Post Mendelian Concept of Heredity

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Introduction

✓Gregor Johann Mendel discovered the basic principles of heredity through experiments with garden pea, which are popularly known as **Mendel's laws.**

✓In 1900, the work of Mendel was independently rediscovered by

- **Hugo de Vries** (Holland)
- **Carl Correns** (Germeny)
- **Erich Tschermak** (Austria).

✓Later on these principles were further clarified and confirmed by several workers and some new concepts of heredity were discovered.

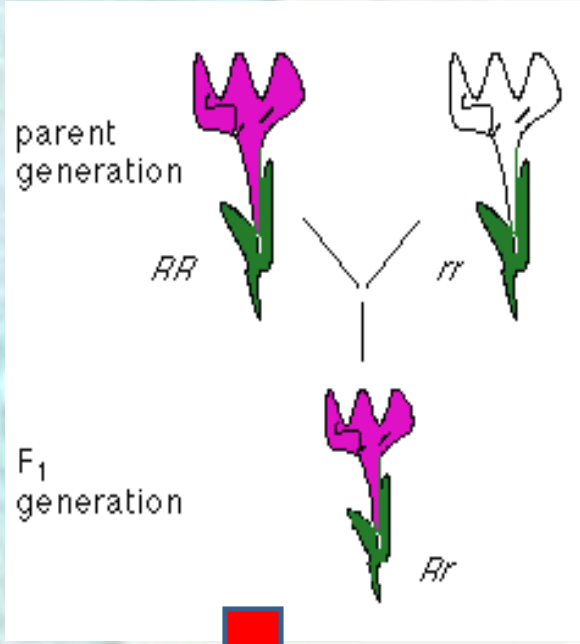
✓These new concepts were different from the findings of Mendel.

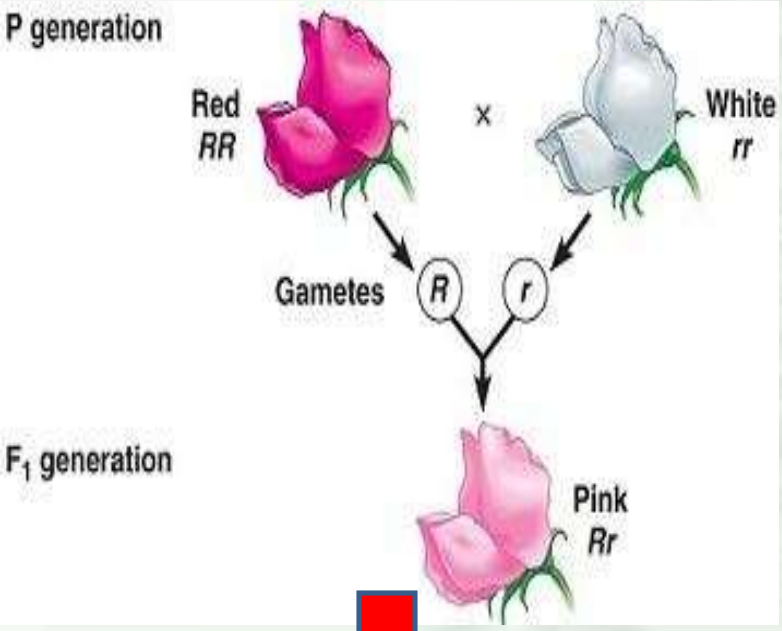
✓These concepts are often referred to as **"Mendelian Deviations"** or **exceptions** or **anomalies**

Mendelian Deviations

- Incomplete dominance
- Co-dominance
- Multiple alleles
- Linkage
- Lethal genes
- Gene interactions
- Pleiotropic gene effect
- Polygenes
- Environmental effects
- Cytoplasmic Inheritance

