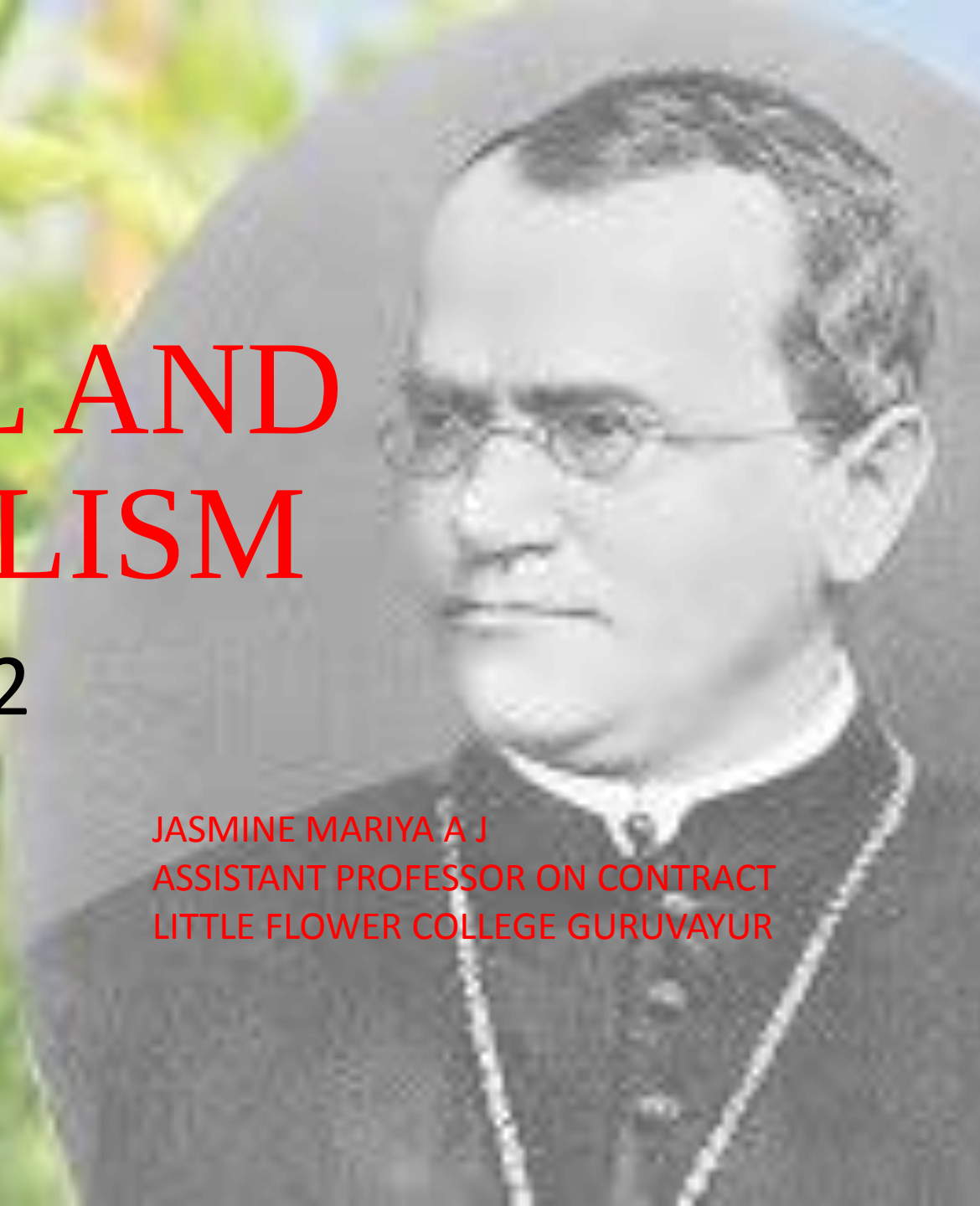
COMPLIMENTARY COURSE ,SEMESTER IV

MENDEL AND MENDELISM

PART 2



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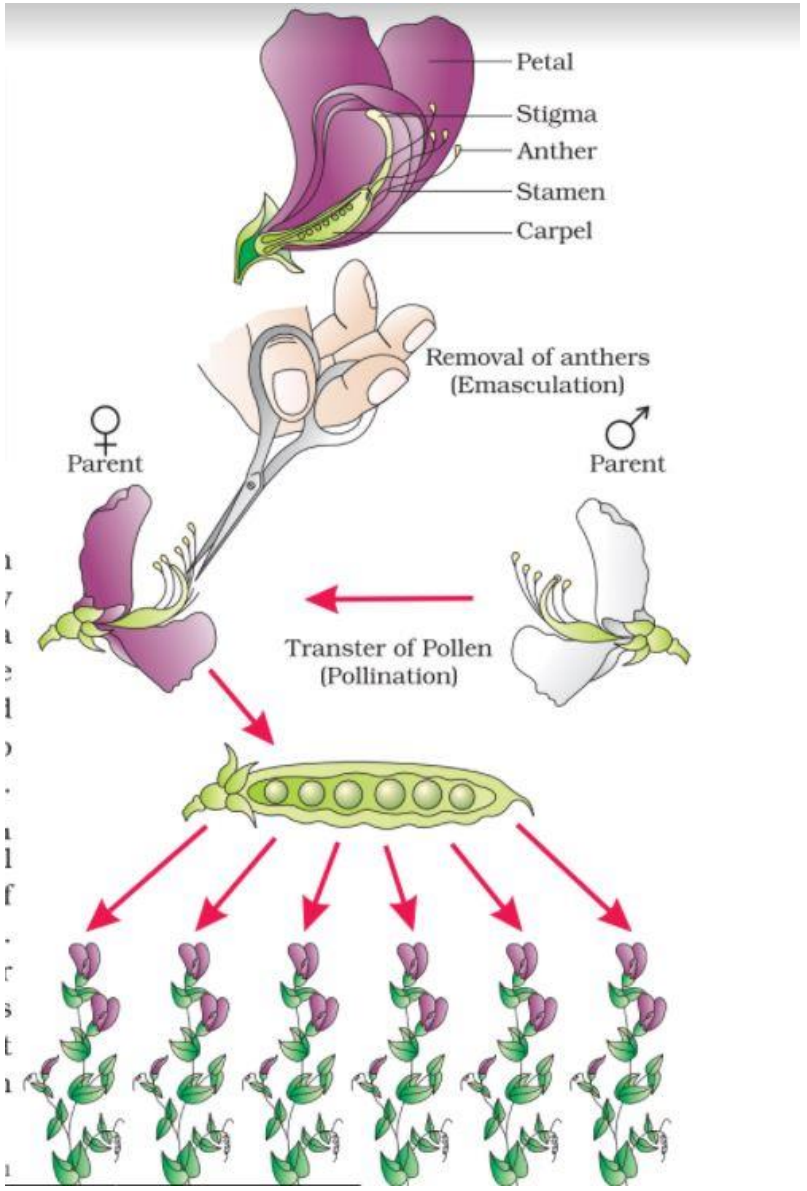
Mendel's monohybrid crosses

