

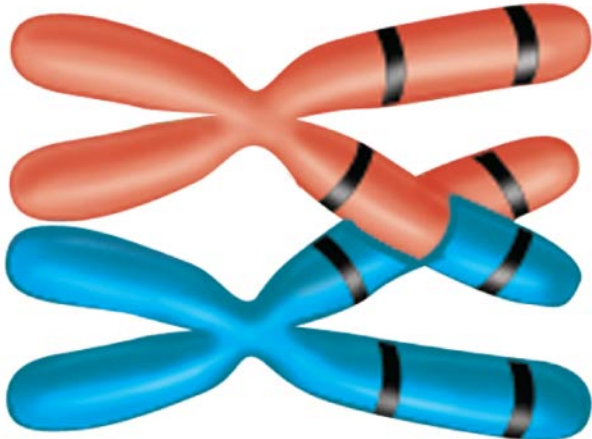
# PATTERNS OF INHERITANCE



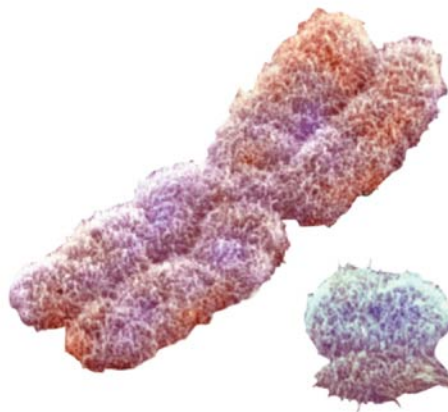
**Mendel's Laws**



**Variations on Mendel's Laws**



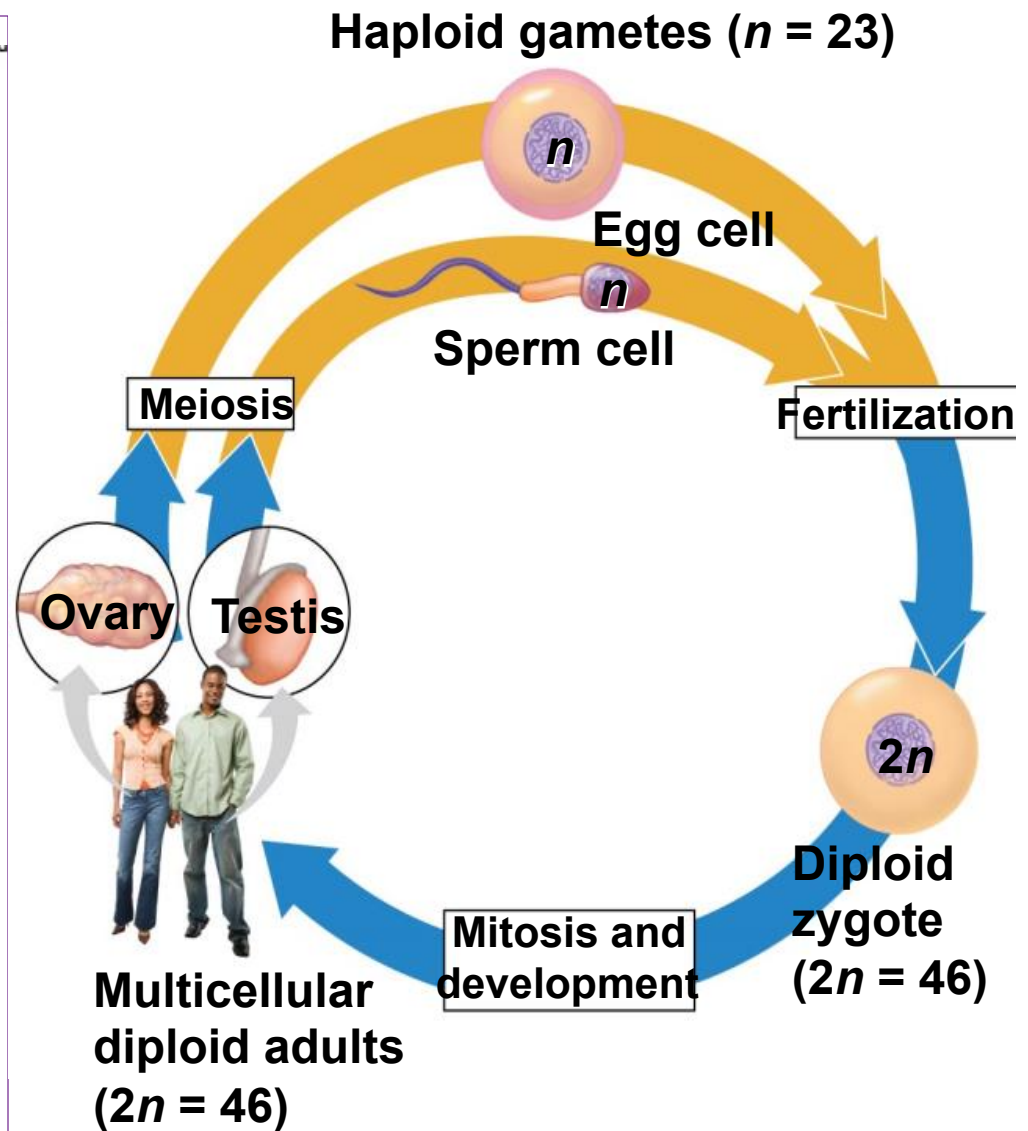
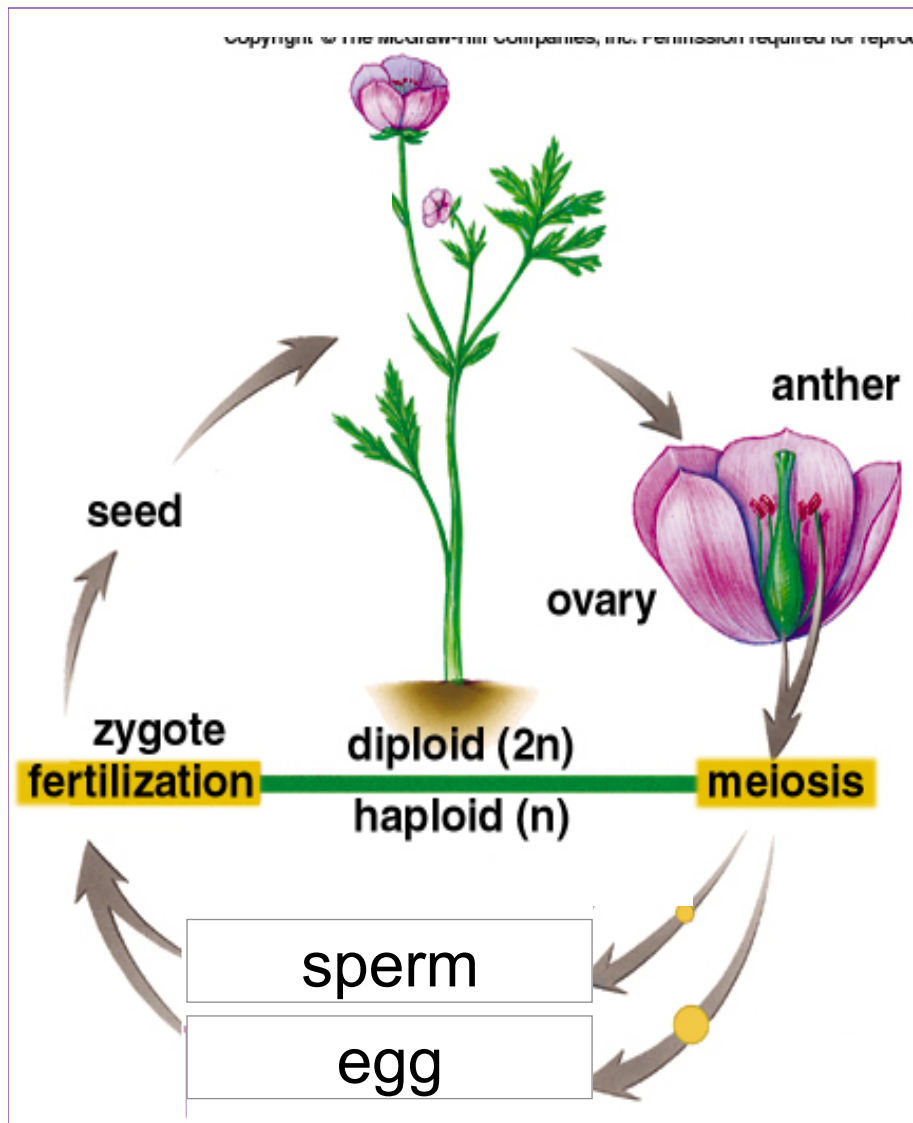
**The Chromosomal Basis of Inheritance**



**Sex Chromosomes and Sex-Linked Genes**

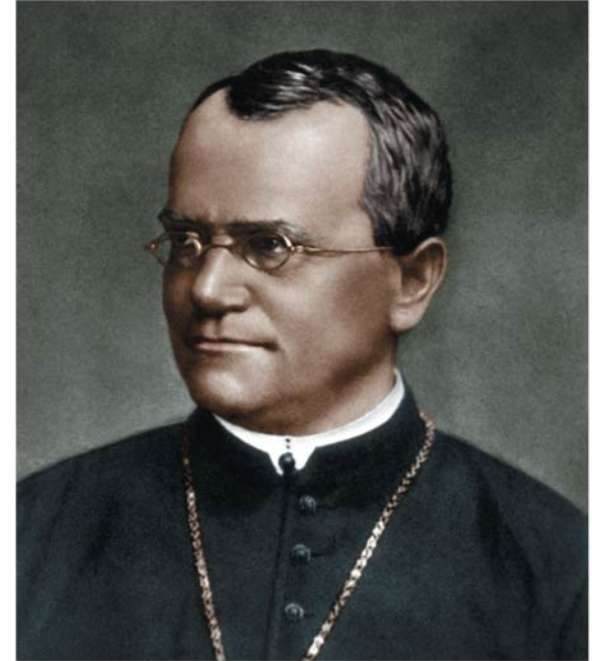


# Sexual Reproduction: Two different sets of chromosomes determine the offspring characters



# Gregor Mendel, Father of Genetics

Mendel described laws governing inheritance in 1866, when the knowledge of genes, DNA, cell division and several other molecular processes did not exist.



