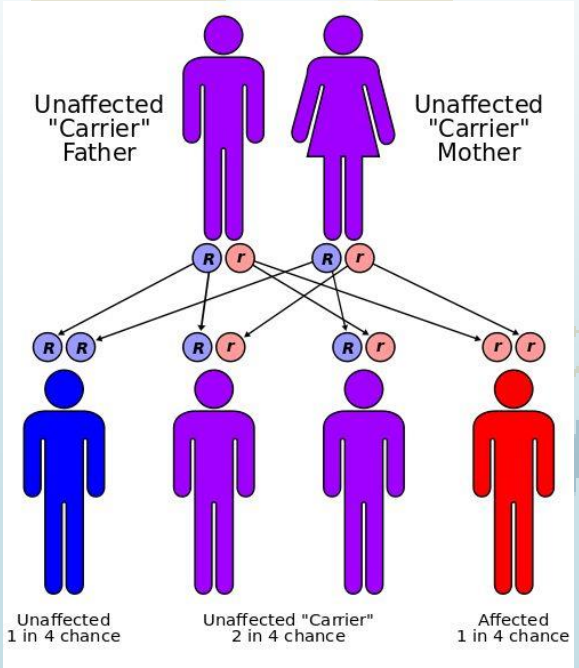
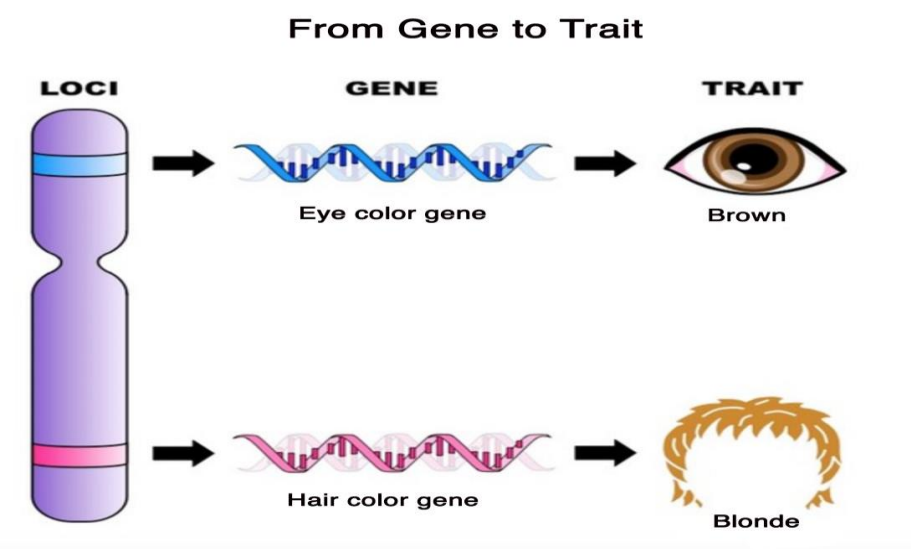
Chapter 2: Transmission of Genes

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



Document 1

Hereditary Traits and Genes



Why do you think these children look different?

⇨What makes us different from each other is the:

genetic information.

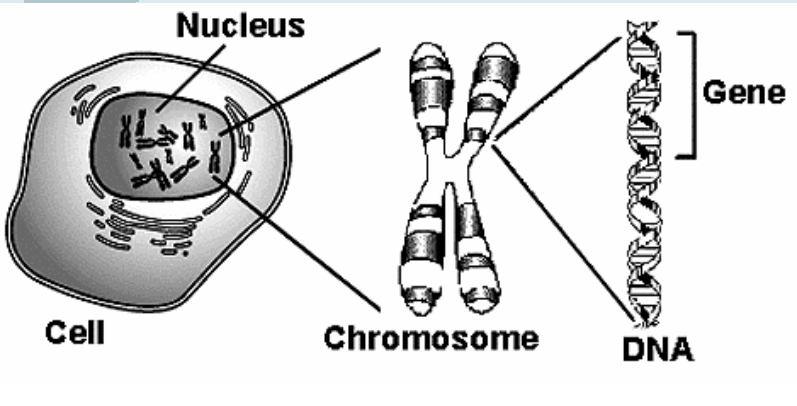
- Genetic information = Genetic Program = Genome:

- All the information that determines the traits (characteristics) of an individual.

- It is located in the nucleus of cells and carried by specific structures known as: Chromosomes.

- It is transmitted from parents to offsprings (children)

⇨ Hereditary.



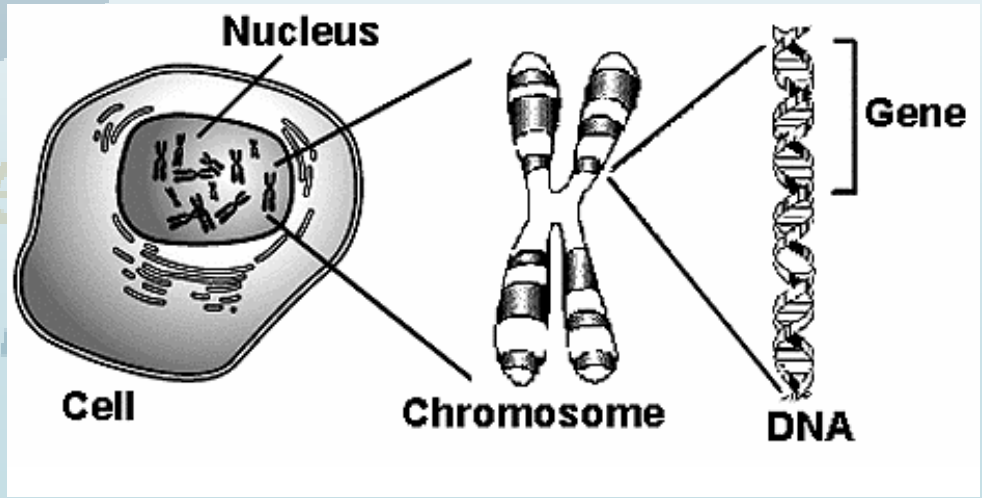
- **Heredity:** is the transmission of genetic characteristics from parents to offsprings (children)
- **Trait:** a characteristic controlled by genes.

  Example: tongue roller, hair color, eye color….

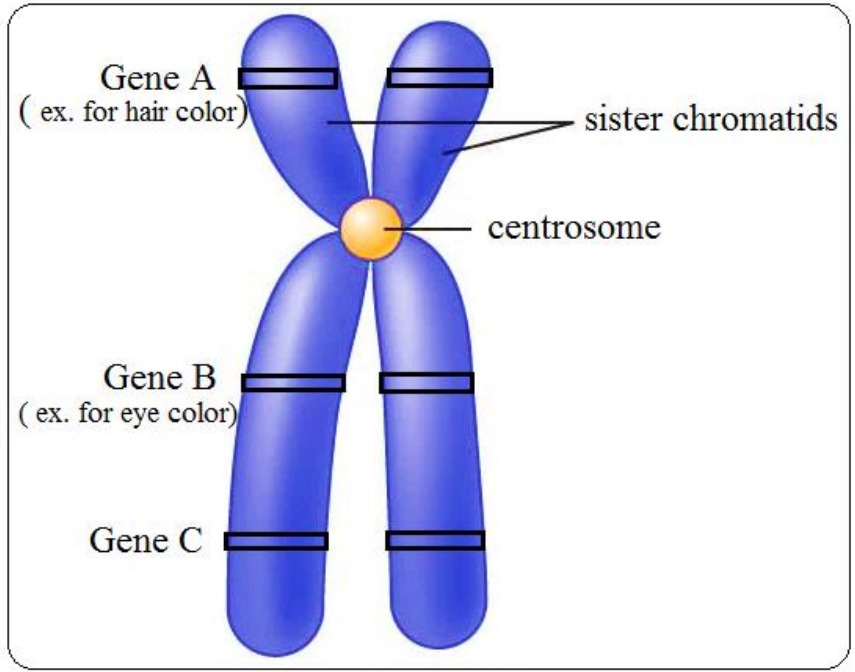
- Chromosomes:

  - A threadlike structure of DNA found in the nucleus of the cell, that carries genetic information in the form of genes.

