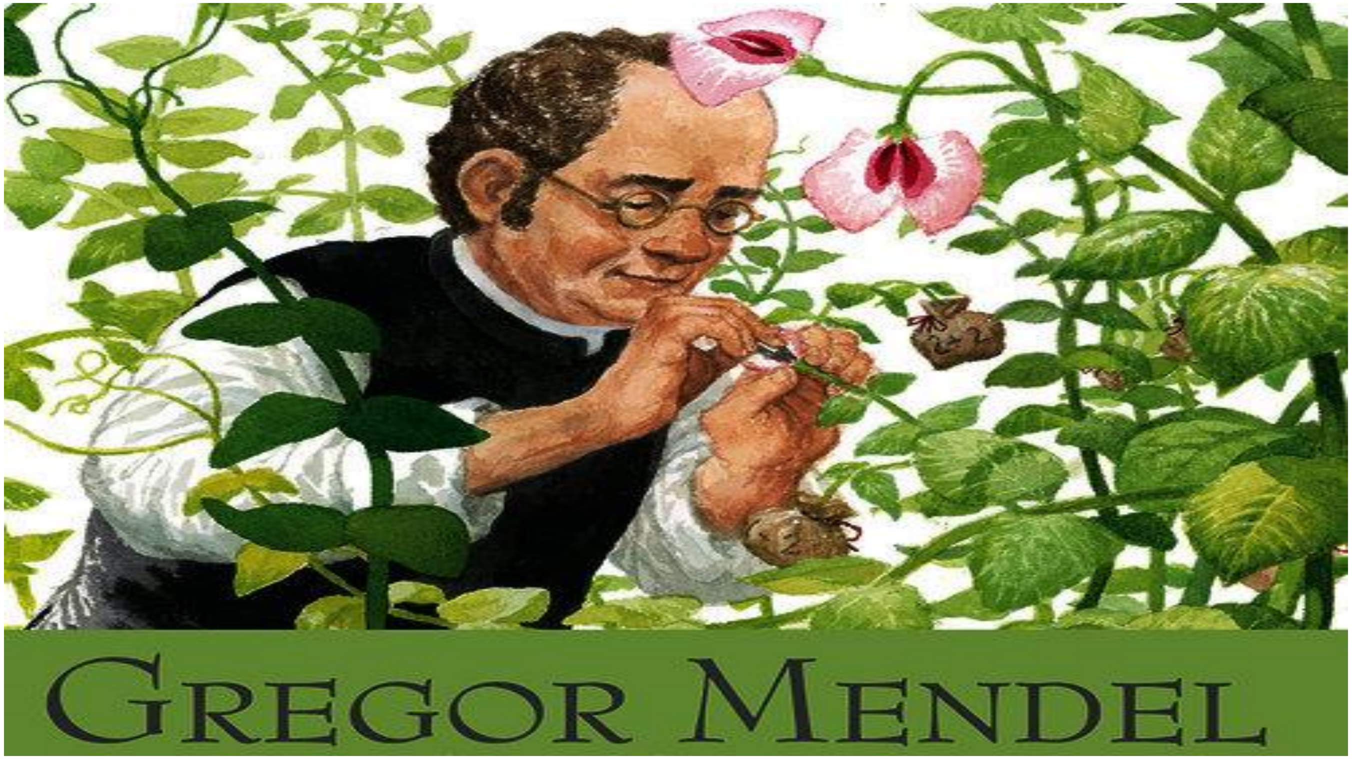
MENDELISM

For B.Sc. Part I (Subs.) (Group B)



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Lecture No. 34

- Experiments performed by Mendel on genetics and description of mechanisms of hereditary processes and formulation of principles are known as **Mendelism.**

- **Gregor Johann Mendel** (1822-1884) is called as **Father of Genetics**.
- He was born (1822) in a family of poor fathers an area that is now part of Czech Republic.
- His father had a great love for plants and this influenced Mendel a lot. As he grew older, he became interested in plant hybridization.
- After completing his school education Mendel joined University to take up a two year course in Philosophy. He then entered the Augustinian Monastery at Brunn and was ordained a priest in 1847.
- There he continued his interest in plant hybridization. In 1849 Mendel got a temporary position in a school, served there for one year and left in order to join the University of Vienna for training in physics, mathematics and the natural sciences.
- This enabled him to design and analyse precise experimental work which he conducted at the monastery.

