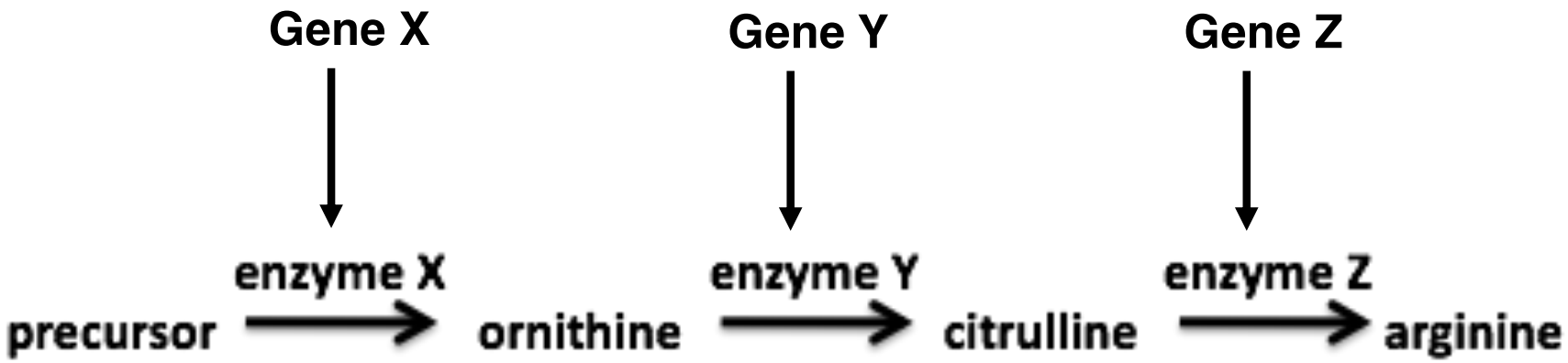
Interactions between genes in a single pathway: "*one-gene-one-enzyme*" hypothesis



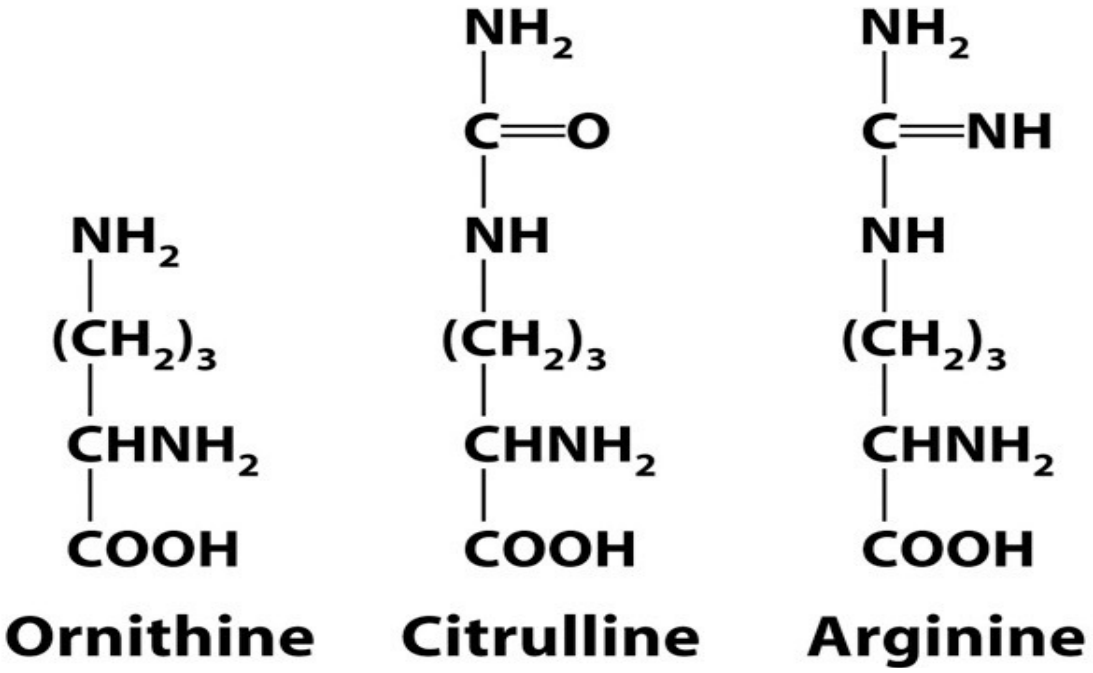
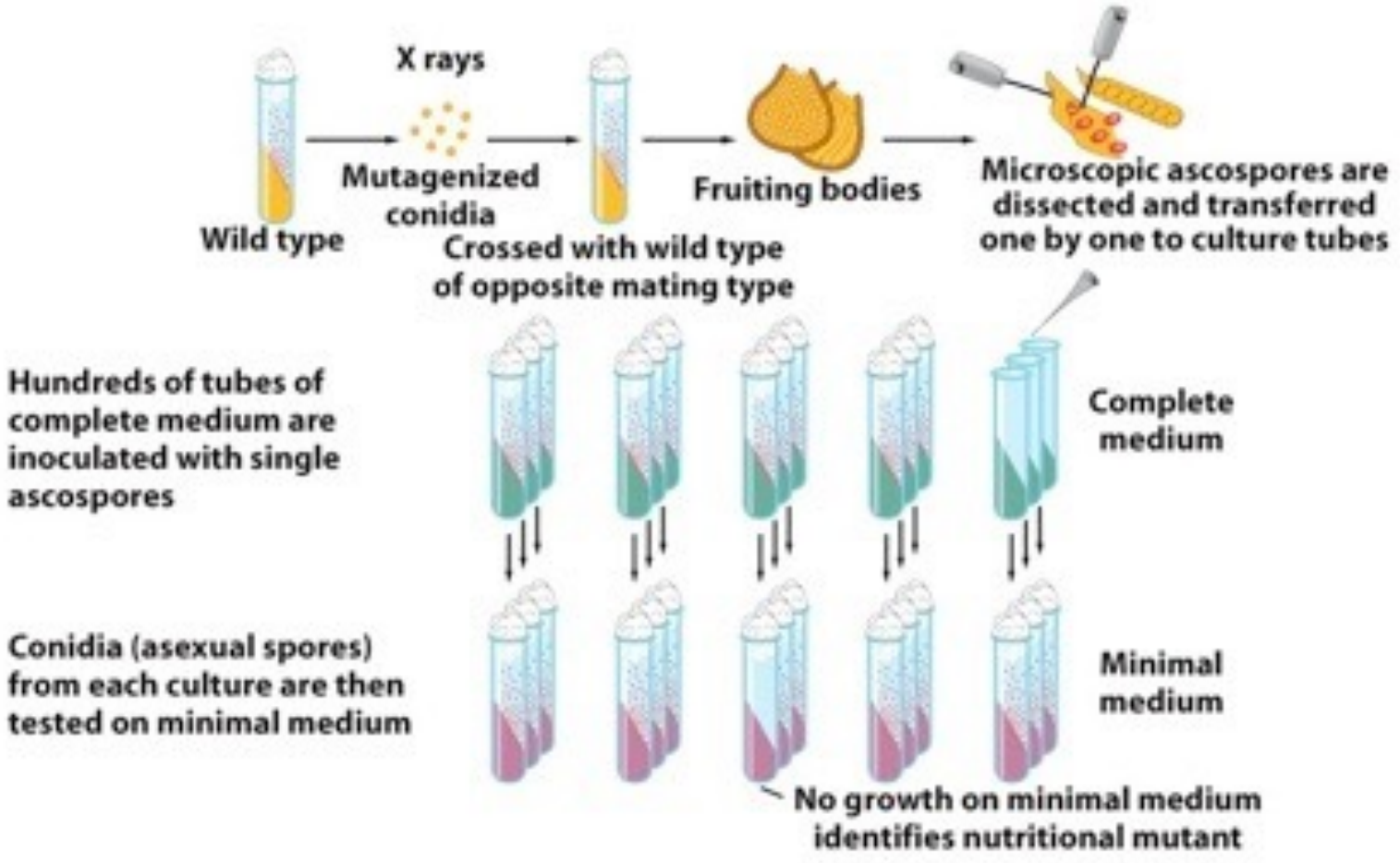