  - The DNA molecule consists of two strands (made of long sequence of nucleotides) that wind around one another to form a double helix.

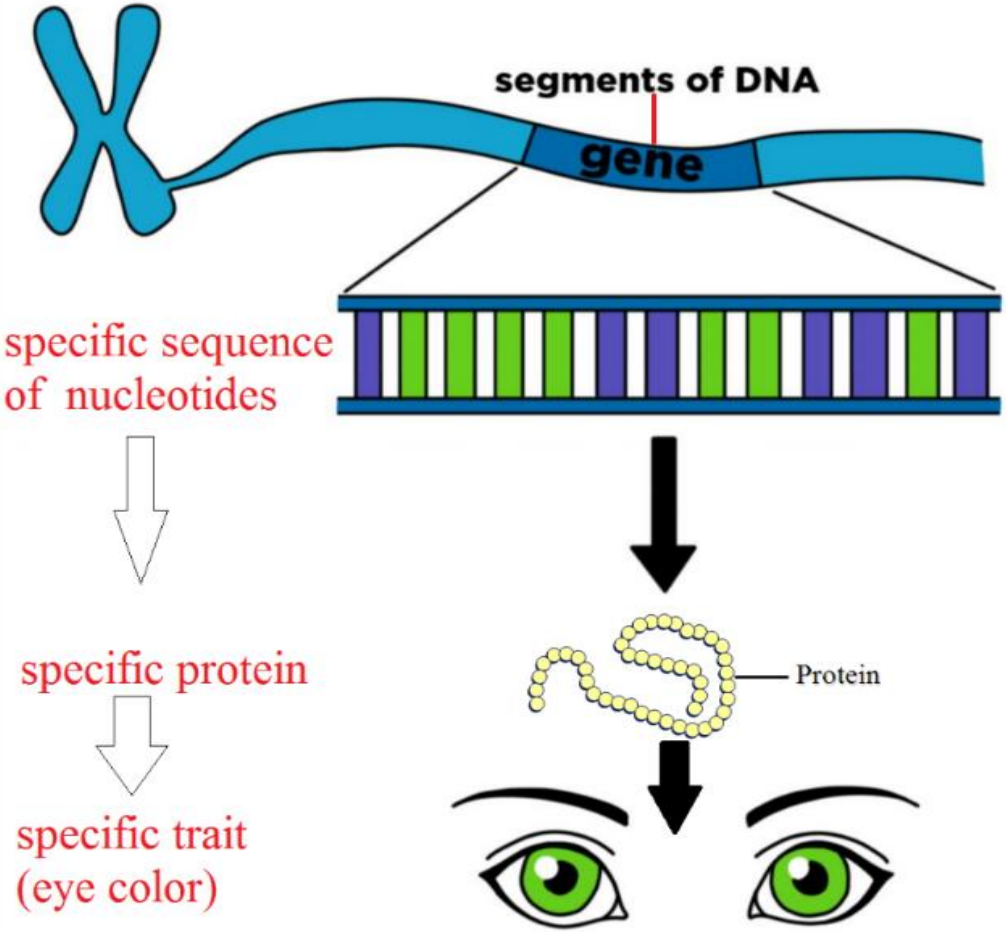


- **Chromosomes are made of 2 chromatids, joined by a centromere.**



Document 2

WHAT IS A GENE?



Genes are segments of DNA

Each gene contains information about a certain trait

Genes are transcribed and translated by the cell to make proteins

Proteins create a visible phenotype

Example:

One gene might code for eye color.

The gene is used by cells to make proteins which create green pigment in our eyes

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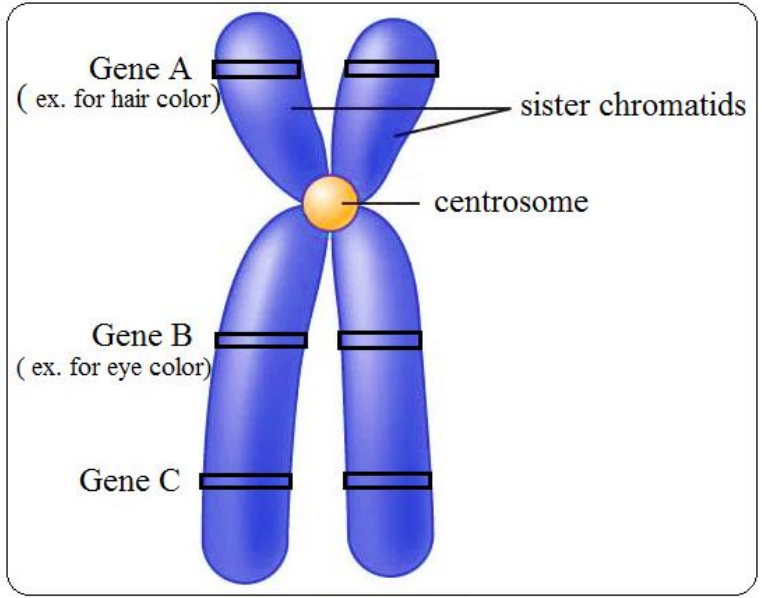
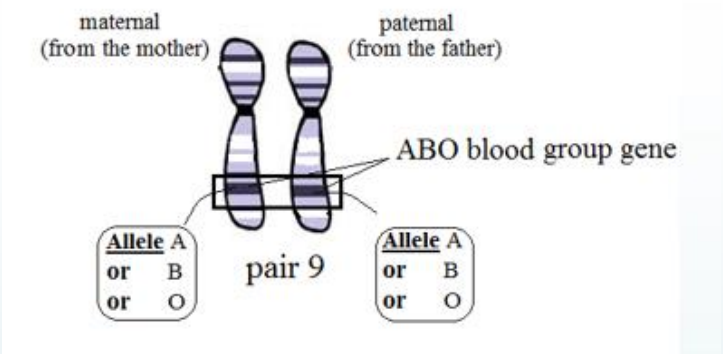
- **Gene:** is a fragment or segment of DNA made up of specific sequence of nucleotides which is responsible for a specific genetic information that codes for a specific protein which determines a specific trait.
- Genes occupy a specific locus on a chromosome and are arranged in a linear manner
- **Protein**: is the expression of a gene.



Document 2

I. Phenotypes and Genotypes:



* Example: Gene determining Blood group.

- Blood groups are: A, B, O and AB.

- Gene responsible for blood group is located on chromosome 9 on the lower part of the long arm.