(1822–1884)

- Persistence
- Systematic and scientific method of problem solving
- Good model system















# Why is pea a good model?

1. Has easily distinguishable Characters
2. Has a short life cycle
3. Is a self-pollinating plant
4. Can easily be cross pollinated
5. Produces large numbers of offspring





# Character Traits

Flower color	 Purple	 White
Flower position	 Axial	 Terminal
Seed color	 Yellow	 Green
Seed shape	 Round	 Wrinkled
Pod shape	 Inflated	 Constricted
Pod color	 Green	 Yellow
Stem length	 Tall	 Dwarf

- **Character** - a heritable feature
- **Trait** - variant forms of a character



Discuss with your neighbors and come up with a list of some **characters** and **traits** that you can think of.

Which of the following are characters?  
Which of the following are traits?

- Hair color
- 160 cm tall
- Length of Spines on a plant
- Banded Snake Pattern
- Type A+ blood



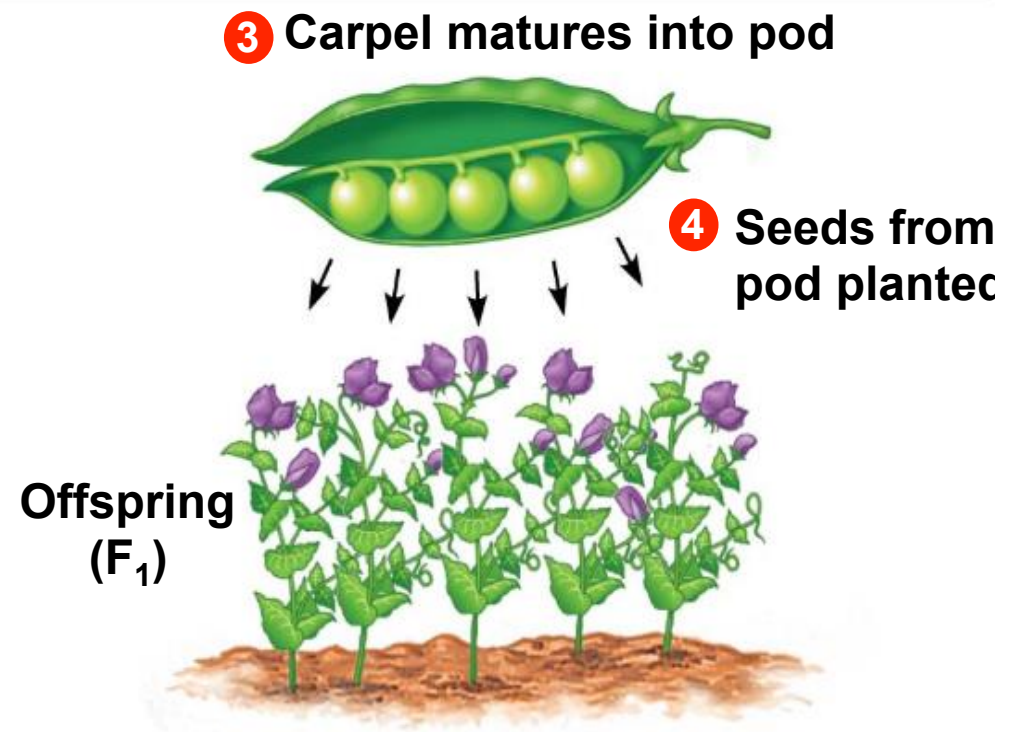
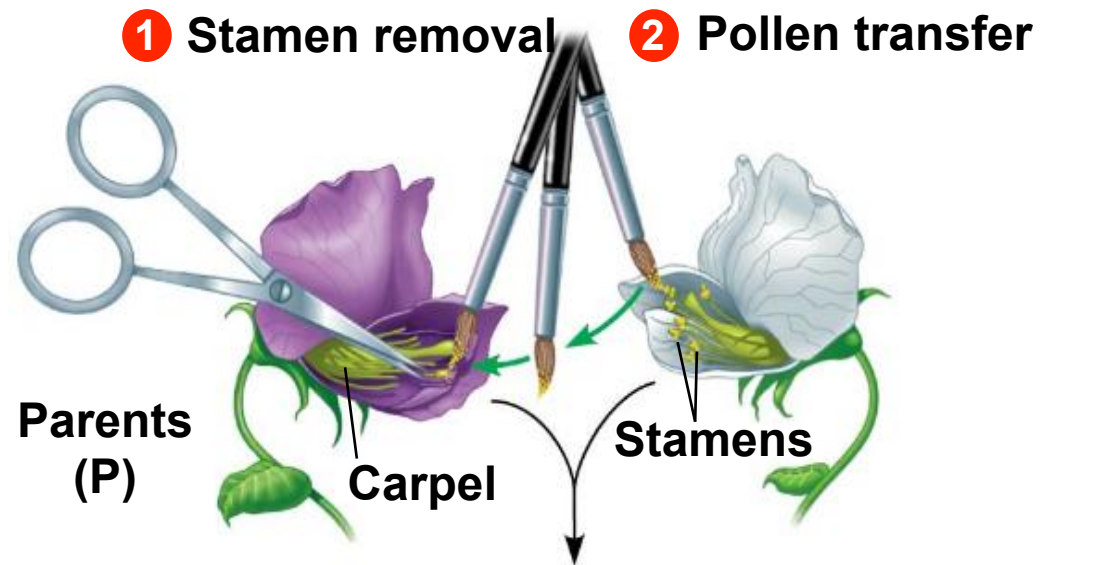
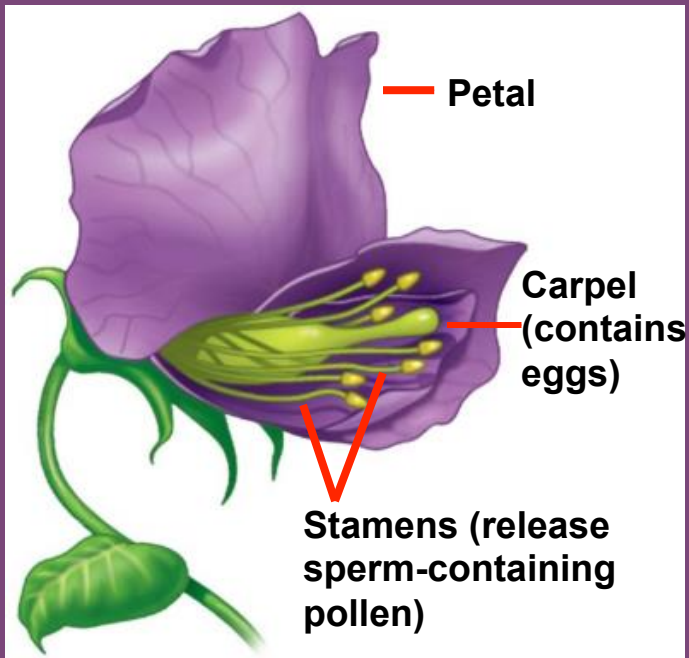
These homologous chromosomes come from the somatic cells of a diploid organism, do they have the same genes?







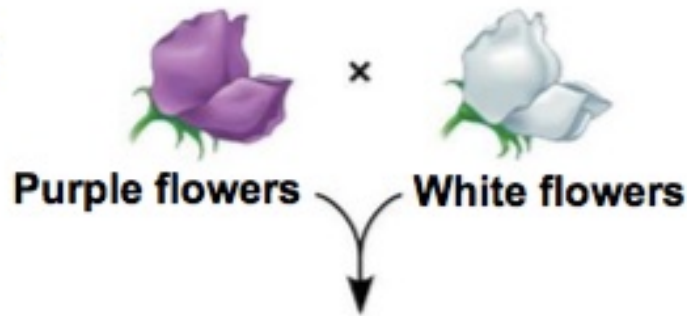
# How to Cross Pea Plants



# Mendel's monohybrid cross Creates Hybrids for 1 character

## The Experiment

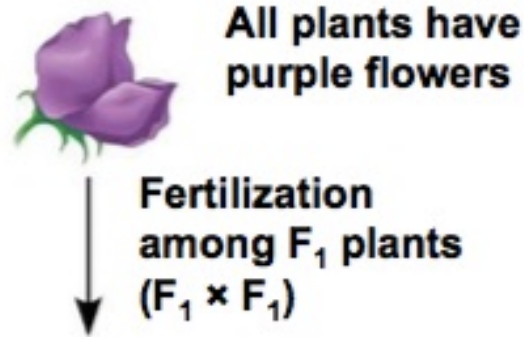
P generation  
(true-breeding  
parents)



P= Parent  
F<sub>1</sub>= First Filial

F<sub>1</sub> generation

(Hybrids)

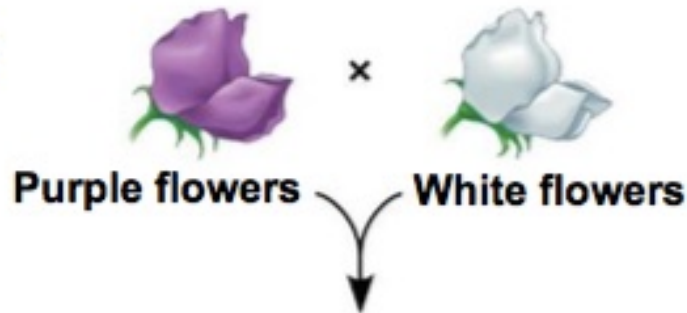


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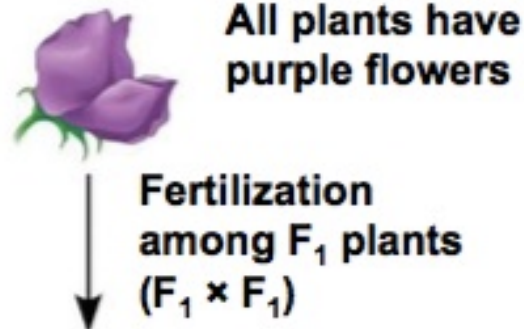
# Mendel's monohybrid cross

