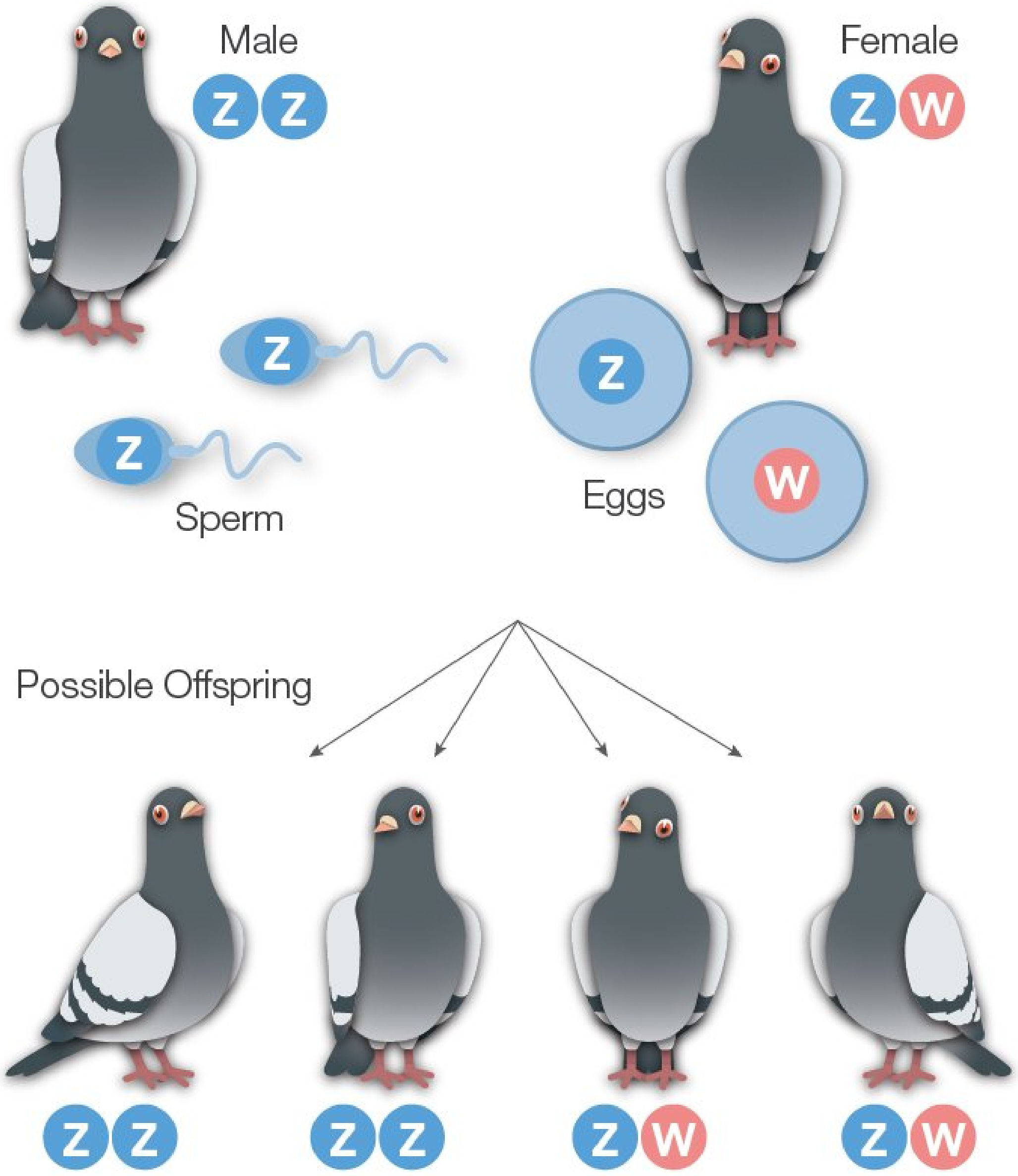
XX: 2/2 → female
XY: 1/2 (<1) → male

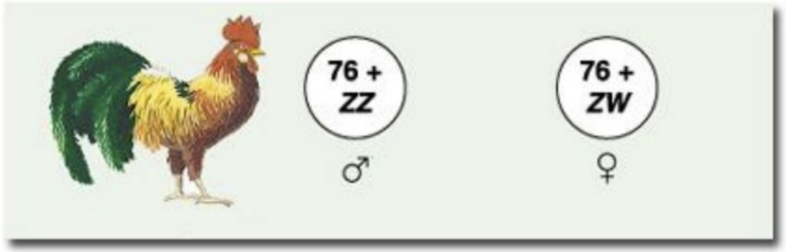
SEX-DETERMINATION SYSTEMS

(Haplodiploidy)



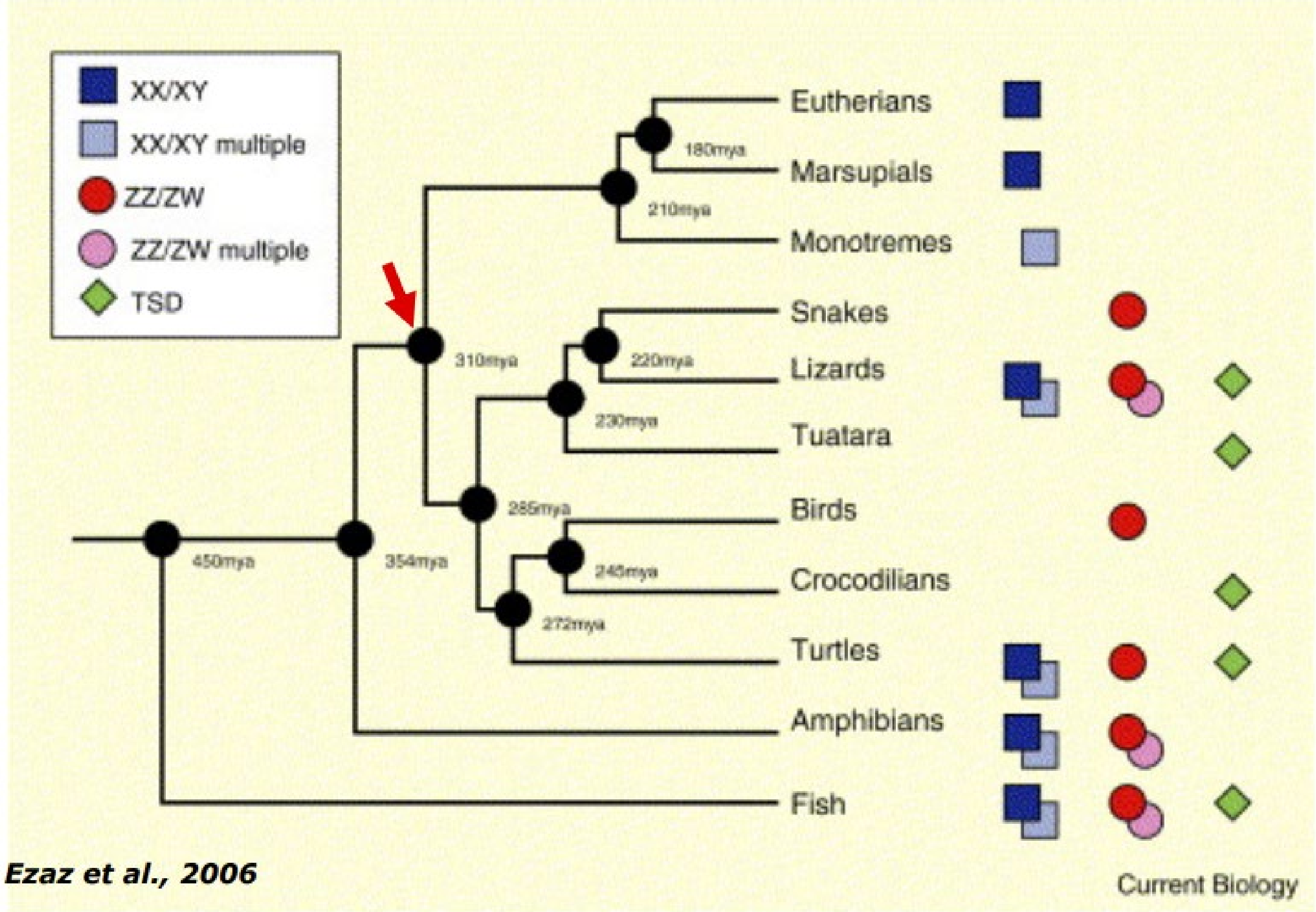
SEX-DETERMINATION SYSTEMS





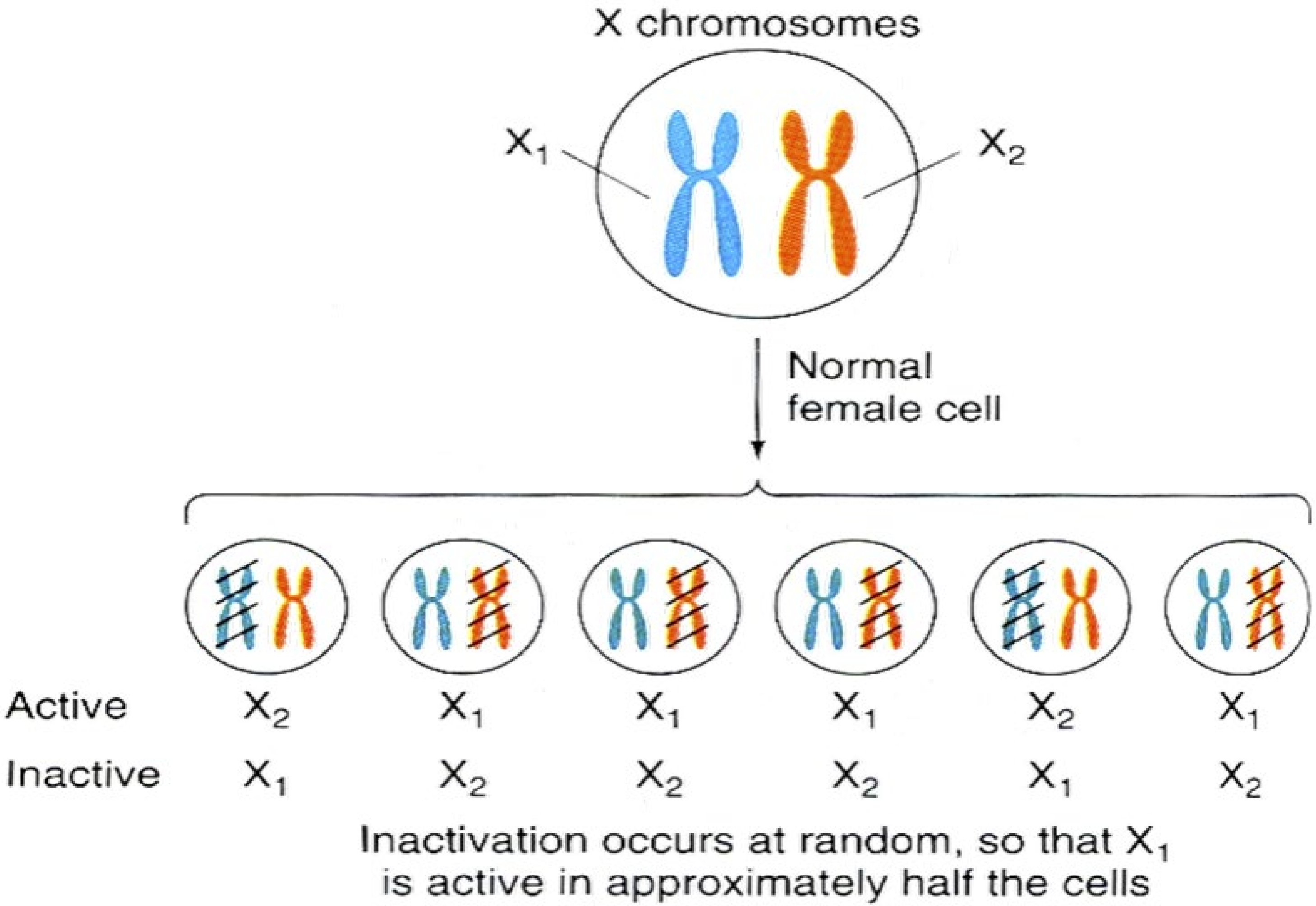
Homogametic males |
Heterogametic females

