



# Principles of Inheritance

Development of genetics

- Gregor Mendel (1865)
  - **Discovered basic laws of heredity**
  - **Studied inheritance of single characteristics**
  - **Applied mathematic principles toward his hypothesis that each trait is determined by 2 genetic factors**



# Principles of Inheritance

Development of genetics

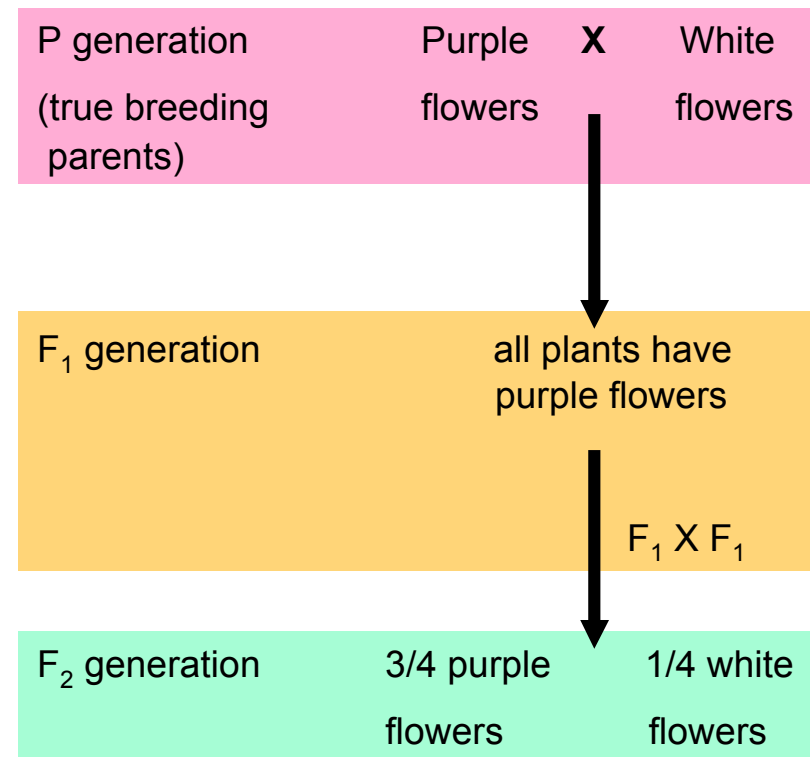
- Mendel studied pea plants
  - **Easily manipulated**
  - **Self-fertilization**
- Performed experiments tracking several characteristics in pea plants from which he formulated several hypotheses