## The Experiment

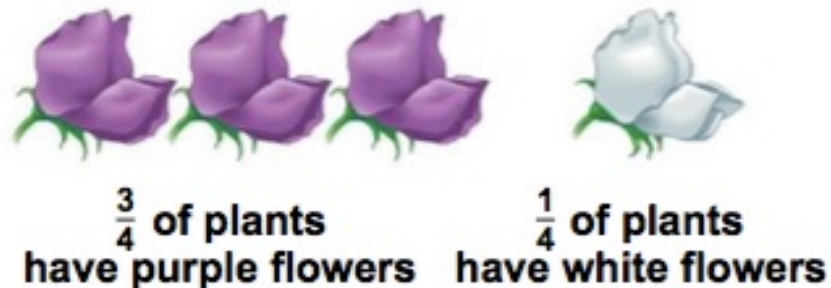
**P generation**  
(true-breeding  
parents)



**F<sub>1</sub> generation**  
(Hybrids)



**F<sub>2</sub> generation**  
(Hybrids)



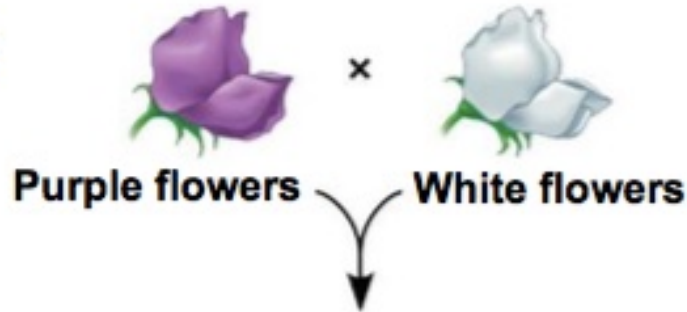
**Conclusion?**

F<sub>1</sub> had purple and  
white inheritance  
factors, but only the  
dominant factor was  
visible

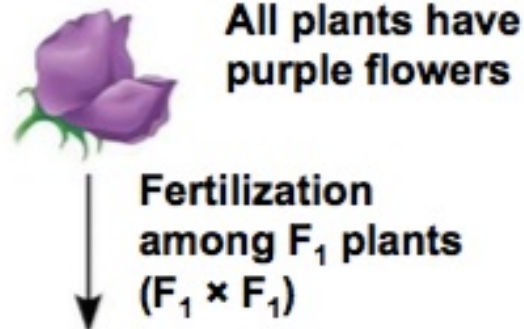
# Mendel's monohybrid cross

## The Experiment

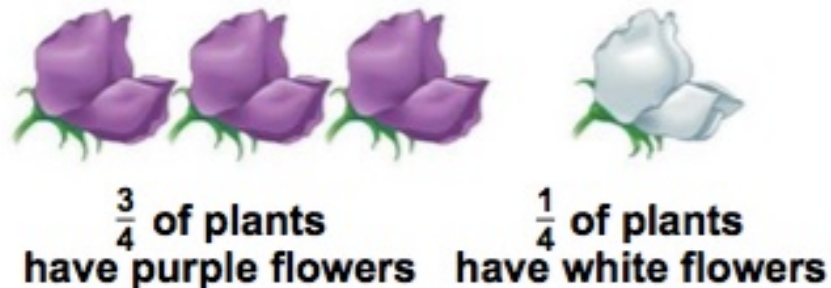
P generation  
(true-breeding  
parents)



F<sub>1</sub> generation  
(Hybrids)



F<sub>2</sub> generation  
(Hybrids)



**Conclusion?**

F<sub>1</sub> had purple and white **alleles** , but only the dominant **allele** was visible

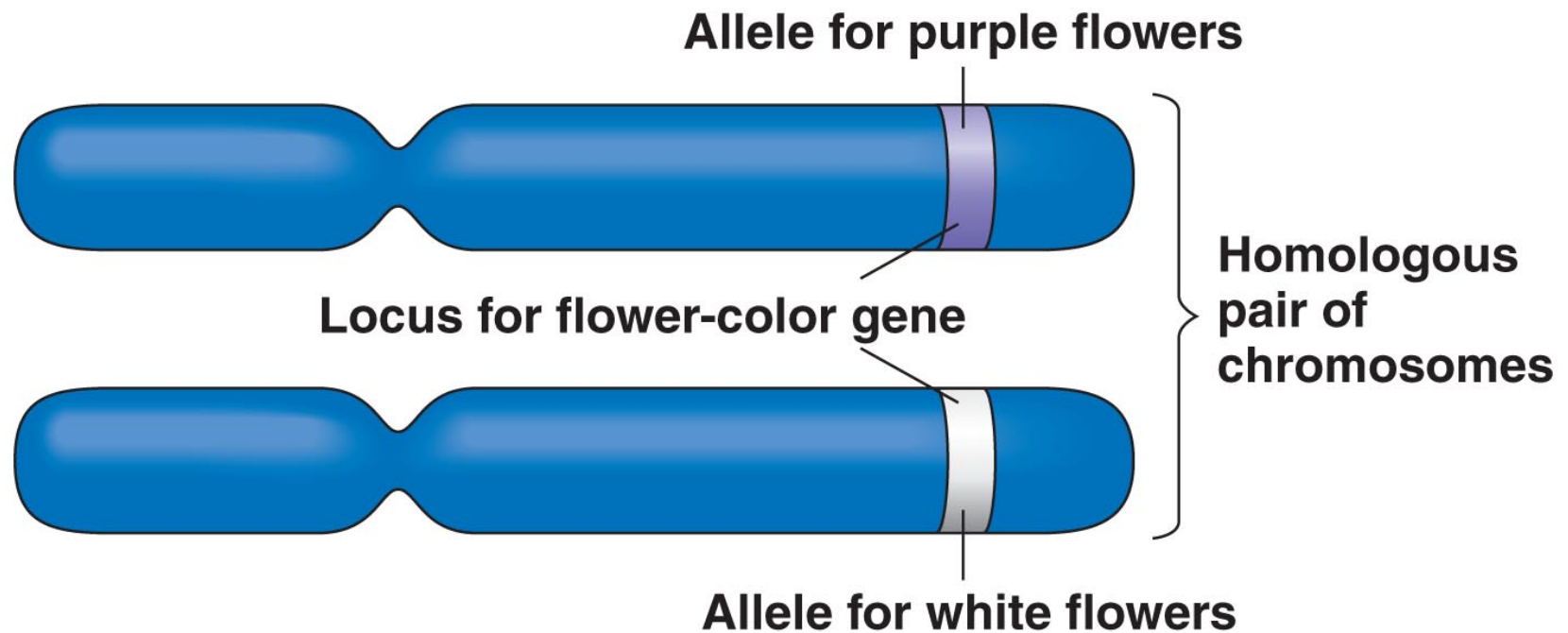


# Mendel's Hypotheses

Derived from his plant breeding experiments



- 1) *There are alternative versions of genes (**alleles**) that account for variations in inherited characters.*



# Genes and alleles

- Hair color
- 160 cm tall
- Length of Spines on a plant
- Banded Snake Pattern
- Type A+ blood



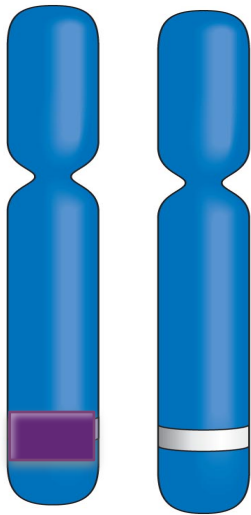
2) *An individual inherits one allele from each parent.*