- In this he considered the inheritance of only a single pair of contrasting characters.
- Eg. A plant with tall stem crossed with a plant with dwarf stem
- A plant with yellow pods crossed with a plant with green pods

- ***The crosses in which the parents differ from each other with respect to a single pair of alleles or contrasting characters are called monohybrid cross and the resulting hybrids are known as monohybrids***

He performed artificial cross pollination between plants showing contrasting characteristics.



- Mendel crossed true breeding tall plants (TT) with true breeding dwarf plants (tt)through artificial pollination
- All F1 progenies were tall
- F1 plants were self pollinated to produce F2
- This produced a mixed F2 progeny of Tall and Dwarf plants in the ratio 3:1 ratio
- Dwarf trait which was masked in the F1 generation reappered in 25% of F2progeny

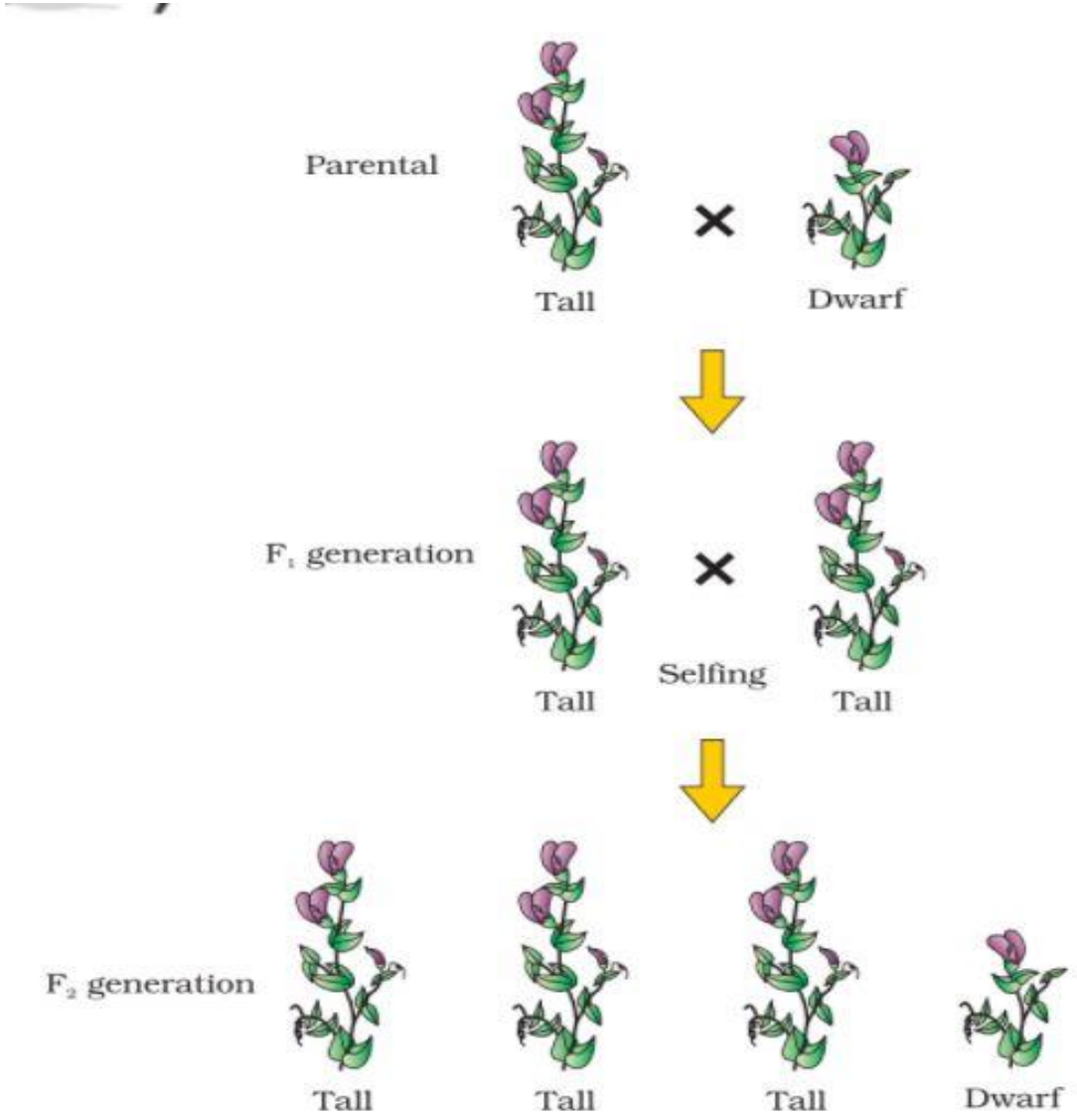
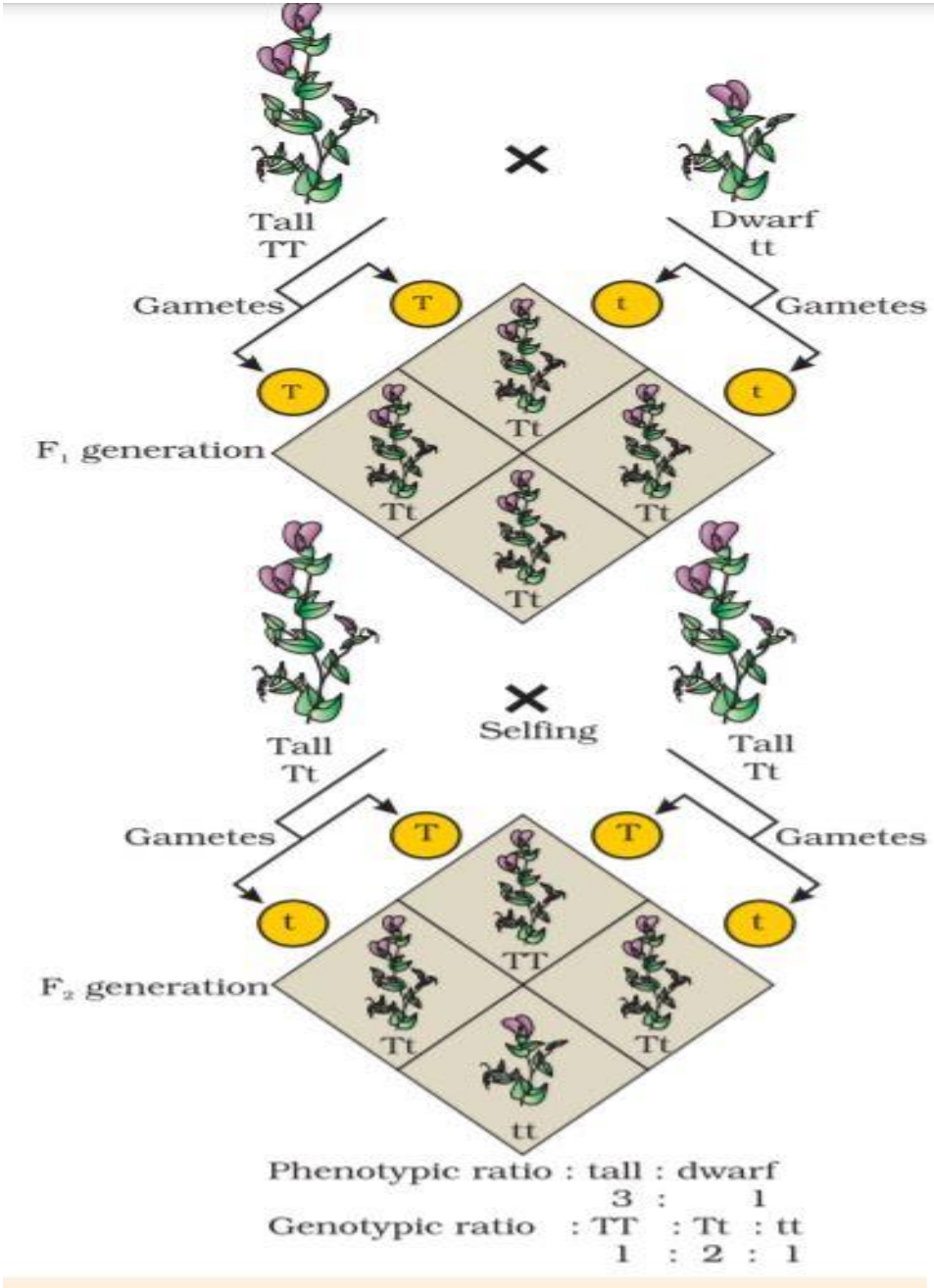
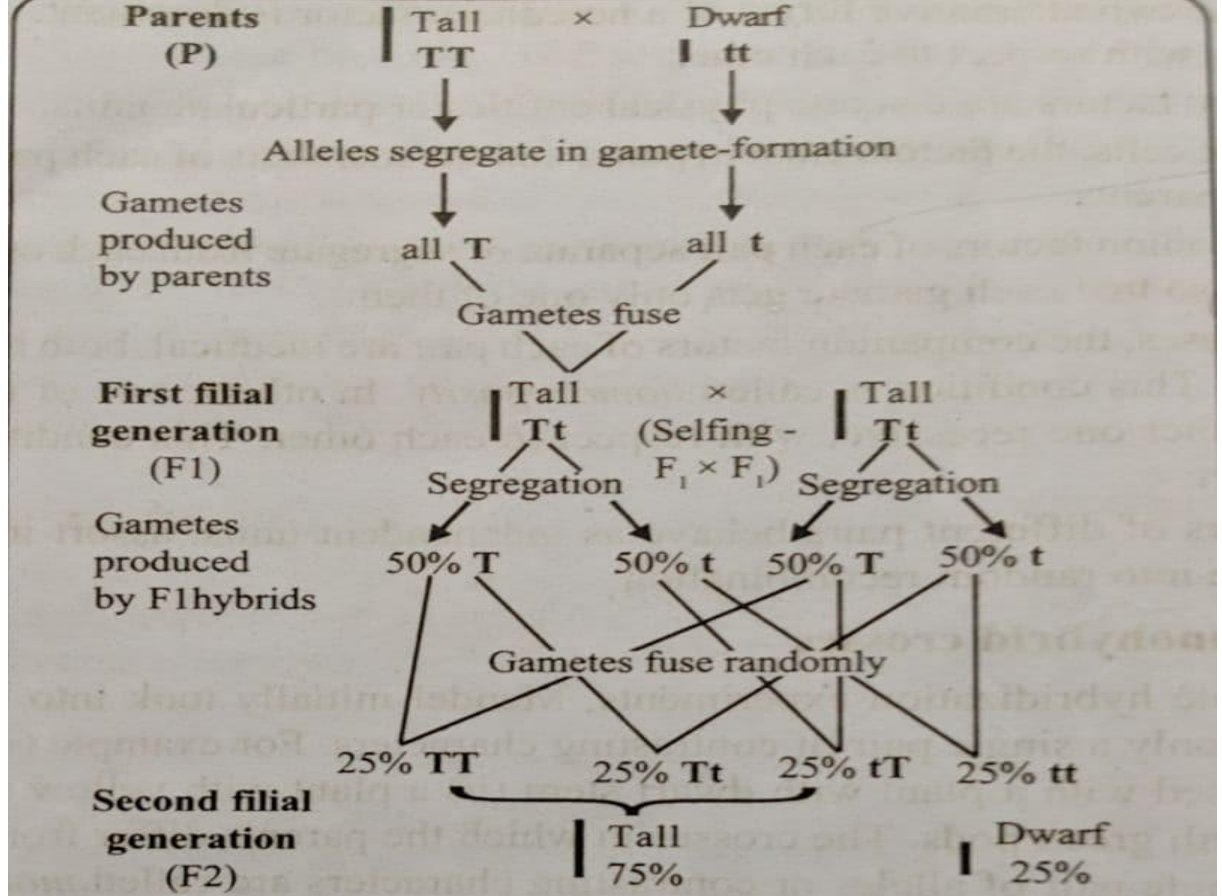