Fig 5.13

Forward genetic screens to identify genes involved in a biochemical pathway



Auxotrophy: The inability of an organism to synthesize a particular organic compound required for its growth

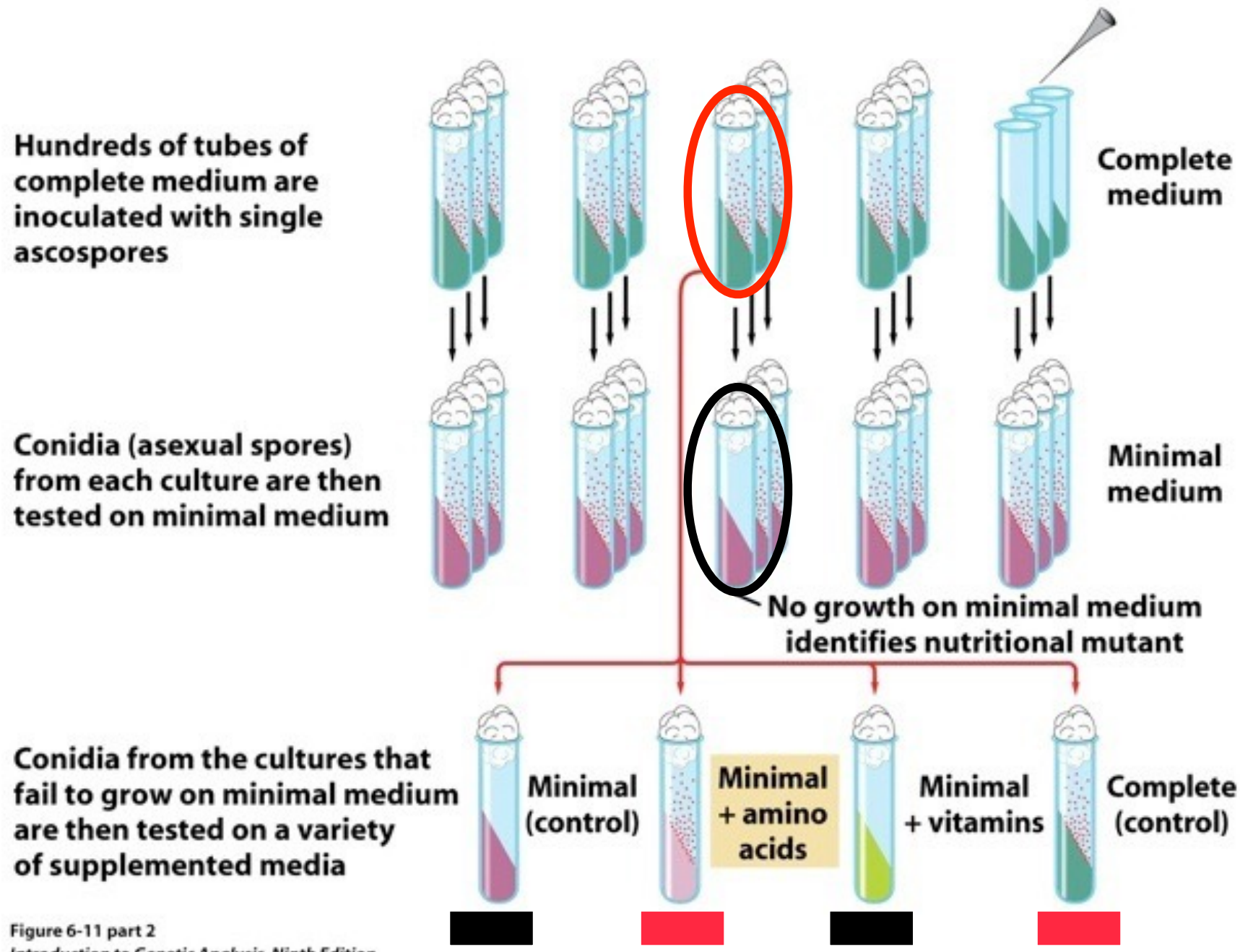


Figure 6-11 part 2
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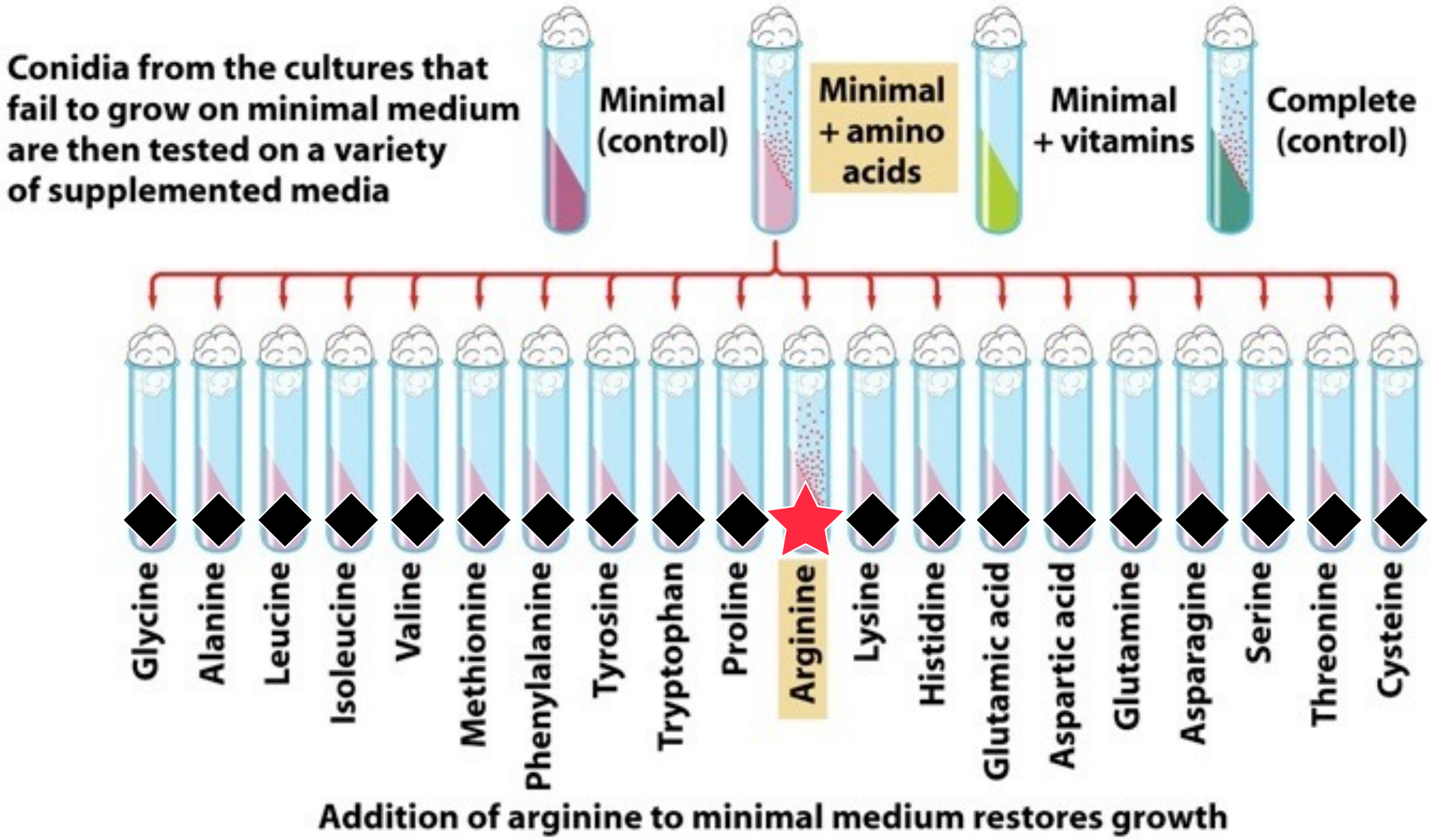

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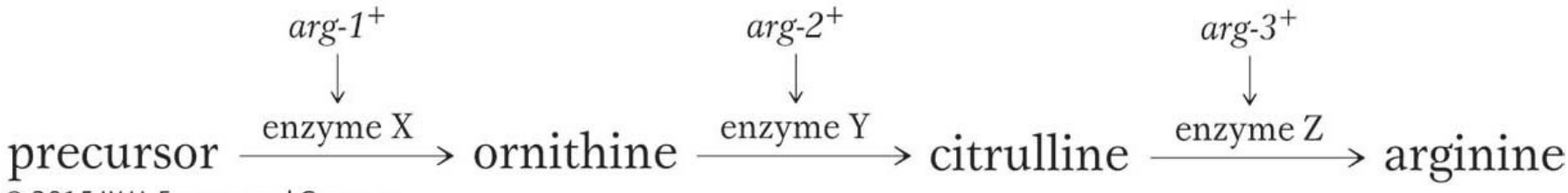
Interactions between genes in pathways

Mutant	Supplement		
	Ornithine	Citrulline	Arginine
arg-1	+	+	+
arg-2	−	+	+
arg-3	−	−	+

Note: A plus sign means growth; a minus sign means no growth.