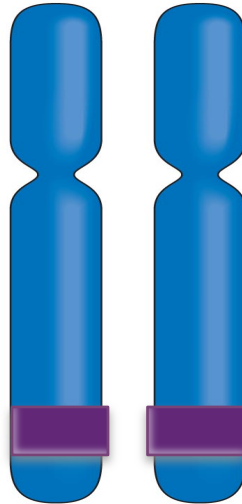
**Allele for white flower**



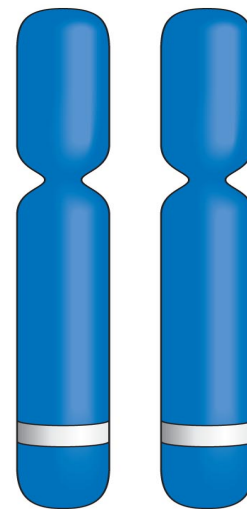
**Allele for purple flower**



**Plant A**  
**Heterozygous**

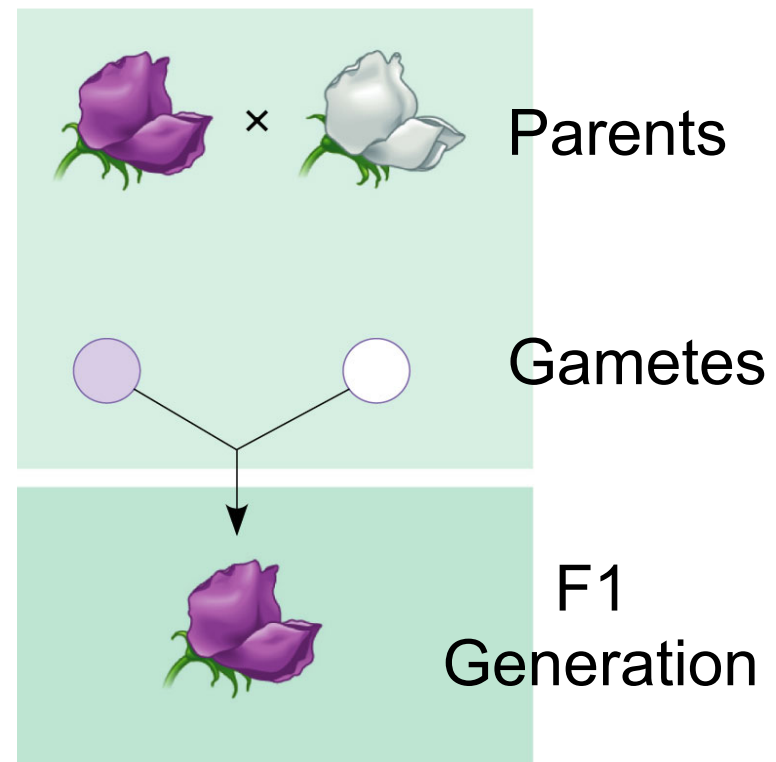


**Plant B**  
**Homozygous**



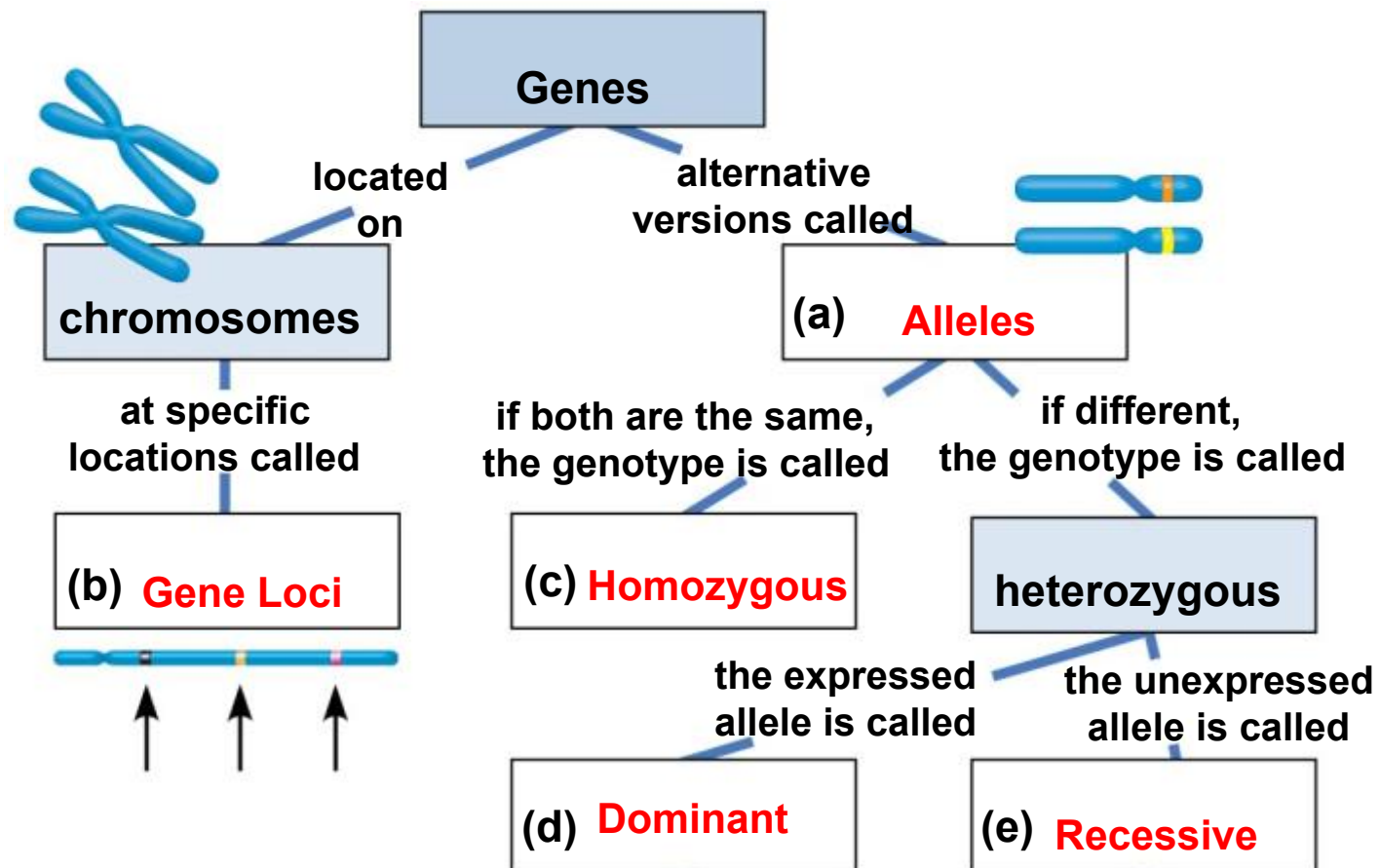
**Plant C**  
**Homozygous**

**3)** *The dominant allele determines the appearance of an heterozygous individual*



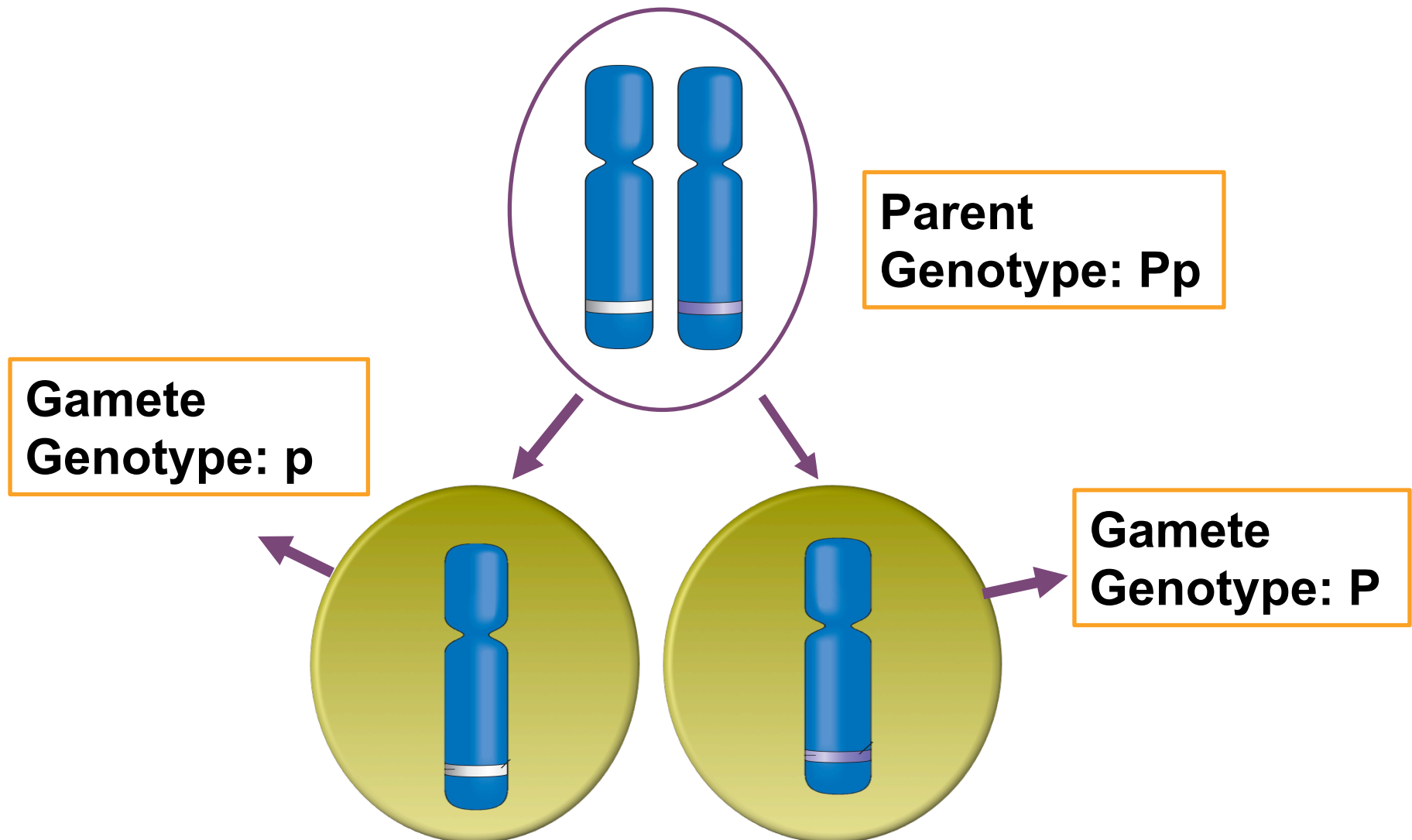
**Phenotype**

## Practice:

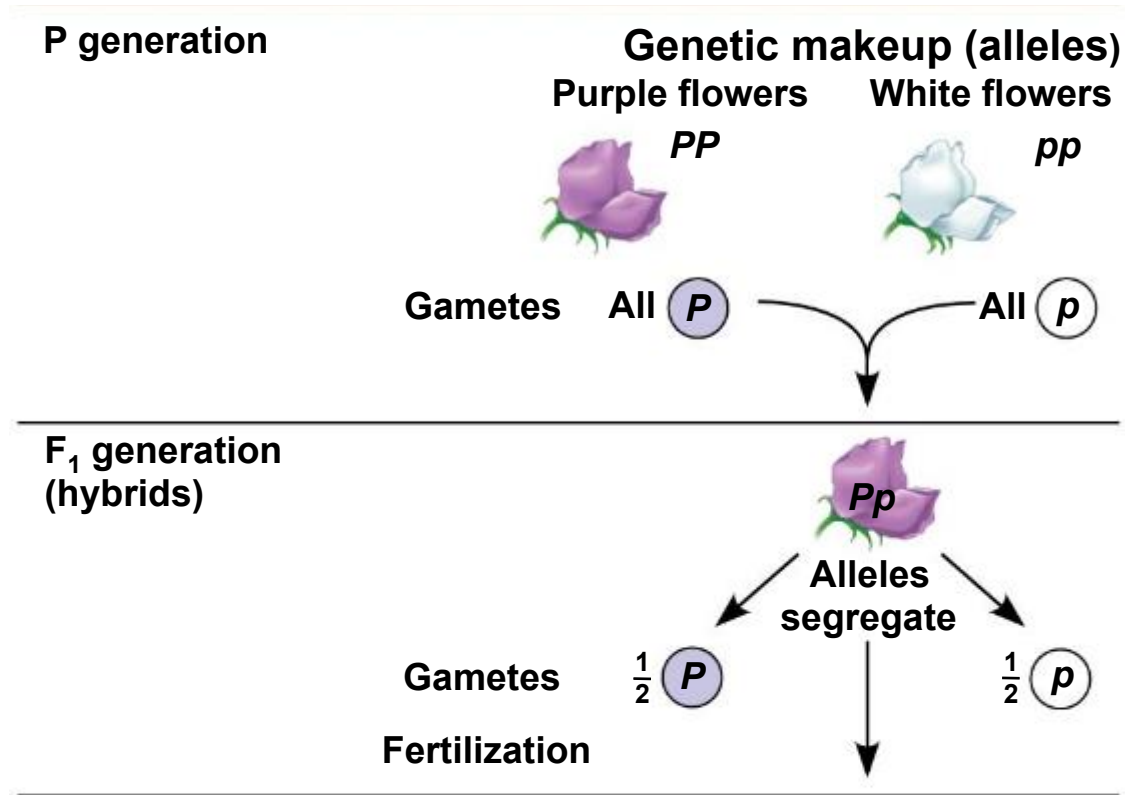




**4)** Allele pairs segregate (separate) during the production of gametes (=Law of Segregation)

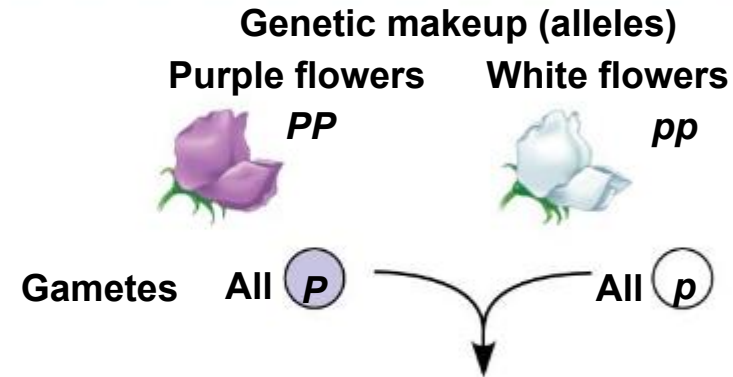