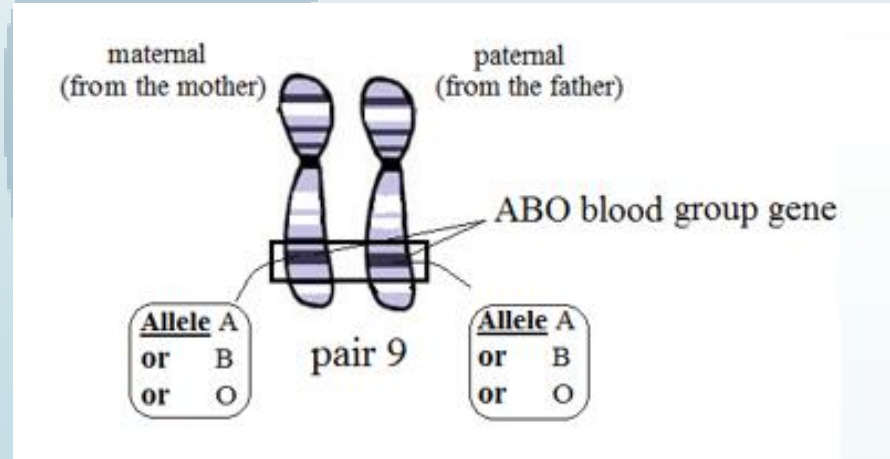
- This gene exists in three different forms/versions known as: **alleles.**

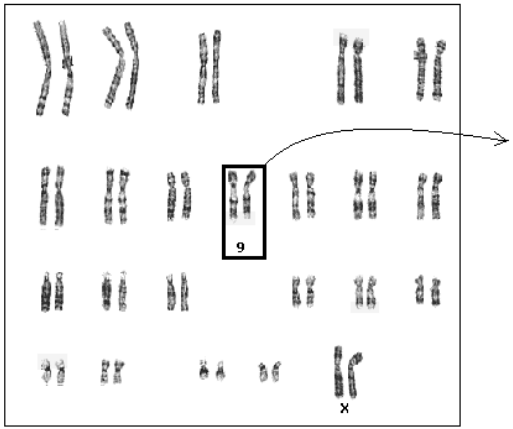
- **Alleles:** are different versions of the same gene.

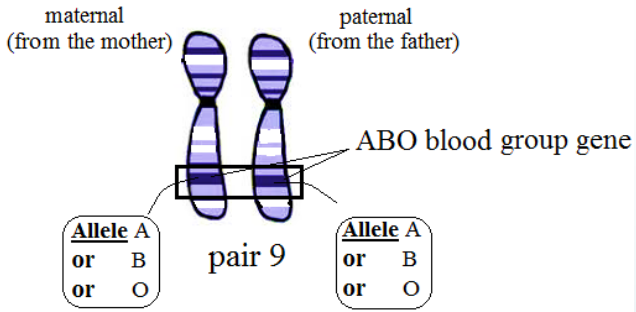
  - Gene of blood group has 3 different alleles: A, B and O.

  - In the human body, each gene exists in 2 alleles, one maternal and one paternal.

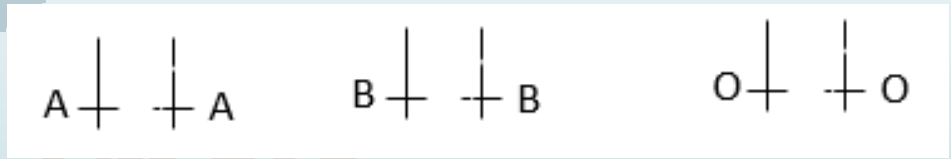
The 2 alleles of a certain gene which are located on homologous chromosomes have the same locus (location).



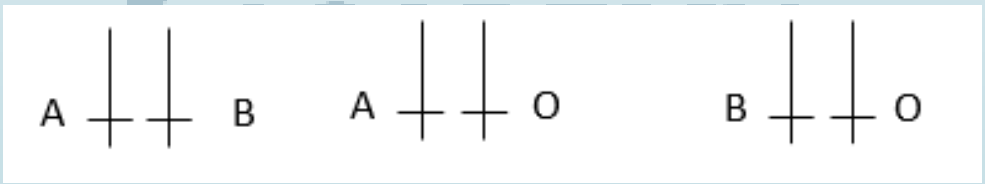




- The 2 alleles may be the: same

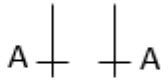


Or different:



- **Application 1:**

Document 1 shows chromosomal representation of alleles for ABO blood groups located on a pair of chromosome 9.

Blood Group	"A"	"B"	"O"/ "AB"
Same alleles			
Different alleles			

Referring to doc 1, answer the following questions:

1. Indicate the origin of each allele in each case.

One allele is of maternal origin and the other is of paternal origin.

For blood group A:

- Presence of alleles A and O ⇨ blood group is **A.**

⇨ allele A is expressed but allele O wasn't (didn't appear).

For blood group B:

- Presence of alleles B and O ⇨ blood group is **B.**

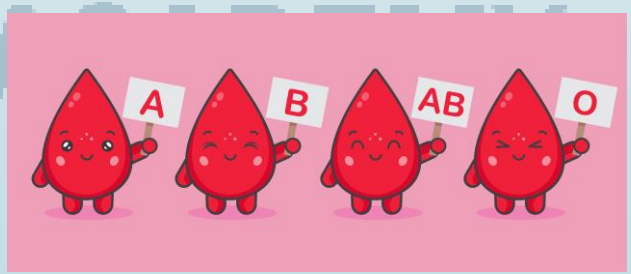
⇨ allele B is expressed (appeared) but allele O didn't.

⇨ Allele A and allele B are **strong** with respect to allele O (didn't appear).

⇨ Alleles A and B are **dominant** over allele O.

⇨ Allele O is **recessive.**

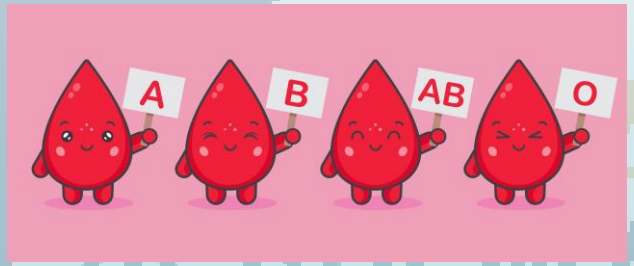
⇨ Dominant (strong) allele is always expressed, whether it is found in one or two copies.



For blood group O:

-Presence of 2 alleles O ⇨ blood group is O.

⇨ Recessive (weak) allele should be found in 2 copies in order to be expressed (to appear).



→ **Pure** or **homozygous**.:

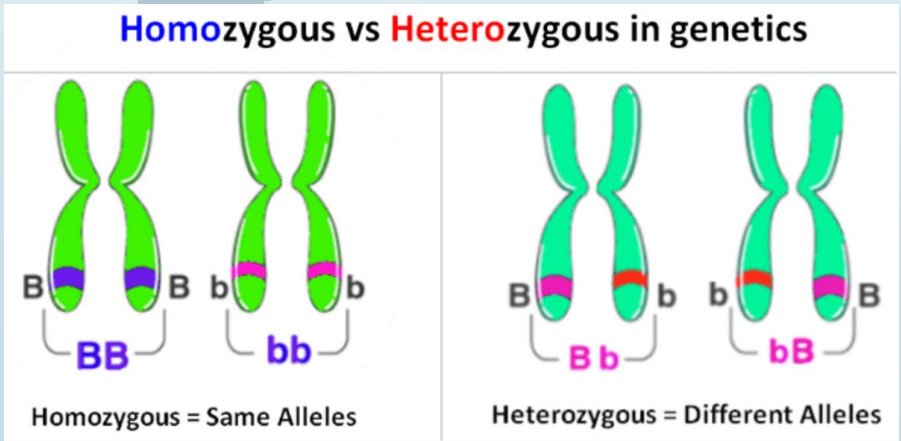
An organism having 2 **same** alleles of a specific trait.