Figure 5.3 Diagrammatic representation of monohybrid cross



- Phenotypically 3 out of 4 progenies are tall and one of them is dwarf .
- Hence Phenotypic ratio is 3(Tall):1(Dwarf)
- Genotypically one is homozygous dominant (TT) two of them is heterozygous dominant (Tt) and one is homozygous recessive(tt).
- Hence genotypic ratio is 1(TT):2(Tt):1(tt).



Flow chart of monohybrid cross

Punnett square to show fusion of F1 gametes

♀ gametes	♂ gametes: 50% T	♂ gametes: 50% t
50% T	25% TT Tall	25% Tt Tall
50% t	25% tT Tall	25% tt Dwarf

Fusions

Fusions

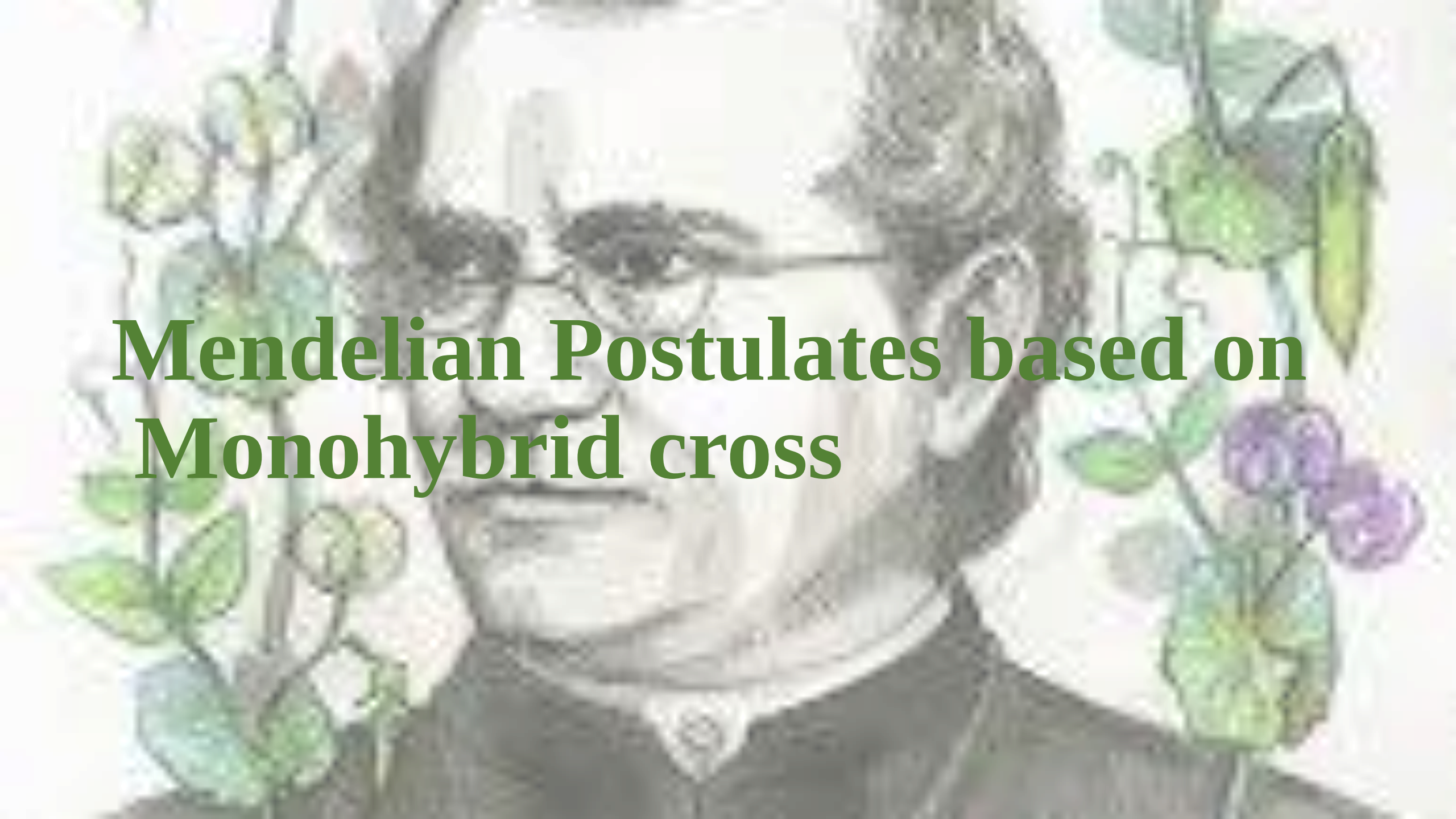
Phenotypic ratio - 3 tall:1 dwarf (3:1)
Genotypic ratio - 1TT:2Tt:1tt (1:2:1)

Punnett square to show fusion of F_1 gemetes

Mendel's Generalisations

- Transmission and expression of hereditary characters are governed by discrete units called hereditary factors.
- Hereditary factors are occurring in pairs and companions of each pair come from two different parents.
- During gamete formation ,these two parental factors segregate and separate out from each other .So, both parents contribute equally for the development of a character in the progeny.
- In the F1 progenies character of only one parent is expressed ,which is called the dominant character and the character from other parent is suppressed which is called the recessive character.