# Inheritance of a single character, The explanation to Mendel's experiments

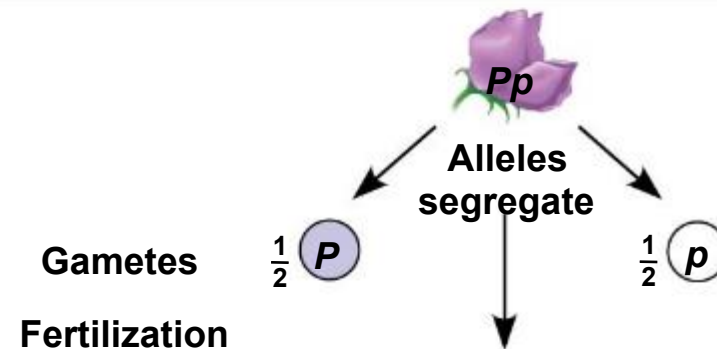


# Inheritance of a single character

P generation



F<sub>1</sub> generation  
(hybrids)

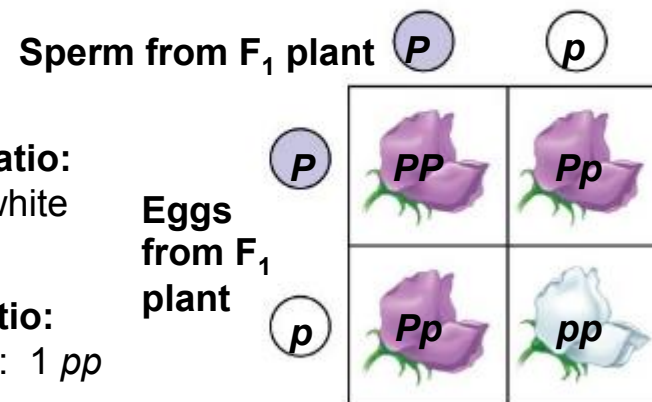


F<sub>2</sub> generation

Results:



Phenotypic ratio:  
3 purple : 1 white

Genotypic ratio:  
1  $PP$  : 2  $Pp$  : 1  $pp$



Results

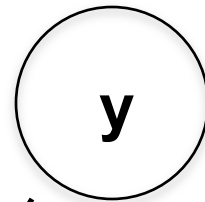
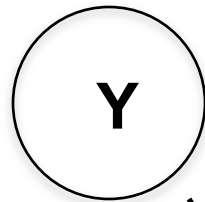
# Solving Genetics Problems

Character	Traits	
	Dominant	Recessive
Seed color	 Yellow	 Green

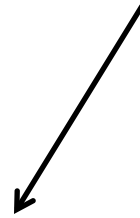
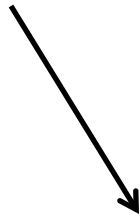
# Solving Genetics Problems



