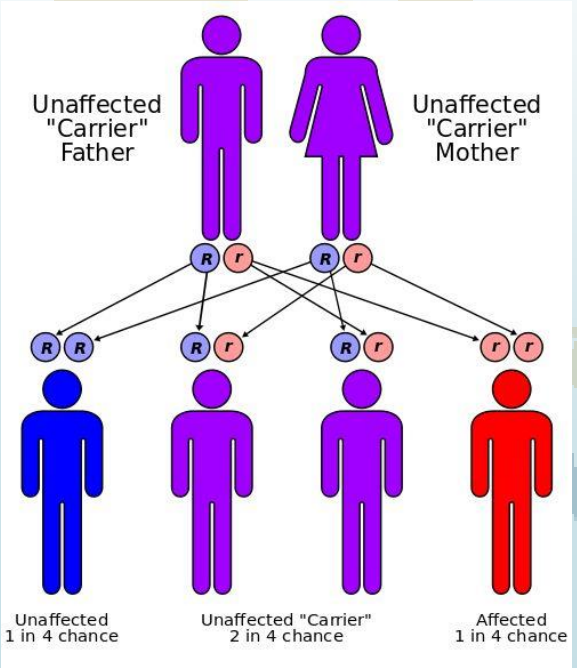
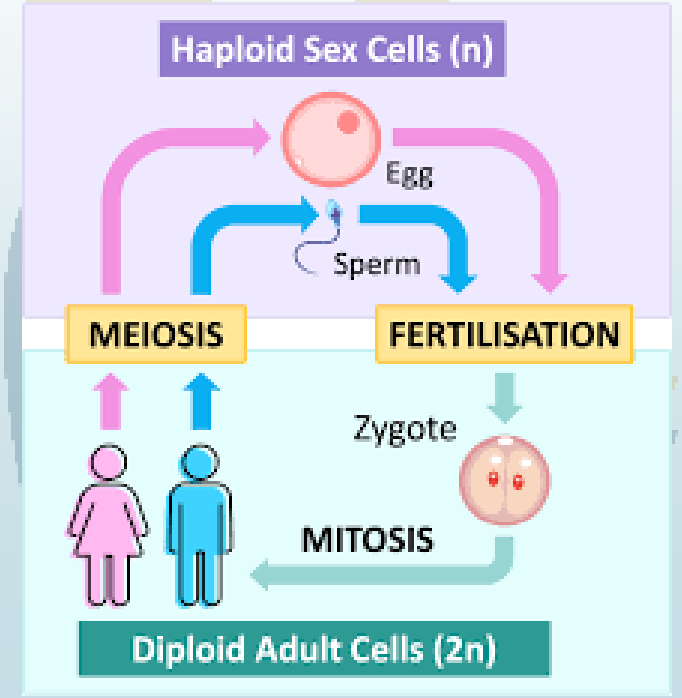
Chapter 2: Transmission of Genes

- Document 1: Hereditary Traits and Genes
- Document 2: Transmission of Allelic Genes



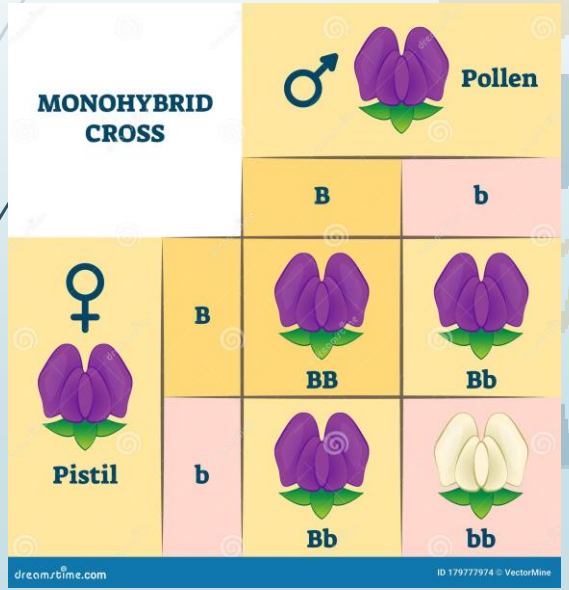
*Transmission of alleles to the Offspring

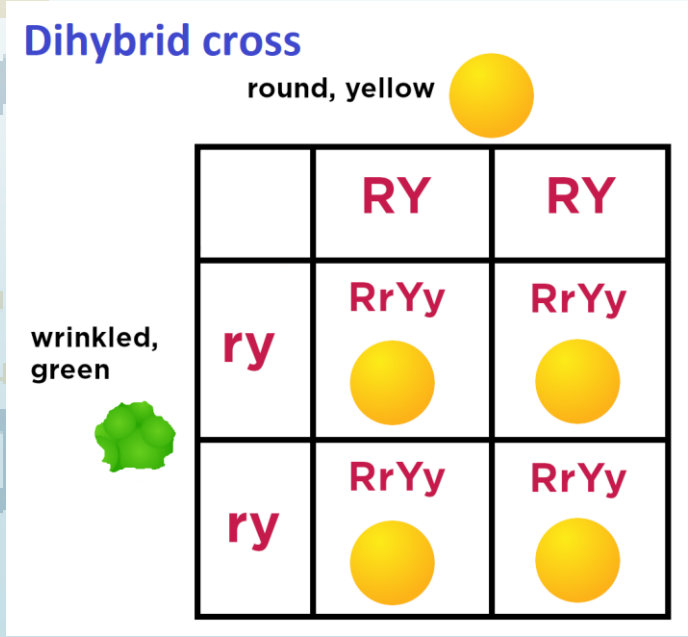
- Meiosis and fertilization ensure the transmission of maternal and paternal chromosomes to the offsprings.



Be Smart ACADEMY

- **Monohybrid cross:** is an experimental crossing of two true-breeding organisms that differ in one trait only.
- ex: skin color, blood group, eye color…





II. Cases of Transmission of Alleles during a Monohybrid Cross

1- Selection

2- Hybridization

3- Self-Cross or Self-fertilization

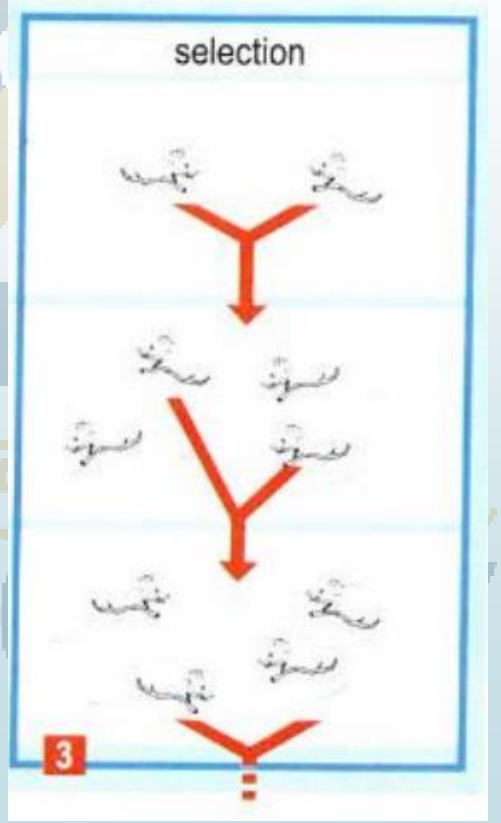
4- Test-cross

5- Codominance

6- Incomplete dominance

7- Lethal allele

1- Selection: If parents are pure and have the same phenotype and genotype, in this case F1 will be pure.