# Principles of Inheritance

Mendel's principles of segregation

- The monohybrid cross

- a cross between parent plants that differ in only one characteristic





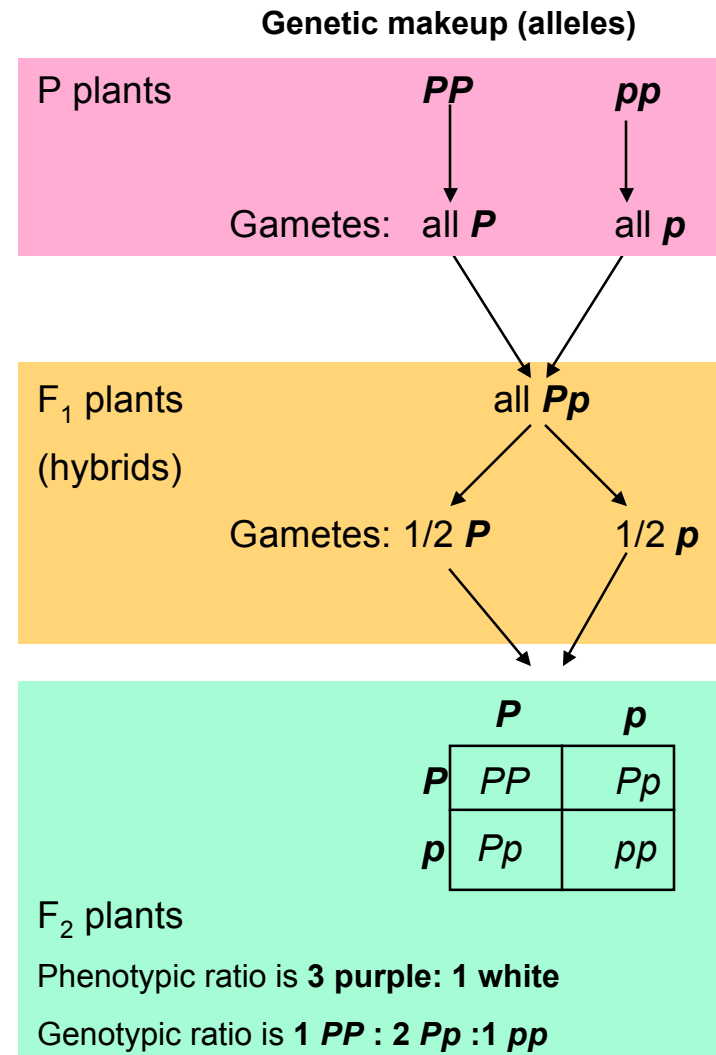
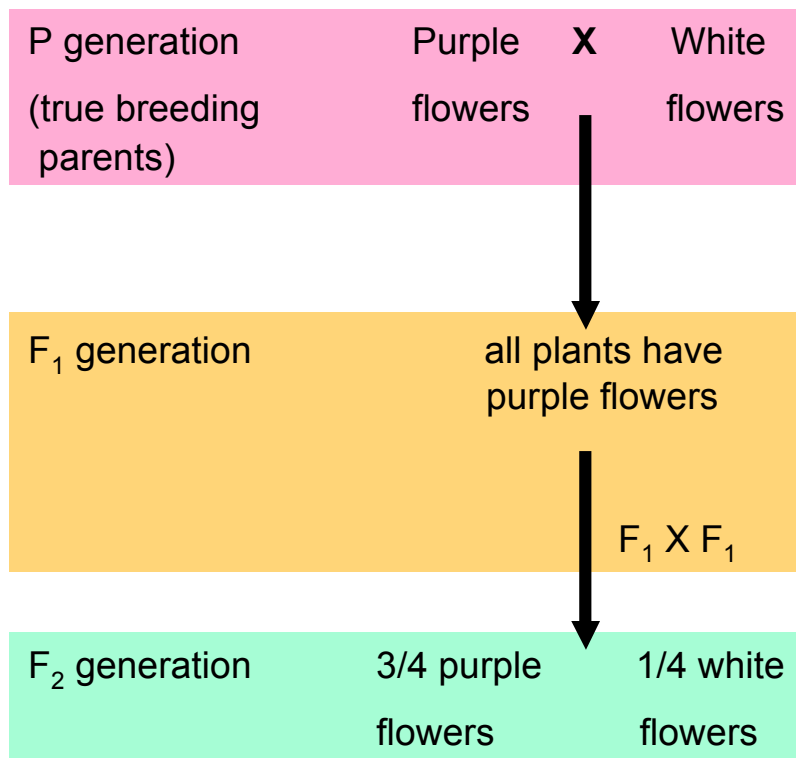
# Principles of Inheritance

Mendel's principles of segregation

- Mendel developed 4 hypotheses from the monohybrid cross
  - **There are alternative forms of genes (called [alleles](#))**
  - **For each characteristic, each organism has two genes**
  - **Gametes carry only one allele for each inherited characteristic**
  - **Alleles can be dominant or recessive**

# Principles of Inheritance

## Monohybrid cross results





# Principles of Inheritance

Some genetic terminology

- Phenotype - an organisms expressed or physical traits
- Genotype - genetic make-up
- Allele - alternative forms of a gene
- Dominant allele - fully expressed allele --> determines the phenotype
- Recessive allele - no noticeable effect on phenotype