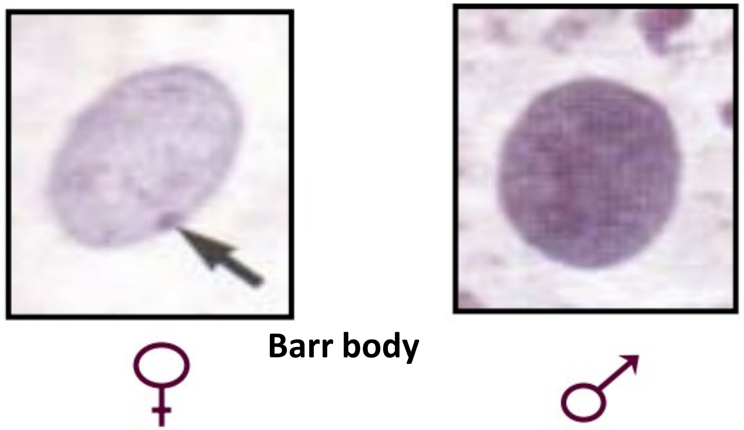
SEX-DETERMINATION SYSTEMS



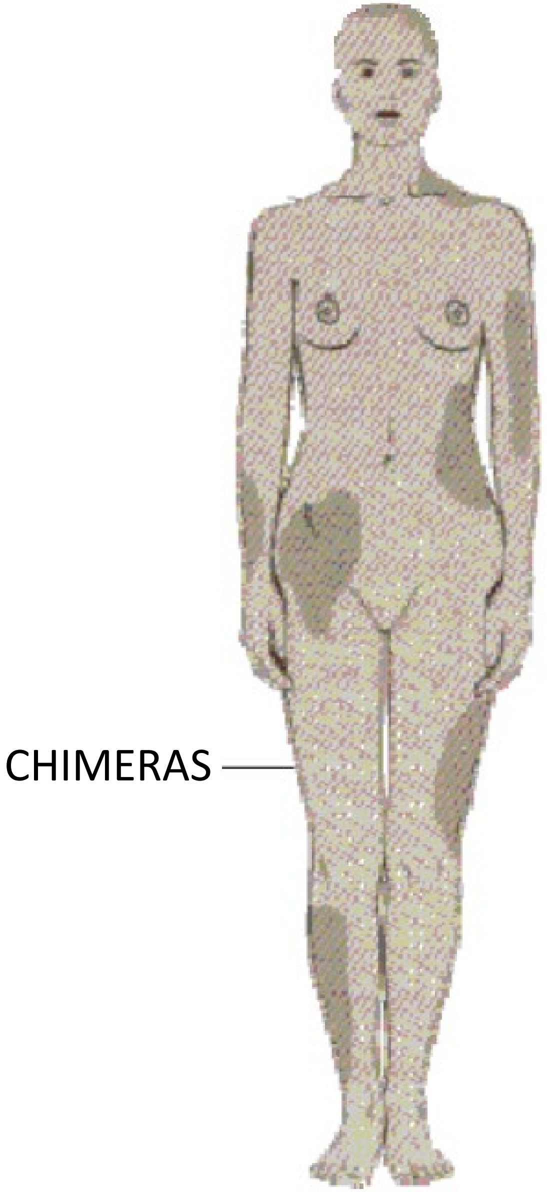
Ezaz et al., 2006

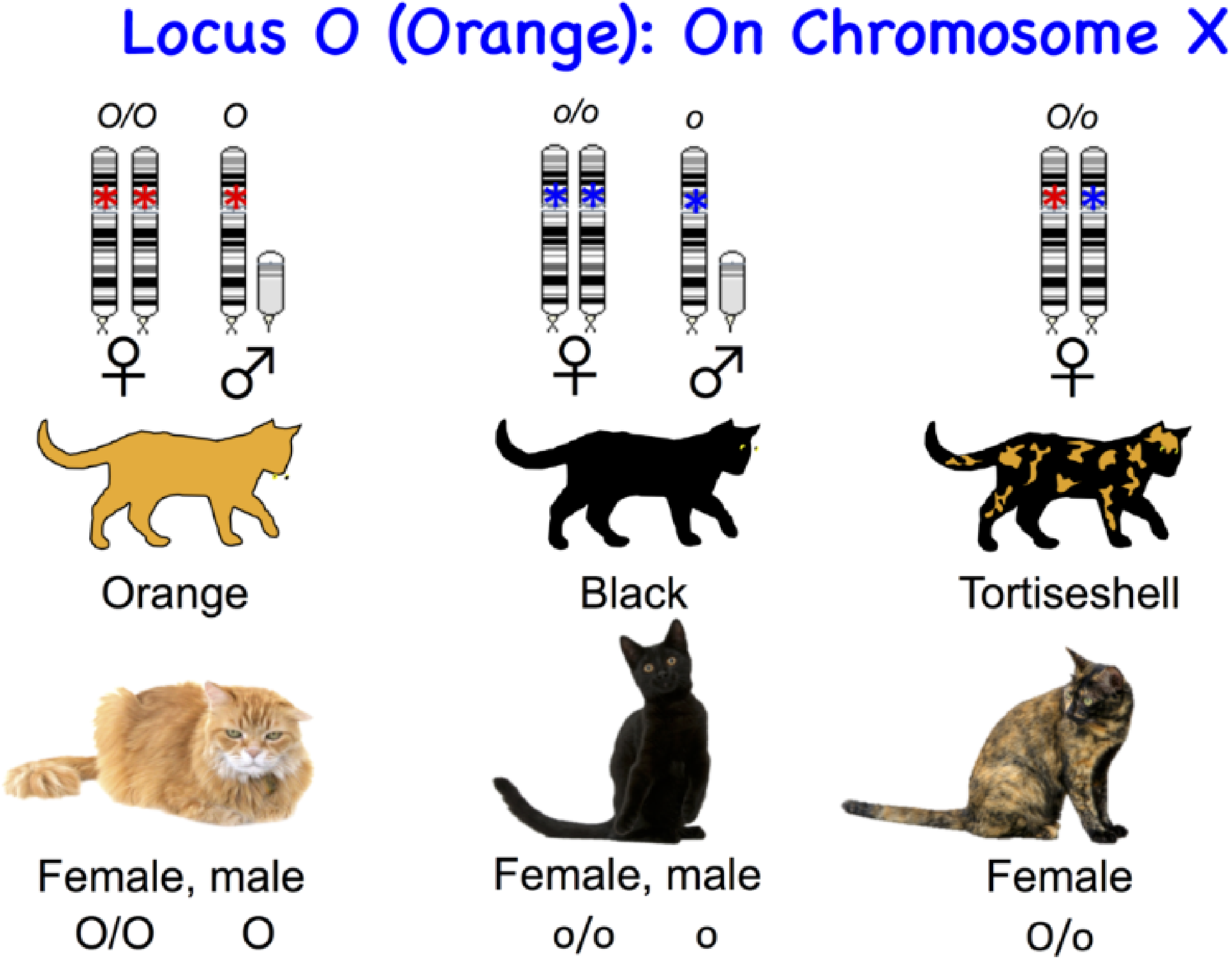
X INACTIVATION



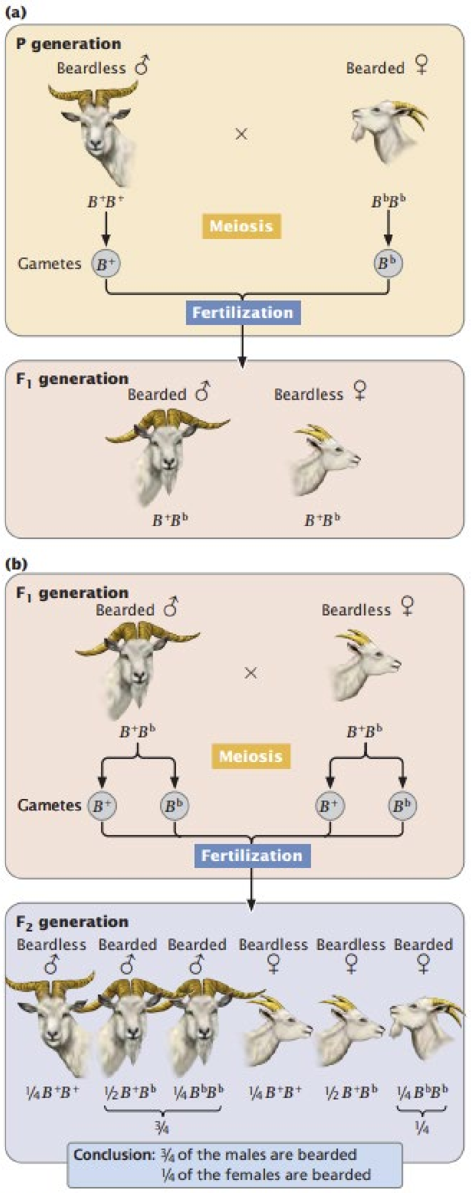


X INACTIVATION



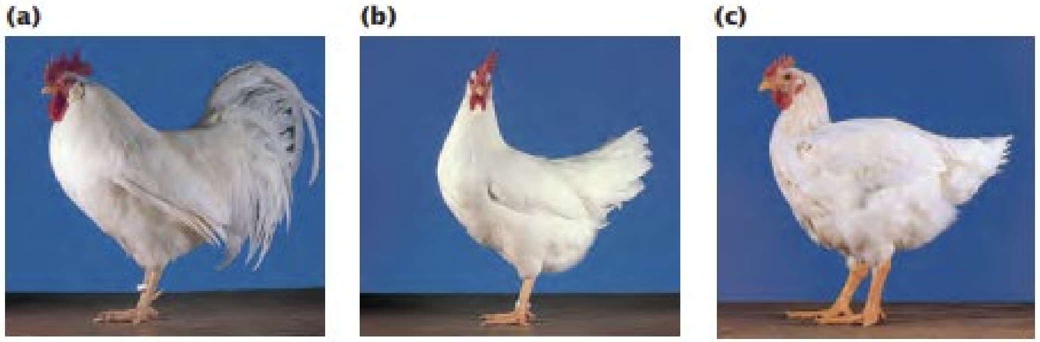


SEX-INFLUENCED AND SEX-LIMITED TRAITS



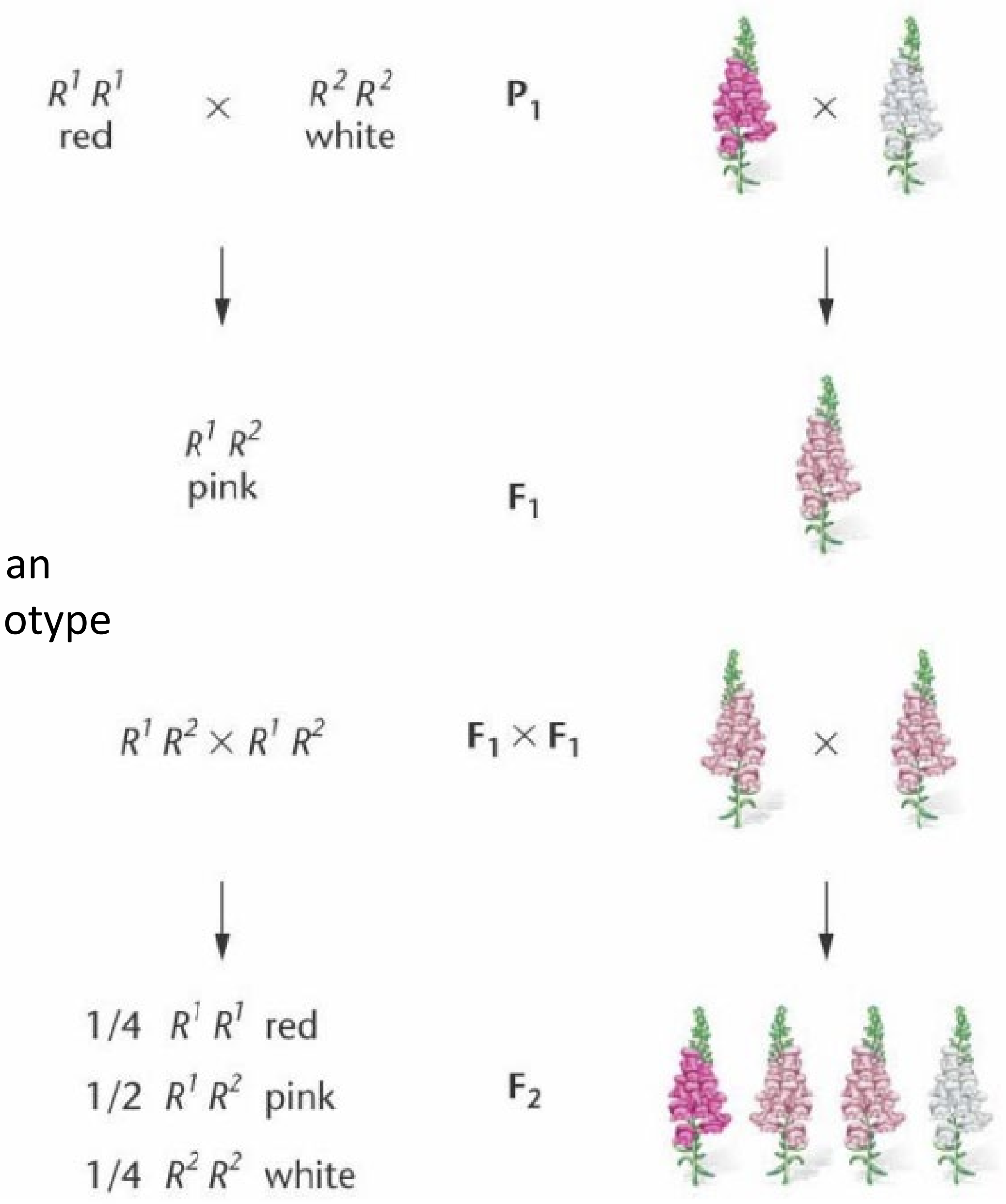
5.12 **Genes that encode sex-influenced traits are inherited according to Mendel's principles but are expressed differently in males and females.**

Genotype	Fenotype Males	Fenotype Females
a'a'	Bald	Bald
a'a	Bald	Hair
aa	Hair	Hair



5.13 A sex-limited characteristic is encoded by autosomal genes that are expressed in only one sex. An example is cock feathering in chickens, an autosomal recessive trait that is limited to males. (a) Cock-feathered male. (b) Hen-feathered female. (c) Hen-feathered male. [Larry Lefever/Grant Heilman Photography.]