➢In 1854 Mendel again took up the profession of a teacher and continued there for fourteen years. During this long period he conducted his famous garden pea experiments in the monastery garden.

➢ His experiments were in fact the extension and development of hybridization experiments on pea conducted by earlier workers like Knight (1799) and Goss (1824).

➢Mendel conducted his historic experiments with garden pea (*Pisum sativum*) in the monastery garden for about nine years (1856-1864) and published his results in a less known journal-**The Annual proceedings of the Natural History Society of Brunn in 1865.**

➢ Mendel was unable to get any popularity. No one understood of him. He died in 1884 without getting any credit of his work.

➢After 16 years of Mendel's death in 1900, Mendel's postulates were rediscovered.

✓**Carl Correns – Germany –** (Experiment on Maize)

✓ **Hugo deVries (Holland)** (Experiment on Evening Primerose)

He republished the Mendel's result in 1901 in **Flora magazine**

✓ **Erich von Tschermak Seysenegg – (Austria)** (Experiment on different flowering plants)

The credit of rediscovery of Mendelism goes to these three scientists.

Mendel's Experiments

➢ Mendel performed cross breeding experiments on garden pea (*Pisum sativum*).

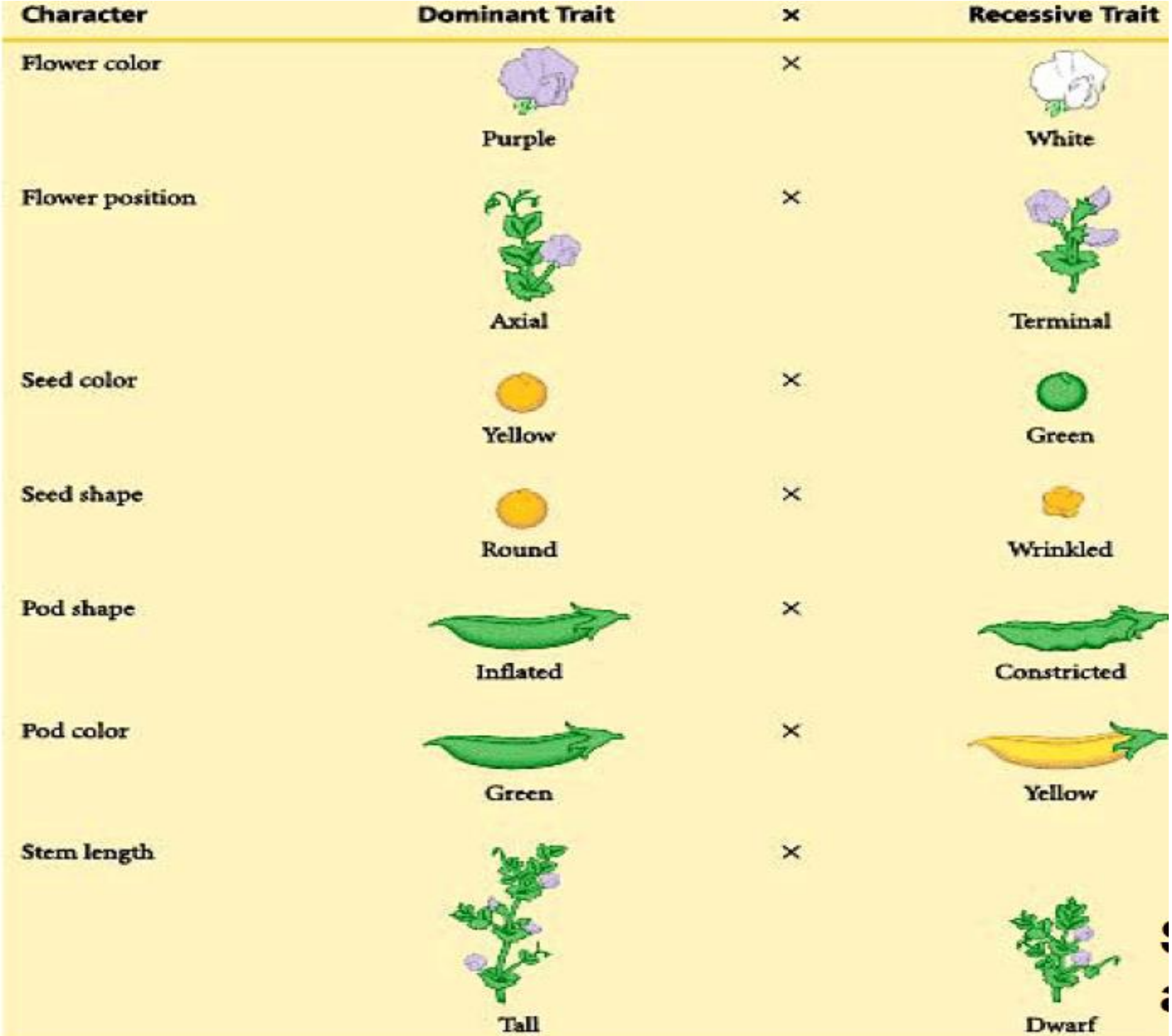
➢ He studied the inheritance of seven different pairs of contrasting characters in this plant but considered only one pair at a time.