# Principles of Inheritance

## Principle of Segregation

- Pairs of alleles separate during gamete formation

$$\begin{array}{c} Pp \\ / \quad \backslash \\ P \quad p \end{array}$$

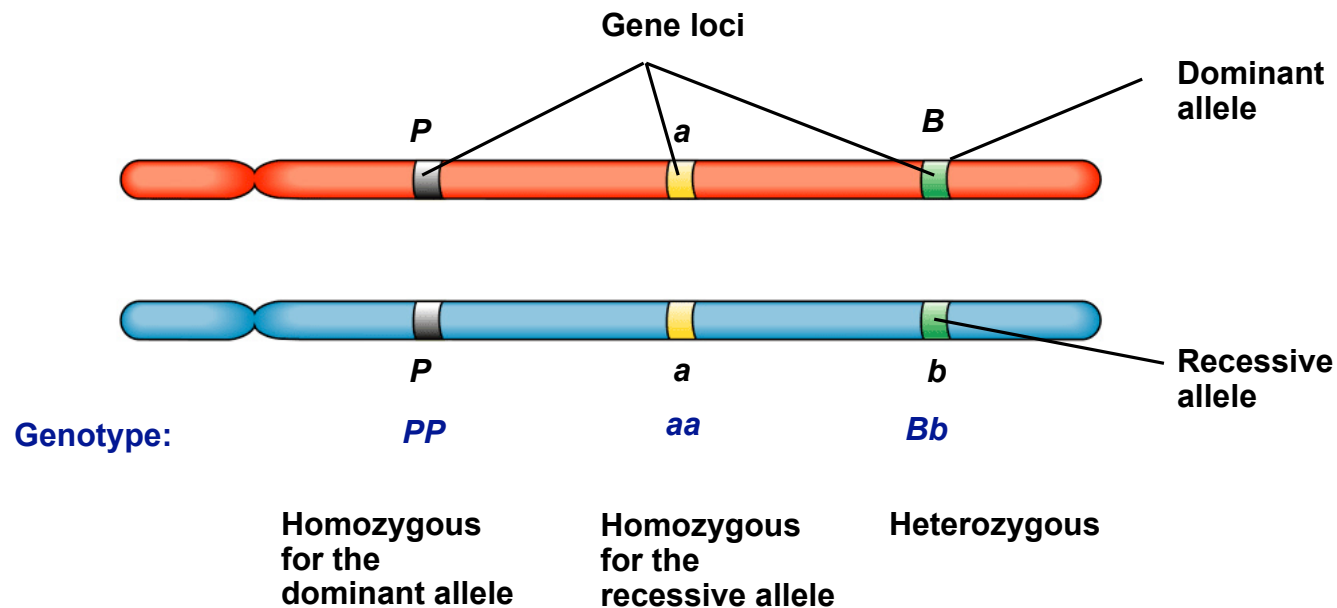
- The fusion of gametes at fertilization creates allele pairs again

$$\begin{array}{c} P \quad p \\ \backslash \quad / \\ Pp \end{array}$$

# Principles of Inheritance

## Alleles and Homologous chromosomes

- Homologous chromosomes have genes at specific loci
- Have alleles of a gene at the same locus







# Principles of Inheritance

Some more terminology

- Homozygous- having two identical alleles for a given gene (*PP* or *pp*)
- Heterozygous - two different alleles