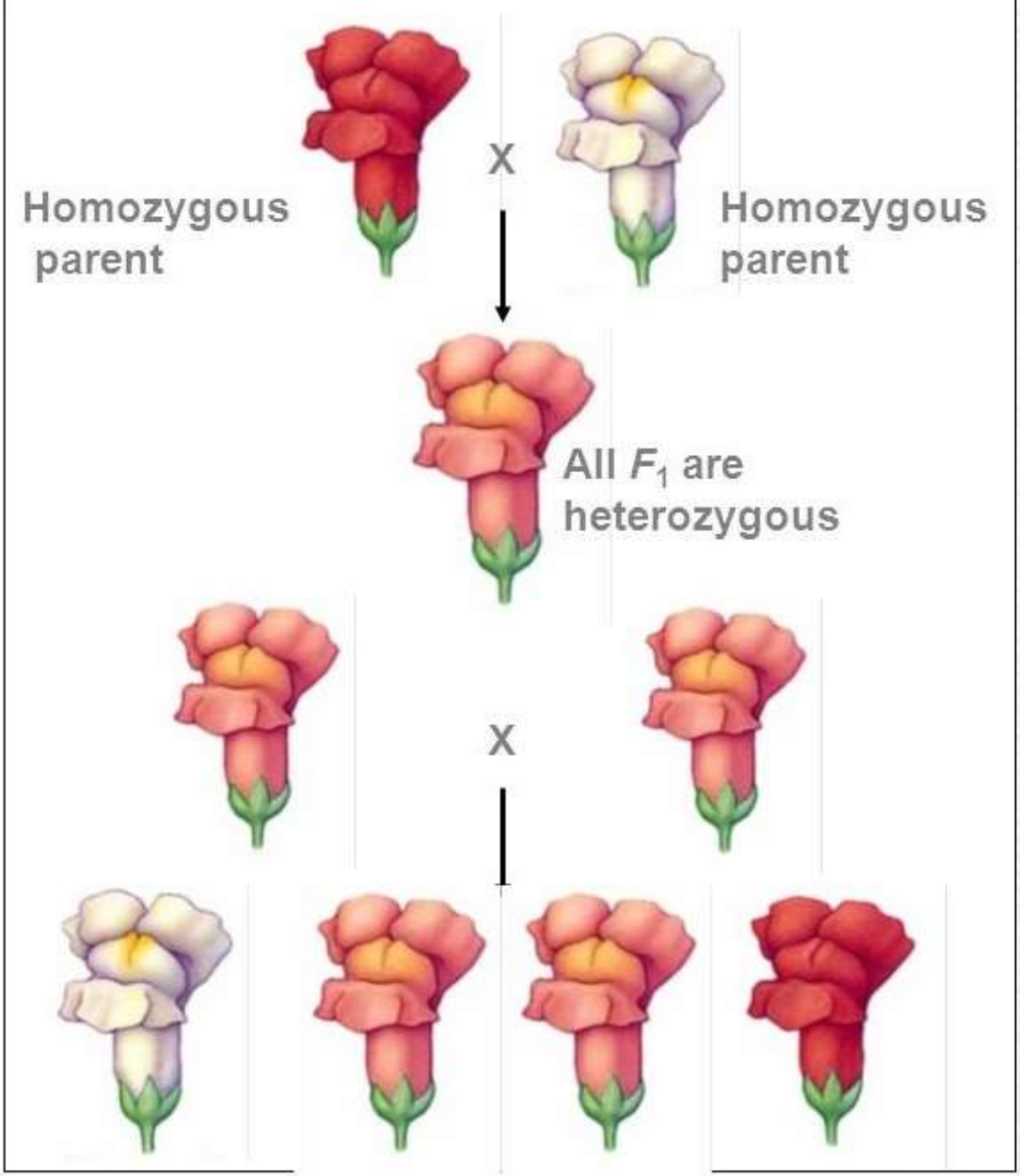
Incomplete dominance





Complete Dominance

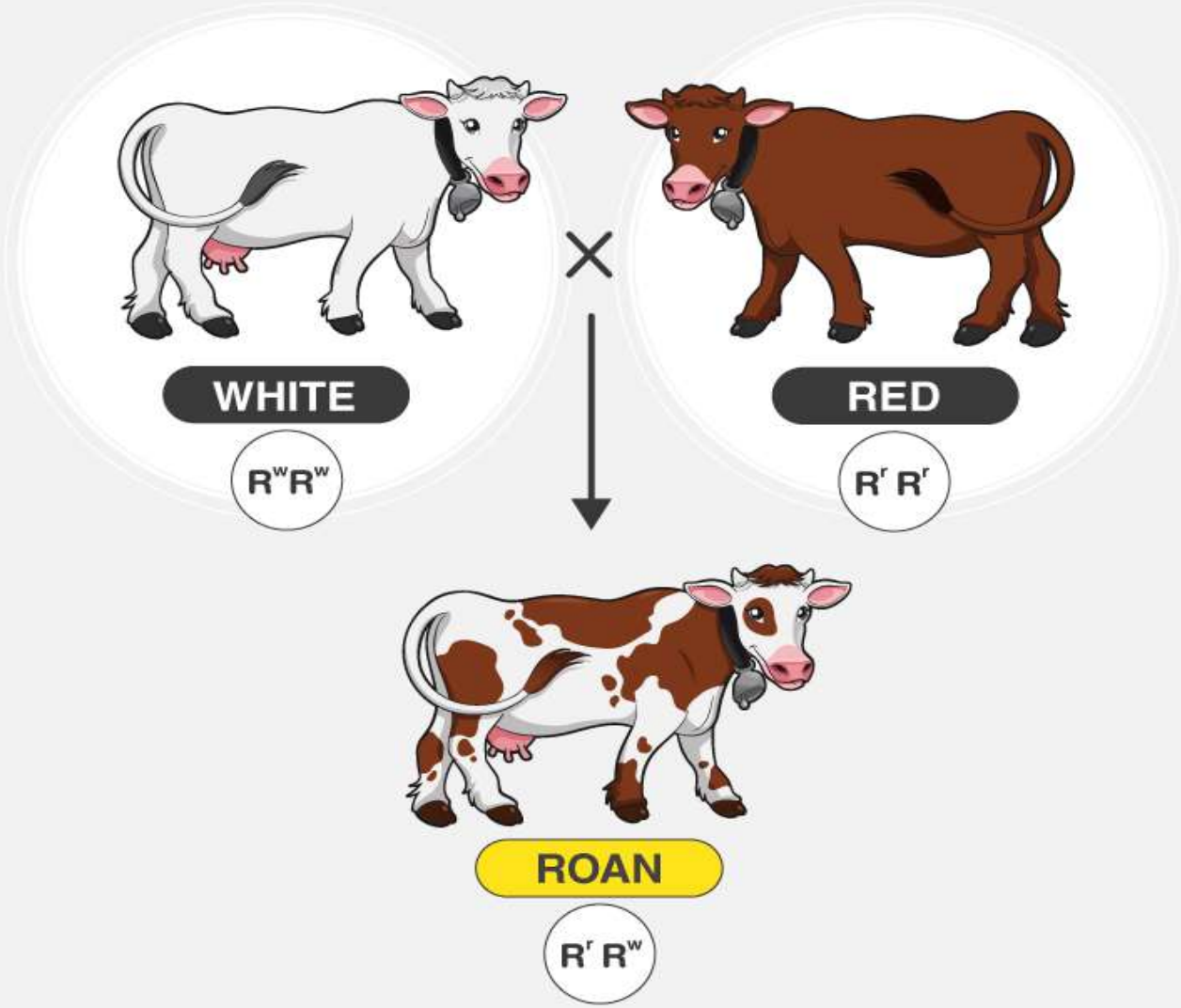
Incomplete Dominance



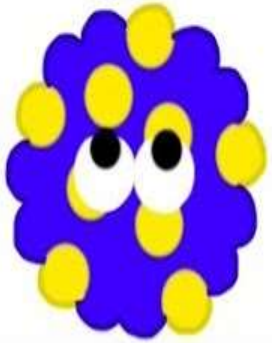
F_2 shows three phenotypes in 1:2:1 ratio

- Also called **Blended Dominance**
- The phenotypic and the genotypic ratio are identical in the case of incomplete dominance **(1:2:1).**

Co-dominance



- Both alleles of a gene express their phenotype in heterozygote.
- The phenotypic and the genotypic ratio are identical in the case of incomplete dominance **(1:2:1).**

GENOTYPE	COMPLETE DOMINANCE	CO-DOMINANCE	INCOMPLETE DOMINANCE
$C^B C^B$			
$C^Y C^Y$			
$C^B C^Y$			

Multiple alleles

- ✓ **Gene mutations** may produce many different alleles of a gene.
- ✓All such altered alternative forms of a gene, whose number is more than two, are called multiple alleles.
- ✓Any **two** of these can be present in the genome of diploid organism, but a haploid or a gamete can have just **one** of them in its genome.
- ✓Multiple alleles always occupy the **same locus** on the chromosome.
- ✓Multiple alleles always influence the **same character**.
- ✓**No crossing over** among the member alleles of the same Multiple alleles series.