Table 5.1



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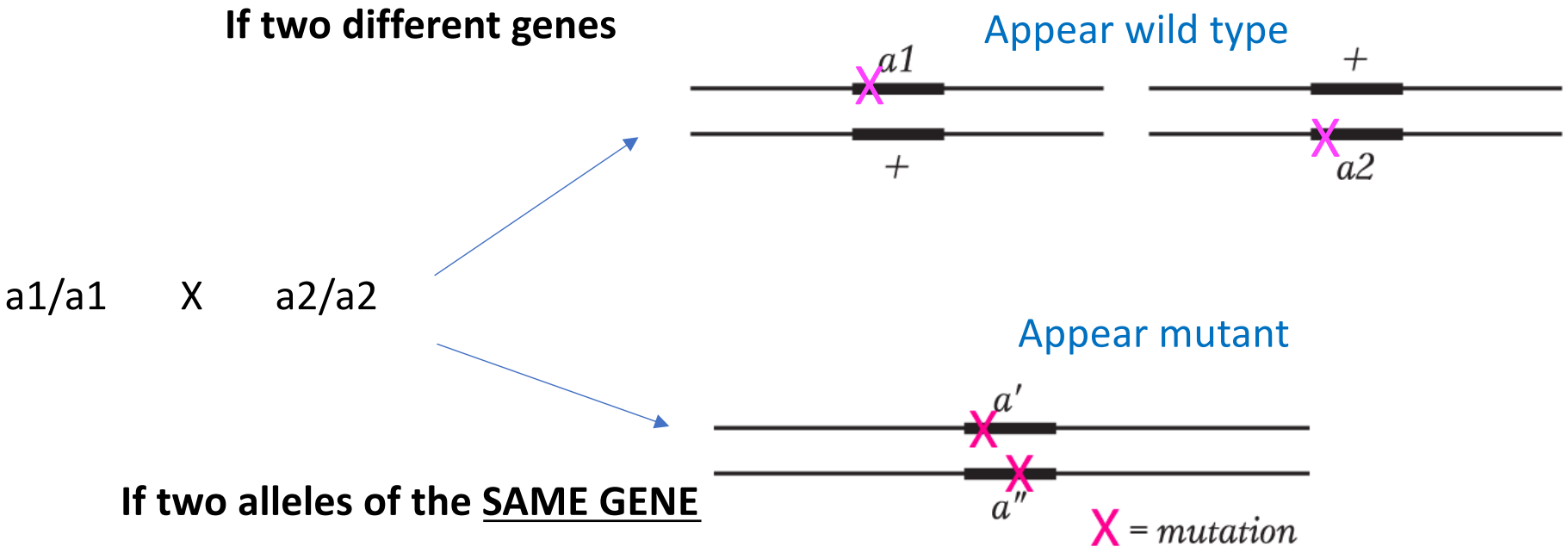
Genes affecting the same trait

In a forward genetic screen, mutants carrying mutations in different genes can be isolated (e.g. arg1, arg2, arg3, etc). Also, multiple mutant alleles of the same genes can be isolated (e.g. different mutant alleles caring mutations in arg1). Part of the process of studying gene interactions involves first determining whether the mutations are alleles of the same gene or different genes.

For recessive mutations, we can use the complementation test.



Interactions between genes in pathways

(harebell plants)

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Several varieties of true-breeding white flowered mutants can be found....are these mutations of the same or different alleles?

Complementation testing

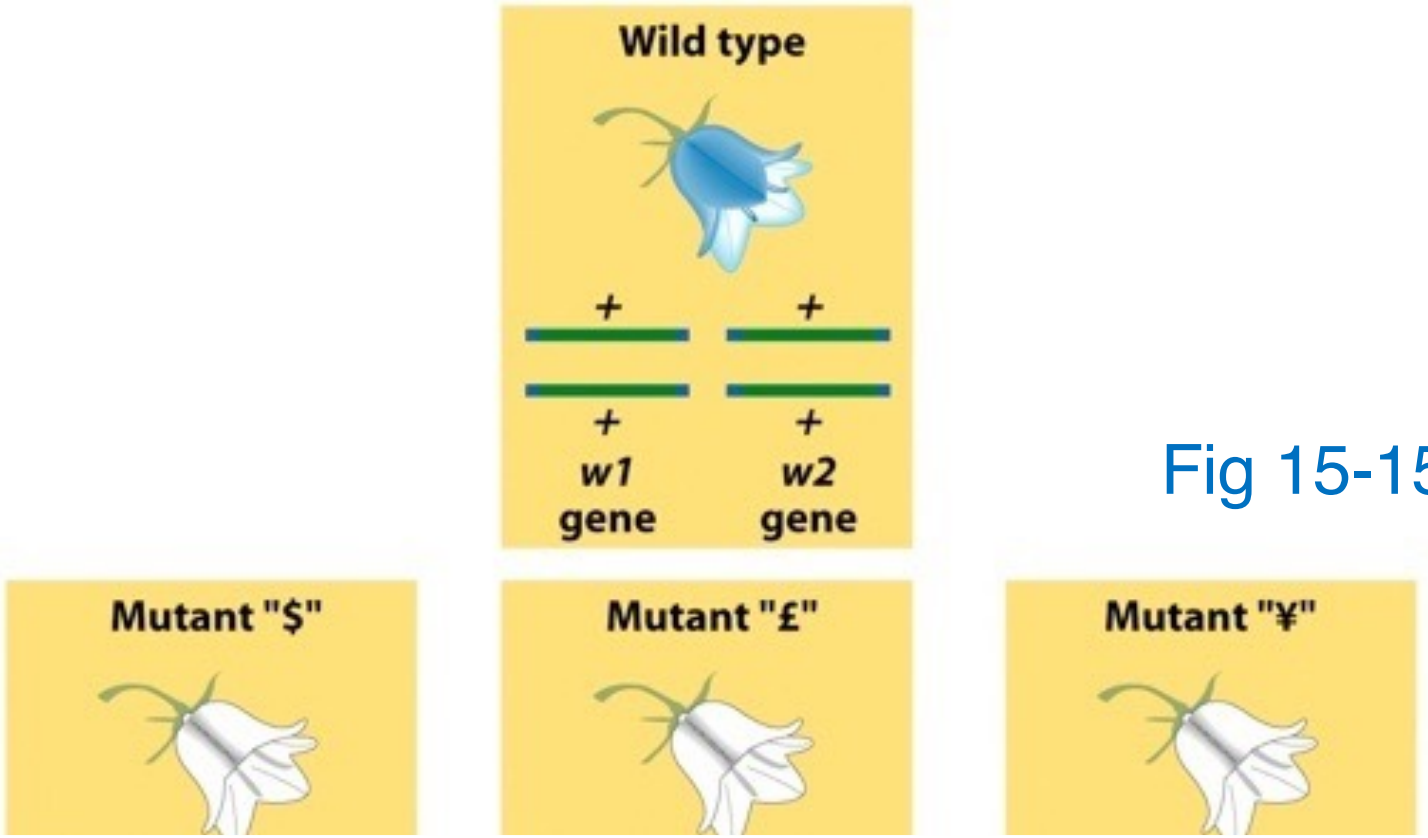
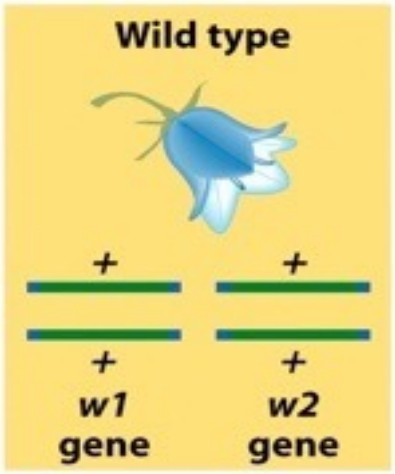