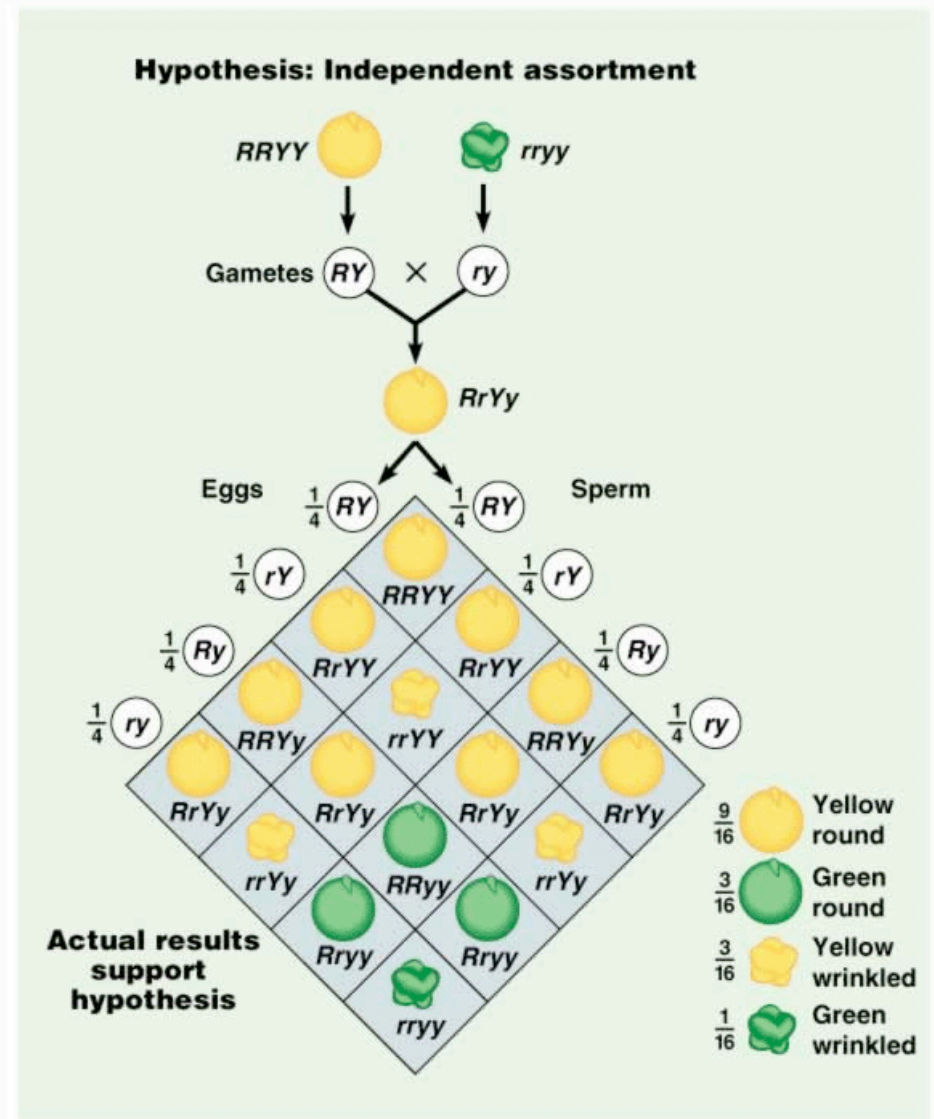
# Principles of Inheritance

Mendel's principles of [independent assortment](#)

- Each pair of alleles segregates independently of the other pairs during gamete formation
- A cross of 2 dihybrids produces phenotype ratio of 9 : 3 : 3 : 1
- Results in variation in sexual reproduction

# Principles of Inheritance

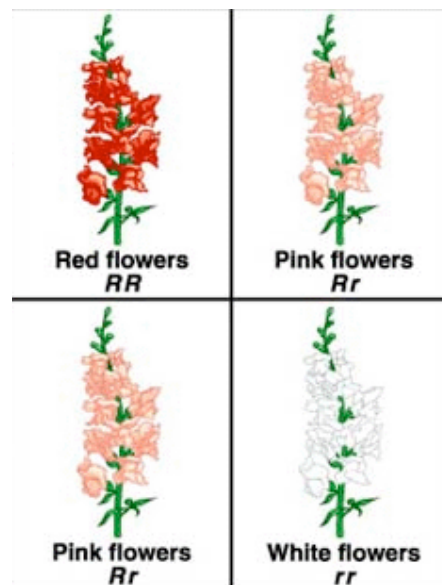
Independent assortment



# Principles of Inheritance

## Post Mendelian Genetics

### ■ Incomplete dominance



In **incomplete dominance**,  $F_1$  hybrids have an appearance in between the phenotypes of the two parents.