2- Hybridization: a cross between 2 true breeding(pure)lines where parents differ in phenotype, case of dominance.

***Make the necessary factorial analysis to find the phenotypic and genotypic % of F1 generation, starting from the initial parents, in case of hybridization. Doc. d (2) p43 of the National textbook.**

phenotype of parents: ♂Gray x ♀ white

genotype of parents : ♂ GG X ♀ ww

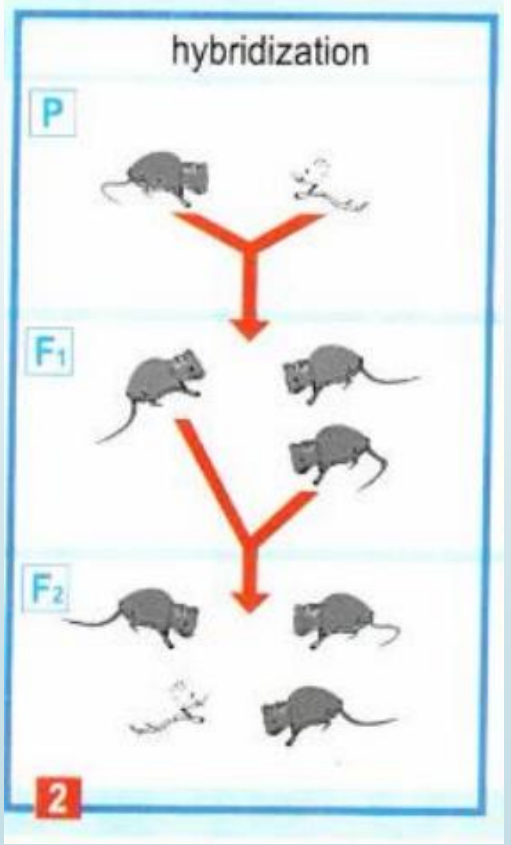
gametes of parents : G 100% ; w 100%

Table of cross

♀ \ ♂	100 % G
100 % w	100% Gw

genotypes of F_1: 100% Gw

phenotypes of F_1: 100% gray



3- Self-cross or Self-fertilization: crossing 2 members of F1 to give F2

*** Make the necessary factorial analysis to find the phenotypic and genotypic % of F2 generation, starting from the first generation, in case of hybridization.**

phenotype of F_1 : ♂ gray X ♀ gray

genotype of F_1 : ♂ Gw X ♀ Gw

gametes of F_1 : 50% G, 50% w, 50% G, 50% w

Self cross: F1 X F1

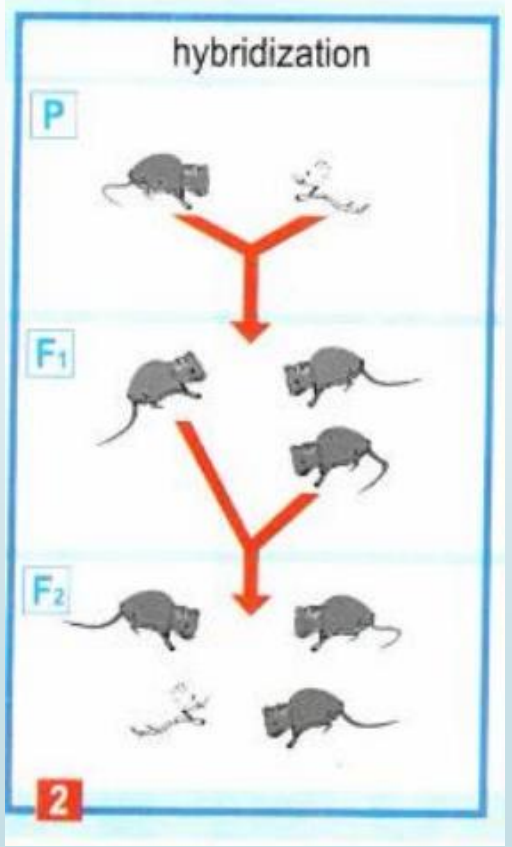
Table of cross

♀ / ♂	50 % G	50 % w
50 % G	25% GG	25% Gw
50 % w	25% Gw	25% ww

genotypes of F_2: 25% GG 50% Gw 25% ww

phenotypes of F_2: 75% gray, 25% white

Thus, the results are verified.



☞ Upon crossing two different phenotypes for a certain trait, if:

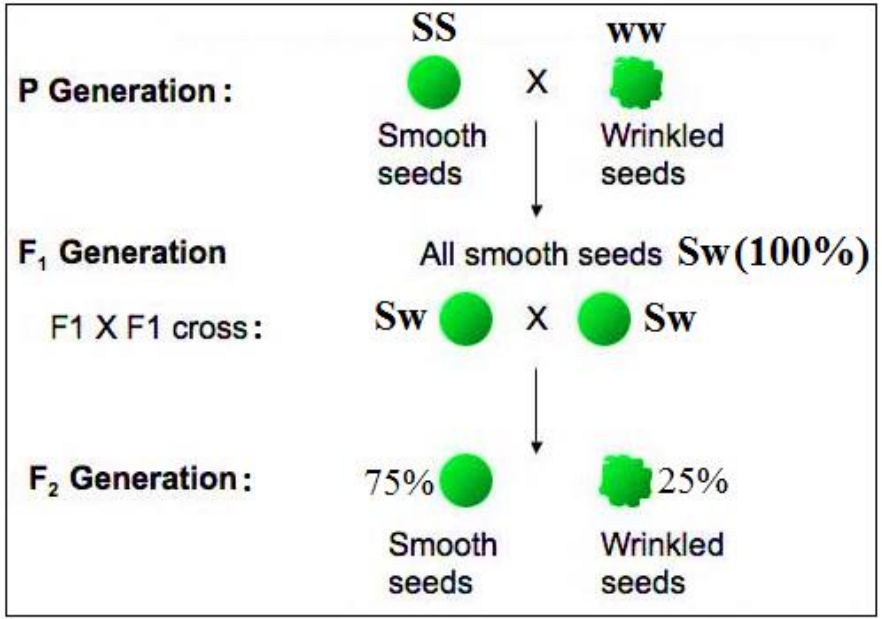
☞ **<u>all F1(100%)</u>** have the **<u>same phenotype and genotype</u>**:

⇨ ***parents are pure and F1 shows the dominant phenotype.***

Example: Upon crossing smooth and wrinkled seeds, all F1 have 100% smooth seeds.