Example: AA, BB, OO.

→ **Hybrid** or **heterozygous**:

An organism having 2 **different** alleles of a specific trait.

Example: AO, BO, AB.

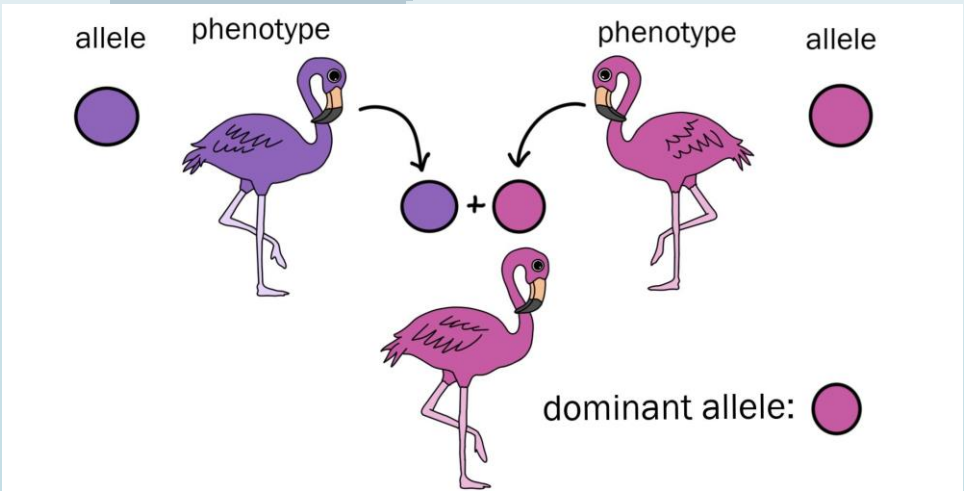


→ Dominant allele:

- Allele which always expresses itself even when it is present in 1 copy (it is always expressed whether it is pure or hybrid)

ex: BO or BB⇨ blood group is B.

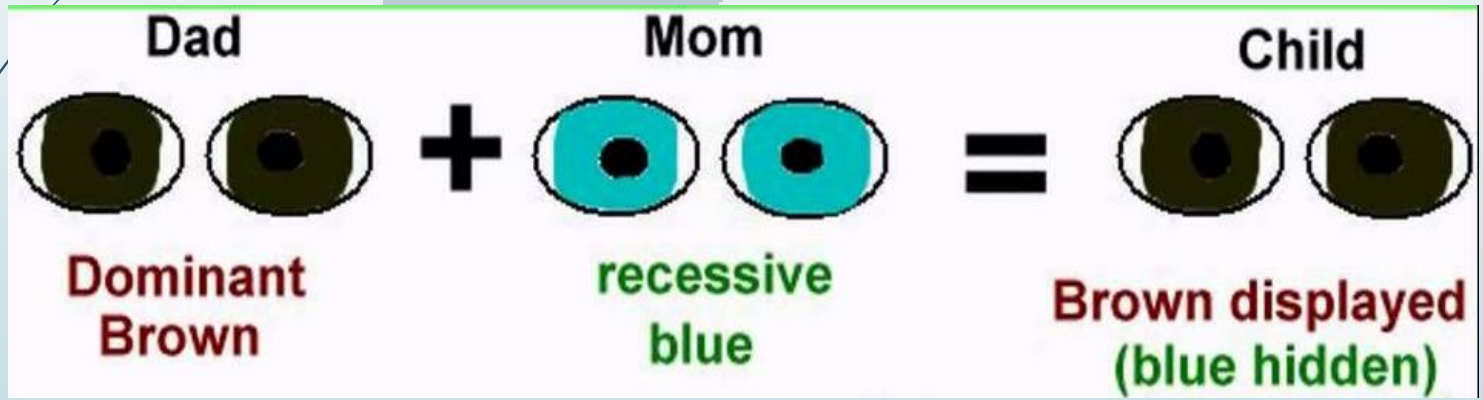
- It is symbolized by a capital letter.
- It may be present in 1 or 2 copies: (**A**O or **AA**, **B**O or **BB**).



→ Recessive allele:

- Allele that doesn't express itself in presence of dominant allele.

- It should be present in 2 copies in order to be expressed (it should be pure).
  Example: (**OO** blood group O).
- It is symbolized by a small letter.



Genotype Vs Phenotype

Genotype	Phenotype
	
Genetic Code	Physical Expression

→ **Genotype:** is the combination of 2 alleles which corresponds to a certain trait.

Example: OO, AO, AB, BB ...

→ **Phenotype:** is the observable characteristic of an individual which is determined by genotype.

The phenotype is the expression of the genotype.

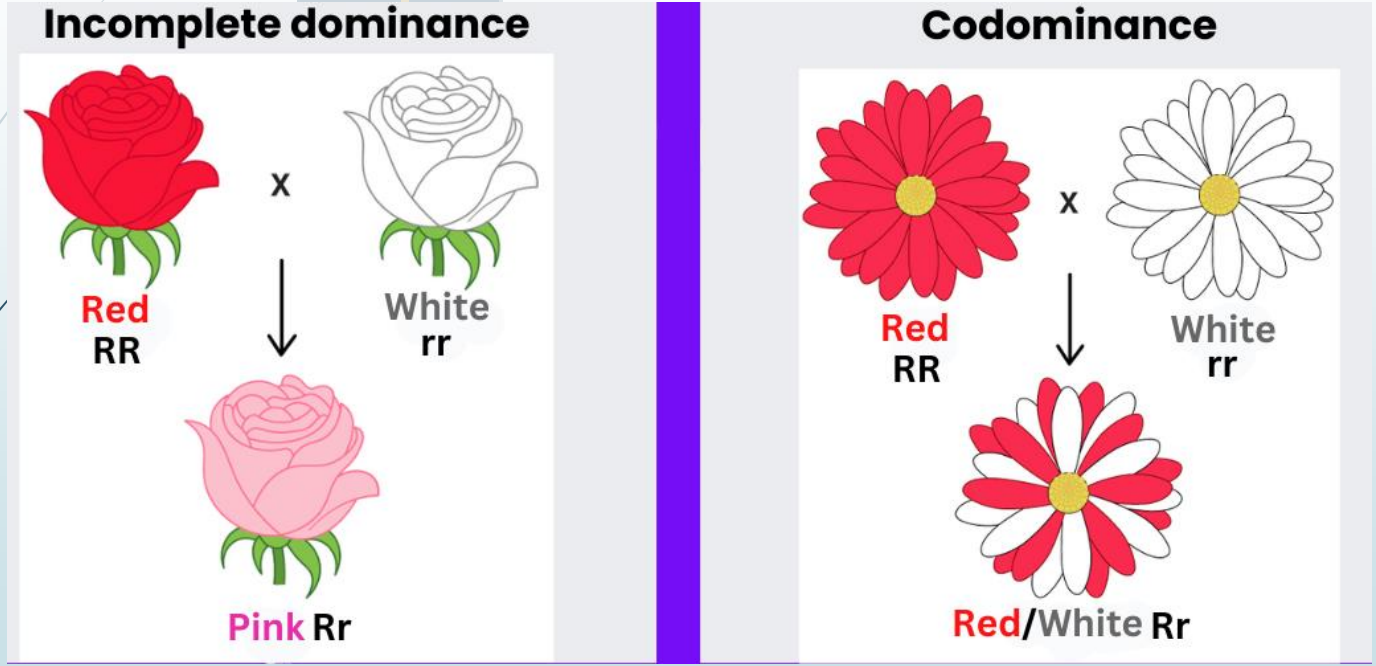
Ex: AO ⇒ blood group A.