# Principles of Inheritance

## Post Mendelian Genetics

### ■ Multiple Alleles

















- **3 or more alternative genes (alleles) which can occupy a single locus**
- **Produce different phenotypes**

### ■ ABO blood groups in humans

- **Two of the human blood type alleles exhibit codominance**
- **Both alleles are expressed in the phenotype**

# Principles of Inheritance

## ABO blood groups in humans

Blood Group (Phenotype)	Genotypes	Antibodies Present in Blood	Reaction When Blood from Groups Below Is Mixed with Antibodies from Groups at Left			
			O	A	B	AB
O	$ii$	Anti-A Anti-B				
A	$I^A I^A$ or $I^A i$	Anti-B				
B	$I^B I^B$ or $I^B i$	Anti-A				
AB	$I^A I^B$	—				



# Principles of Inheritance

## ABO blood groups in humans

Blood Type	Distribution (%)	Antigen on RBC	Antibody in serum plasma	Will clot with blood from these donors	Can receive from:	Can give to:
O	48	-	Anti-A Anti-B	A, B, AB	O	All
A	42	A	Anti-B	B, AB	A & O	A & AB
B	7	B	Anti-A	A, AB	B & O	B & AB
AB	2	A & B	-	-	All	AB

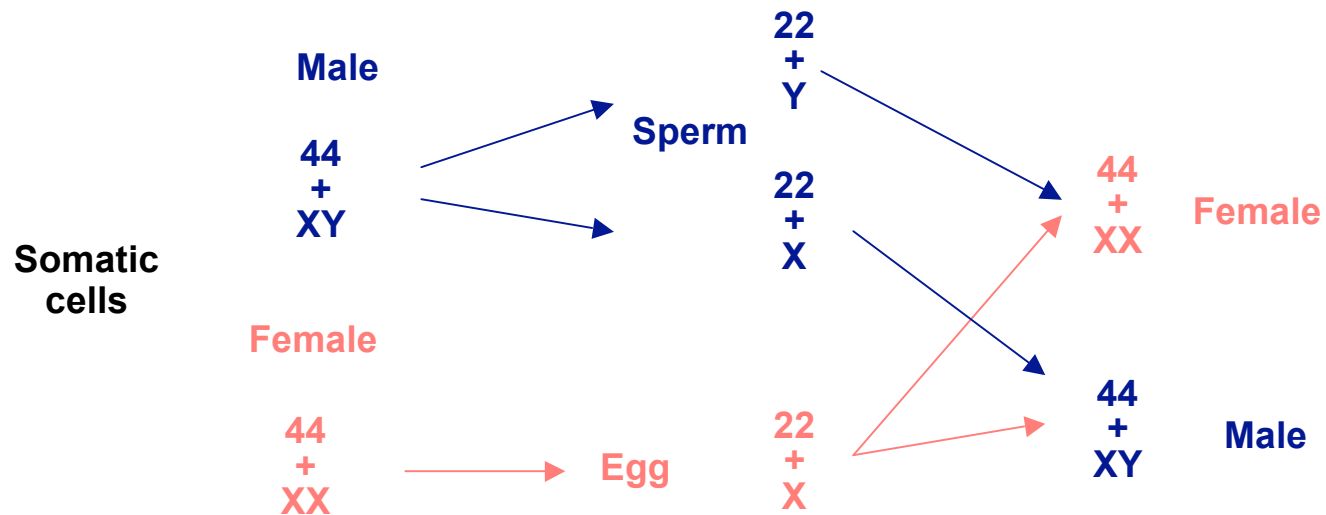
**Type O Blood:** Universal Donor as it contains no A or B antigens, so the receivers' blood will not clot when given the O blood.

**Type AB Blood:** Universal Receiver, as it contains no Anti-A or Anti-B antibodies in its plasma. It can receive all blood types.