⇨ Parents are pure (each has same alleles).

⇨ Smooth is dominant and dominant character is pure in the parents.



⇨ **Genotype of parents**: SS Not (Sw) × ww

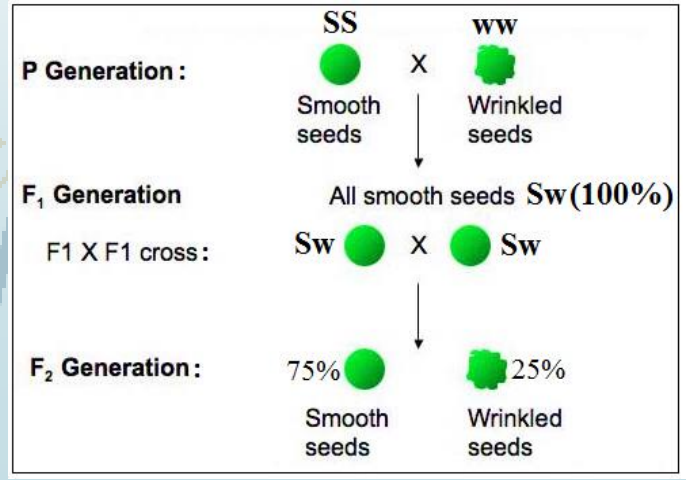
pure pure

F1: 100% Sw

(Smooth)

F1: Genotype :100% Sw (hybrid)

Phenotype:100% smooth.



4- Test-cross:

- Is a cross done between an organism having a dominant trait of unknown genotype (pure or hybrid) and an organism having a recessive trait (always pure).

☞***Genotype of Dominant trait may be:***

Pure: LL, WW, SS... (same alleles) **or** **Hybrid:** Lv, Sw... (different alleles).

- **Aim of test-cross:** used to verify if an individual of dominant trait is pure or hybrid for this trait.

- ***How to make a test cross?***

By crossing the dominant trait (unknown genotype: pure or hybrid) with the recessive trait (always pure).

Dominant (?????????) × Recessive (pure)

- **Example:** Green color is dominant while black color is recessive in group of drosophila.

Genotype of green color: GG or Gb

Genotype of black color: bb

What is the real genotype of green trait, GG or Gb?

Case 1:

Dominant (??) × recessive

----------?? × bb

⇩

F_1: Genotype: 100% GG (1 result)

Phenotype: 100% green

⇨ Dominant is **pure** : GG

Case 2:

Dominant (??) × recessive

----------?? × bb

⇩

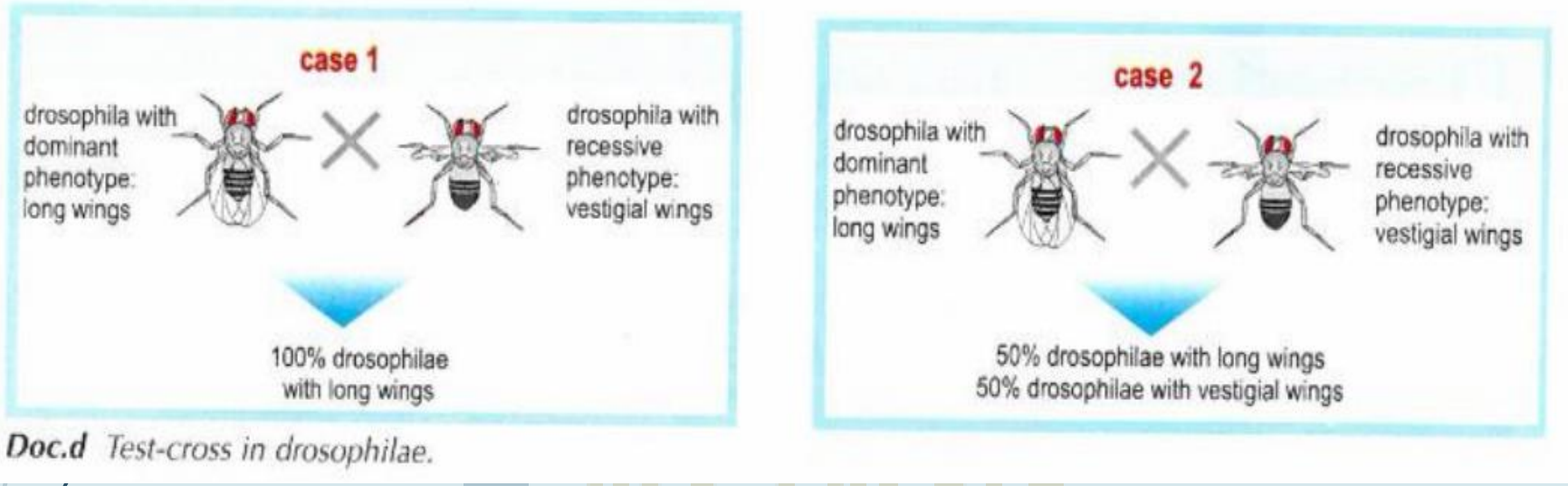
F_1: Genotype: 50% Gb 50%bb (2results)

Phenotype: 50% green 50% black

⇨ Dominant is **hybrid**: Gb

Application 1:

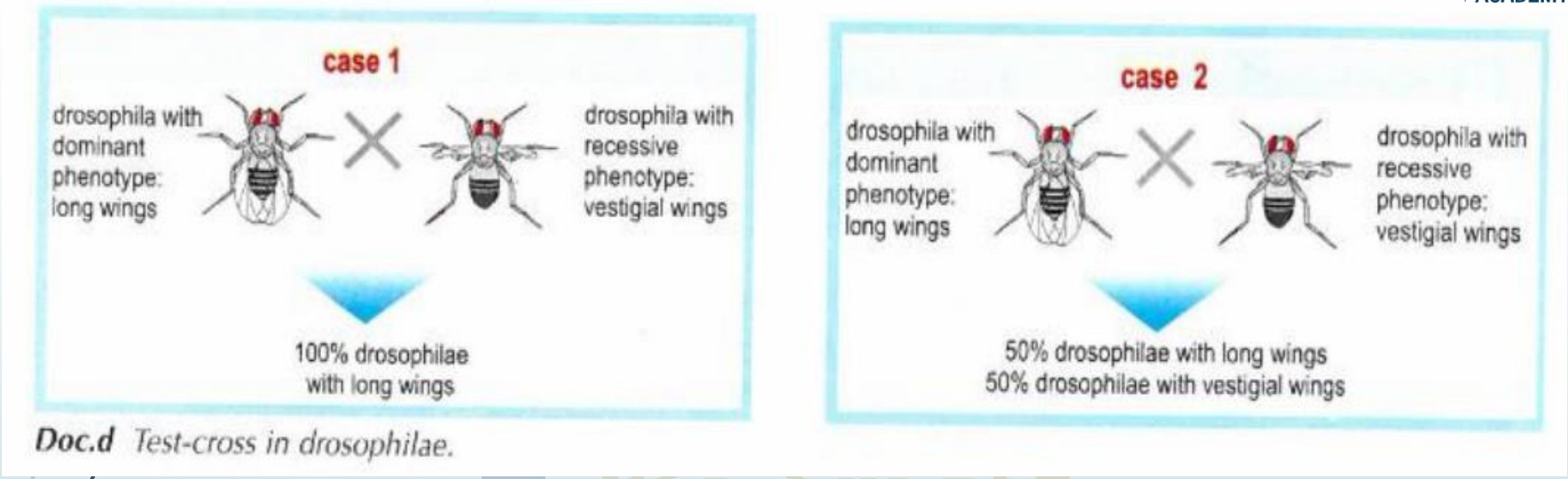
- Referring to Doc. d, p.45 of the National textbook:



Doc.d *Test-cross in drosophilae.*

1- Indicate the dominant and the recessive allele. Justify

Long wing is the dominant allele and vestigial wing is the recessive one, since upon crossing drosophila with long wings with drosophila with vestigial wings, all the obtained drosophila were with long wings.

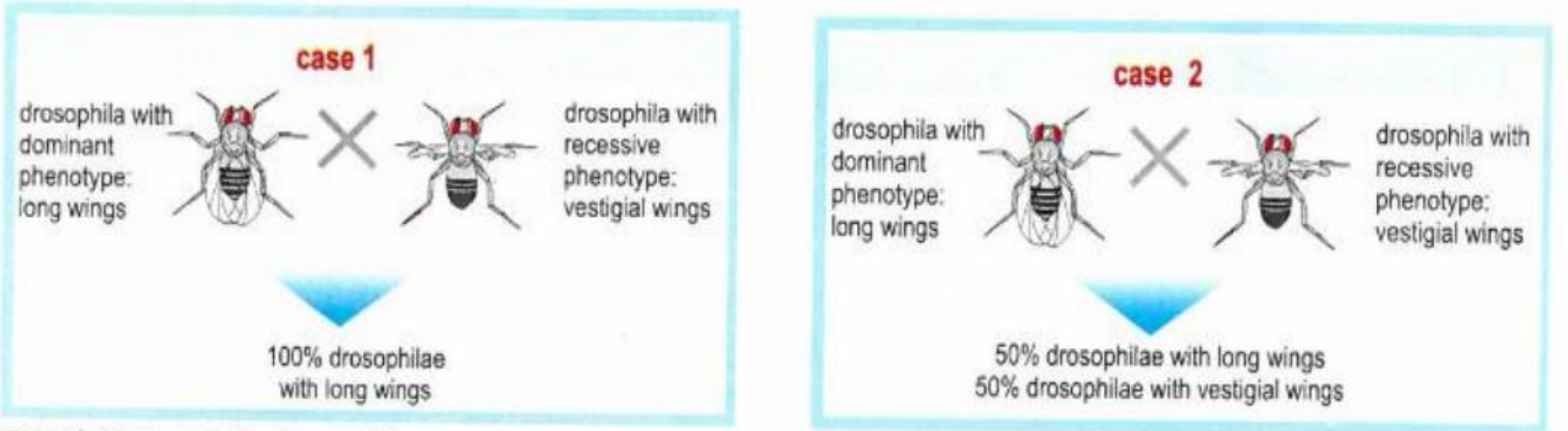


Doc.d *Test-cross in drosophilae.*

2- Designate by symbols the corresponding alleles.

-Let L be the symbol of the long wing trait, which is dominant.

-Let v be the symbol of the vestigial wing trait, which is recessive.



Doc.d *Test-cross in drosophilae.*

3- Specify the genotypes of the parents in each case.

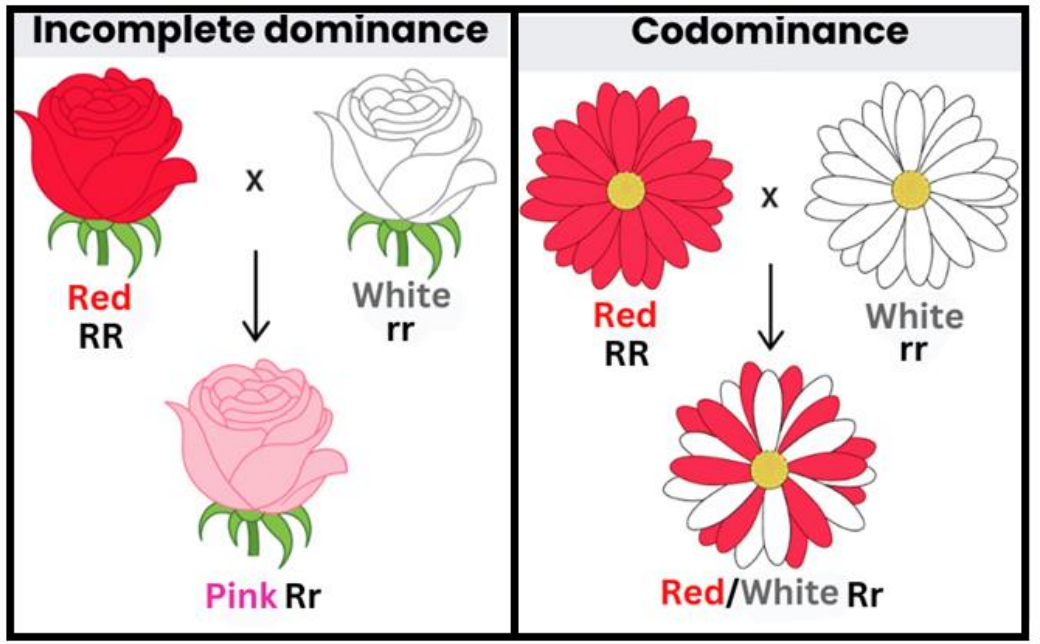
In case 1, the parents have genotypes LL and vv since all the drosophila obtained have vestigial wings, this means that the parents are pure.