Fig 15-15

-Recessive to the blue

-F1 monohybride cross will tell if the phenotype is caused by one gene or multiple genes (3:1 ratio of blue to white).

Complementation testing



$w^{\$}/ w^{\$}$ $w^{£}/w^{£}$ $w^{¥}/w^{¥}$

white $^{\$}$ X white $^{£}$ white $^{\$}$ X white $^{¥}$ white $^{£}$ X white $^{¥}$

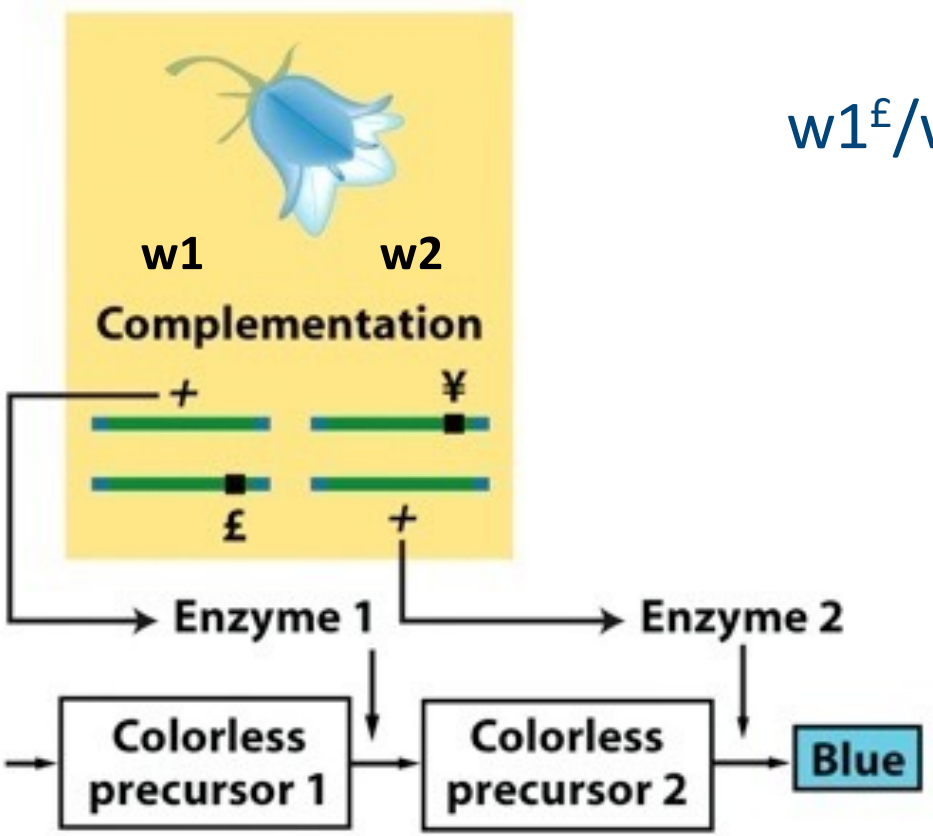
↓ ↓ ↓

all white all blue all blue

Failed to complement complement complement

white $^{\$}$ & white $^{£}$ have mutations affecting the same gene.

Genetic interaction often results in a modified 9:3:3:1 ratio



$w1^{£}/w1^{£;}$; $w2^{+}w2^{+}$ $w1^{+}w1^{+}$; $w2^{¥}/w2^{¥}$ P

$w1^{+}/w1^{£}$; $w2^{+}/w2^{¥}$ F_1

9:7 ratio indicates that the two genes in the same pathway

Blue: 9	**$w1^{+}$ /–**	**; $w2^{+}$/–**	**9**
White: 7	$w1^{+}$ /–	; $w2^{¥}/w2^{¥}$	**3**
	$w1^{£}/w1^{£}$	; $w2^{+}$/–	**3**
	$w1^{£}/w1^{£}$	; $w2^{¥}/w2^{¥}$	**1**

F_2

Gene interactions and Mendelian ratios:
Interaction between *regulator* gene and *target* gene