- Recessive trait is not destroyed ,it is only suppressed in F1 . It will reappear in F2 .
- In the F2 generation, the dominant and recessive parental traits are expressed in the ratio 3:1
- 1/3 of F2 generation are homozygous dominant, 2/4 of F2 is heterozygous dominant and 1/4 homozygous recessive.

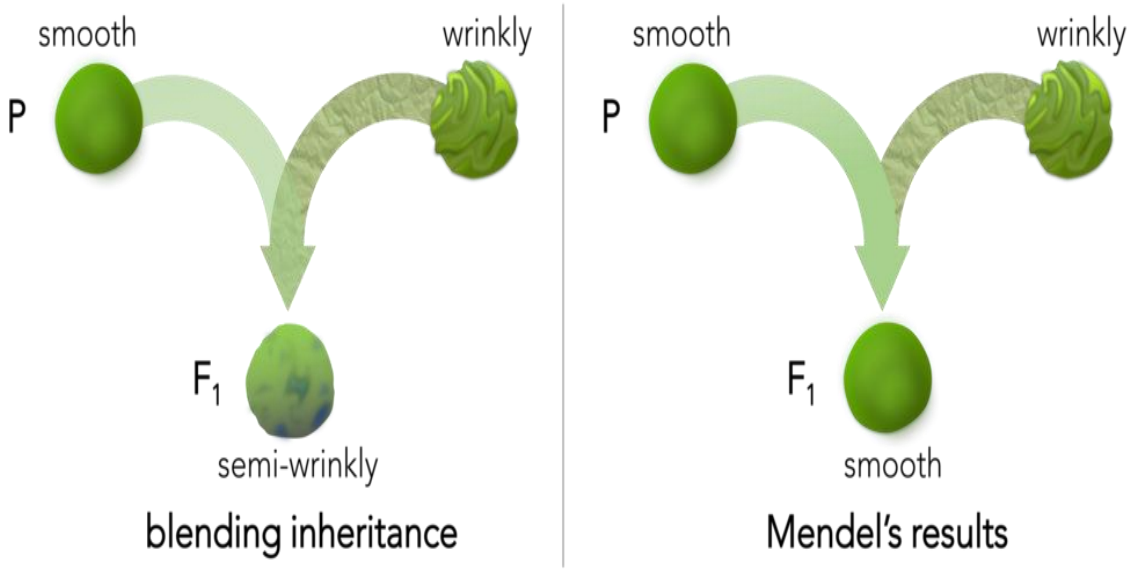


Mendelian Postulates based on Monohybrid cross

1.Principle of Unit characters

- Every trait or character of an organism is an independent unit by itself, and its inheritance is controlled by a pair of hereditary determiners or factors.
- These factors are now called as genes ,the specific segments of DNA

It was against the concept of blending inheritance



- Blending Inheritance : Hereditary traits are transmitted from parents to offspring ,and they mix together and get expressed in progeny
- Particulate Inheritance: Hereditary factors are discrete units. They get transmitted from parents to progeny as such .

2.Principle of Dominance

(i) Characters are controlled by discrete units called factors.

(ii) Factors occur in pairs.
(iii) In a dissimilar pair of factors one member of the pair dominates
(dominant) the other (recessive)

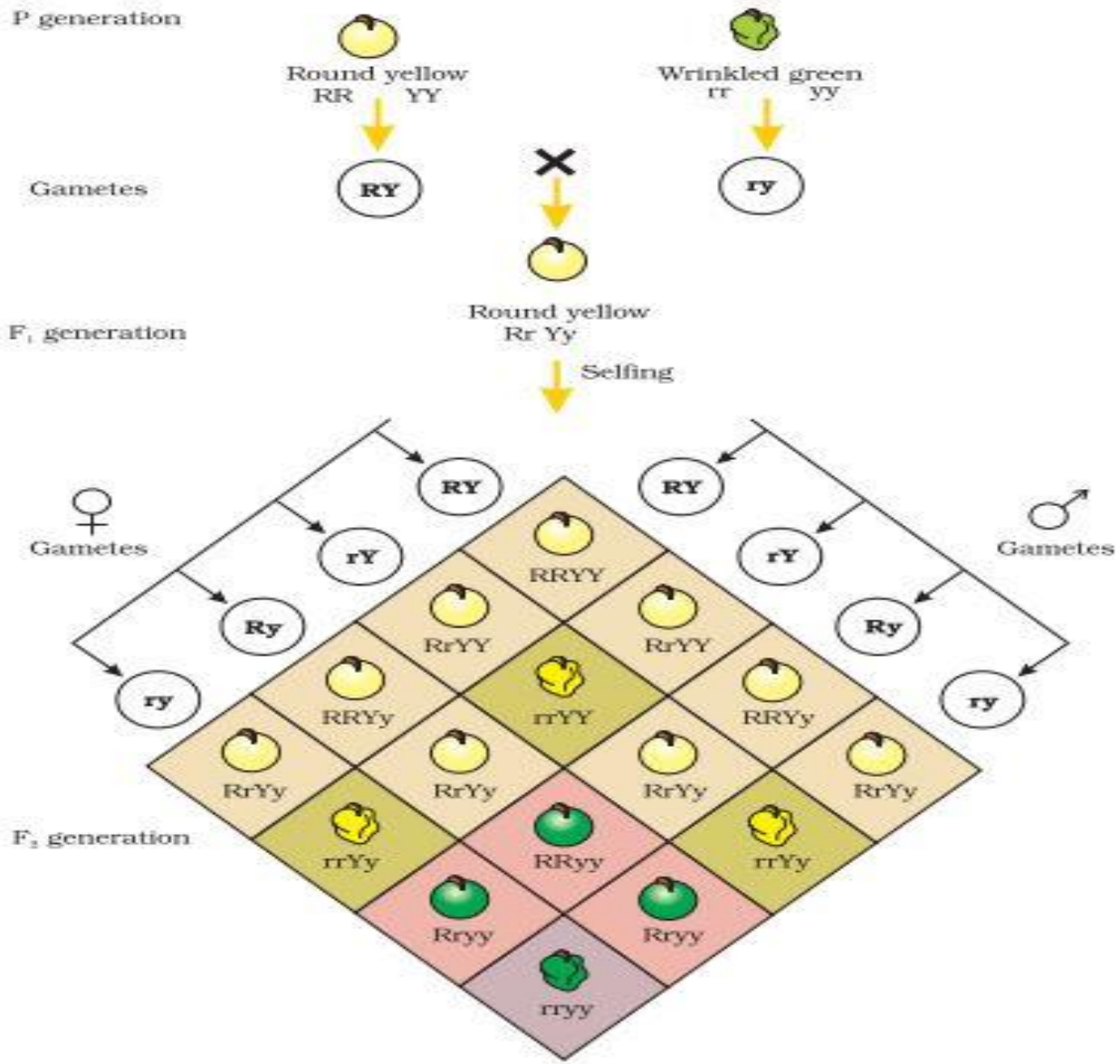
3. Law of Segregation (First Law of Mendel)