In case 2, the parents have genotypes Lv and vv since the drosophila obtained have 50% vestigial wings and 50% long wings, this means that the parent with dominant trait is not pure.

5- Codominance and Incomplete-dominance:

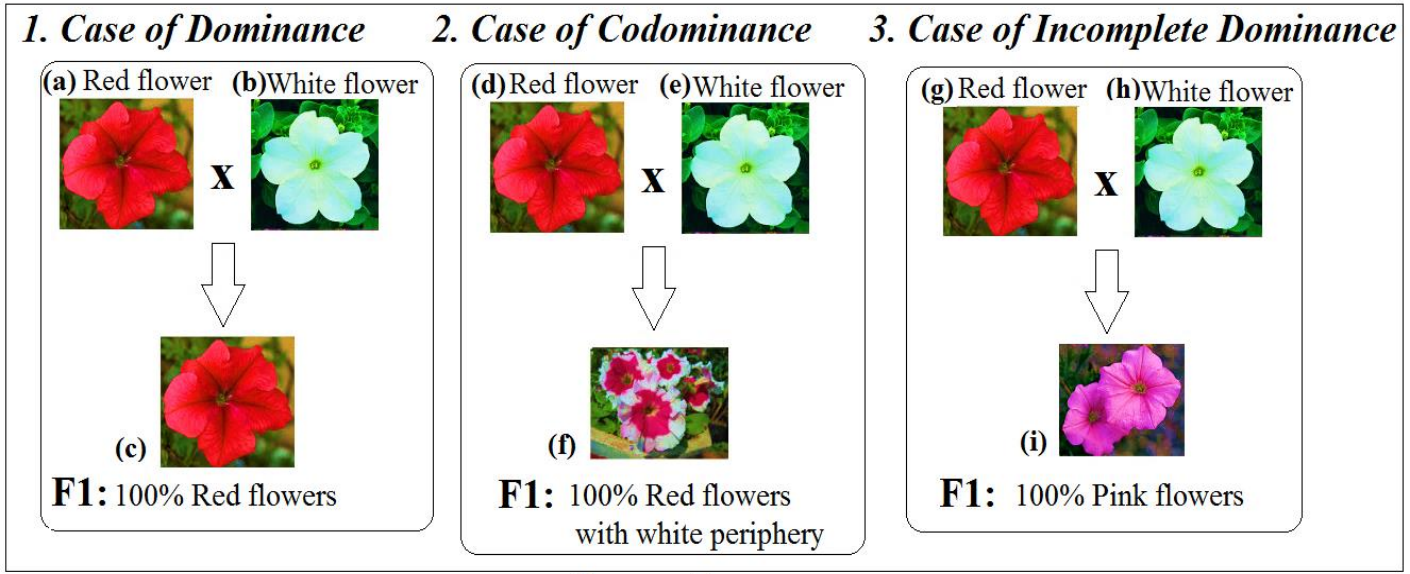
-In incomplete dominance, a new phenotype not found in each of the parents appears in F1.

- In co-dominance, both phenotypes of parents appear in F1 at the same time (both alleles are expressed).



- Application 2:

Document 1 shows different modes of inheritance for flower color.



Document 1

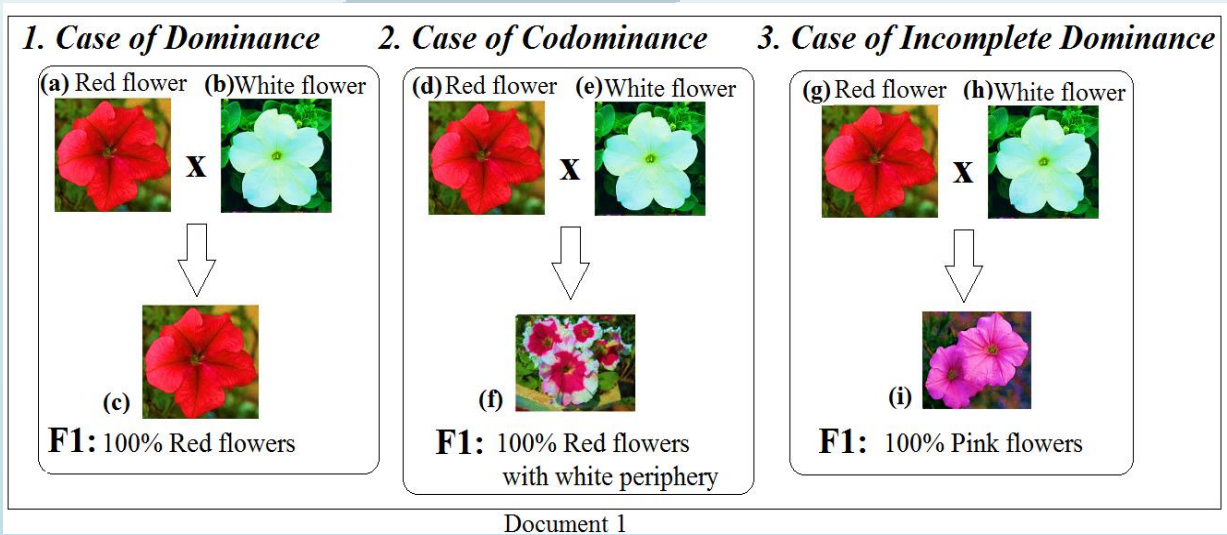
- In cases 2 and 3 neither red nor white allele had appeared alone in F1:

In case 2, both parents' phenotypes appeared in F1 at the same time

⇨ Both alleles are dominant (expressed) or both alleles are: **codominant.**

In case 3, a new phenotype which is intermediate between the parents' phenotypes had appeared in F1 .