P



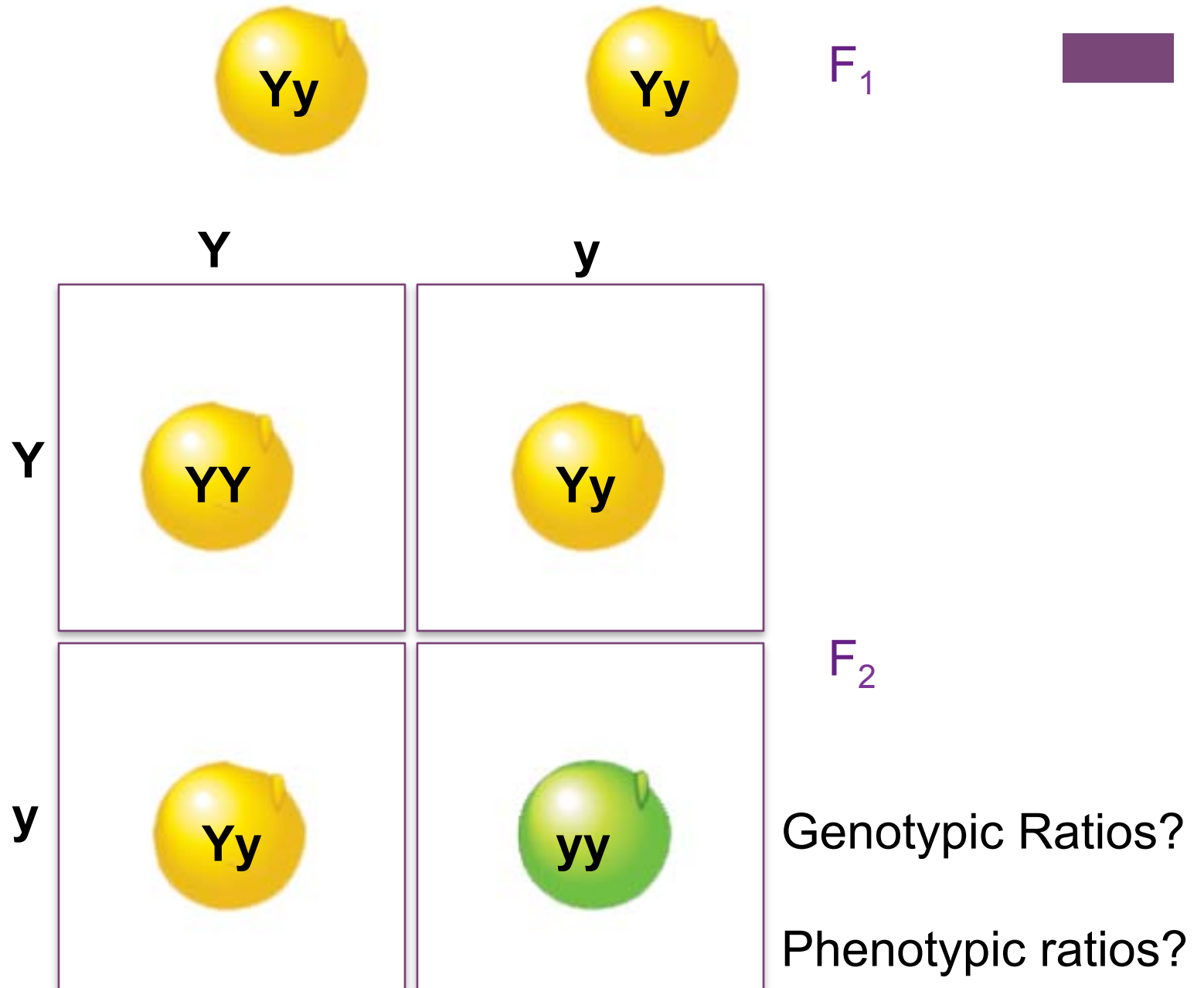
gametes



F<sub>1</sub>



# Practice



# A **diybrid cross**: mating of parental varieties that differ in **two characters**

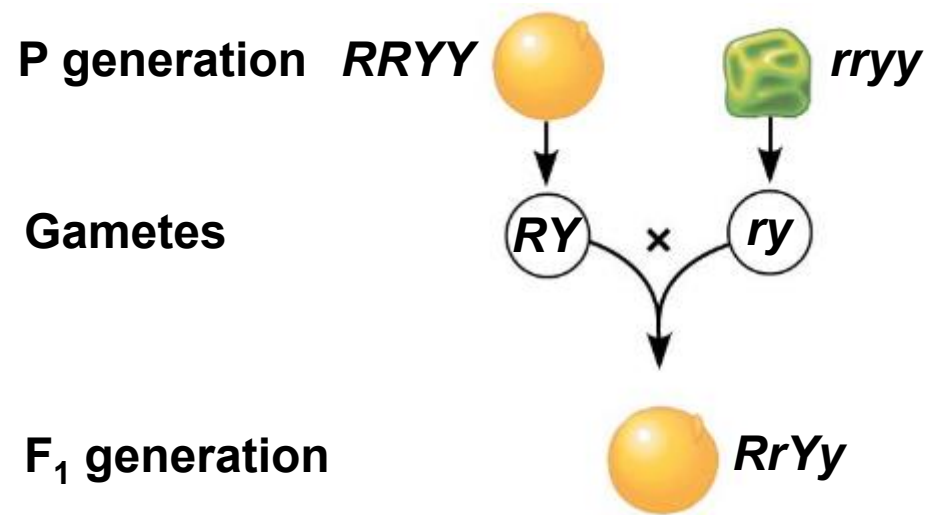
Seed color

and

Seed Shape



















## A dihybrid cross: mating of parental varieties that differ in two characters







# A dihybrid cross: mating of parental varieties that differ in two characters

F<sub>1</sub> generation  RrYy

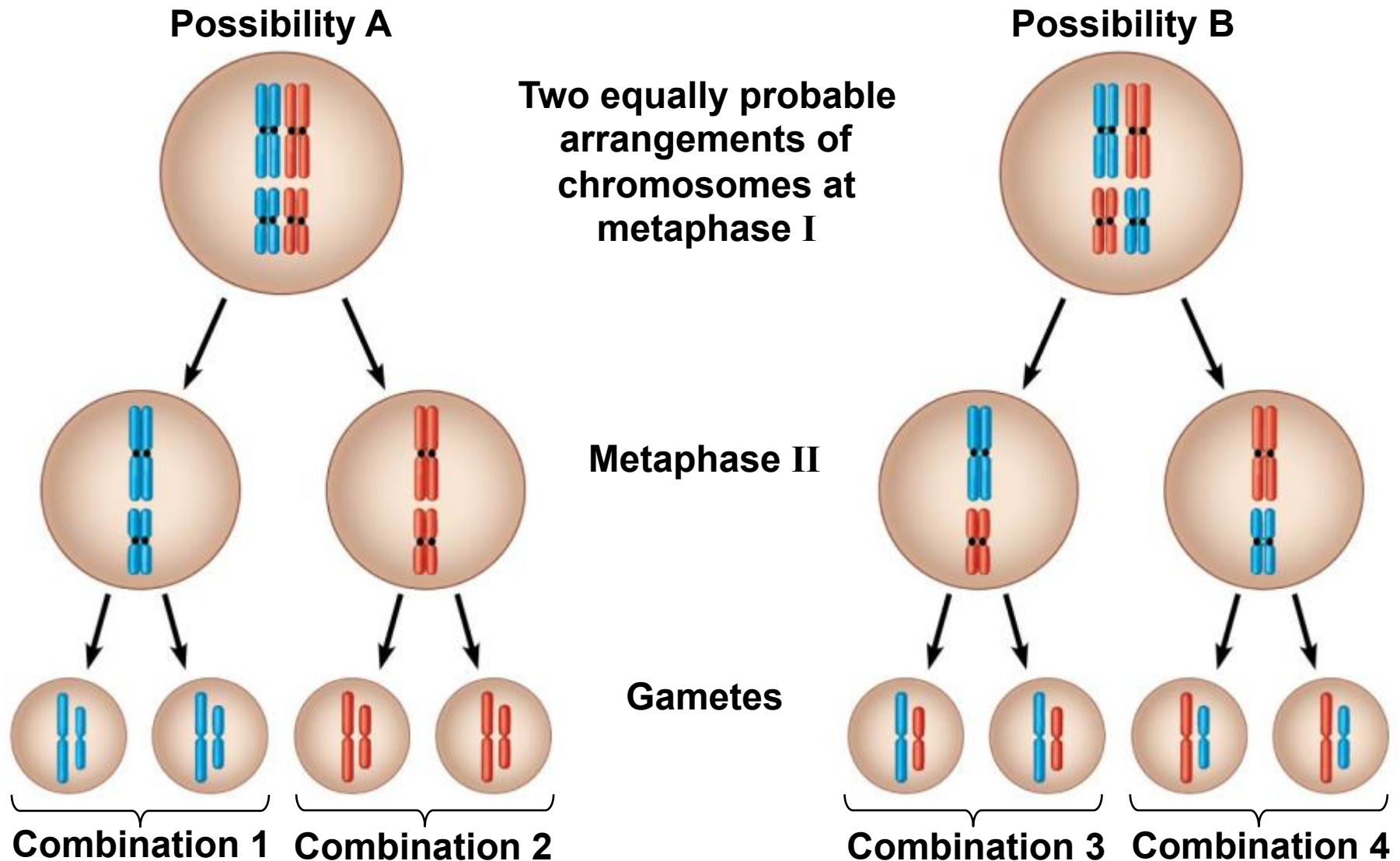
		Sperm			
		$\frac{1}{4}$ RY	$\frac{1}{4}$ rY	$\frac{1}{4}$ Ry	$\frac{1}{4}$ ry
Eggs	$\frac{1}{4}$ RY	 RRYY	 RrYY	 RRYy	 RrYy
	$\frac{1}{4}$ rY	 RrYY	 rrYY	 RrYy	 rrYy
	$\frac{1}{4}$ Ry	 RRYy	 RrYy	 RRyy	 Rryy
	$\frac{1}{4}$ ry	 RrYy	 rrYy	 Rryy	 rryy

Results:

$\frac{9}{16}$   Yellow round  
 $\frac{3}{16}$   Green round  
 $\frac{3}{16}$   Yellow wrinkled  
 $\frac{1}{16}$   Green wrinkled

# The law of independent assortment

5) *Each pair of alleles segregates independently of the other pair of alleles during gamete formation*





# Test Cross – determining the genotype of the parents

What is the genotype of the black dog?

Testcross



x



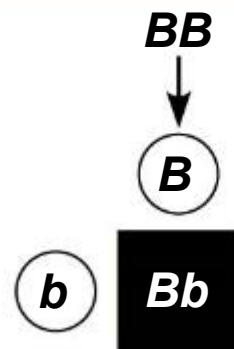
Genotypes

$B\_?$

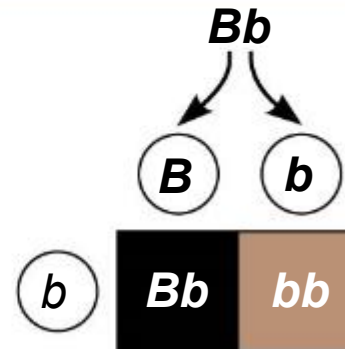
$bb$

Two possibilities for the black dog:

Gametes



or



Offspring

All black

1 black : 1 chocolate

# Variations On Mendelian Laws



- Genotype to phenotype relationships are rarely as simple as Mendel demonstrated
- Most characters are inherited in more complex patterns
  - **Incomplete dominance**
  - **Codominance**
  - **Multiple allele inheritance**
  - **Sex-linked inheritance**
  - **Pleiotropy**
  - ***Environmental influence***
  - **Polygenic inheritance**

# Incomplete Dominance

Heterozygote exhibits a phenotype ***intermediate*** between both homozygous conditions



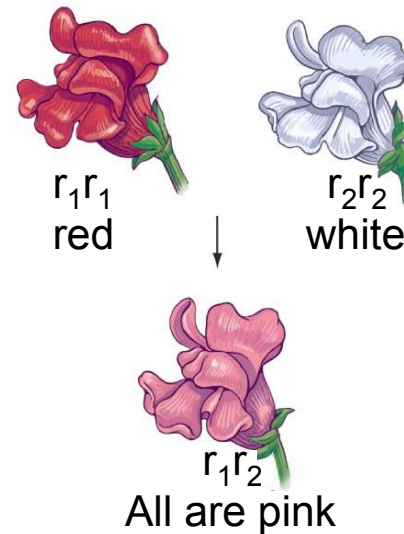
$C_2C_2$

$C_1C_1$

# Incomplete Dominance

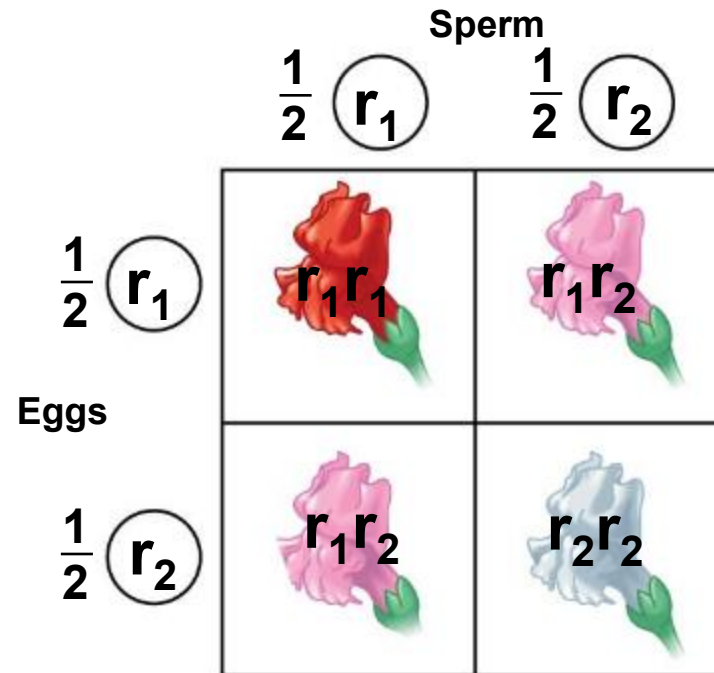
Another example:  
Flower color in some plants