1. In somatic cells hereditary factors occur in pairs ,but in gametic cells only one member of each pair is found.
2. The two factors which govern a biological trait never contaminate or modify each other nor do they blend or fuse together in anyway , but always remain distinct.
3. During gamete formation, the members of each pair segregate or separate out from each other and get distributed to different gametes in equal frequency.

- This view implies that gametes despite their fusion during fertilisation, always retain their genetic purity and individuality. Hence this law is also known as ‘Law of the purity of gametes’
- This law holds that the two alleles of a gene separate or segregate from each other during gametic transmission and enter into new pairing in the next generation.

Mendel’s Dihybrid crosses

- The crosses in which the parents differ from each other with respect to two pairs of contrasting characters are called dihybrid crosses
- Eg. Double dominant plant with round and yellow seeds crossed with double recessive plant with wrinkled and green seeds.



Phenotypic ratio : round yellow : round green : wrinkled yellow : wrinkled green
9 3 3 1

Parents - Round yellow (RRYY) × Wrinkled green (rryy)

Gametes - RY, ry

Crossing -

F_1 generation - Rr Yy Round yellow

Selfing - $F_1 \times F_1$, i.e. RrYy × RrYy

Gametes

♀ \ ♂	RY	Ry	rY	ry
RY	RRYY Round yellow	RRYy Round yellow	RrYY Round yellow	RrYy Round yellow
Ry	RRYy Round yellow	RRyy Round green	RrYy Round yellow	Rryy Round green
rY	RrYY Round yellow	RrYy Round yellow	rrYY Wrinkled yellow	rrYy Wrinkled yellow
ry	RrYy Round yellow	Rryy Round green	rrYy Wrinkled yellow	rryy Wrinkled green

Punnett square to illustrate dihybrid cross

Round yellow	Round green	Wrinkled yellow	Wrinkled green
RRYY-1/16 RRYy-2/16 RrYY-2/16 RrYy-4/16	RRyy-1/16 Rryy-2/16	rrYY-1/16 rrYy-2/16	rryy-1/16
Total-9/16 :	3/16 :	3/16 :	1/16

Dihybrid phenotypic ratio - 9:3:3:1

Dihybrid genotypic ratio - 1:2:2:4:1:2:1:2:1

Progeny analysis

Mendelian Postulates based on Dihybrid cross

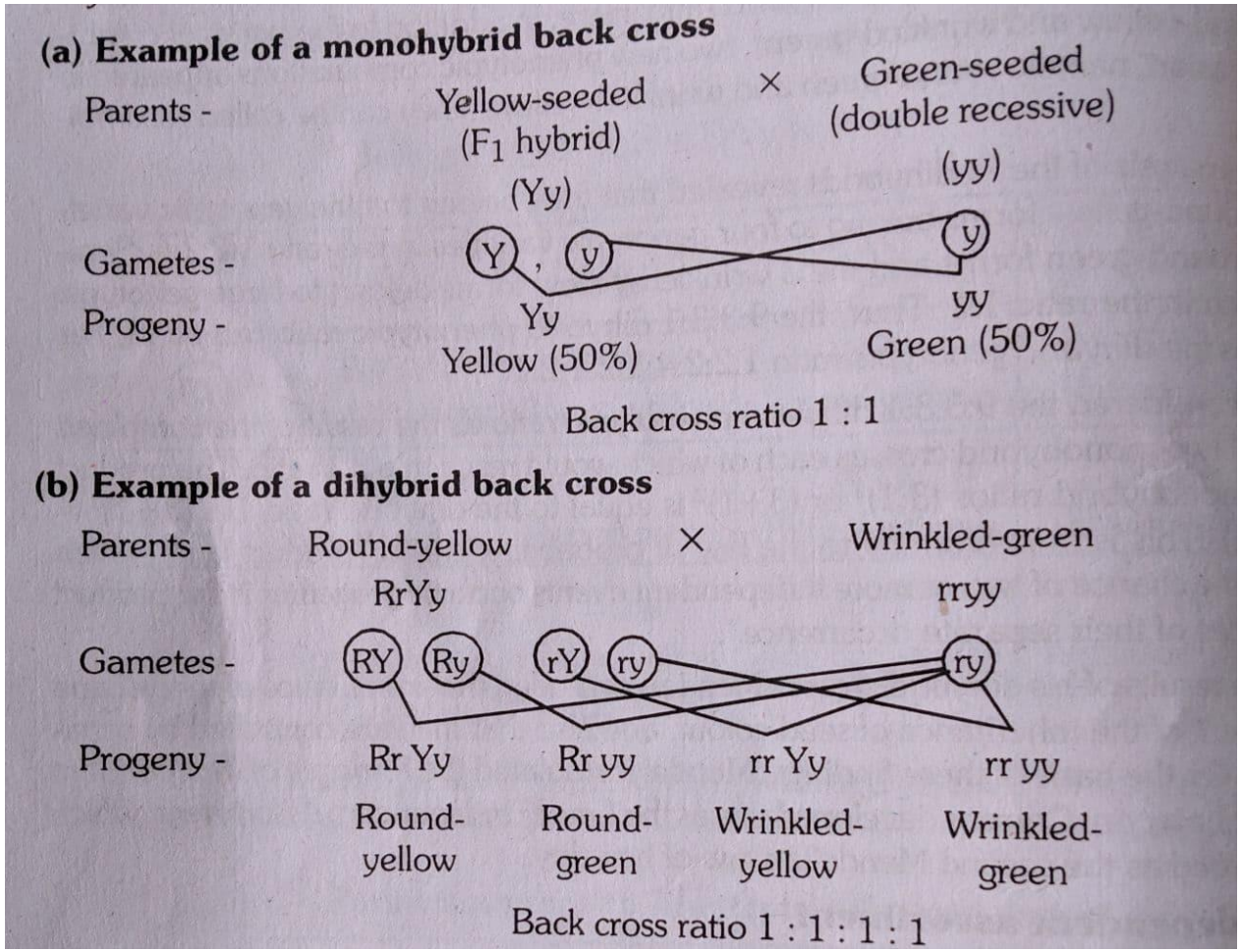
Law of Independent assortment (second law)