INCOMPLETE DOMINANCE

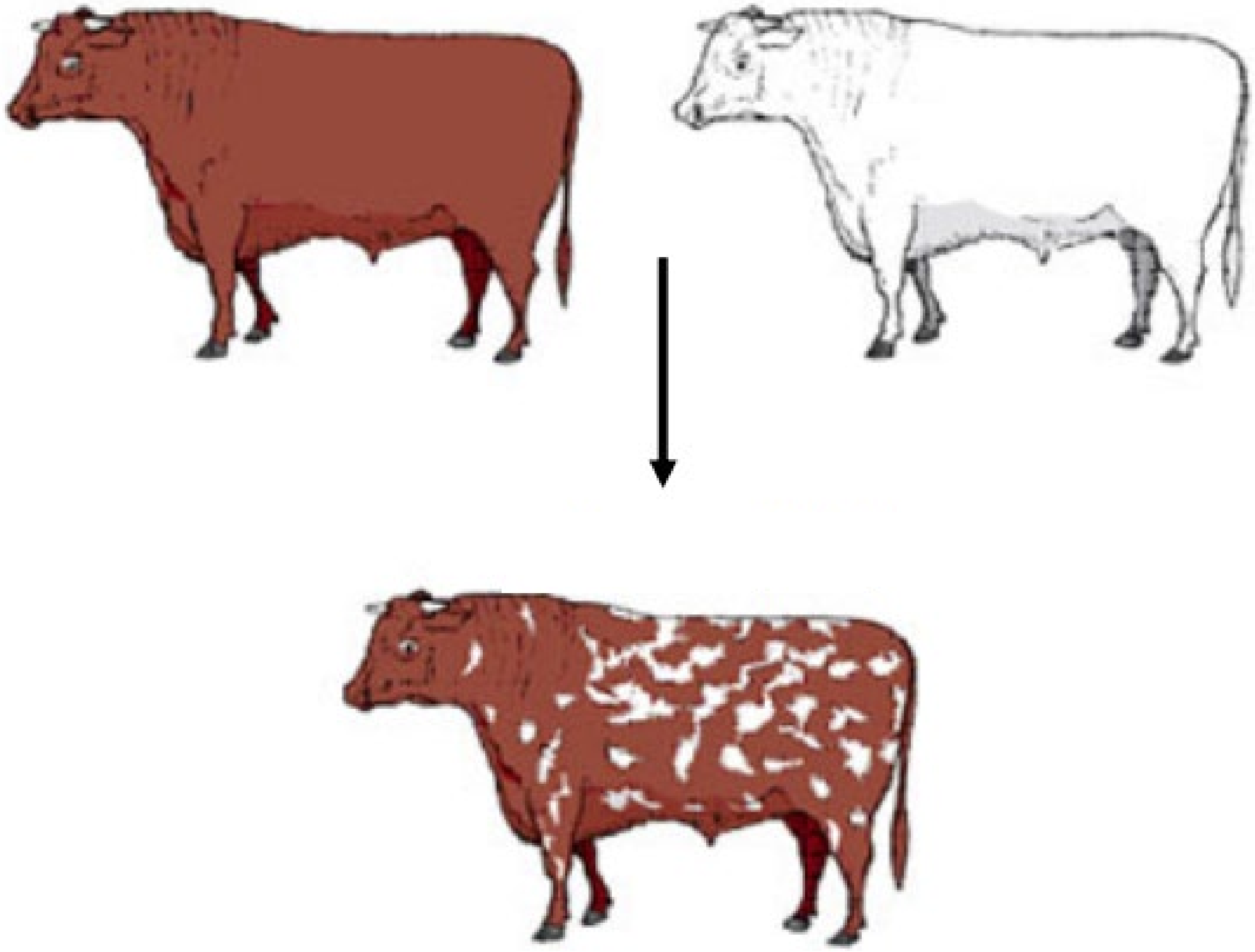


Hybrids exhibit an intermediate phenotype

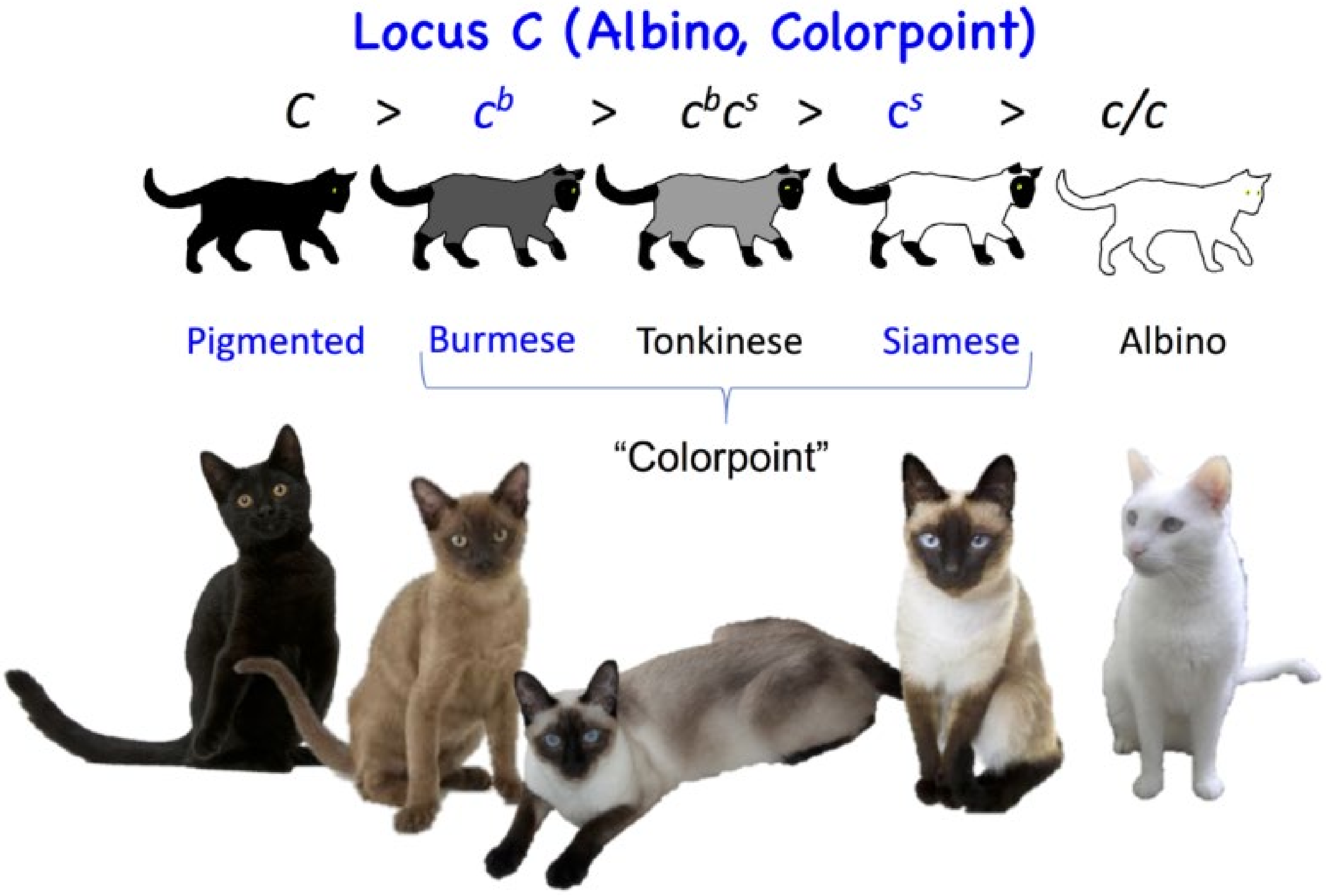
Phenotypic proportions = Genotypic proportions

CODOMINANCE

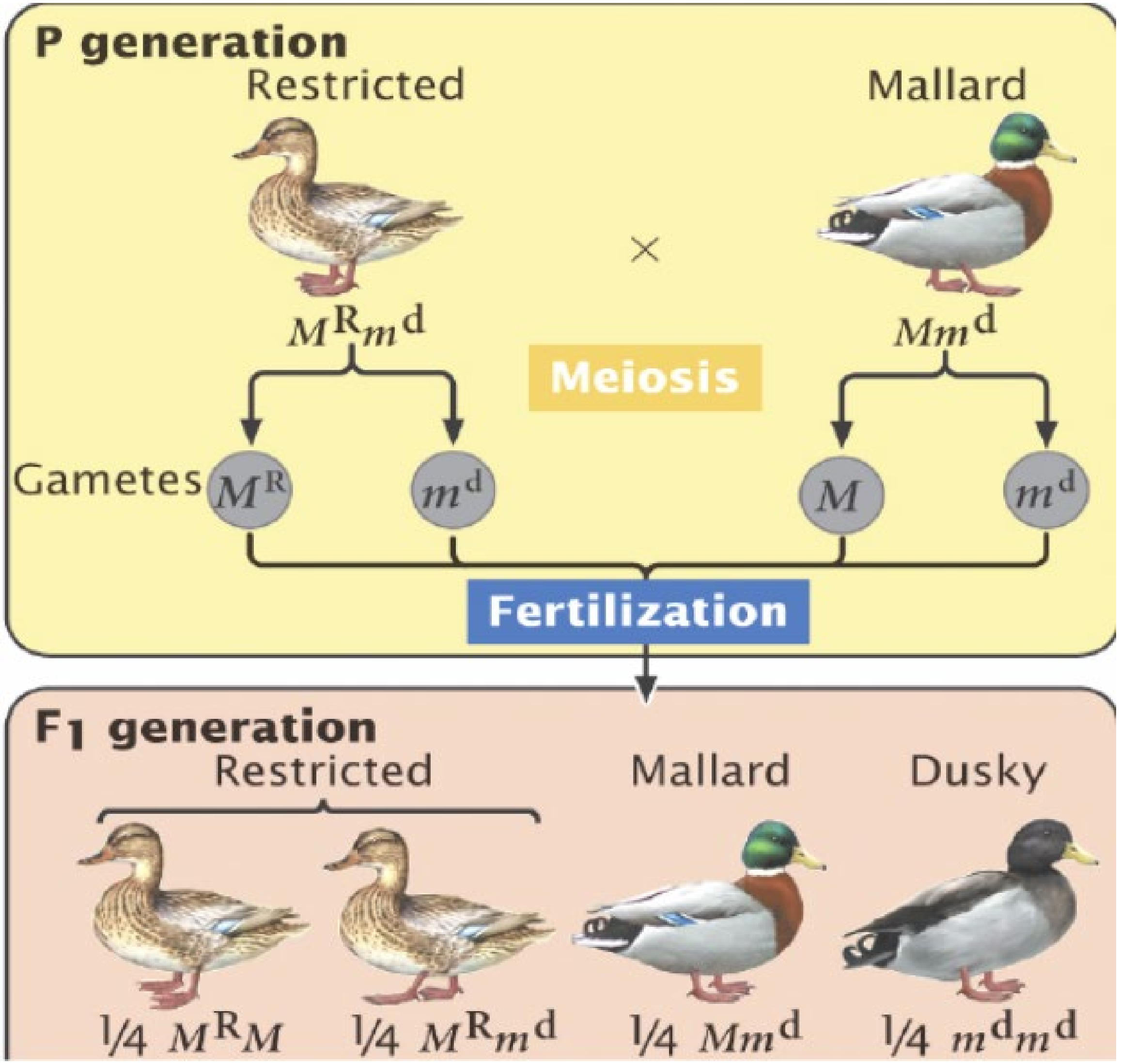
Hybrids exhibit dominant and recessive phenotypes



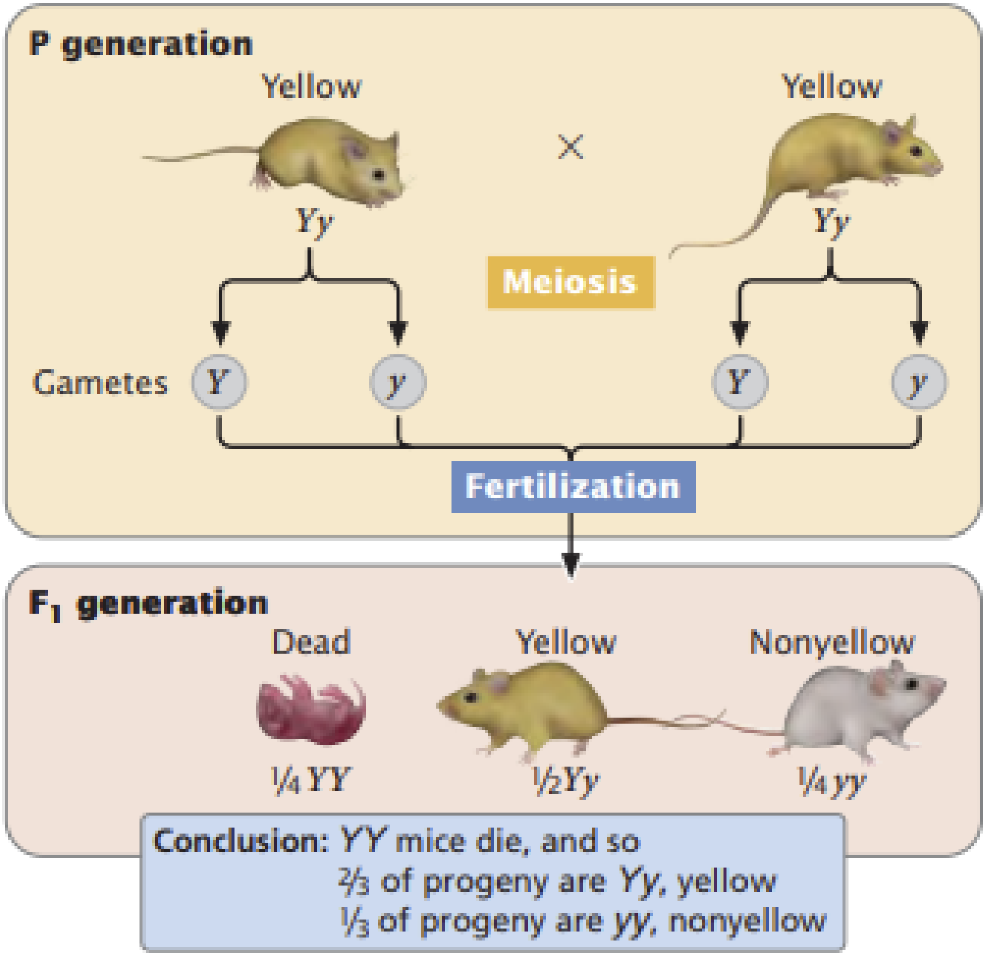
ALLELIC SERIES



ALLELIC SERIES



LETHAL GENES



5.1 The 2 : 1 ratio produced by a cross between two yellow mice results from a lethal allele.

GENE INTERACTION

(separate metabolic pathways)