Genotype Phenotype

ABO Blood Group

Genotype	Phenotype(blood type)
AA	A
AO	A
BB	B
BO	B
OO	O
AB	AB

Incomplete dominance Vs codominance



→ Co-dominance:

Both alleles are expressed, and both phenotypes of the parents will appear in the off springs.

Example: blood group AB. Both alleles are written in capital letters.

→ Incomplete dominance (intermediate dominance):

A new phenotype not found in the parents appears in the off springs.

Example:

red flower x white flower → pink flower.

Both alleles are represented in capital letters.

2. Referring to all the preceding information, complete the following table:

Blood Type (phenotype)	Genotype(s)		Alleles	Chromosomal Representation	
	Pure	Hybrid		Pure	Hybrid
A	AA	AO	Alleles A and O		
B	BB	BO	Alleles B and O		
AB		AB	Allele A and allele B		
O	OO		Allele O		

- Application 2:

A man of blood group A marries a woman of blood group AB.

1. Write the possible genotype(s) of this couple.
   1.1- Genotype(s) man:
   AA or AO
   1.2- Genotype(s) woman:
   AB

2- If the man is **heterozygous,** make a **factorial analysis** to find the phenotypes and genotypes of their children/off springs/descendants.

How to make a factorial analysis?

- Step 1: Write the phenotypes of parents.

  Phenotype of parents: ♂ blood group A × ♀ blood group AB.

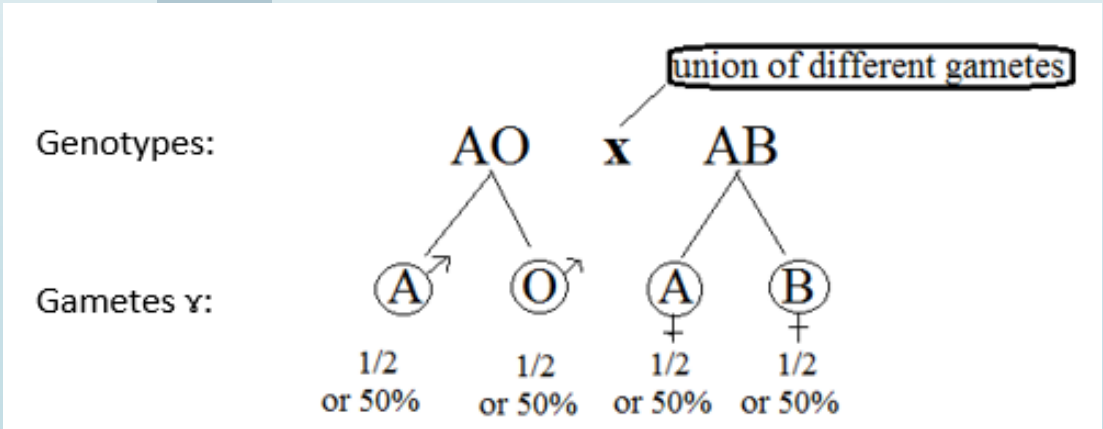
- Step 2: Write the genotypes of parents.

  Genotype of parents: ♂ AO × ♀ AB.

- Step 3: Write the gametes.

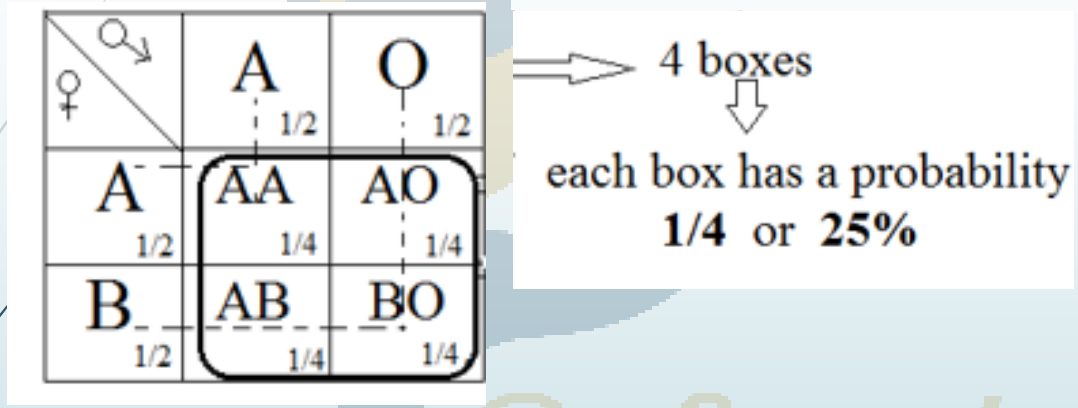
♂: male symbol

♀: female symbol



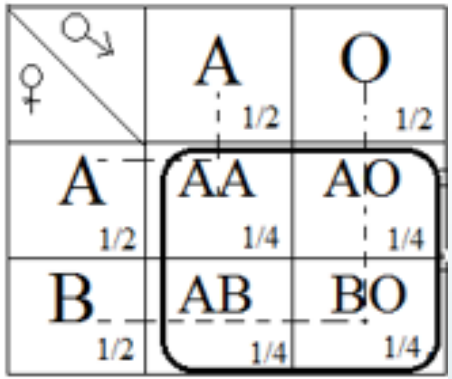
- Step 4: Draw the table of cross.

Title: Table of cross or punnet square:



- Step 5: Read the question carefully to pick out from the table the ***phenotypes or genotypes or both***.

In our question: phenotypes and genotypes are required.