⇨ Both alleles red and white are: **incompletely dominant.**



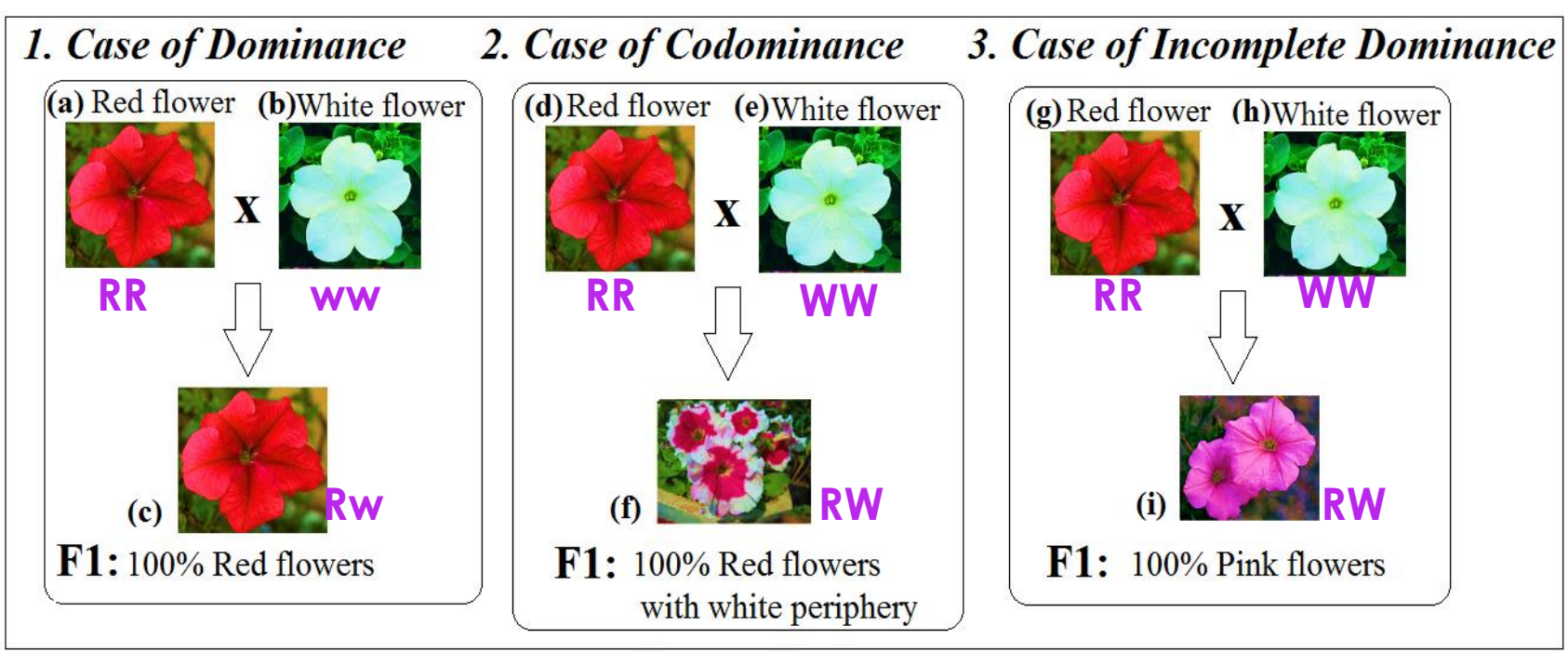
Document 1

- Symbol of Alleles:

- In both cases 2 and 3, alleles of white and red flowers are designated by capital letters.

W: white flower R: red flower

- Referring to document 1, write the genotypes from (a) to (i).



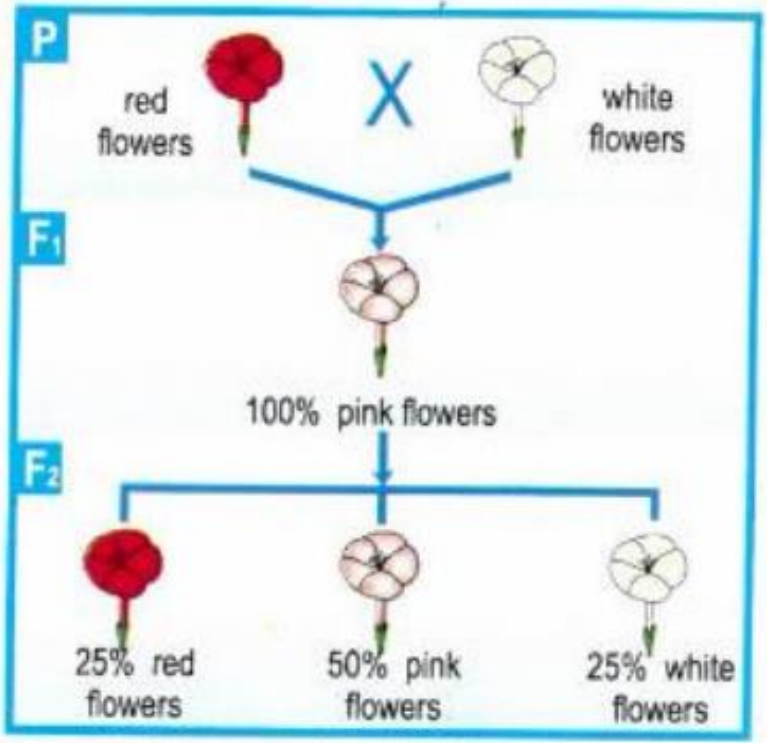
Document 1

Application 3:

- Referring to Doc.e, p.45 of the National textbook:

1. Determine the case of dominance.

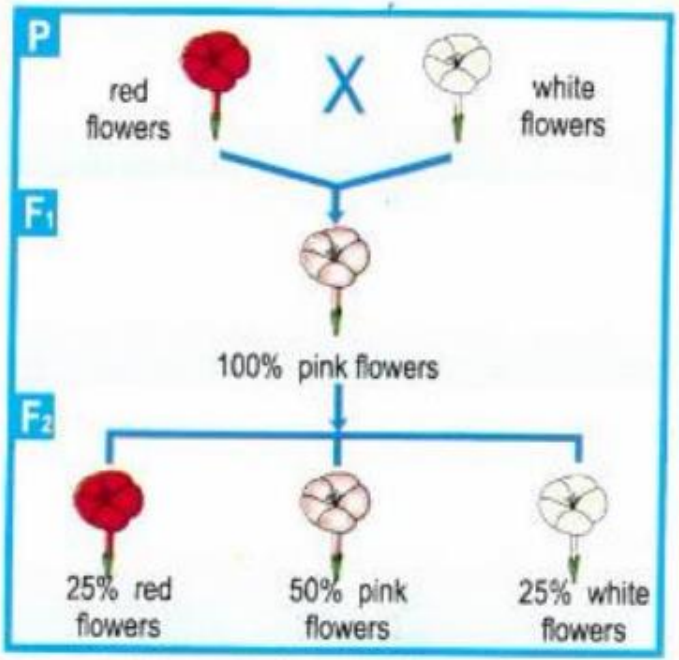
Since upon crossing red flowers with white flowers, all the flowers obtained in F1 were pink. This means that a new phenotype which is intermediate between the parents' phenotypes had appeared in F1. Therefore, it's the case of incomplete dominance.



Doc.e *Transmission of the color of flowers in snapdragons.*

2. Designate by symbols the corresponding alleles.

-Let R be the symbol of red colored allele.
-Let W be the symbol of white colored allele.