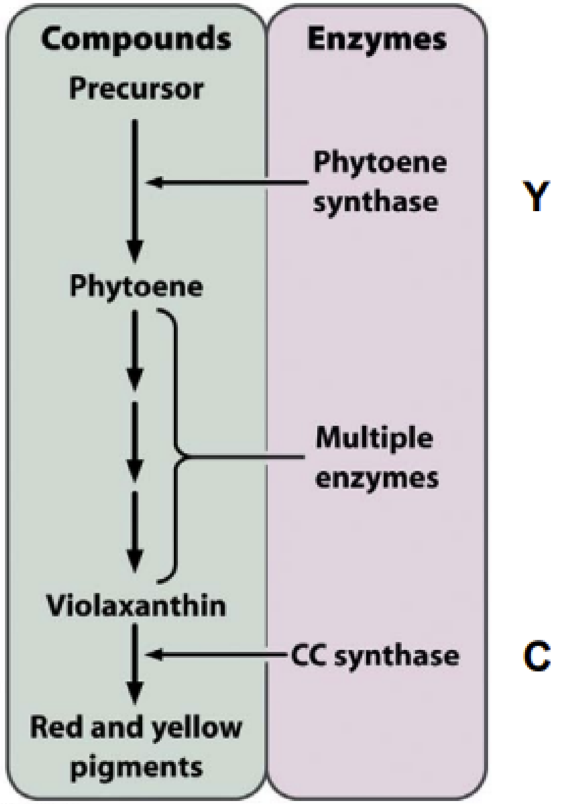
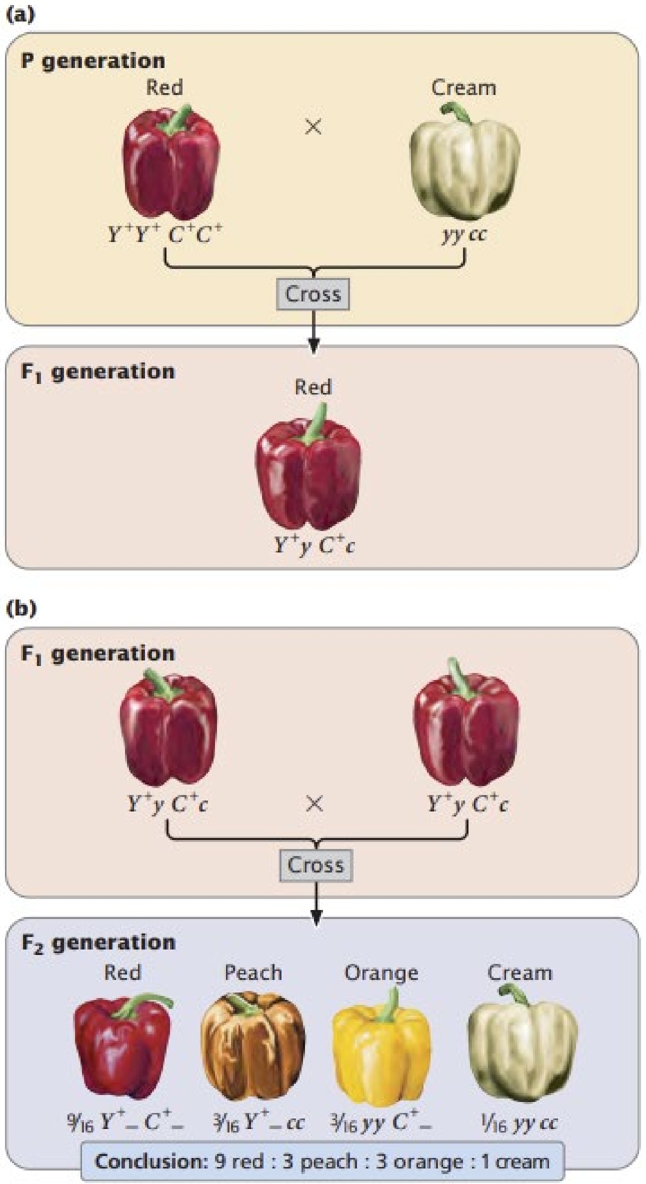


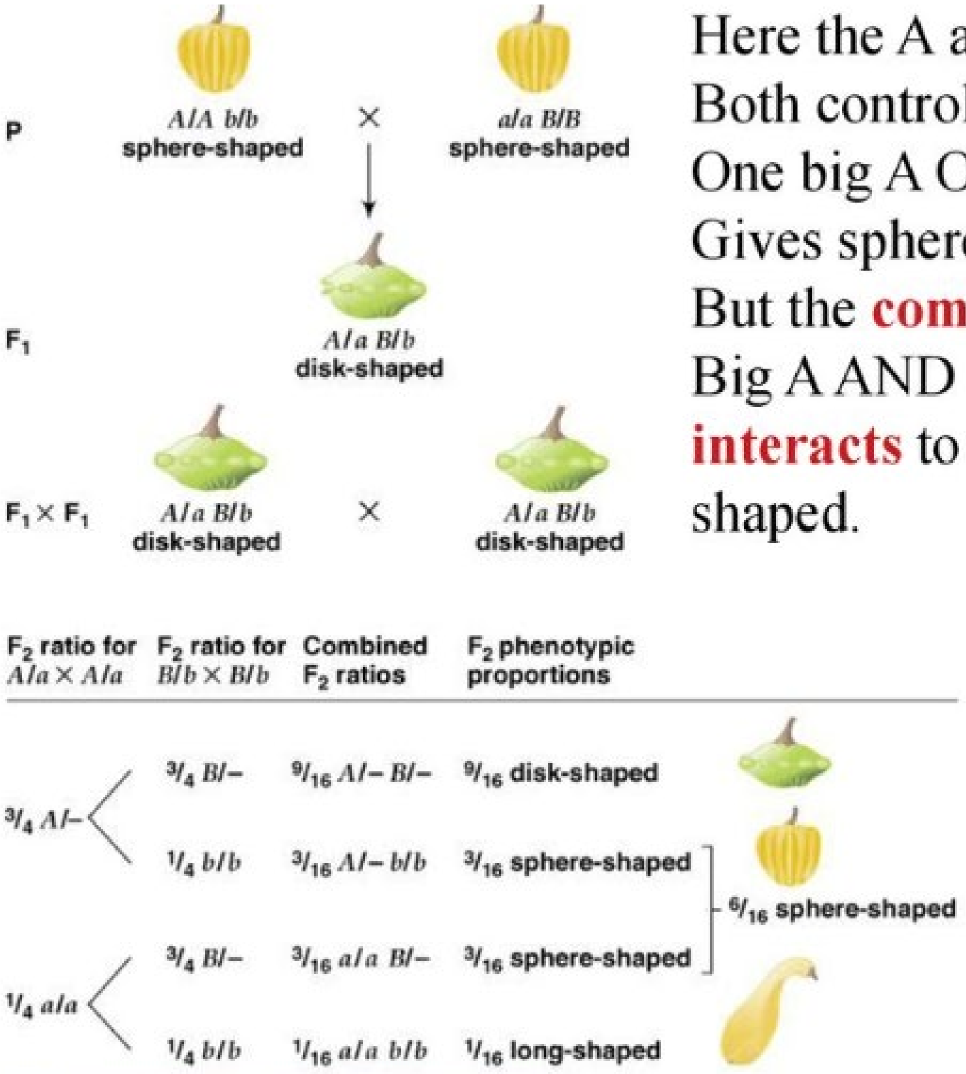
Figure 5-7
Genetics: A Conceptual Approach, Third Edition



5.7 Gene interaction in which two loci determine a single characteristic, fruit color, in the pepper *Capsicum annuum*.

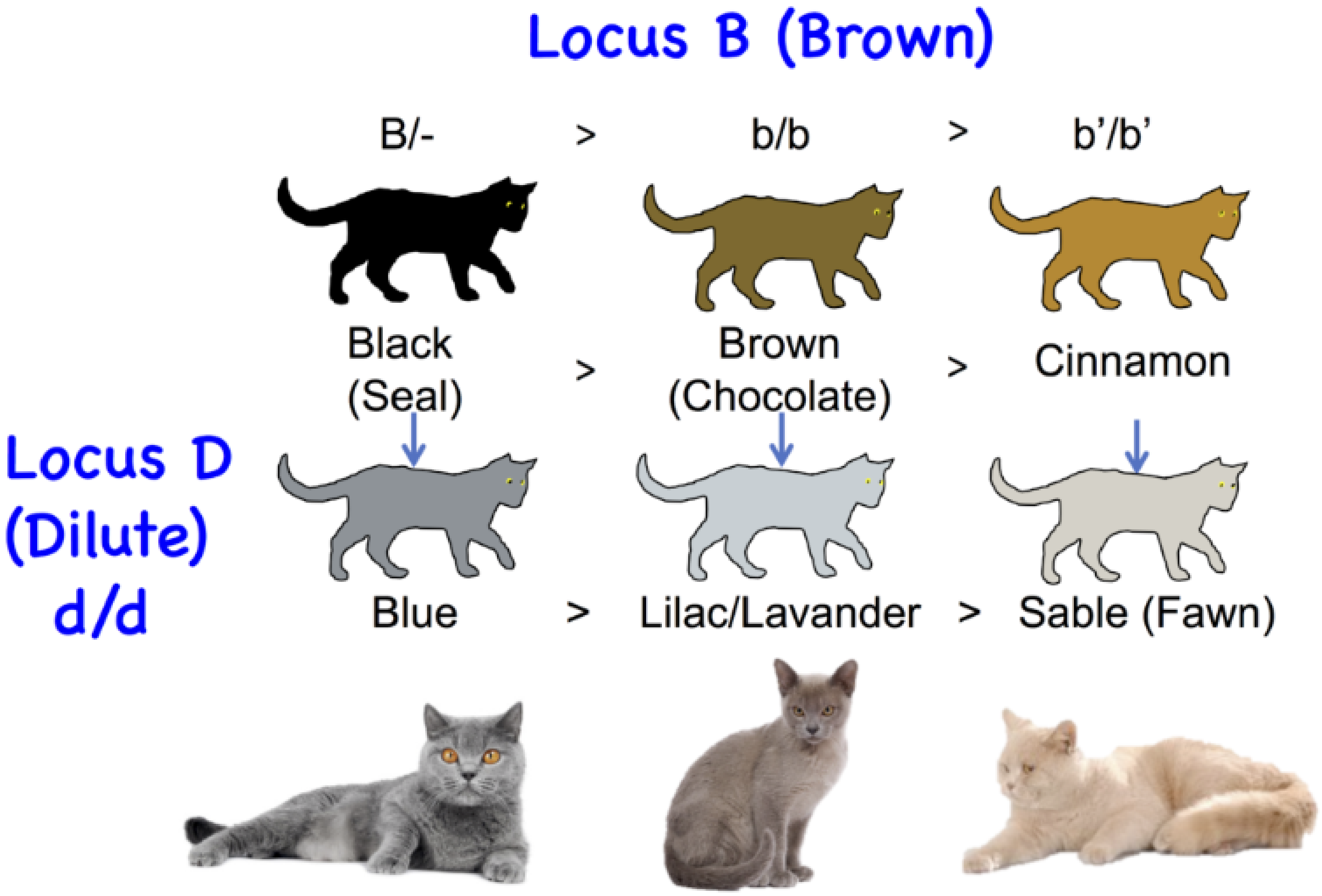
DUPLICATE INTERACTION

(separate metabolic pathways)