- The factors for different pairs of contrasting characters behave as independent units so that their distribution in the gametes and also in the succeeding generations is independent of each other.

Test cross

- Cross between two organisms ,one with unknown genotype but exhibiting dominant phenotype of one or more genes, and the other is homozygous recessive for these genes.
- Back cross with homozygous recessive parent is also considered as test cross

- Monohybrid test cross ratio 1:1
- Dihybrid test cross ratio 1:1:1:1
- Trihybrid test cross ratio 1:1:1:1:1:1:1:1



How to determine an unknown genotype ?

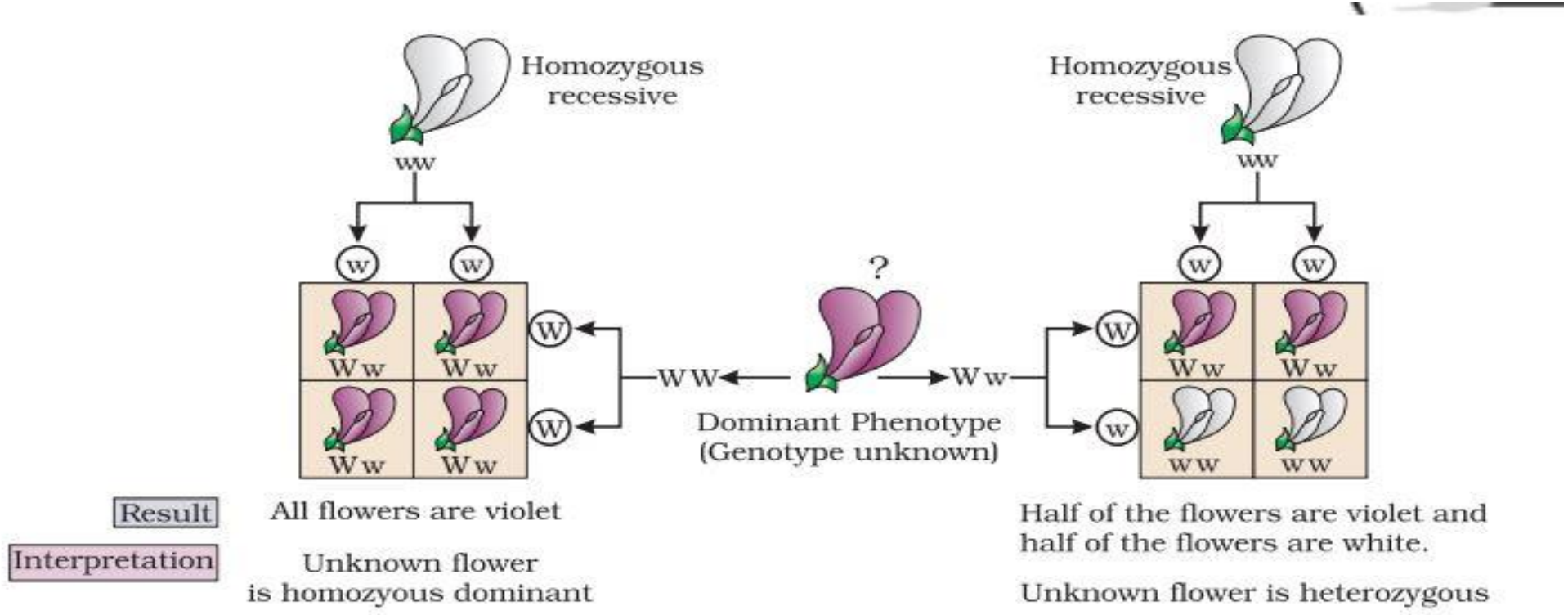
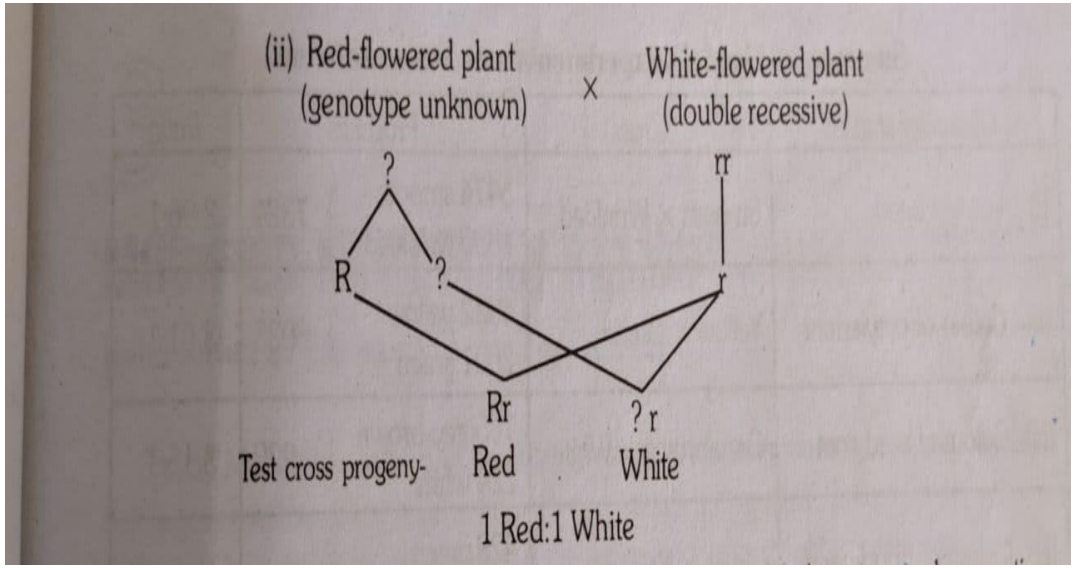