Allele

C	c^{ch}	c^{h}	c

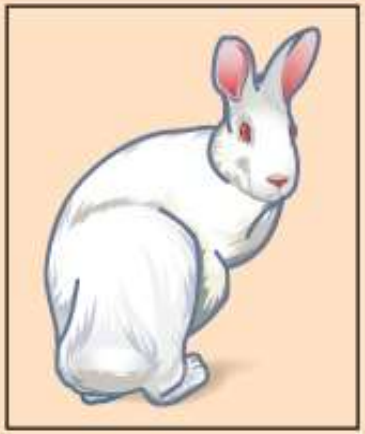
Genotype

CC	$c^{ch}c^{ch}$	$c^{h}c^{h}$	cc

Phenotype

WILD TYPE:	CHINCHILLA:	HIMALAYAN:	ALBINO:
Brown fur	Black-tipped white fur	White fur with black paws, nose, ears, tail	White fur



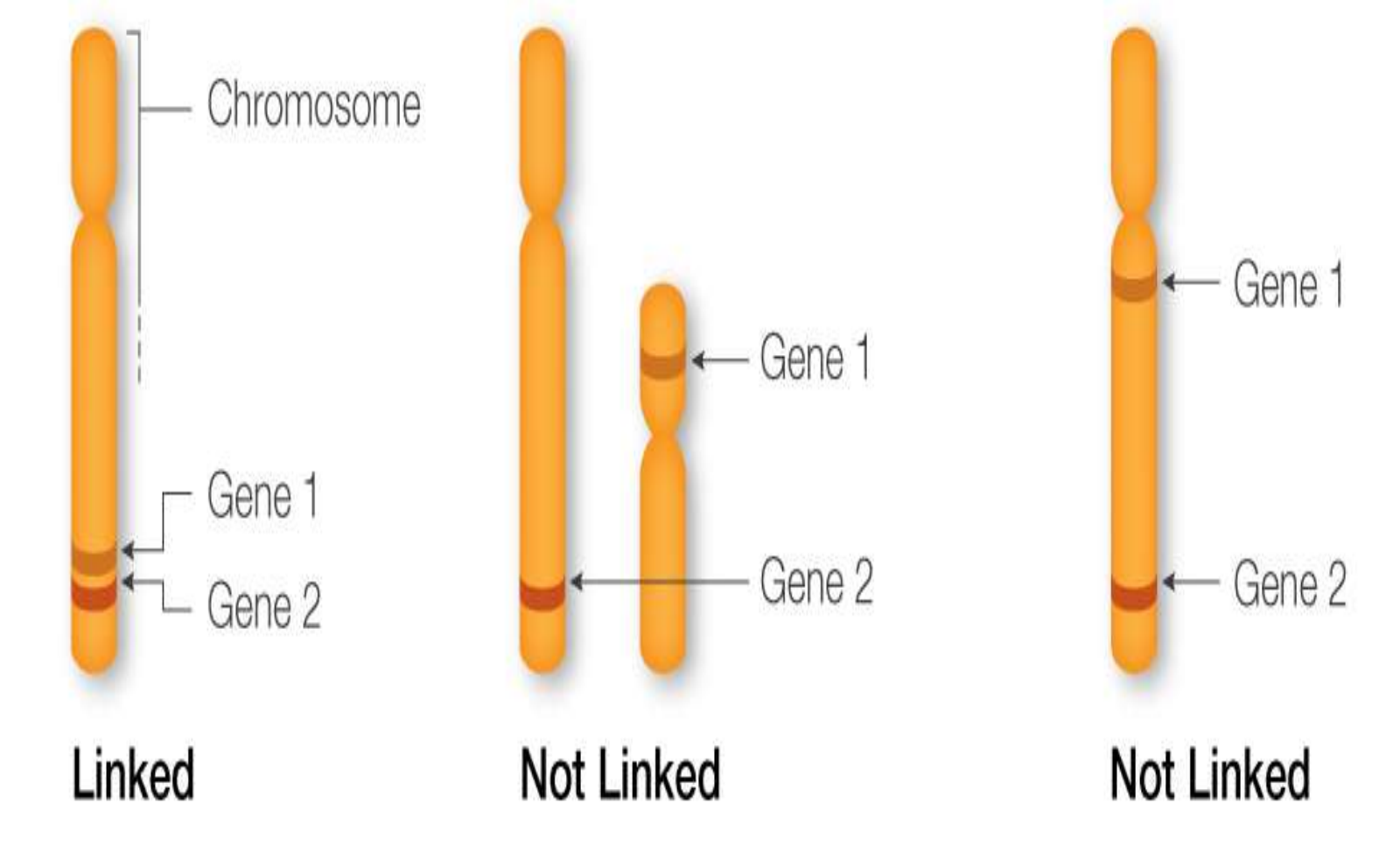



Four different alleles exist for the rabbit coat color (*C*) gene.