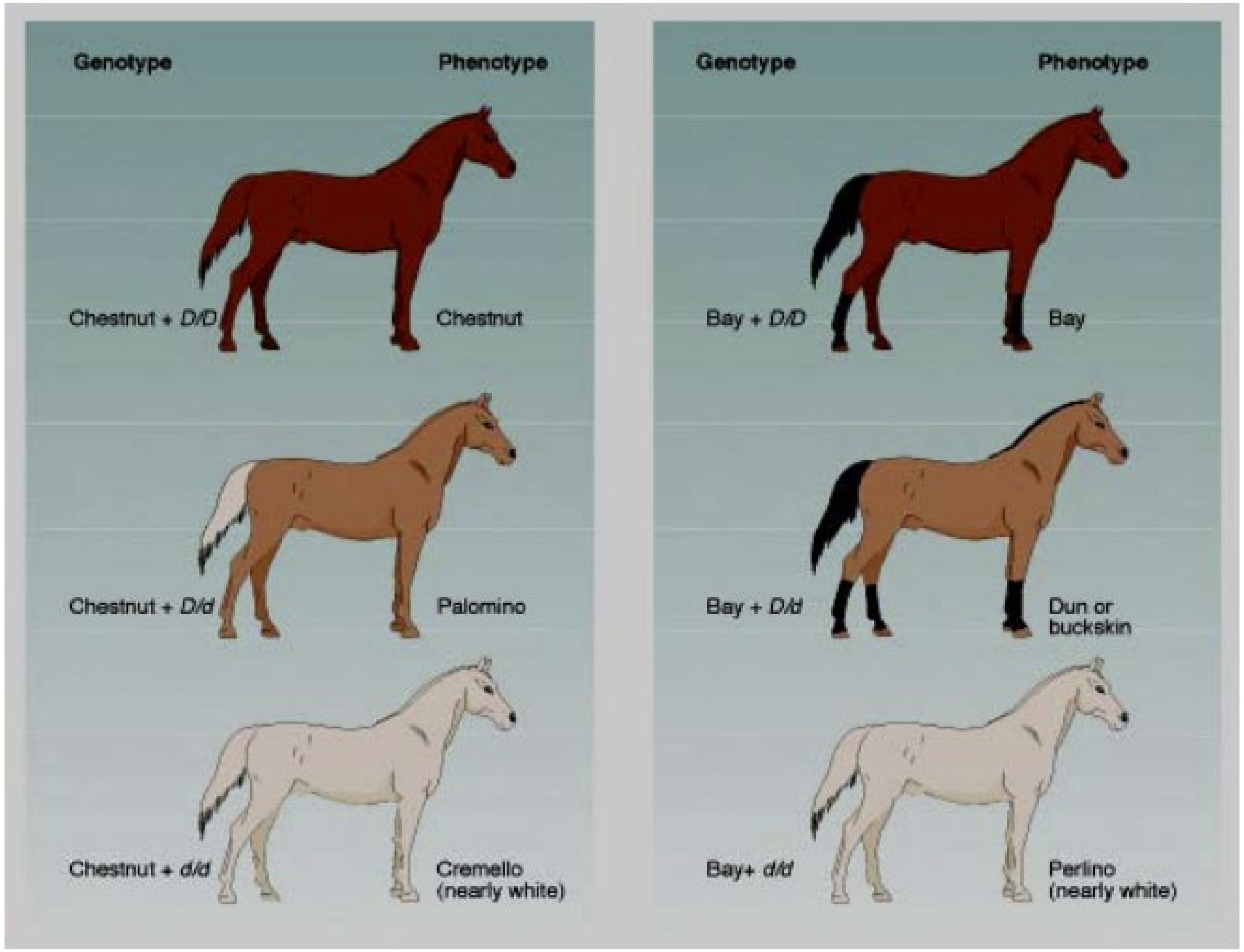


Here the A and B genes
Both control fruit shape.
One big A OR one big B
Gives sphere-shaped.
But the **combination** one
Big A AND one big B
interacts to give disk-
shaped.

DILUTION GENES

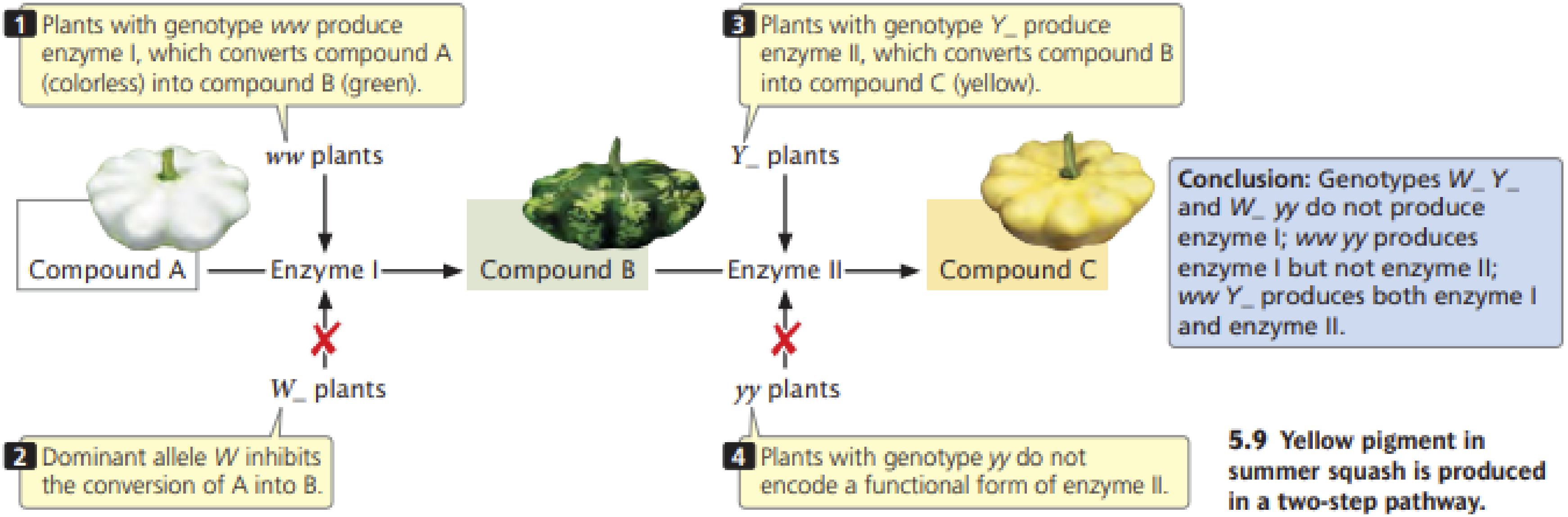


DILUTION GENES



DOMINANT EPISTASIS

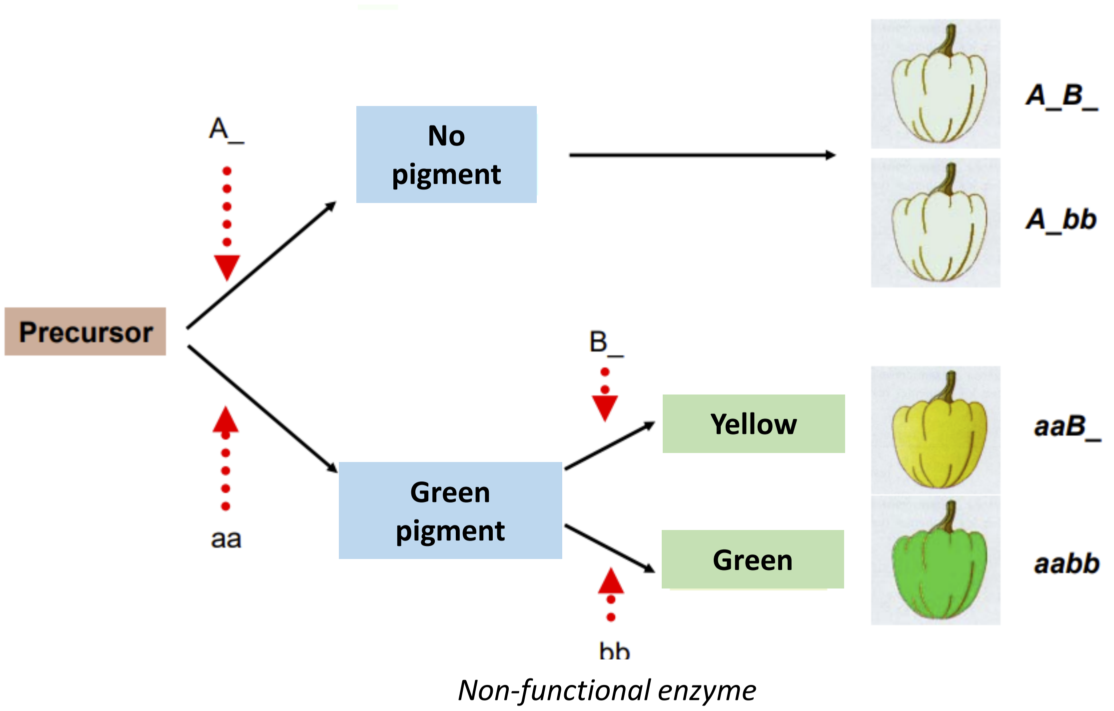
(same metabolic pathway)

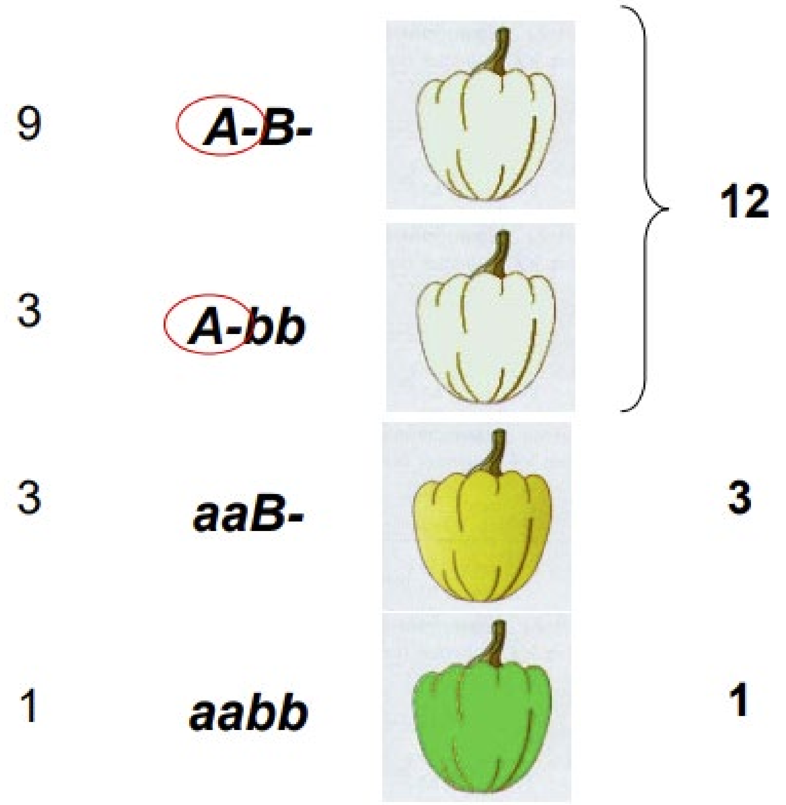


5.9 Yellow pigment in summer squash is produced in a two-step pathway.

DOMINANT EPISTASIS

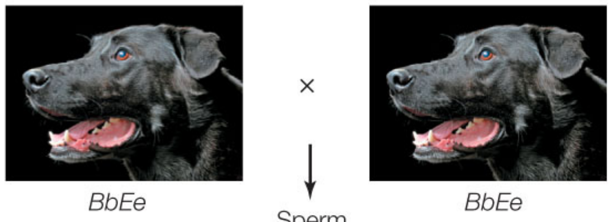
(same metabolic pathway)





RECESSIVE EPISTASIS

(same metabolic pathway)