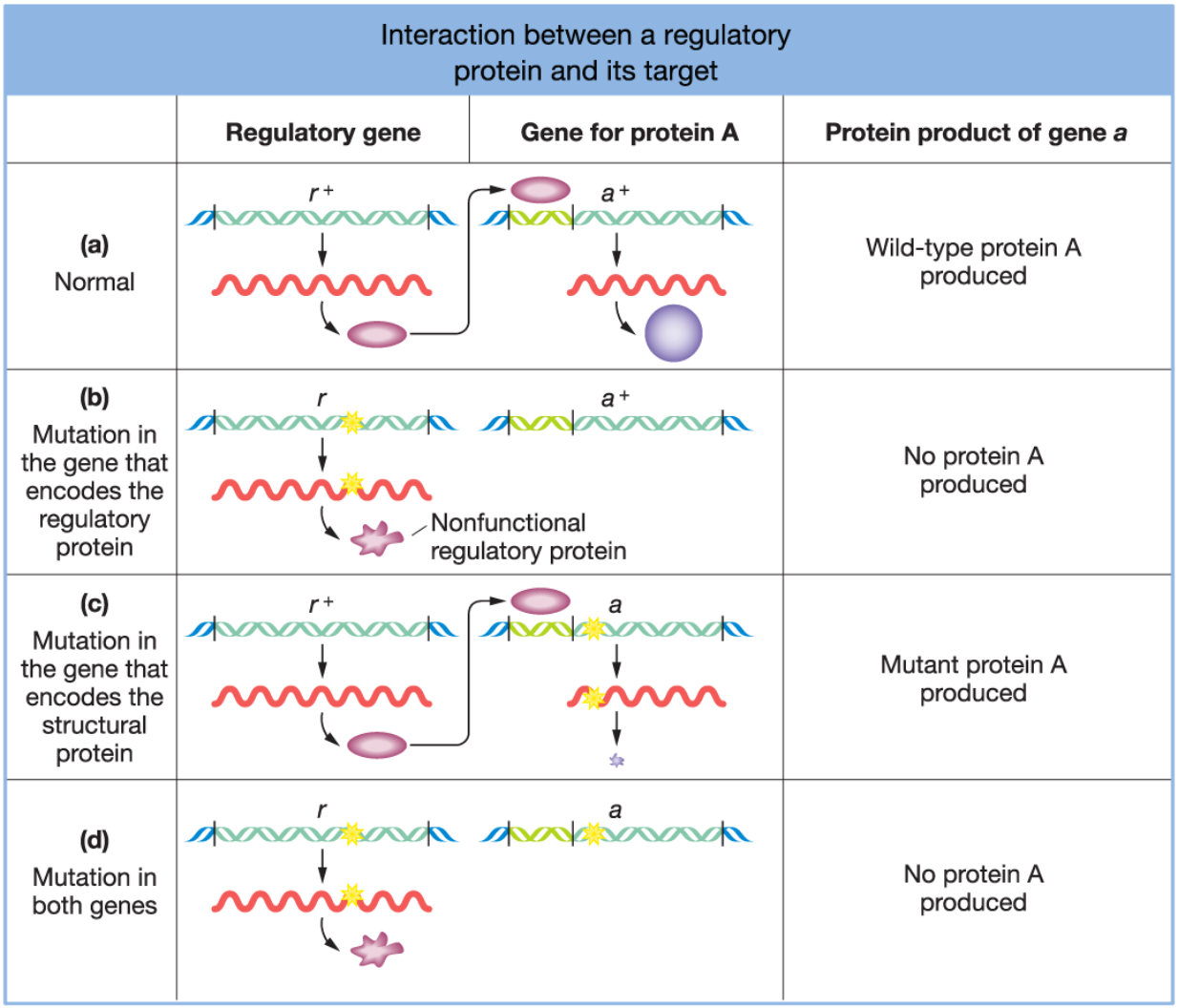
Genotype

9: $r^+/-$; $a^+/-$

3: r /r; $a^+/-$

3: $r^+/-$; a/a

1: r /r ; a/a



Phenotype

9

7

Fig 5.18

Mendelian ratio of two genes affecting on the same characteristic but working independently.

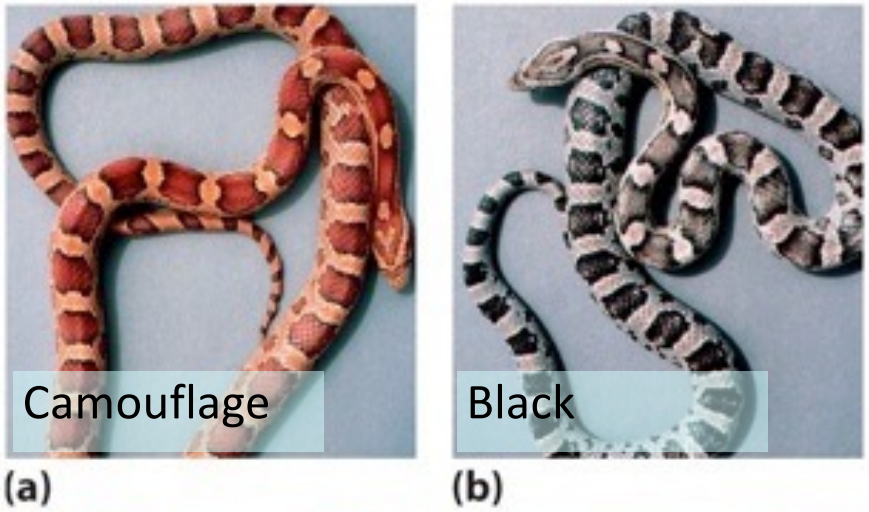


Figure 6-17
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Camouflage	**O/– ; B/–**	9
Black	**o/o ; B/–**	3
Orange	**O/– ; b/b**	3
Albino	**o/o ; b/b**	1

Colour of this snake is controlled by two genes:

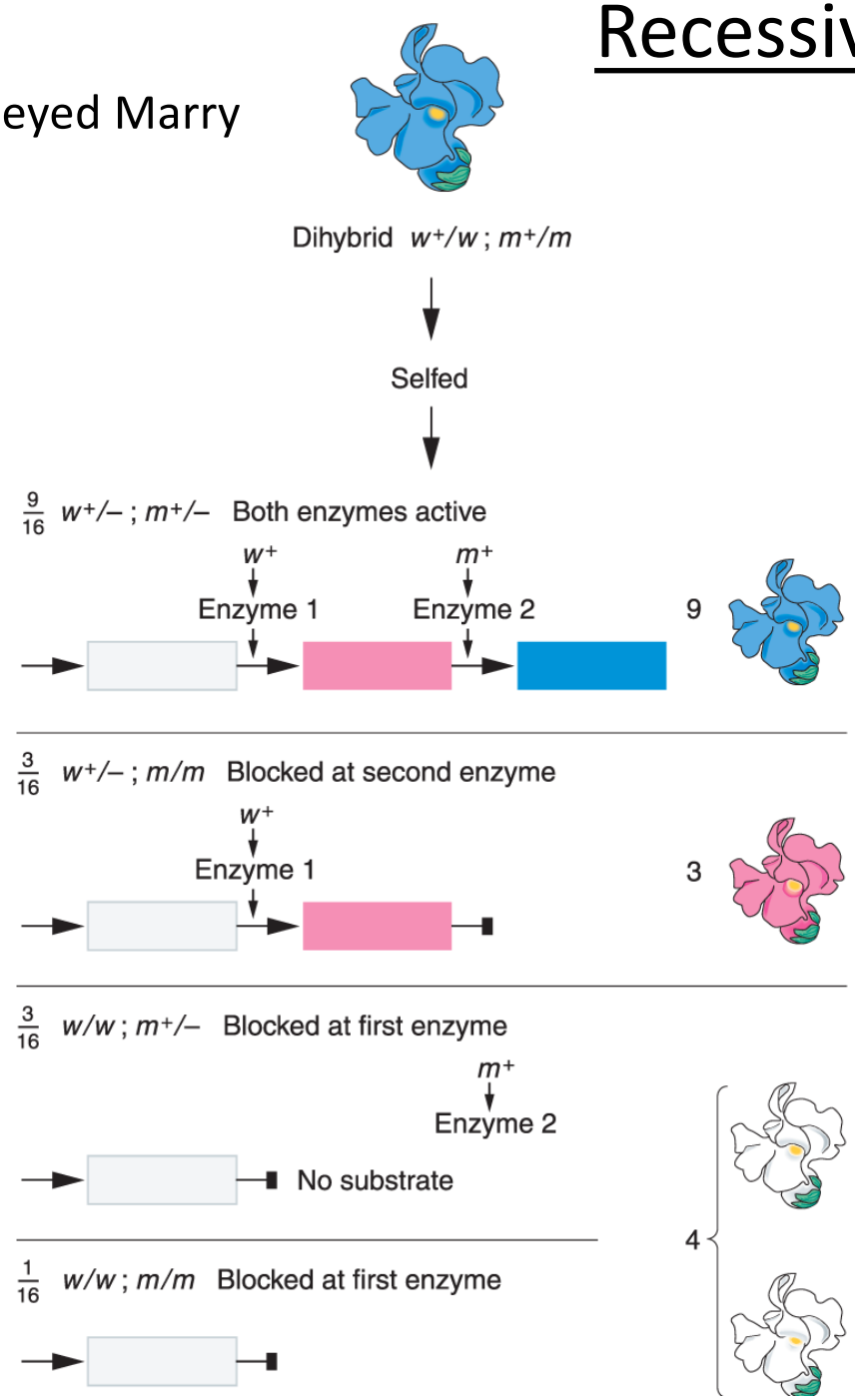
- the orange gene (*o*) O versus o, that determines orange pigment production
- the black gene (*b*) B versus b, that determines black pigment production

•O + B = Camouflage

O and B involved in the same biological process but not in the same pathway!

Recessive epistasis

Blue-eyed Marry



Epistasis is a situation where phenotypic manifestation of an allele is dependent on the genotype of a different gene.

This example is called **recessive epistasis** because the recessive genotype of one gene (*w*) masks the pink flower phenotype associated with the other gene (m)

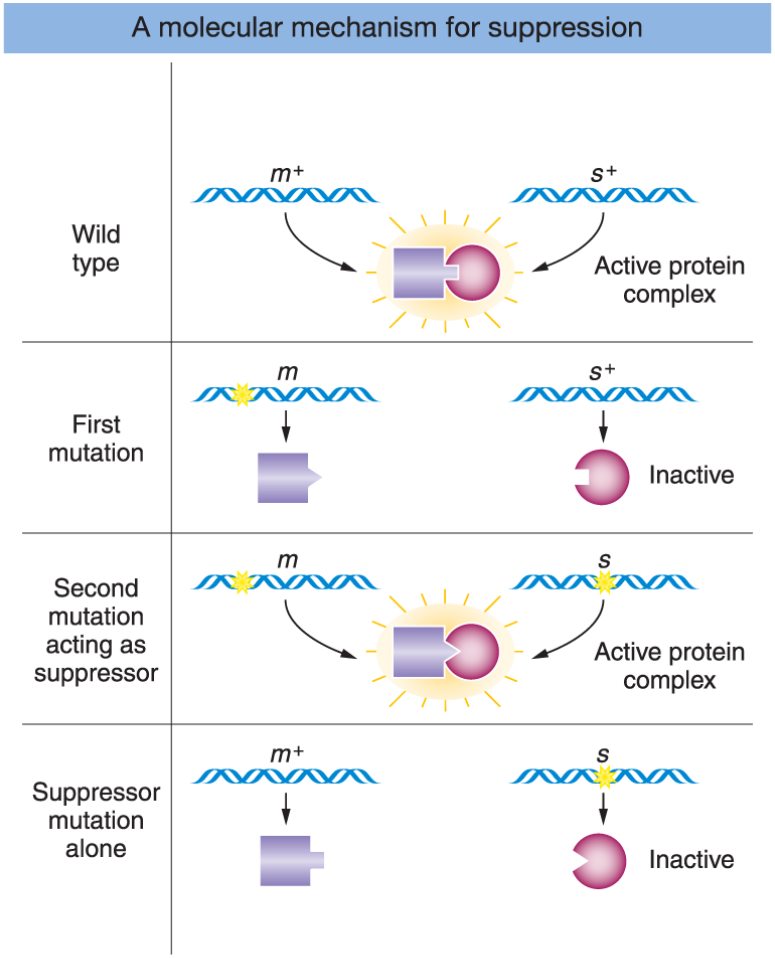
w is epistatic to *m*

In this context dihybrid cross result in 9:3:4 ratio where 4 represent white flower.

Fig 5.19

Gene interactions: SUPPRESSORS

Suppressor is a mutant allele of a gene that REVERSES the effects of an original mutation.