Doc.e *Transmission of the color of flowers in snapdragons.*

3. A self-cross is done between members of F1. Make the necessary factorial analysis in order to verify the results obtained in F2 (only phenotypes= flower colors).

phenotype of F_1 : ♂ ..pink X ♀ ..pink

genotype of F_1 : ♂ .RW X ♀ ..RW

gametes of F_1 : 50% (R) ♂ 50 % (W) ♂ 50 % (R) ♀ 50 % (W) ♀

Table of cross

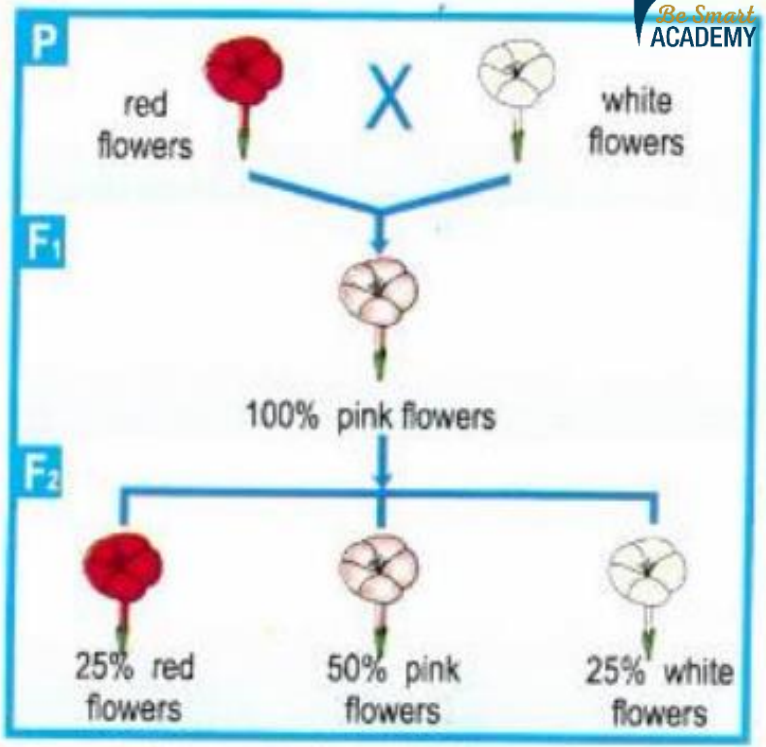
♀ / ♂	50 % R	50 % W
50 % R	25% RR	25% RW
50 % W	25% RW	25% WW

genotypes of F_2:

..Not needed.....

phenotypes of F_2: ...25% red, 25% white and 50 % pink

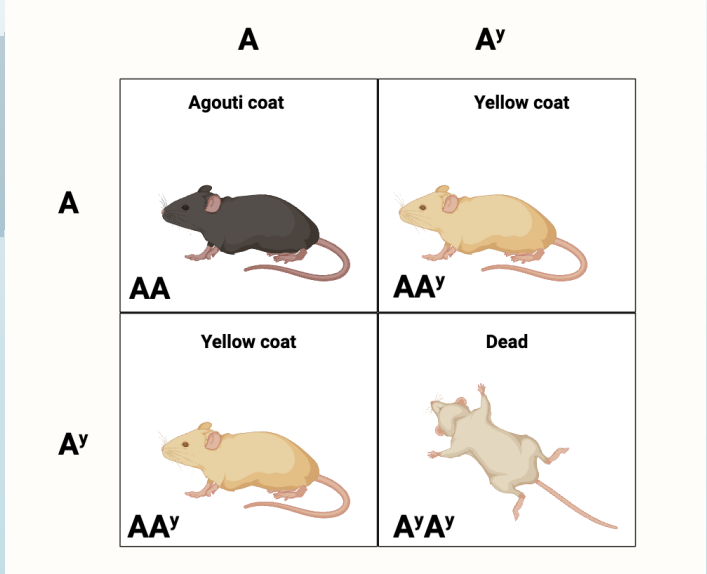
Thus, the results are verified.



Doc.e *Transmission of the color of flowers in snapdragons.*

7- Lethal allele:

- A lethal allele is the allele which causes the death of its homozygous carrier. It should be present in 2 copies in order to cause death.
- Example: ss, bb..
  - ☞ When there is a lethal case, there will be a modification in the results of the phenotypes of the off springs (there will be missing phenotypes).



CASE OF LETHAL GENE

Application 4:

Three crosses are made in mice.

1st cross: between males and females with black coat always gives black mice.

2nd cross: between males and females with yellow coat always gives 2/3 yellow mice and 1/3 black mice.

3rd cross: between black-coated males and yellow-coated females gives 1/2 yellow mice and 1/2 black mice.

How can you explain in the 2nd cross, the proportions 2/3 yellow mice and 1/3 black mice instead of 3/4 yellow mice and 1/4 gray mice?

1st cross: cross between two black mice

♂ black mouse ♀ black mouse black mice

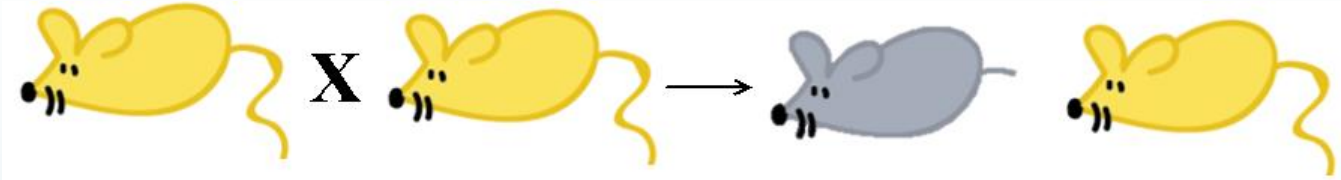
Document 22: 1st cross, prepared by Abir Bechara

1- What can you draw out?

Black mice are of pure line.

2nd cross: cross between two yellow mice

♂ yellow mouse ♀ yellow mouse 1/3 black mice 2/3 yellow mice



Document 23: 2nd cross, prepared by Abir Bechara

2- Specify the dominant allele and the recessive allele.

The yellow allele is dominant with respect to the black allele which is recessive because the crossing of yellow mice has given black mice which shows that the black allele is present in both parents but masked by the yellow allele and not expressed in the phenotype.

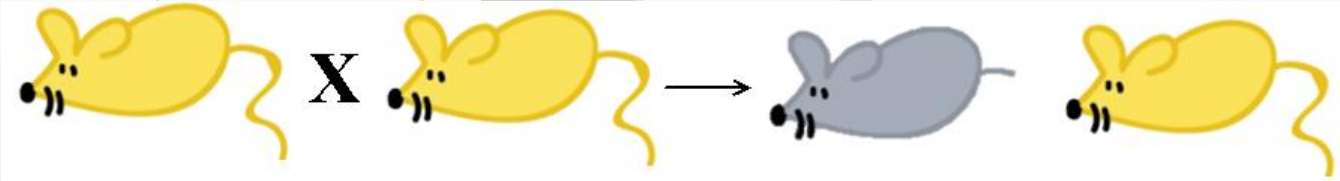
Let Y be the symbol of the dominant yellow allele and b the symbol of the recessive black allele.