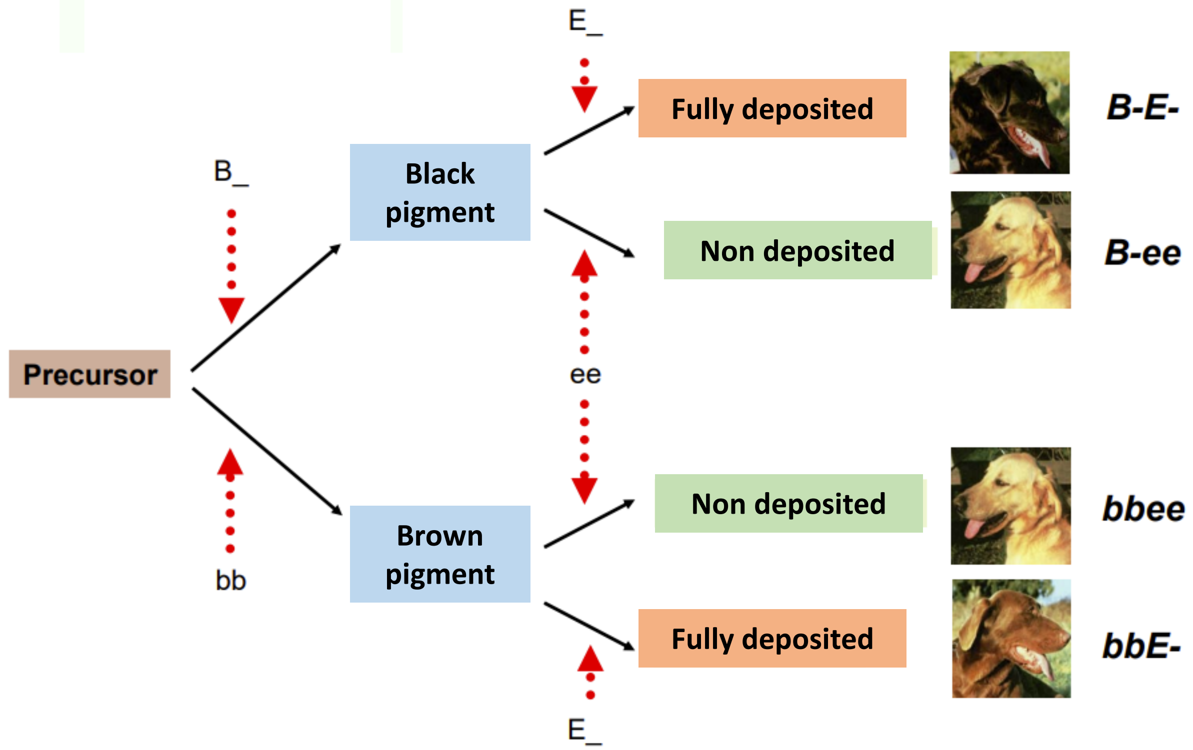


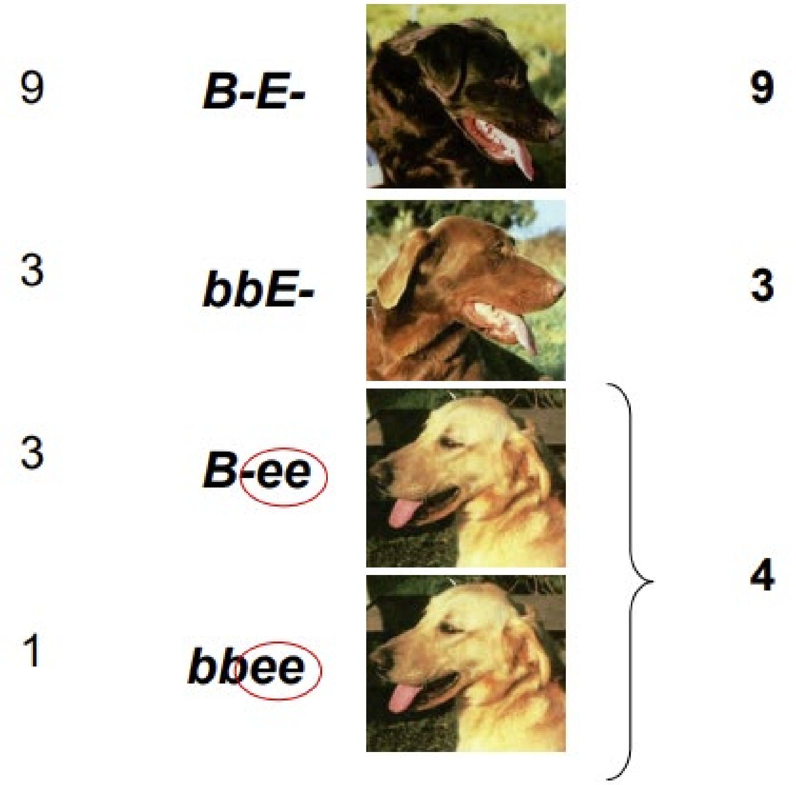
Sperm

Eggs	*BE*	*Be*	*bE*	*be*
BE	Black *BBEE*	Black *BBEe*	Black *BbEE*	Black *BbEe*
Be	Black *BBEe*	Yellow *BBee*	Black *BbEe*	Yellow *Bbee*
bE	Black *BbEE*	Black *BbEe*	Brown *bbEE*	Brown *bbEe*
be	Black *BbEe*	Yellow *Bbee*	Brown *bbEe*	Yellow *bbee*

RECESSIVE EPISTASIS

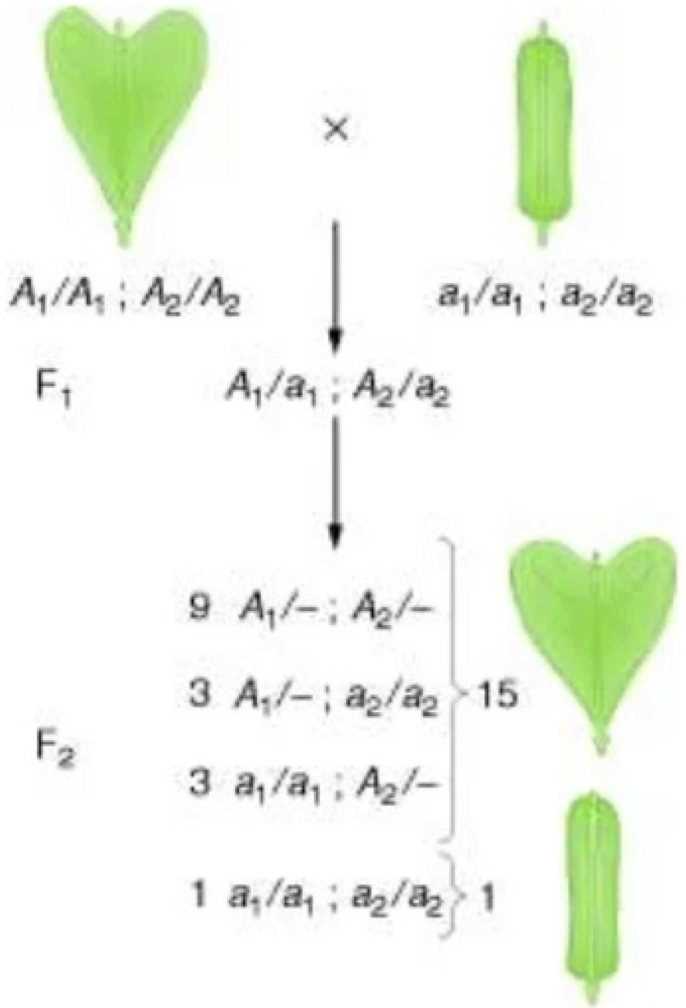
(same metabolic pathway)



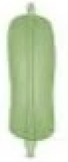


DUPLICATE DOMINANT EPISTASIS

(same metabolic pathway)



A_ or B_ = heart shape 

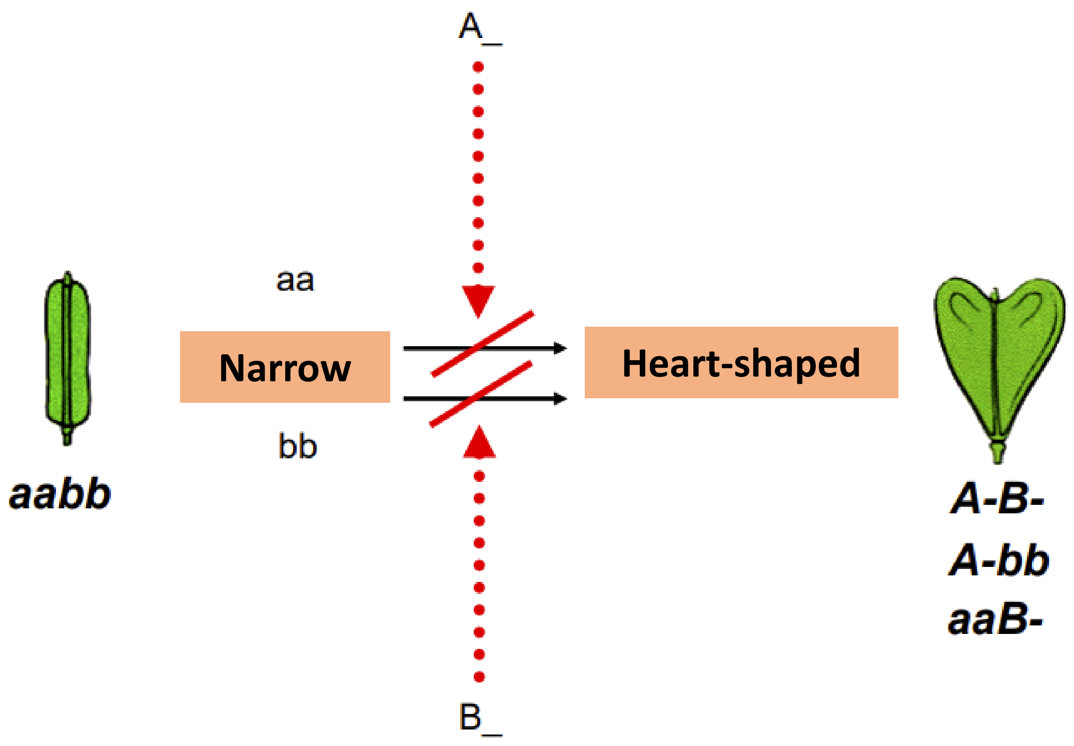
aa and bb = narrow shape 

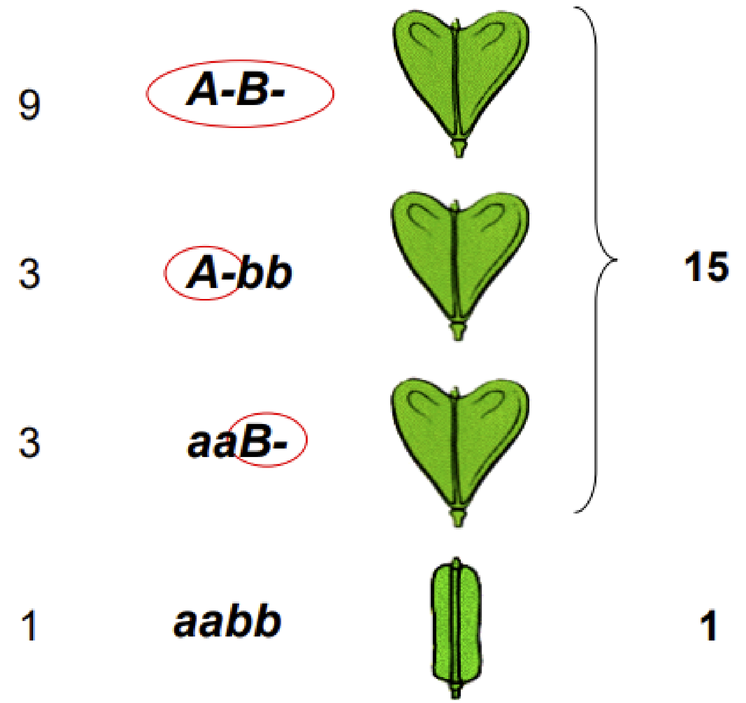
Fruit shape in Shepherd's purse

DUPLICATE DOMINANT EPISTASIS

(same metabolic pathway)

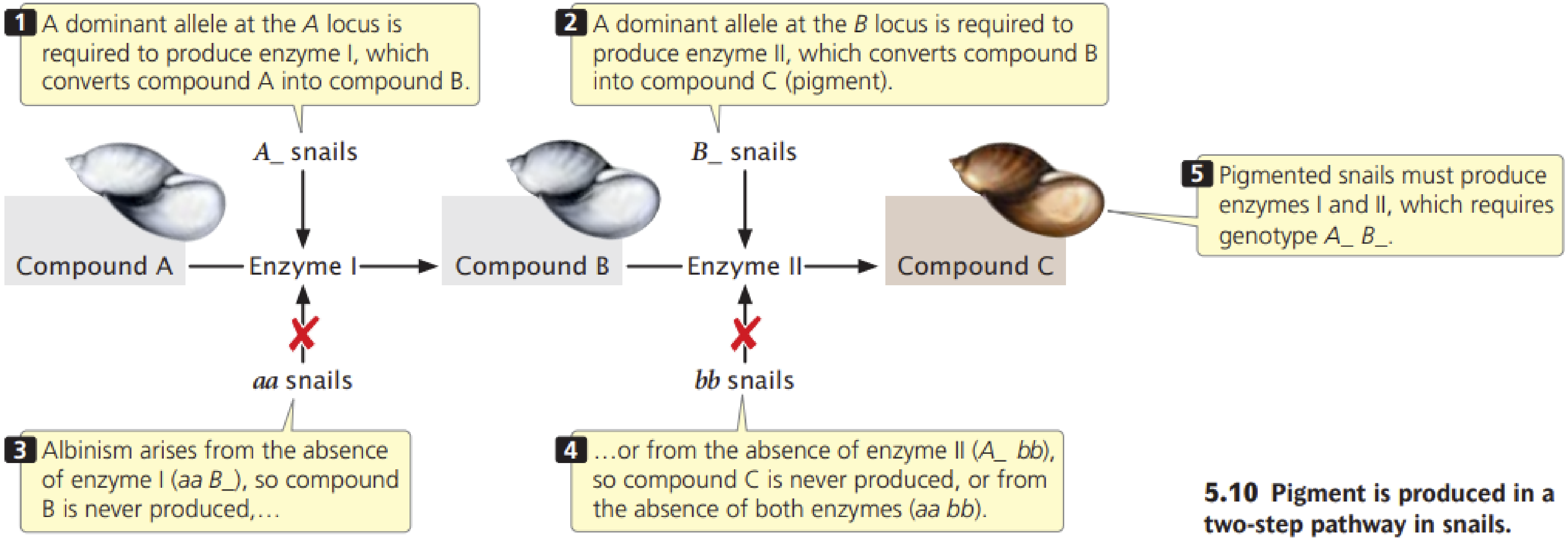
In some cases: duplicate genes





DUPLICATE RECESSIVE EPISTASIS

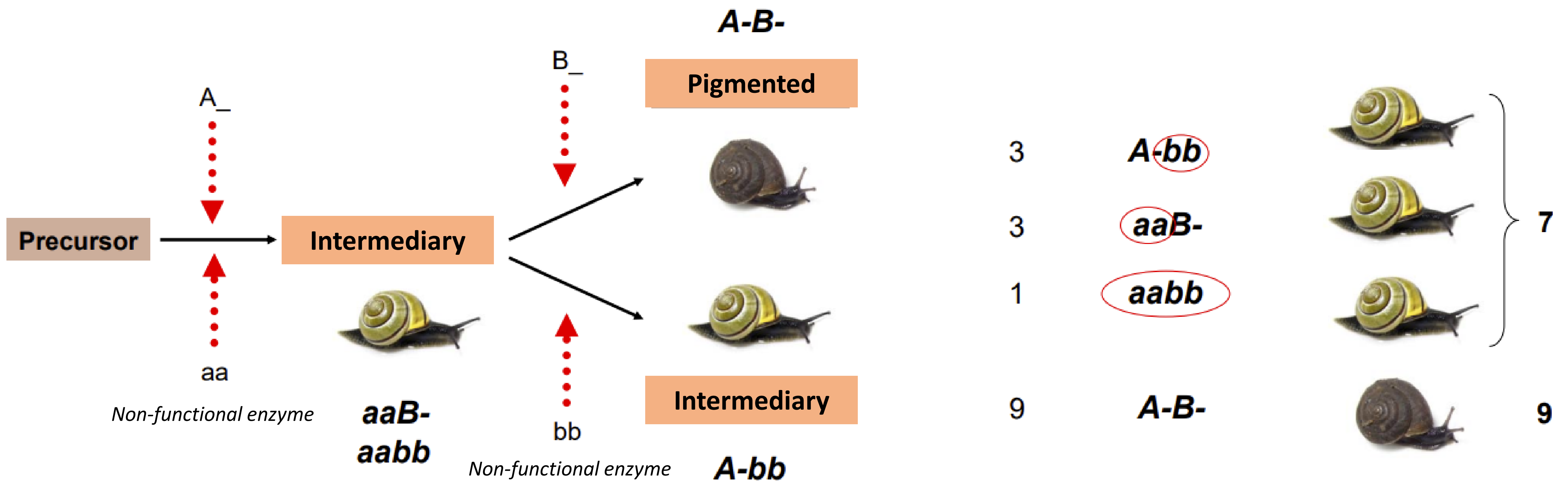
(same metabolic pathway)