Figure 5.5 Diagrammatic representation of a test cross

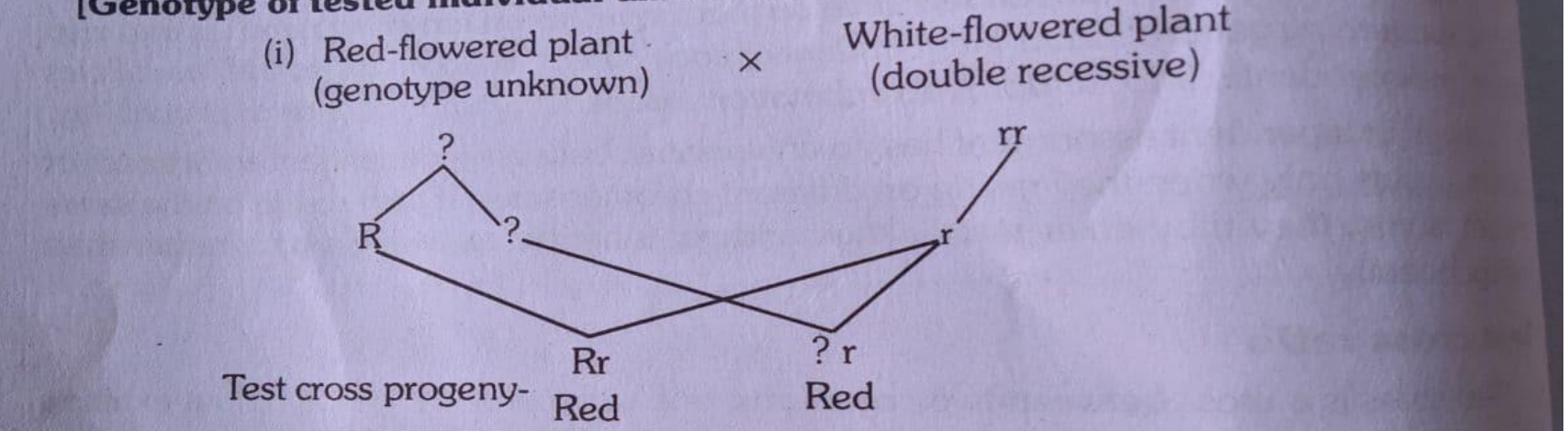
If test cross progeny consist of 50% red and 50% white plants ,the unknown genotype is heterozygous dominant

If test cross progeny consist of only red plants ,the unknown genotype is homozygous dominant



(c) Example of a monohybrid test cross

[Genotype of tested individual unknown]



Test cross progeny consists of only red-flowered plants. So, the unknown genetype in homozygous dominant (RR).

Mendelian ratios

Type of cross	Phenotypic ratio	Genotypic ratio
(i) Monohybrid cross	3 : 1	1 : 2 : 1
(ii) Dihybrid cross	9 : 3 : 3 : 1	1 : 2 : 2 : 4 : 1 : 2 : 1 : 2 : 1
(iii) Trihybrid cross	27:9:9:9:3:3:3:1	1:2:2:2:4:4:4:8:1:2:2:4:1:2 :2:4:1:2:2:4:1:2:1:2:1:2:1
(iv) Monohybrid test cross (heterozygous)	1 : 1	1 : 1
(v) Dihybrid test cross	1 : 1 : 1 : 1	1 : 1 : 1 : 1
(vi) Tribybrid test cross	1:1:1:1:1:1:1:1	1:1:1:1:1:1:1:1

Summary of Mendel's experiments with Pisum sativ

Character studied	Cross	Products		Ratio
(i) Form of seed	Smooth × Wrinkled	5474 smooth 1850 wrinkled	} 7324	2.96:1
(ii) Colour of cotyledons	Yellow × Green	6022 yellow 2001 green	} 8023	3.01:1
(iii) Colour of seed coat	Grey-brown × White	705grey-brown 224 white	} 929	3.15:1
(iv) Colour of unripe pods	Green × Yellow	428 green 152 yellow	} 580	2.82:1
(v) Pod shape	Inflated × Constricted	882 inflated 299 constricted	} 1181	2.95:1
(vi) Position of flowers	Axial × Terminal	651 axial 207 terminal	} 858	3.14:1
(vii) Length of stem	Tall × Dwarf	787 tall 277 dwarf	} 1064	2.84:1