- Alleles
  - $r_1$  = red allele
  - $r_2$  = white allele
- Genotypes and Phenotypes
  - $r_1r_1$  = red flowers
  - $r_1r_2$  = pink flowers
  - $r_2r_2$  = white flowers



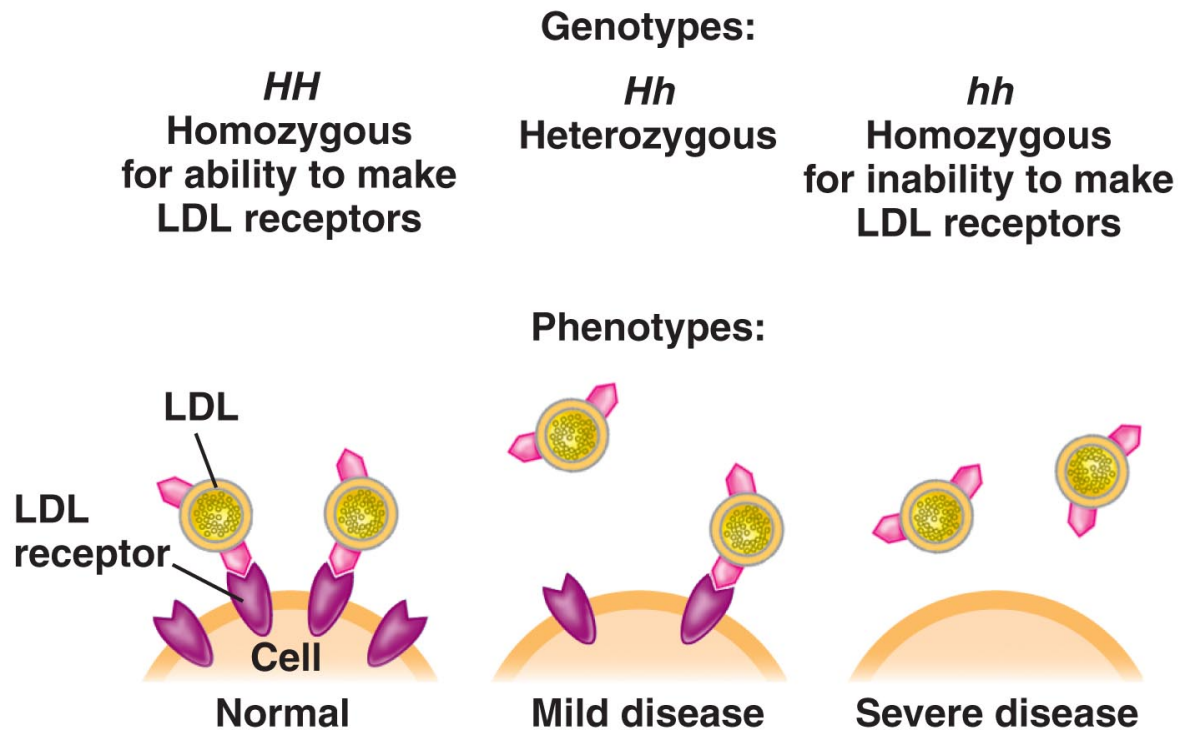
P

F<sub>1</sub>



F<sub>2</sub>

# Practice:



Examine the phenotypes related to the ability to make LDL membrane receptors.

- What type of inheritance does this appear to be?

***Incomplete dominance***

# Codominance

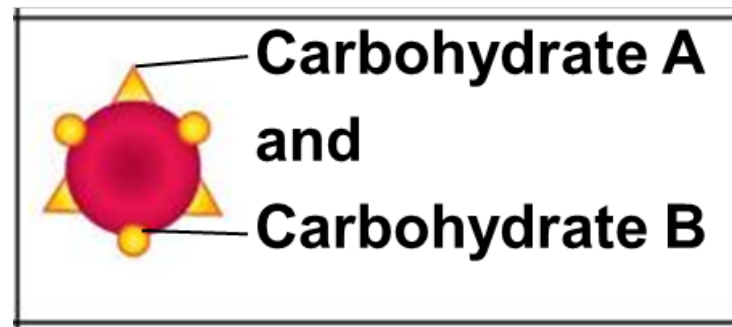
- Both alleles are equally expressed in the heterozygote

Examples:

AB blood type is determined by three alleles.





alleles  $I^A$  (Carbohydrate A)  $I^B$  (Carbohydrate B)

are codominant



$I^A I^B$



Blood group genotypes and phenotypes				
Genotype	$I^A I^A$ or $I^A i$	$I^B I^B$ or $I^B i$	$I^A I^B$	$ii$
Red blood cell appearance				
Phenotype (blood group)	A	B	AB	O



# X-linkage

- Humans have 23 pairs of homologous chromosomes

- 22 pairs of **autosomes**
- 2 **sex chromosomes**: X and Y

- 44, XX = female

- 44, XY = male

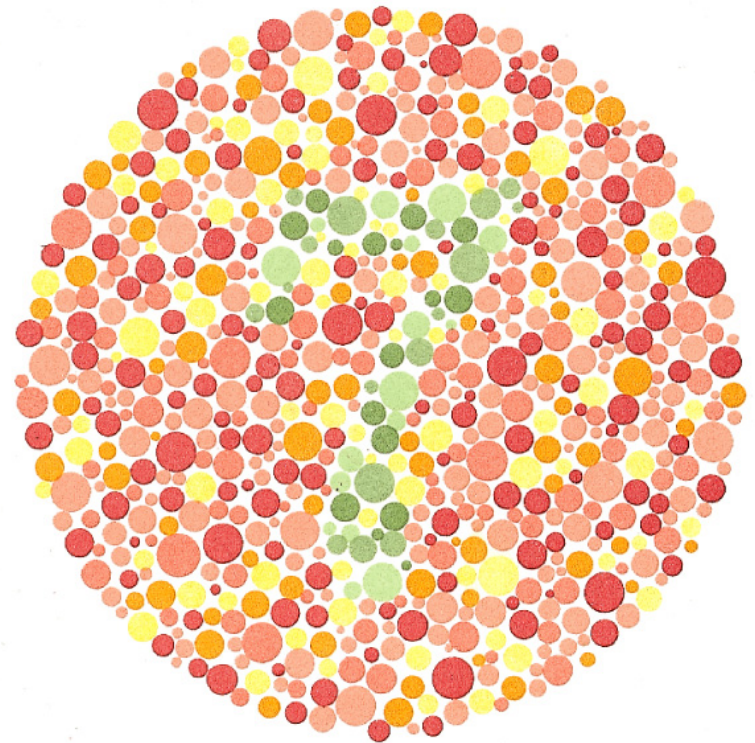
- X and Y are not homologous over their entire length



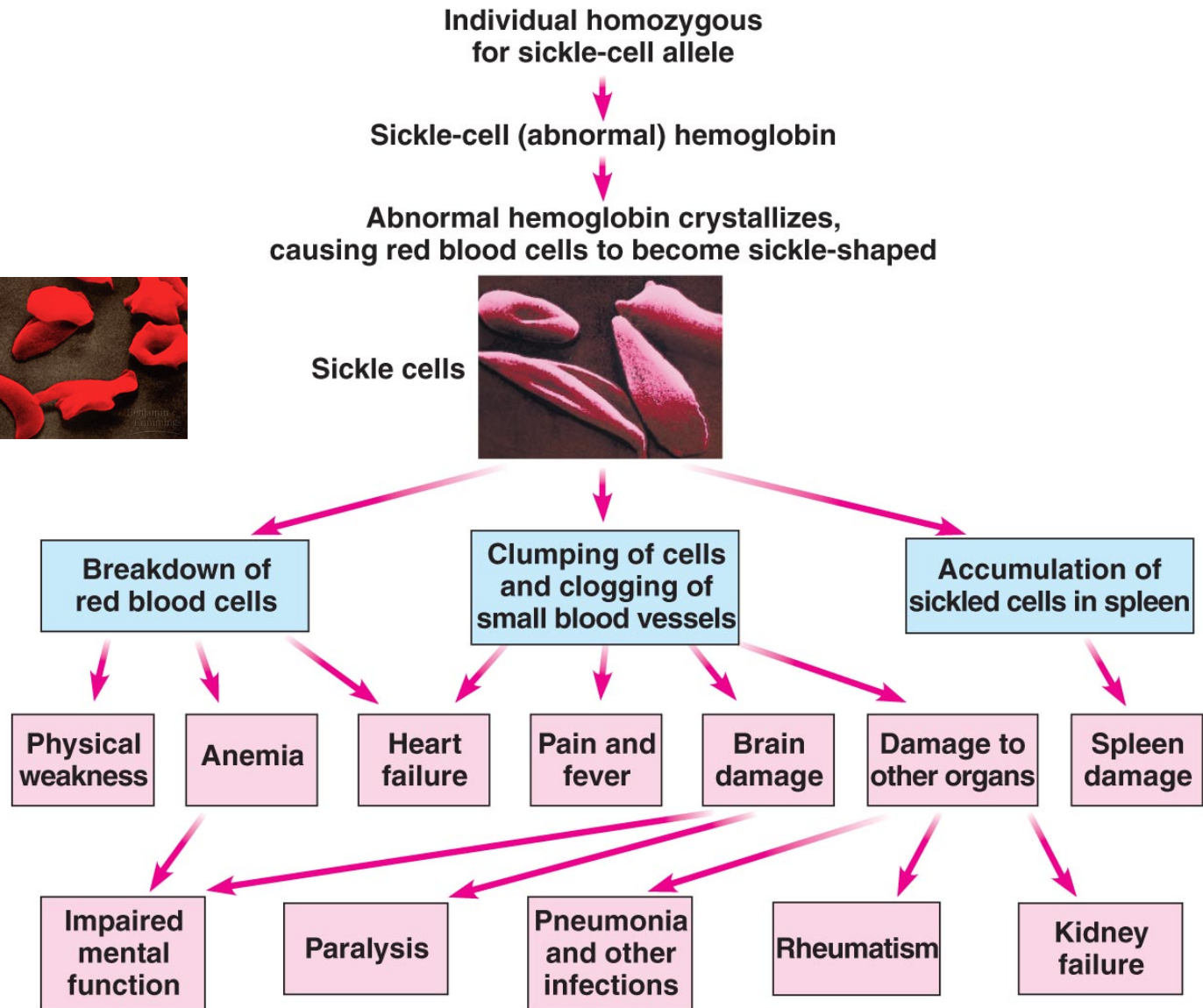
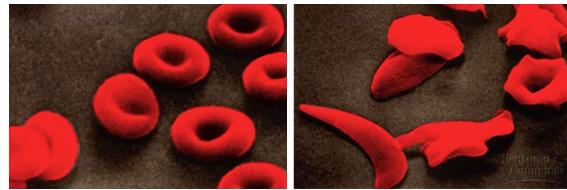
d. Normal male karyotype with 46 chromosomes.