5.10 Pigment is produced in a two-step pathway in snails.

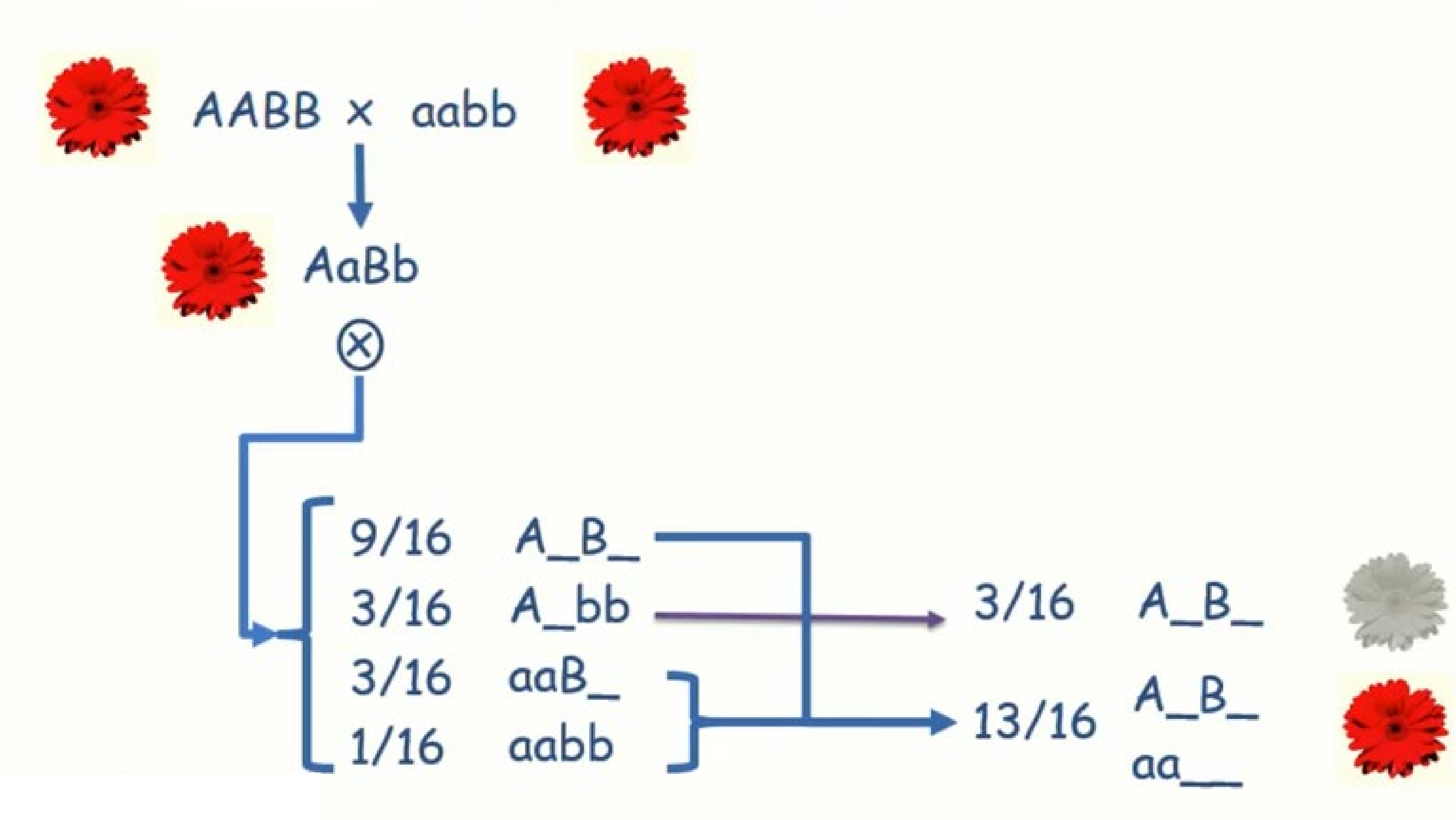
DUPLICATE RECESSIVE EPISTASIS

(same metabolic pathway)



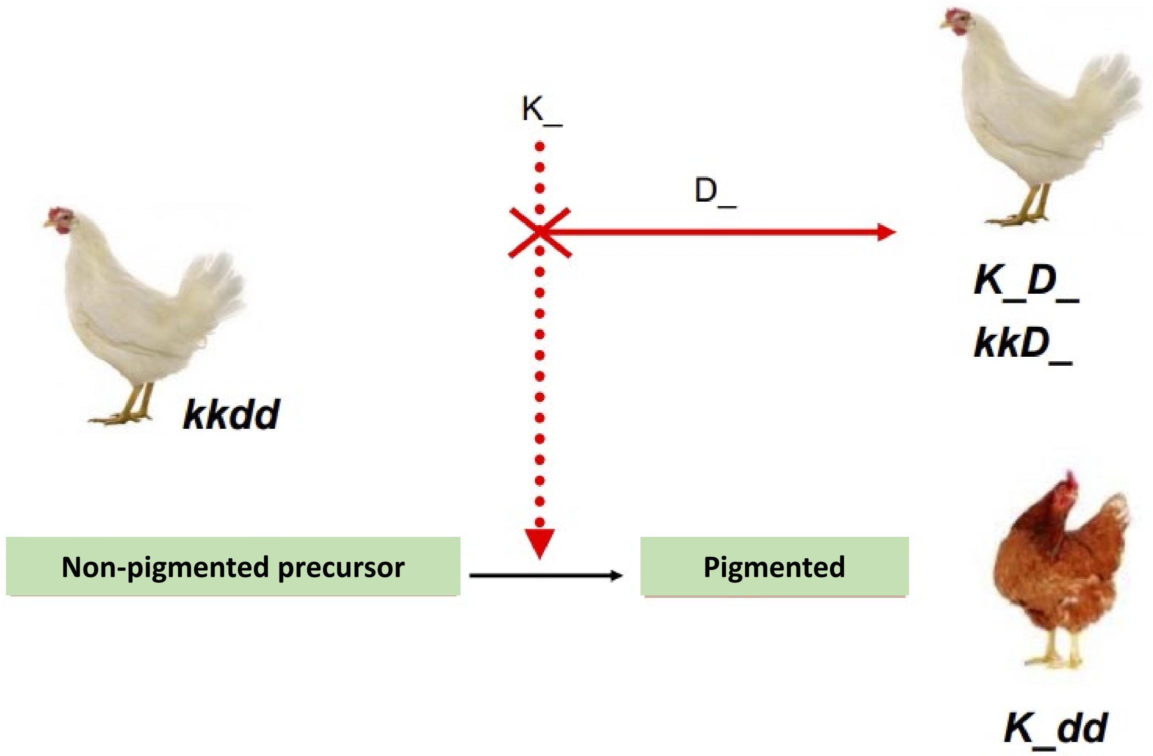
DOMINANT-RECESSIVE EPISTASIS

(same metabolic pathway)



DOMINANT-RECESSIVE EPISTASIS

(same metabolic pathway)



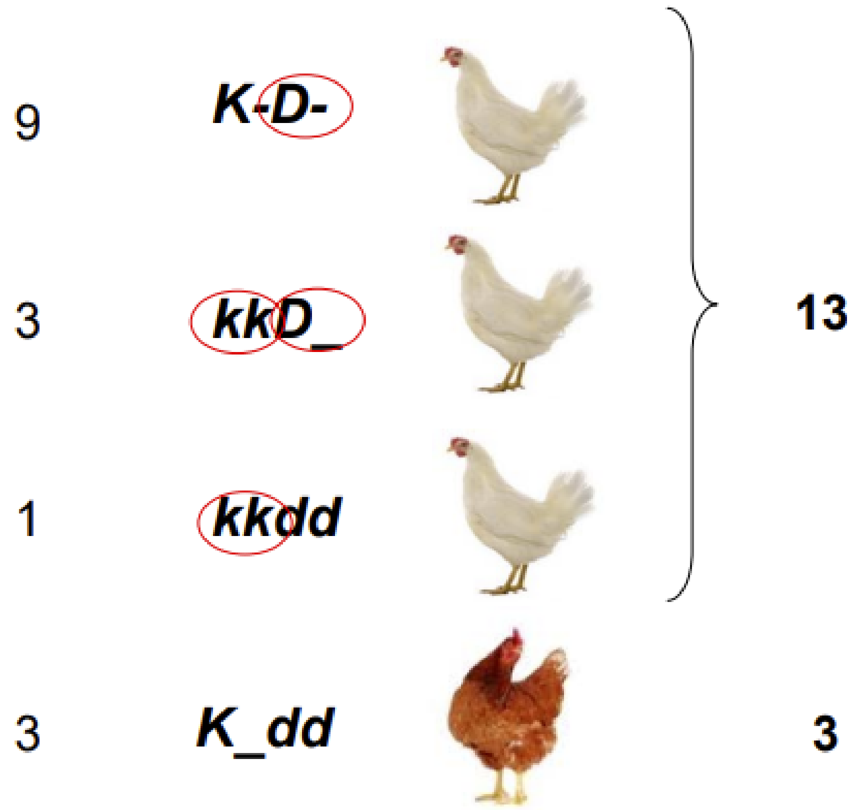
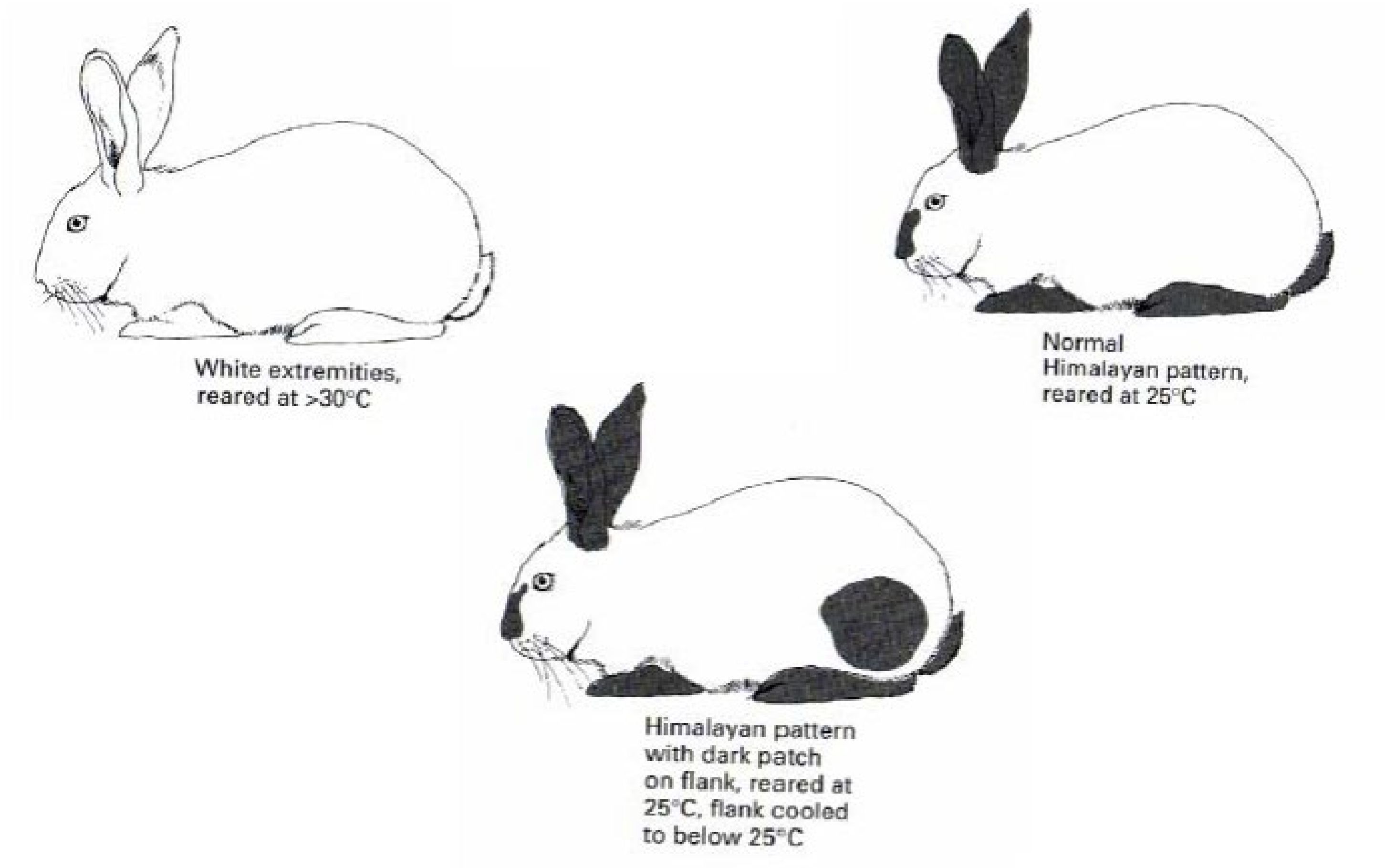