⇨ **Genotypes:**

(2 letters, 2 alleles)

Proportions or Percentages

1/4 AA **or** 25% AA

1/4 AO **or** 25% AO

¼ AB ¼ BO

Phenotypes: (Blood group)

Proportions or Percentages

1/2 [A] or blood group A **or** 50% [A]

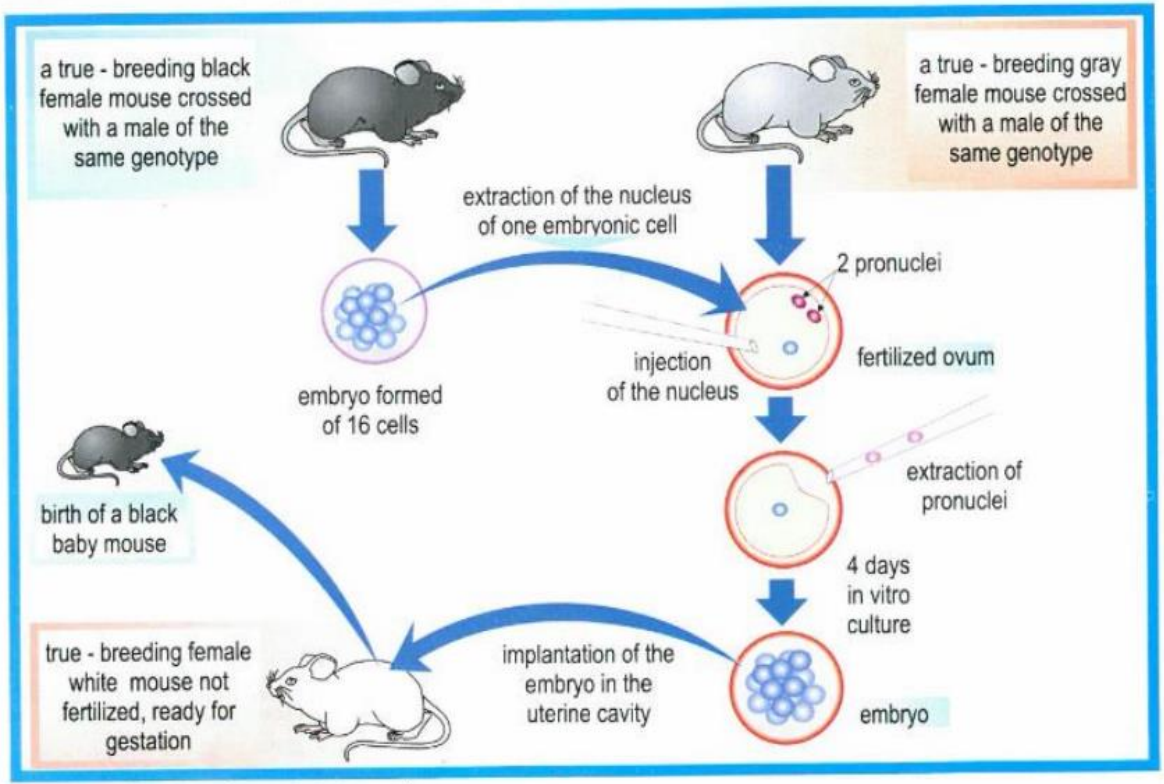
1/4 [B] or blood group B **or** 25%[B]

¼ [AB] or blood group AB

Application 3:

- **Referring to document a p.42, answer the following questions:**

• An experiment was performed on mice to locate the genetic information which determines a hereditary trait: the coat color for example.



Doc.a *Localization of genetic information.*

**The nucleus of black mouse embryo was injected into the fertilized ovum produced by the gray mouse and placed in the uterus of white mouse, the new organism had a black color ⇨The nucleus is responsible for the coat color of the mice ⇨ The genetic information, that determines the hereditary traits is located in the nucleus.*

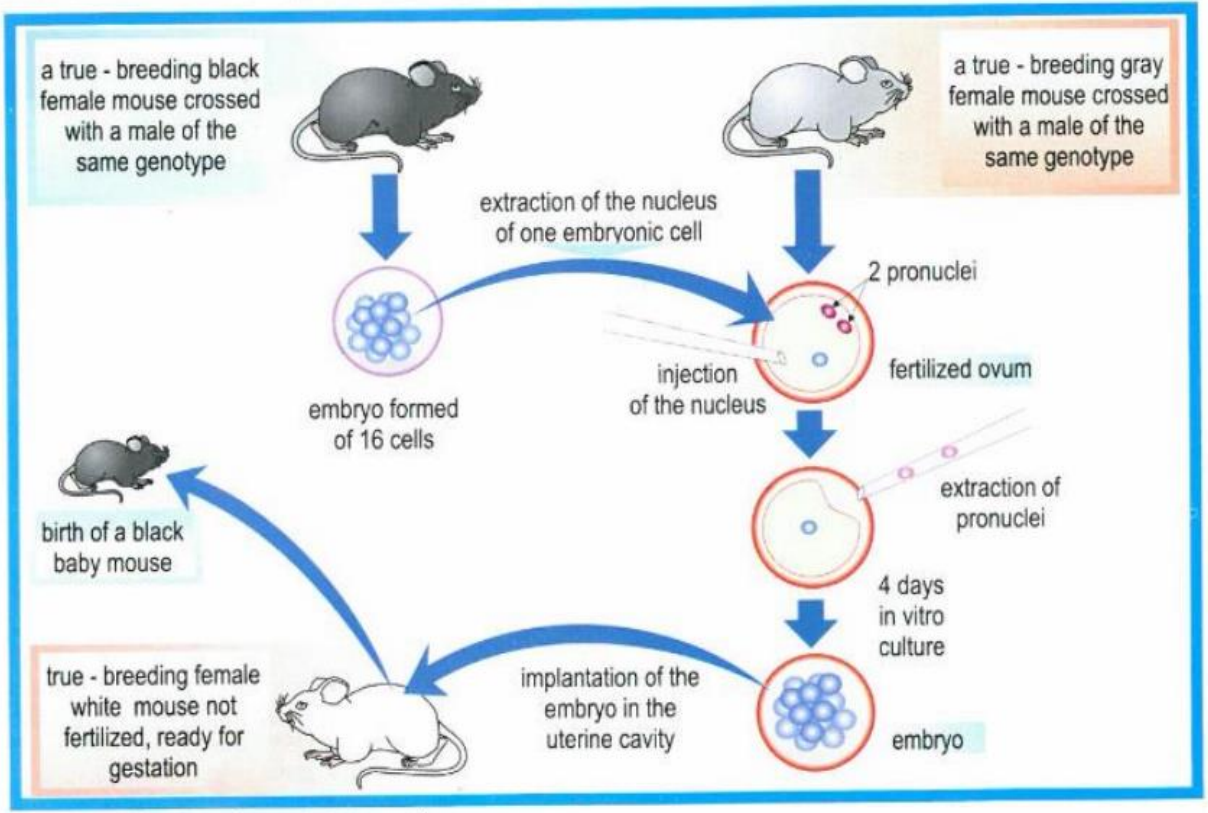
1- Pose the studied problem.

Where is the genetic information that determines a hereditary trait located?

2- Describe doc a.

Write the given only in a paragraph form, using the given only.

• An experiment was performed on mice to locate the genetic information which determines a hereditary trait: the coat color for example.