Linkage

✓Mendel always observed independent assortment of genes, but later on Bateson and Punnett (1906) in sweet pea, Hutchinson in maize and Morgan (1910) in Drosophila observed that genes have tendency to inherit in groups rather than individually.

✓This tendency of two or more genes to remain together in the same chromosome during inheritance is called linkage.



Linked genes sit close together on a chromosome, making them likely to be inherited together

Genes on separate chromosomes are never linked

But not all genes on a chromosome are linked. Genes that are farther away from each other are more likely to be separated

Lethal genes

✓A gene that causes death of its carrier when in homozygous condition is known as lethal gene.

✓Mendel's findings were based on equal survival of all genotypes. In the presence of lethal genes, the normal segregation ratio of 3: 1 is modified into 2: 1 ratio.

✓Lethal genes have been reported both in animals as well as plants.

P :  Yellow X Yellow 

Yy Yy

G : Y y Y y

F1: YY Yy yY yy

Yellow (Die) Yellow Yellow Grey

2 : 1

Gene interactions

✓Gene interactions occur when two or more different loci (gene locations) affect the outcome of a single trait. The most common type of gene interaction is known as epistasis.

✓Epistasis describes a situation where an allele at one locus masks the phenotypic effects of a different locus. The gene being masked is called the hypostatic gene, while the gene doing the masking is called the epistatic gene.

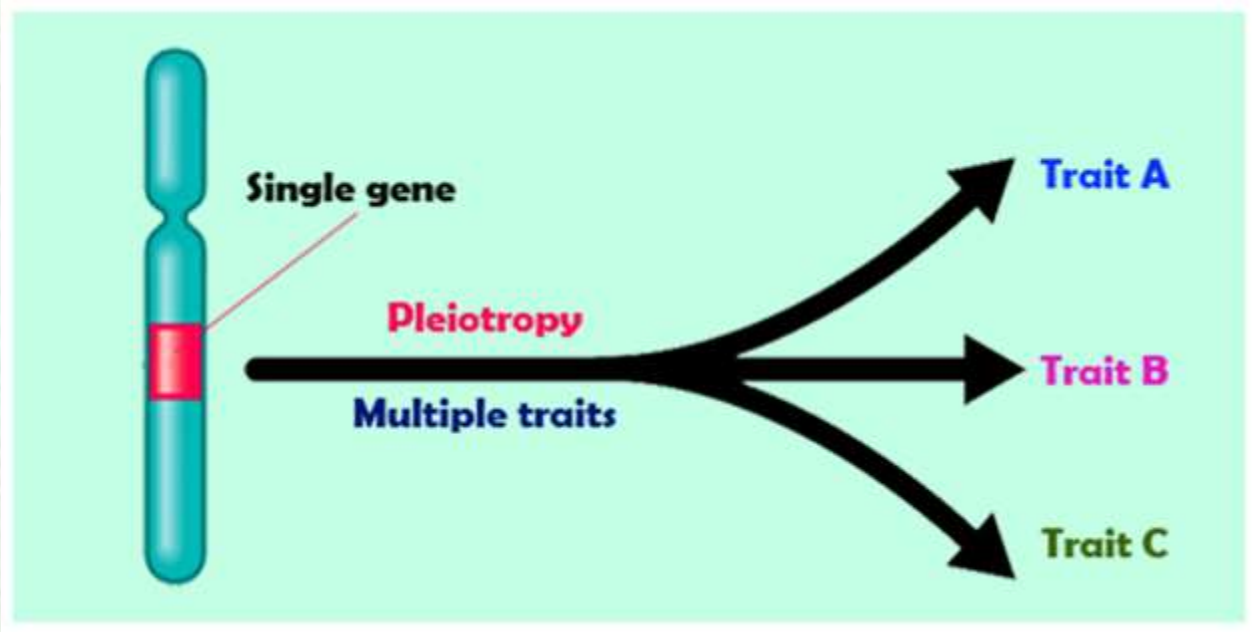
✓Bateson and Punnet discovered this phenomenon during their sweet pea breeding experiments.