Table 5.2 Modified dihybrid phenotypic ratios due to gene interaction

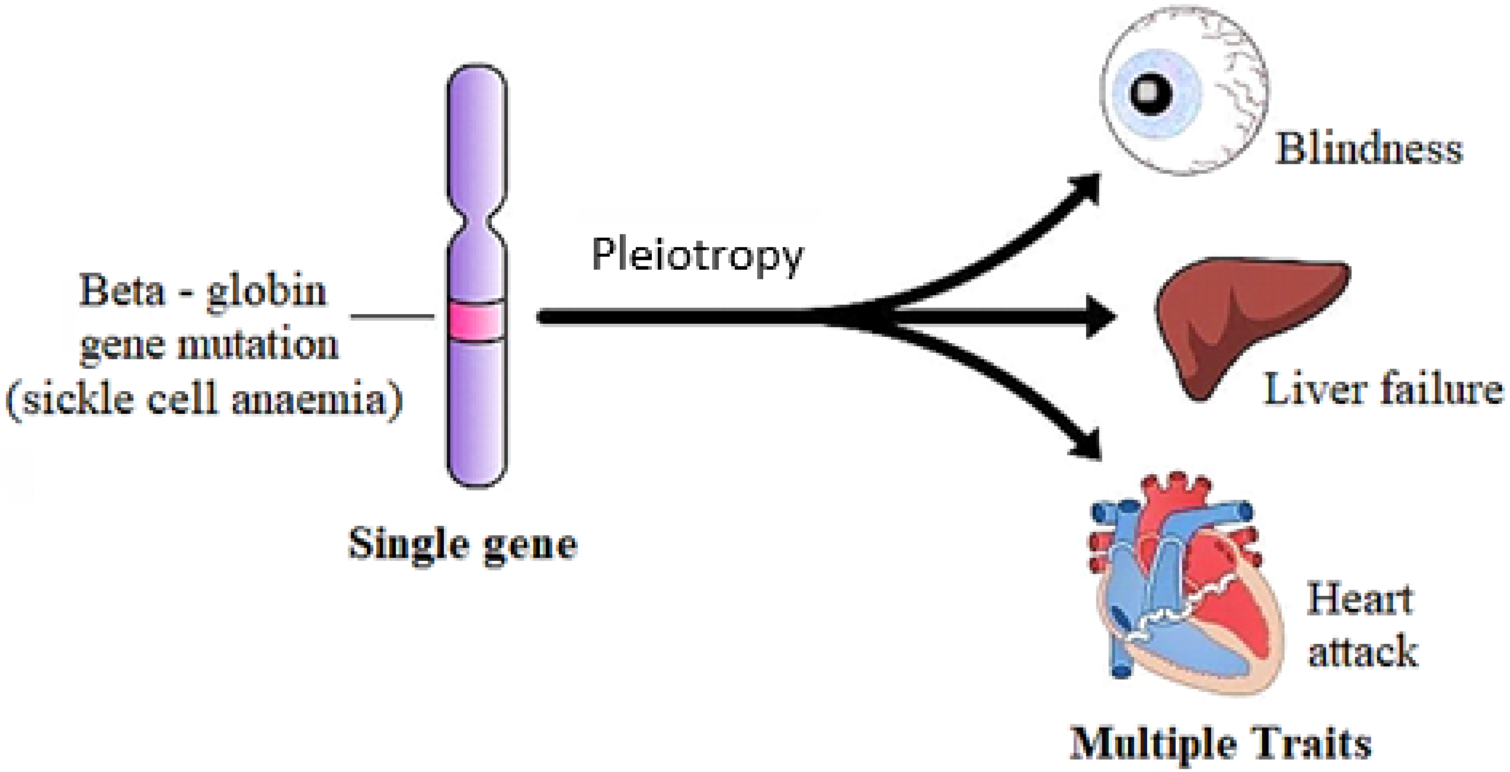
Ratio*	Genotype *A_ B_*	*A_ bb*	*aa B_*	*aa bb*	Type of Interaction	Example
9 : 3 : 3 : 1	9	3	3	1	None	Seed shape and seed color in peas
9 : 3 : 4	9	3	4		Recessive epistasis	Coat color in Labrador retrievers
12 : 3 : 1	12		3	1	Dominant epistasis	Color in squash
9 : 7	9	7			Duplicate recessive epistasis	Albinism in snails
9 : 6 : 1	9	6		1	Duplicate interaction	—
15 : 1	15			1	Duplicate dominant epistasis	—
13 : 3	13		3		Dominant and recessive epistasis	—

*Each ratio is produced by a dihybrid cross (*Aa Bb* × *Aa Bb*). Shaded bars represent combinations of genotypes that give the same phenotype.

PHENOCOPY

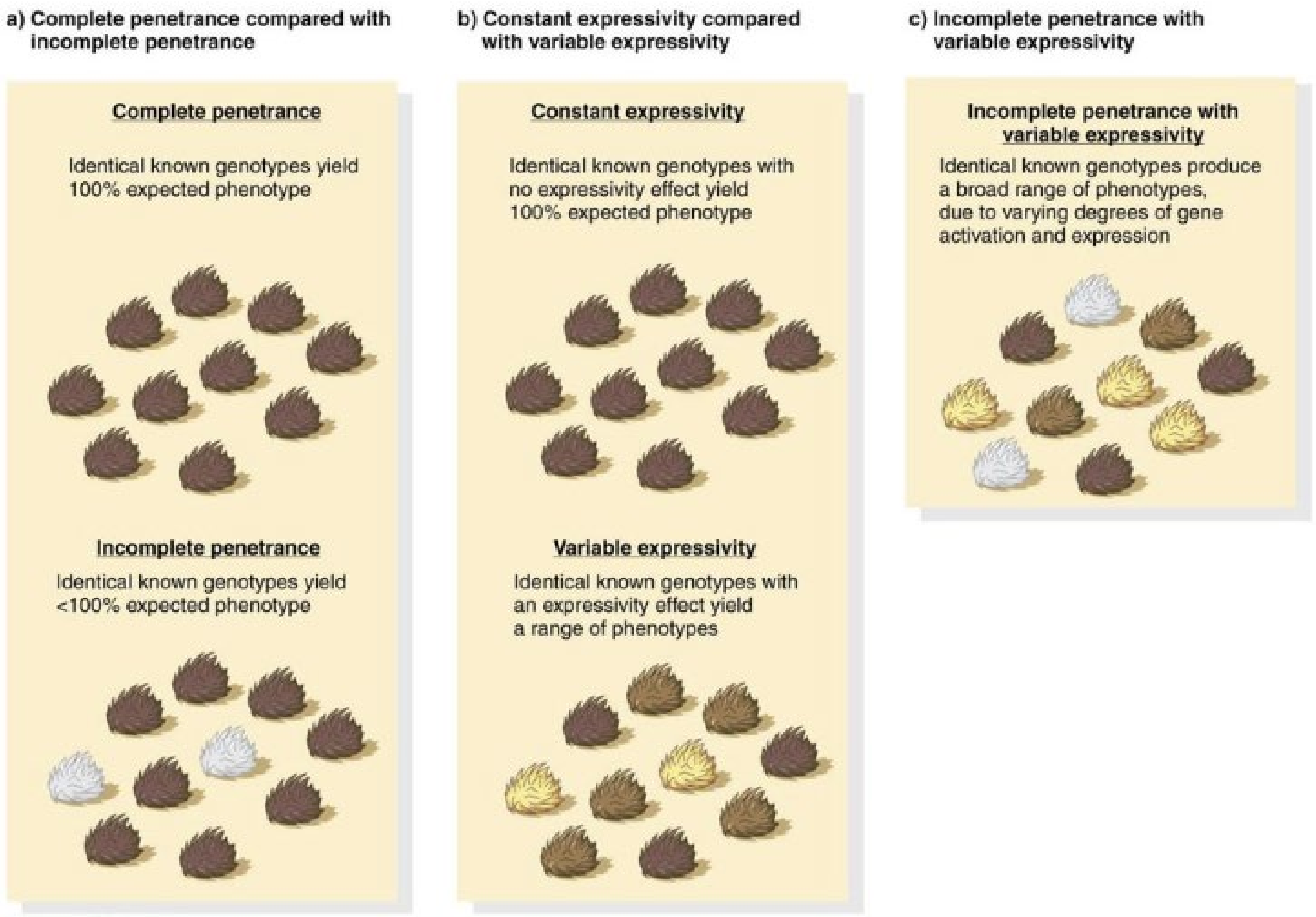

White extremities,
reared at >30°C
Normal
Himalayan pattern,
reared at 25°C
Himalayan pattern
with dark patch
on flank, reared at
25°C, flank cooled
to below 25°C

PLEIOTROPY

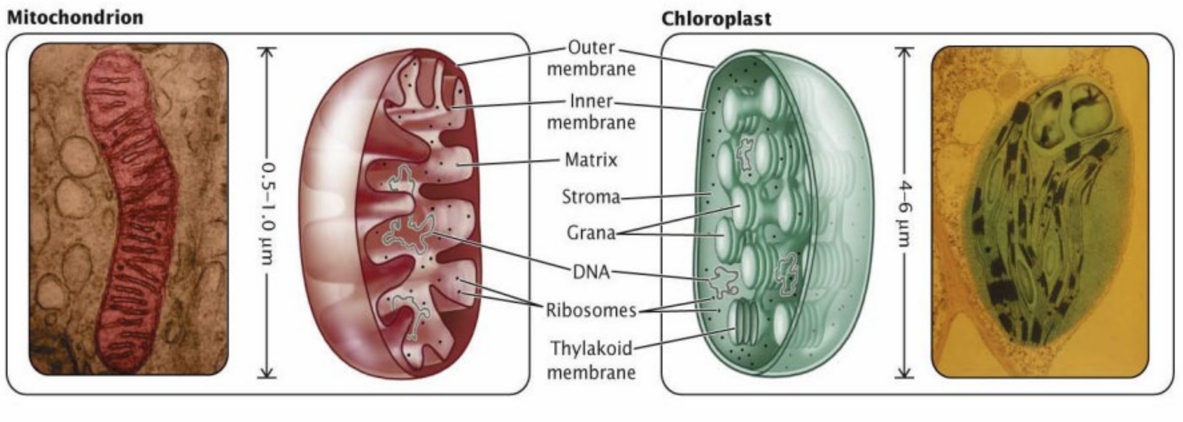


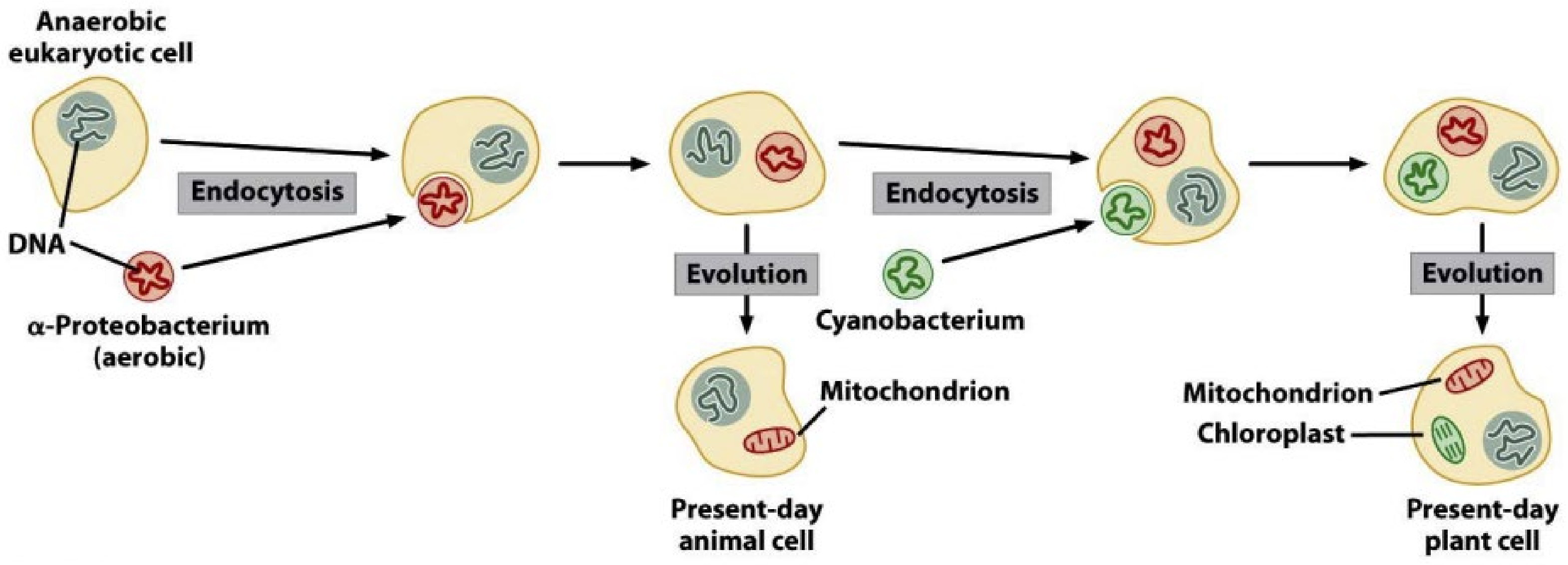
Beta - globin
gene mutation
(sickle cell anaemia)
Pleiotropy
Single gene
Blindness
Liver failure
Heart
attack
Multiple Traits

PENETRANCE AND EXPRESSIVITY



EXTRANUCLEAR INHERITANCE





EXTRANUCLEAR INHERITANCE