Doc.a *Localization of genetic information.*

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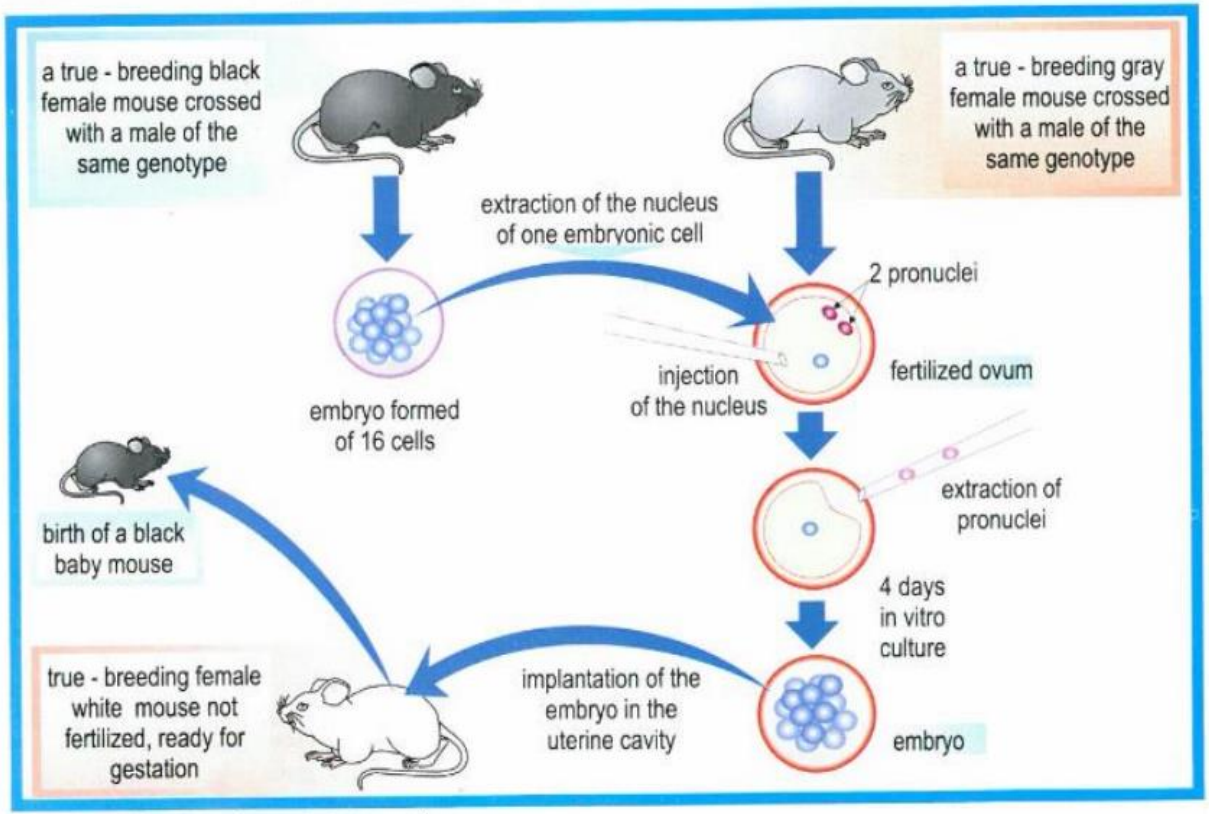
3- Draw out a conclusion.

The genetic information, that determines the hereditary traits is located in the nucleus.

• An experiment was performed on mice to locate the genetic information which determines a hereditary trait: the coat color for example.

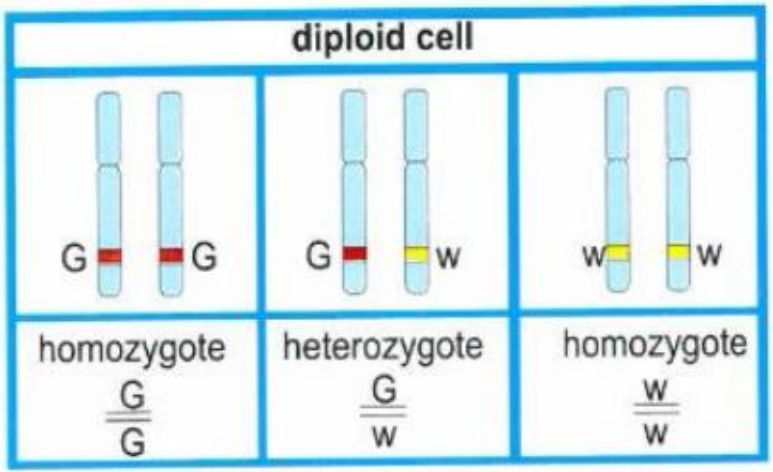


Doc.a *Localization of genetic information.*

- Document b:
- It shows homologous pairs of chromosomes in a diploid cell carrying alleles for coat color gene in mice, where all have the same locus. Gray color is dominant over white color.

Genotype of gray color: GG or Gw

Genotype of white color: ww



Doc.b *Chromosomic and allelic illustration for coat color in mice.*

- Document c:

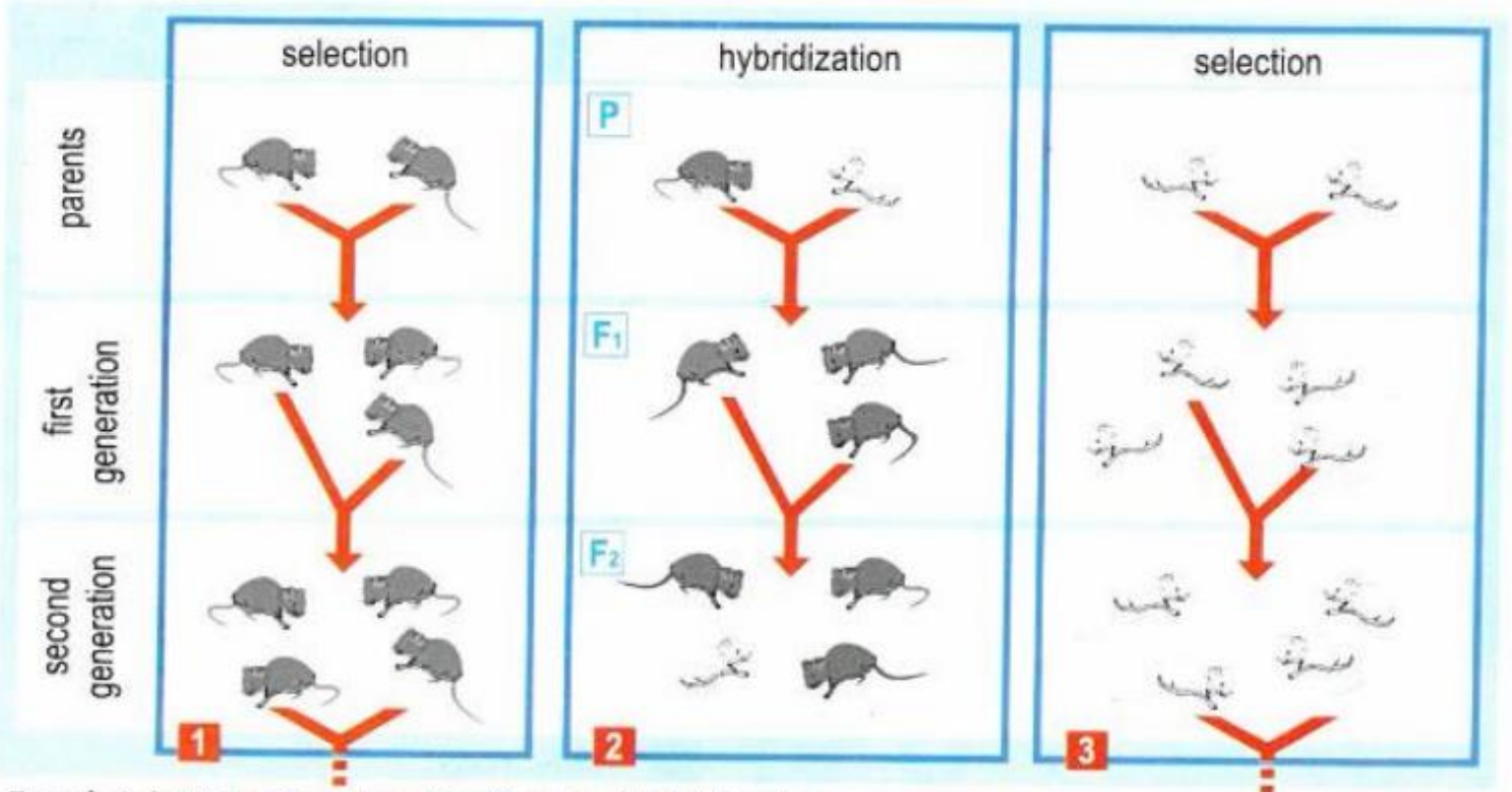
1- Draw out a conclusion.