Red-green colorblindness is an X-linked recessive trait.



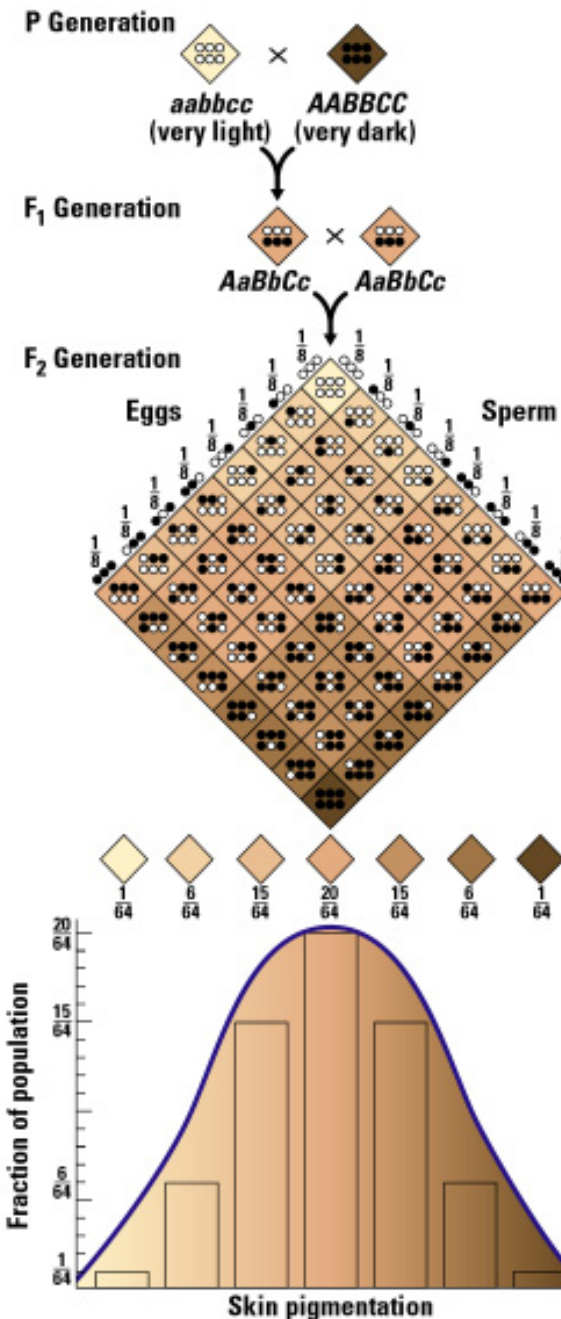
# Pleiotropy: A gene with multiple phenotypic effects



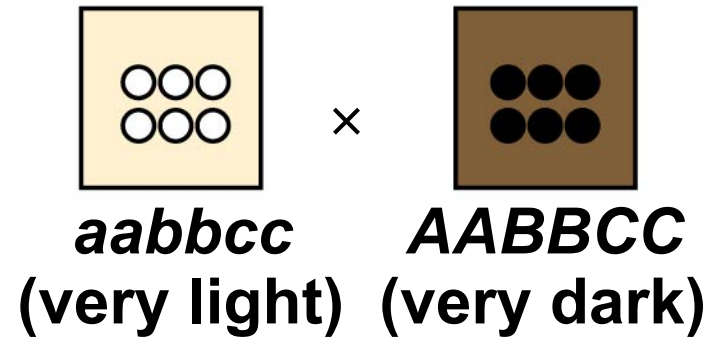
# Polygenic Inheritance

A single character  
is influenced by  
**many genes**

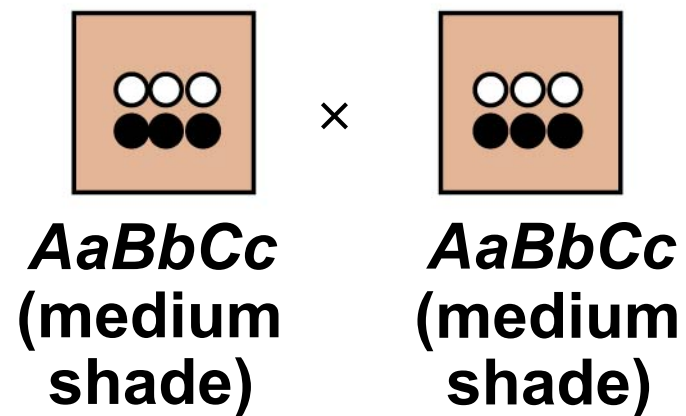
Each dominant  
allele adds a  
“dose” of  
phenotype



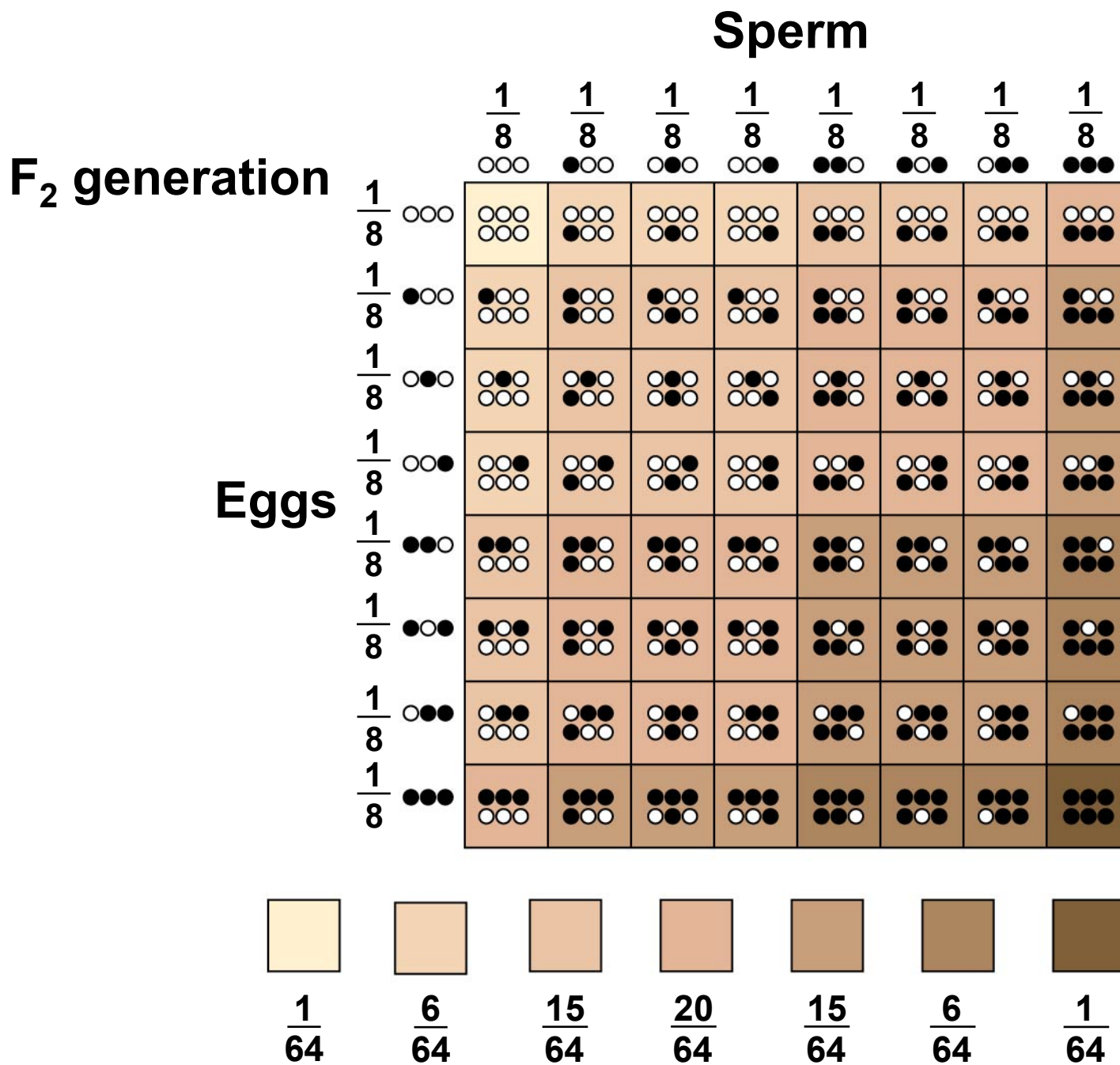
**P generation**



**F<sub>1</sub> generation**







# Linkage

- Examine the homologous chromosomes illustrated. What gametes can this cell produce with respect to the B and C genes?
- How could there be BC and bc gametes?
- Linked genes are located on the same chromosome.
- Linked genes won't segregate unless crossing-over occurs.