✓This too will be discussed in detail later on.

Pleiotropic gene effect

✓Mendel observed that one gene controls the expression of only one character (trait).

✓Later on cases were observed in which one gene was found to control the expression of two or more traits.



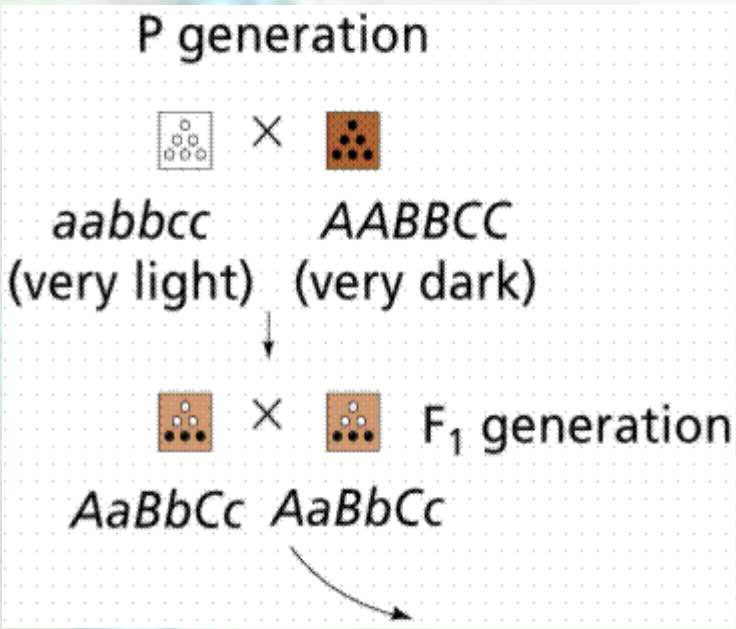
Polygenes

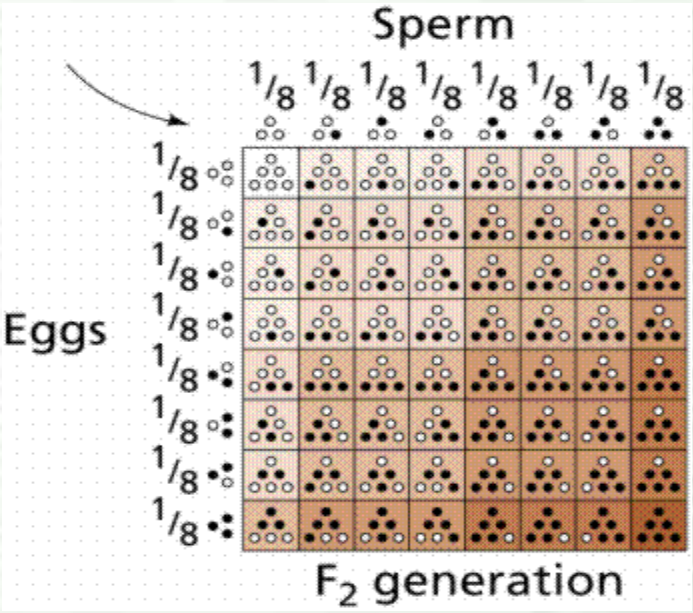
✓Mendel always observed that each character is controlled by a single gene.

✓Later on Nilsson Ehle observed that some characters are governed by several genes and each of such gene has additive effect in the expression of character.

✓ This concept led to the foundation of polygenic inheritance.

✓ East (1916) demonstrated that polygenic characters were perfectly in agreement with Mendelian segregation and later on Fisher and Wright provided a mathematical basis for the genetic interpretation of polygenic characters.


P generation
aabbcc
(very light)
AABBCC
(very dark)
AaBbCc
AaBbCc
F1 generation


Sperm
1/8 1/8 1/8 1/8 1/8 1/8 1/8 1/8
Eggs
1/8
1/8
1/8
1/8
1/8
1/8
1/8
1/8
F2 generation

Environmental effects

✓Genes can interact not only with genes but also with the environment to produce the phenotype.