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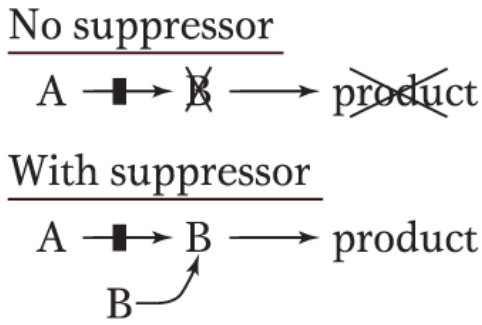
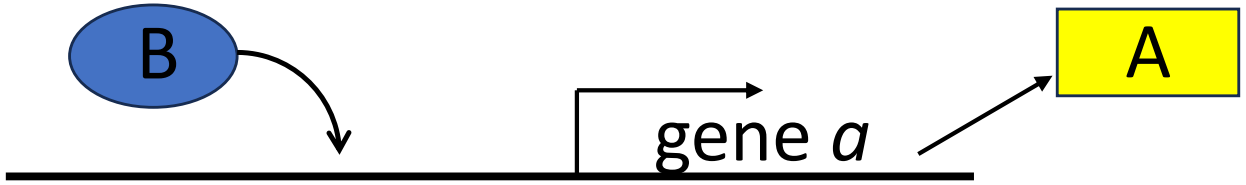


Fig 5.22

Gene interactions: modifier

Modifier: a second mutation that changes the degree of expression of a mutated gene (phenotype).

eg. mutations in the regulatory sequences.



Progeny	Phenotype
$a^+ \cdot b^+$	wild type
$a^+ \cdot b$	defective (low transcription)
$a \cdot b^+$	defective (defective protein A)
$a \cdot b$	extremely defective (low transcription of defective protein)

Gene interactions: Synthetic lethal

Synthetic lethal: mutations in two genes, each often has a weak mutant phenotype, resulting in lethality

Eg. Multiproptien complexes

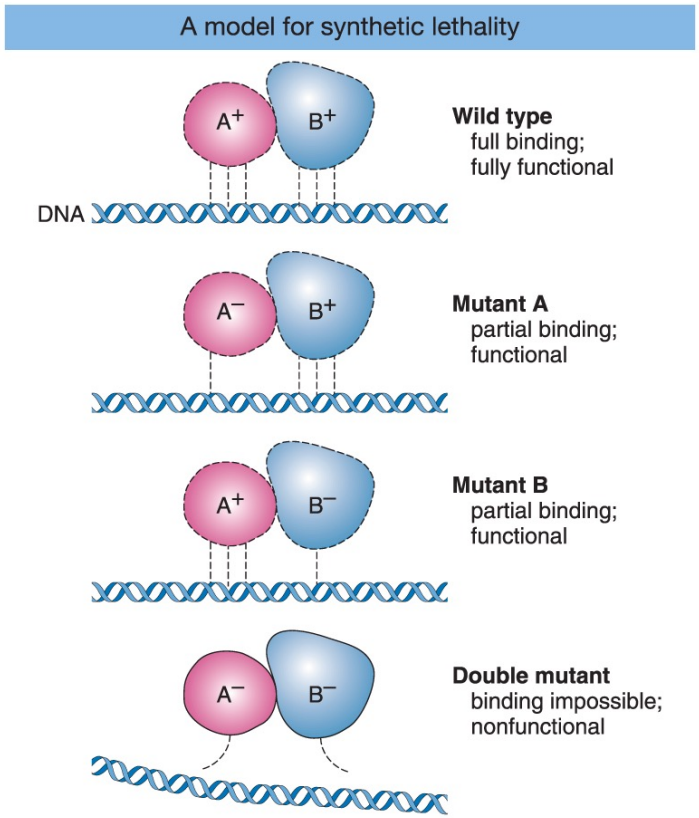


Fig 5.23

Not to be confused with recessive lethal!!!

Gene interactions: Synthetic lethal

Synthetic lethal: mutations in two genes, each often has a weak mutant phenotype, resulting in lethality

Eg. Multiproptien complexes

Genotype

9: $a^+/-$; $b^+/-$

3: a^-/a^-; $b^+/-$

3: $a^+/-$; b^-/b^-

0: a^-/a^-; b^-/b^-

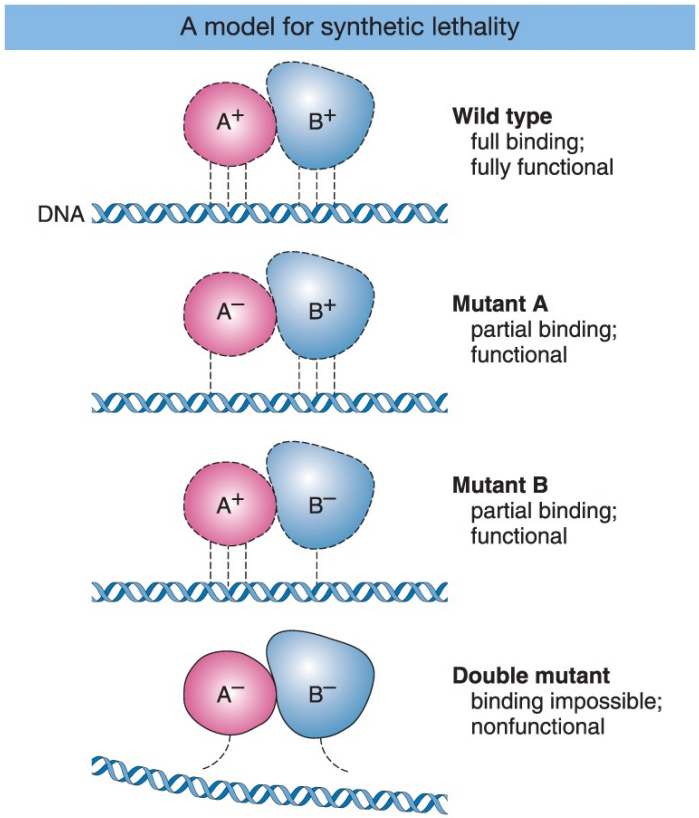


Fig 5.23