# Principles of Inheritance

## Sex Chromosomes

- XY method of sex determination

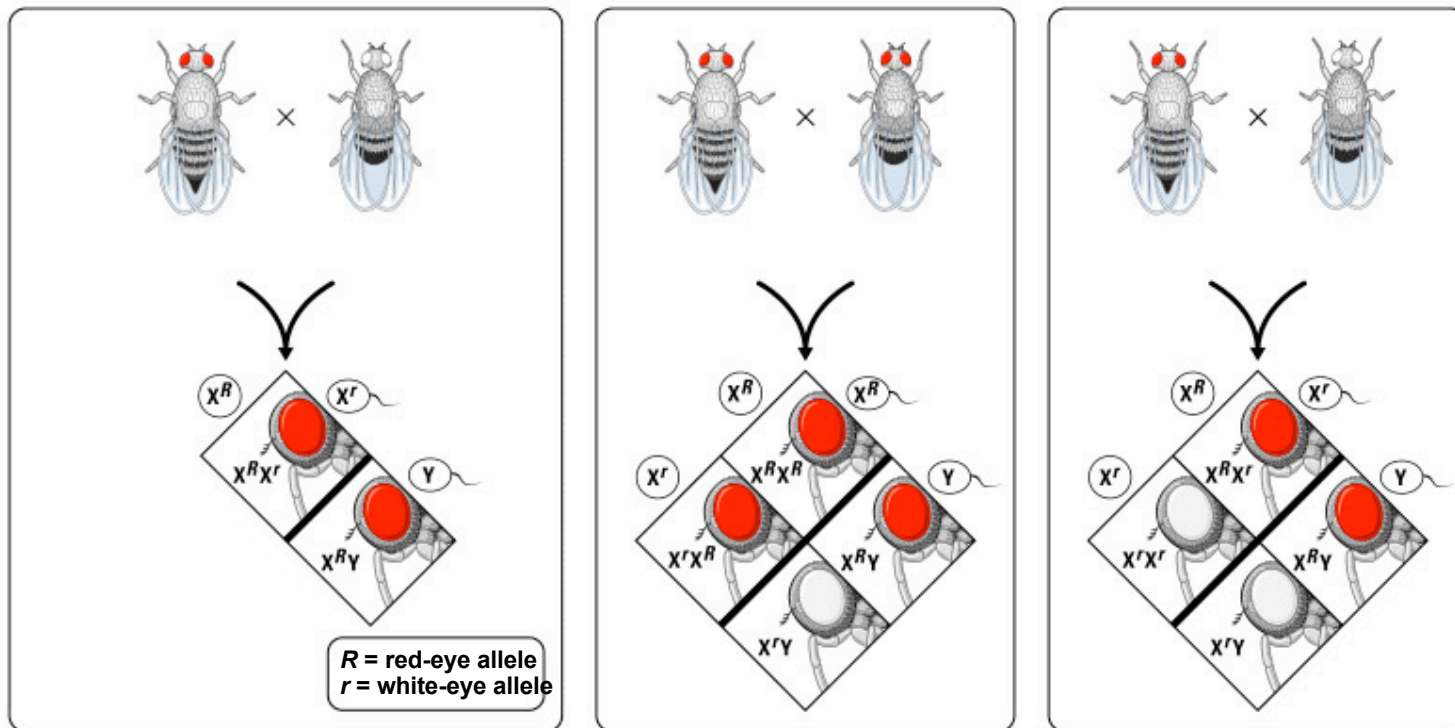




# Principles of Inheritance

## Sex-linked genes

- genes located on a sex chromosome





# Principles of Inheritance

Sex-linkage in humans

- A number of human conditions result from sex-linked (X-linked) genes
  - **Red-green color blindness**
  - **Hemophilia (blood-clotting disease)**



# Principles of Inheritance

Human sex chromosome aberrations

- Results of nondisjunction during meiosis
  - **The members of a chromosome pair fail to separate during anaphase**
  - **Gametes with an incorrect number of chromosomes are produced**



# Principles of Inheritance

Human sex chromosome aberrations

- $XXY$       Klinefelter's Syndrome
- $XO$         Turner's Syndrome
- $XXX$         Triple X Syndrome (normal female)
- $XYY$          $XYY$  Syndrome (normal male)