P= G+E

✓Thus, phenotype is the result of the interaction between genotype and environment.

✓The importance of environment was first realized by Johnnsen.

✓He coined the term genotype and phenotype.

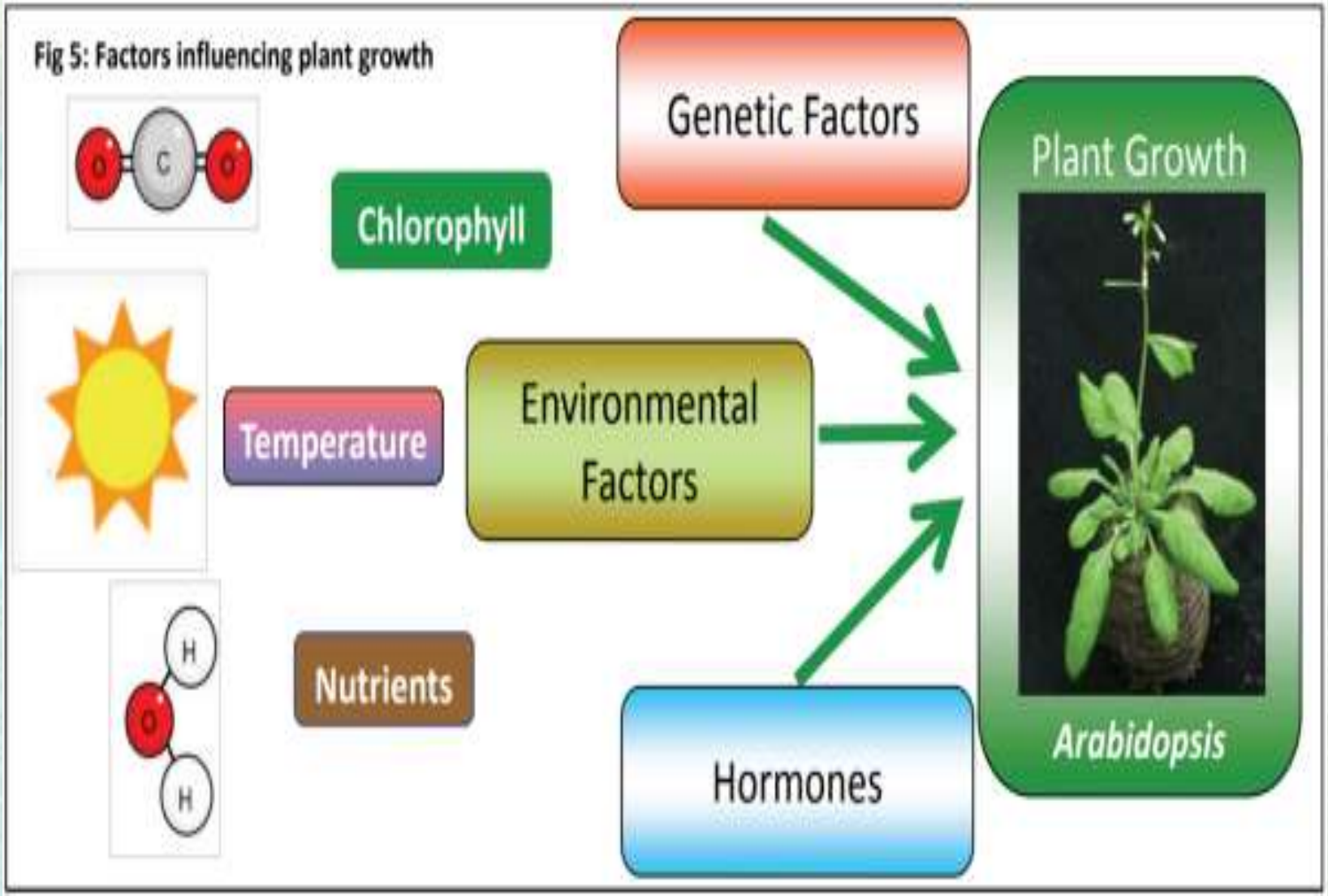


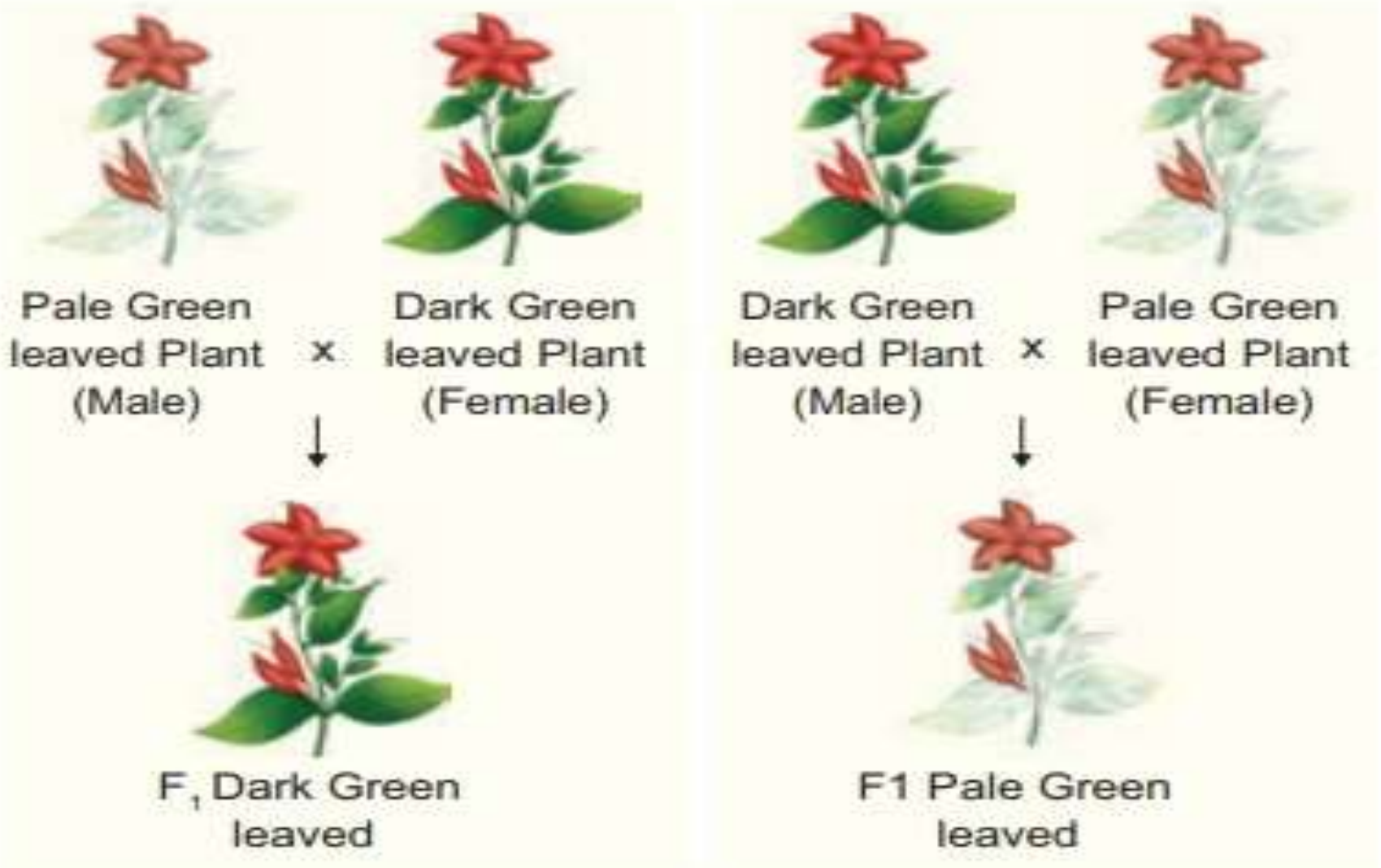
Fig 5: Factors influencing plant growth
C
O
O
Chlorophyll
Temperature
H
O
H
Nutrients
Genetic Factors
Environmental Factors
Hormones
Plant Growth
Arabidopsis

Cytoplasmic Inheritance

✓Mendel did not observe any difference between **direct and reciprocal crosses**.

✓Later investigations revealed the presence of significant difference in the reciprocal crosses, which led to the concept of “cytoplasmic inheritance”.

✓Cytoplasmic inheritance, often known as **maternal inheritance** or **extra nuclear inheritance**, is a phenomenon referring to any genetic traits not inherited from nuclear genes.



Cytoplasmic Inheritance

THANK YOU