3- Indicate the genotype of the yellow mice parents and that of the black mice descendants.

Genotype of yellow mice parents : Yb Genotype of black mice descendants: bb

2nd cross: cross between two yellow mice

♂ yellow mouse ♀ yellow mouse 1/3 black mice 2/3 yellow mice

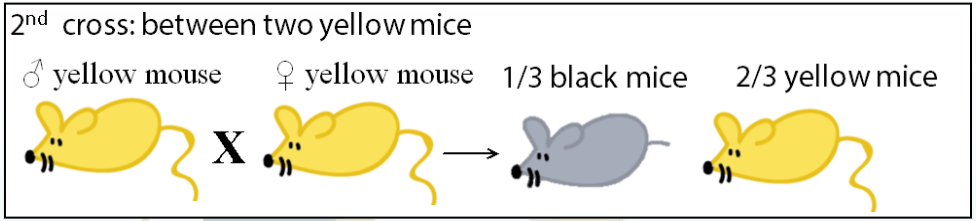


Document 23: 2nd cross

4- Indicate the theoretical results of the genotypes and phenotypes of the descendants obtained from this type of crossing, fertilization of males and females of F_1.

3/4 yellow mice including 1/4 YY , 1/2 Yb
and 1/4 black mice of genotype bb.

INTERPRETATION



5- Explain the experimental results obtained in the second cross knowing that embryos die in the uterus.

In this cross, the number of descendants did not give the expected Mendelian results (3/4 [Y] and ¼ [b] which raised doubts.

This cross which is between two yellow-coated mice (F_1 X F_1) gave as a result 2/3 yellow mice and 1/3 black mice, while the theoretical result of such cross is 3/4 yellow mice and 1/4 black mice. So, this is the case of a lethal allele.

The birth of black mice, having necessarily b//b as genotype, shows that the black allele is not lethal and that the lethal allele is the yellow. Thus, the lethal individuals must be of genotype Y//Y since lethality attacks only the homozygous individuals having the lethal allele (the living yellow mice are heterozygous).

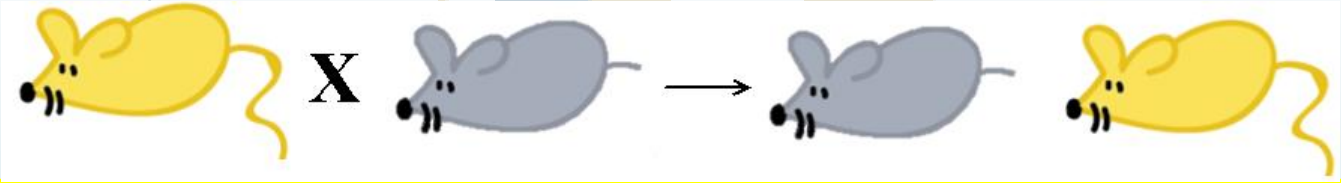
VERIFICATION OF THE EXPERIMENTAL RESULTS

F_1	 Yb	X	 Yb
F_2			
	YY	Yb	bb
Theoretical results	1/4	1/2	1/4
Experimental results		2/3	1/3

Lethal allele in homozygous state

3rd cross: cross between a yellow mouse and a black mouse

♂ yellow mouse ♀ black mouse 1/2 black mice 1/2 yellow mice



Document 26 prepared by Abir Bechara

6- Name this type of cross.

It is a test-cross.

- Doc.f, p.45 of the National textbook, shows the case of a lethal allele.

mice crosses	parents		offspring
	female	male	
1st	black	black	black
2nd	yellow	yellow	2/3 yellow 1/3 black
3rd	yellow	black	1/2 yellow 1/2 black

Doc.f *Transmission of the yellow coat color in mice.*

➢ **If after a self-cross (F1x F1), results obtained:**

- 75% Dom 25% rec or ¾ ¼

  ⇨ Case of dominance.

- 50% Pink 25% white 25% red or ½ ¼ ¼

  ⇨ Case of incomplete dominance.

- 50% red and white 25% white 25% red or ½ ¼ ¼

  ⇨ Case of codominance.

- 66.6% Dom 33.3% rec

  ⇨ Case of lethal allele.

- If in a cross, dominant is crossed with recessive

  ⇨ It is a test cross.

- **Application 5:**

A cross between white and red poultry gives in the first generation F1 all brown poultry.

1. Analyze the results obtained. What do you conclude?

Upon crossing white with red poultry all F1 were brown poultry.
Therefore, it's a case of incomplete dominance where the parents are pure.

2. Designate by symbols the corresponding alleles.

-Let R be the symbol of red colored allele.

-Let W be the symbol of white colored allele.

3. Write the genotypes of parents and F1.

Genotypes of parents: RR and WW

Genotypes of F1: RW

F1 hybrids were crossed among each other. The results obtained were the following:

340 brown poultry 172 red poultry 168 white poultry

4. Name this cross.

Self cross

5. Calculate the percentage of the poultry obtained.

How to calculate percentage?

Rule: % of x = number of x / total (x+y+…) × 100

Total poultry = brown poultry + white poultry+ red poultry

= 340 + 172 + 168 = 680

% of brown poultry = number of brown poultry / total × 100

= 340 / 680 × 100 = 50 %

% of red poultry = 172/680 x 100 ≈ 25%

% of white poultry = 168 /680 x 100 ≈ 25%

6- Calculate the proportions of the poultry obtained.

How to calculate proportions?

Rule: To calculate the proportions:

a. Divide by the smallest number.

168/168 = 1 340/168 = 2 172/ 168 = 1

b. Add the answers: Total = 1 + 2 + 1 = 4.

c. Divide each answer in part (a) by the total in part (b):

Proportion of white poultry = ¼

Proportion of red poultry = 1/4

Proportion of brown poultry = 2/4= 1/2

7- Starting from the initial parents, make a factorial analysis to verify the percentages of the phenotypes obtained in F2.

phenotype of parents: ♂ white poultry X ♀ red poultry

genotype of parents : ♂WW X ♀RR

gametes of parents: 100% W ♂ x 100% R ♀ ⇒ genotype of F1: RW phenotype: brown

phenotype of F_1 : ♂ Brown X ♀ brown

genotype of F_1 : ♂ RW X ♀ RW

gametes of F_1 : 50% R 50% W 50% R 50% W

Table of cross

♀ ♂	50 % R	50 % W
50 % R	25% RR	25% RW
50 % W	25% RW	25% WW

genotypes of F_2: Not needed

phenotypes of F_2:25% red, 25% white and 50 % brown

Thus, the results are verified.