Dominant trait can be pure or hybrid while recessive is always pure.

mice	phenotype	genotype
1 	gray or [G]	$\frac{G}{G}$
2 	gray or [G]	$\frac{G}{w}$
3 	white or [w]	$\frac{w}{w}$

Doc.c *The phenotype is the expression of the genotype.*

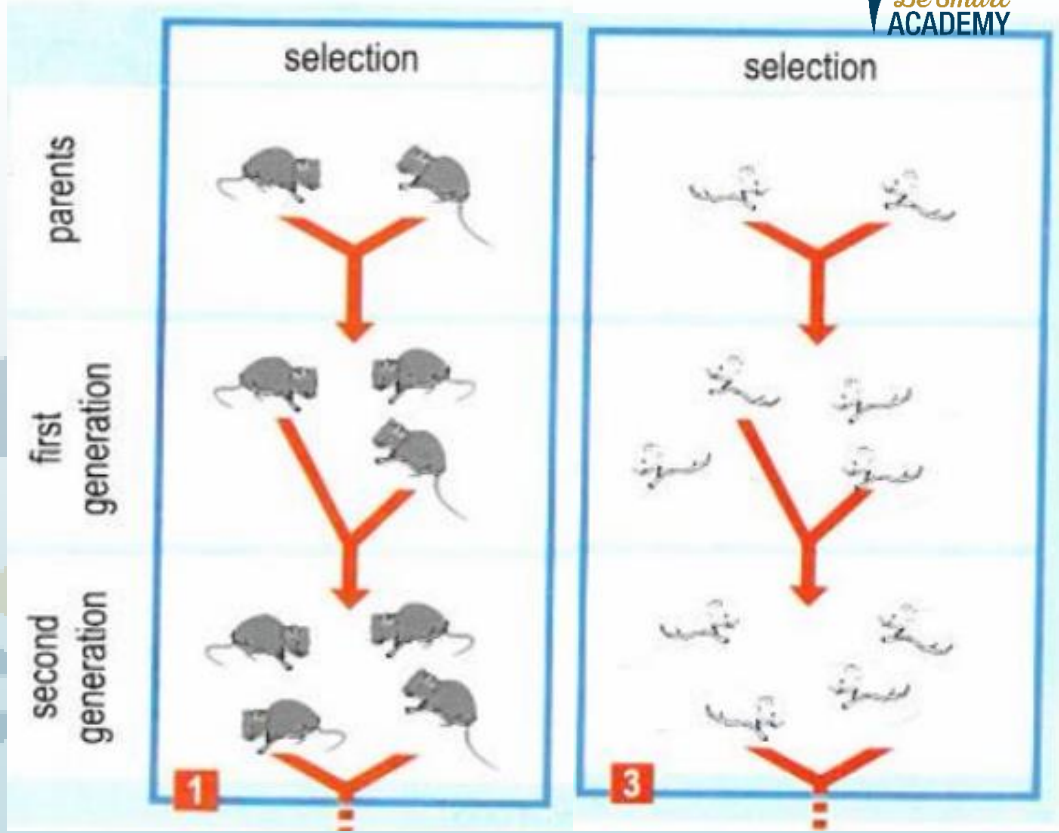
II. True breeding lines سلالة متماثلة and Hybrids مختلط, مهجن : Doc d p.43



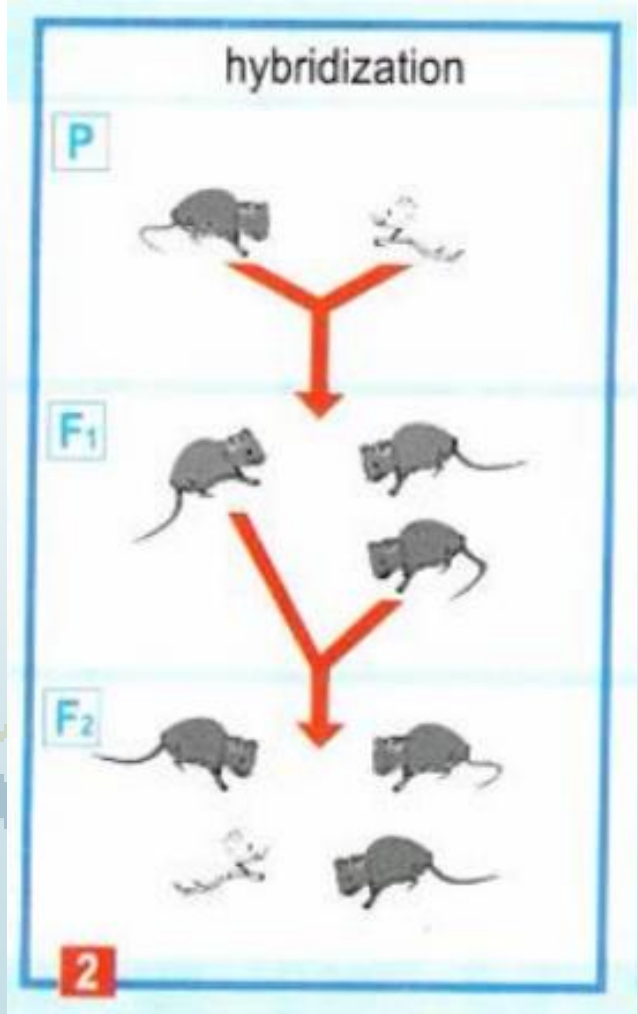
Doc.d *Selection of true-breeding lines and hybridization.*

II. True breeding lines and Hybrids: Doc d p.43

- **True breeding lines:** case where the off springs always have the same trait as their parents.
- **Selection :** is the cross of 2 parents of 2 true breeding lines (pure), having the same trait or character. In this case, the off springs in all generations will have the same trait.
  Doc.d1 and d3.



- **Hybridization:** is the cross between two true breeding organisms (pure parents) that differ in one or more traits. In this case the, the produced off springs are hybrid (heterozygote). Doc.d2
- **Hybrid:** is a heterozygote produced by hybridization.



Nb 4+5

Probing the documents

1. What can you deduce from the analysis of the experiment in ***doc.a***?
2. Define these terms: allele, homozygote, heterozygote, dominant allele, recessive allele, true-breeding line, hybrid, hybridization.
3. a- Does the phenotype always reveal the genotype? Justify the answer.
   b- Which phenotype unambiguously reveals the genotype? Justify the answer.
4. How can you be sure of the true-breeding of a line?
5. How can you explain the presence of white mice in F_2 ***(Doc.d$_2$)*** ?

4. A cross is made between two organisms having the same phenotype. A series of crosses are then performed between members of F1 generation. If the off springs have the same phenotype as the parents, then it's a true breeding line.

5. Mice of the F1 generation have the white allele which is inherited from the parents but is not expressed(masked). They have transmitted this allele to their off spring in the F2 generation.