➢ He crossed two pea plants having contrasting characters (for example tall and dwarf pea plants) by artificial pollination and obtained the hybrids.

➢The resulting hybrid plants were then crossed with each other. He obtained the data from these crosses and analyzed the results carefully.

Characters	**Dominant**	**Recessive**
Stem length	Tall	Dwarf
Flower position	Axial	Terminal
Pod shape	Inflated	Constricted
Pod colour	Green	Yellow
Seed shape	Round	Wrinkled
Seed colour	Yellow	Green
Flower colour	Violet/Grey	White

List of seven pairs of contrasting characters in pea plant



Seven pairs of contrasting characters in pea plant

Mendel selected garden pea as experimental material ?????

- ➢ It was an annual plant. Its short life–cycle made it possible to study several generations within a short period of time.
- ➢The flowers are bisexual containing both male and female parts.
- ➢ It has many contrasting traits. Natural self pollination is present in pea plant.
- ➢ Cross pollination can be performed in it artificially so hybridization can be made possible.
- ➢ Pea plant easy to cultivate.

Mendel's Success ?????

- ➢ Mendel's success may be attributed to a combination of luck, foresight, mathematical background and his scientific aptitude.
- ✓ Mendel studied the inheritance of one character at a time unlike his predecessors who considered the organism as a whole.
- ✓ He carried out his experiments up to F_2 and F_3 generations.
- ✓ His knowledge in statistics helped him to maintain accurate records of all the experiments of findings and analysed them carefully.

✓ He grew pure lines in separate plots and conducted experiments by crossing two plants from pure strains.

✓ The parent plants undergoing crossing belonged to pure lines and had sharply visible contrasting characters.

✓ All this genetical experiments were conducted with utmost care and meticulous planning.

Special points

➢ S. Blixt concluded that the genes studied by Mendel are located on four different pairs of chromosomes.

Cotyledon colour
Flower colour/seed coat colour
Chromosome no. 1st

Pod form/shape
Flower Position
Stem length
Chromosome no. 4th

Pod colour……………………………… **Chromosome no. 5th**

Seed form……………………………… **Chromosome no. 7th**

Some important terms used in Inheritance study

- **Dominant traits-** Traits that are expressed.
- **Recessive traits-** Traits that are covered up.
- **Alleles-** Alternative forms of a gene which are located on same position (loci) on the homologous chromosome is called Allele. Term allele was coined by **Bateson**.
- **Punnett Squares-** Show how crosses are made.
- **Probability-** The chances/ percentages that something will occur.
- **Genotype-** The types of genes (Alleles) present.
- **Phenotype-** What it looks like.
- **Homozygous-** A zygote is formed by fusion of two gametes having identical factors is called homozygote and organism developed from this zygote is called homozygous. **Example: TT, RR, tt.**.
- **Heterozygous-** Two different alleles (Tt, Rr)

Mendel's experiments

Monohybrid cross: (Crosses involving one pairs of contrasting characters).

➢When we consider the inheritance of one character at a time in a cross this is called monohybrid cross. First of all, Mendel selected tall and dwarf plants

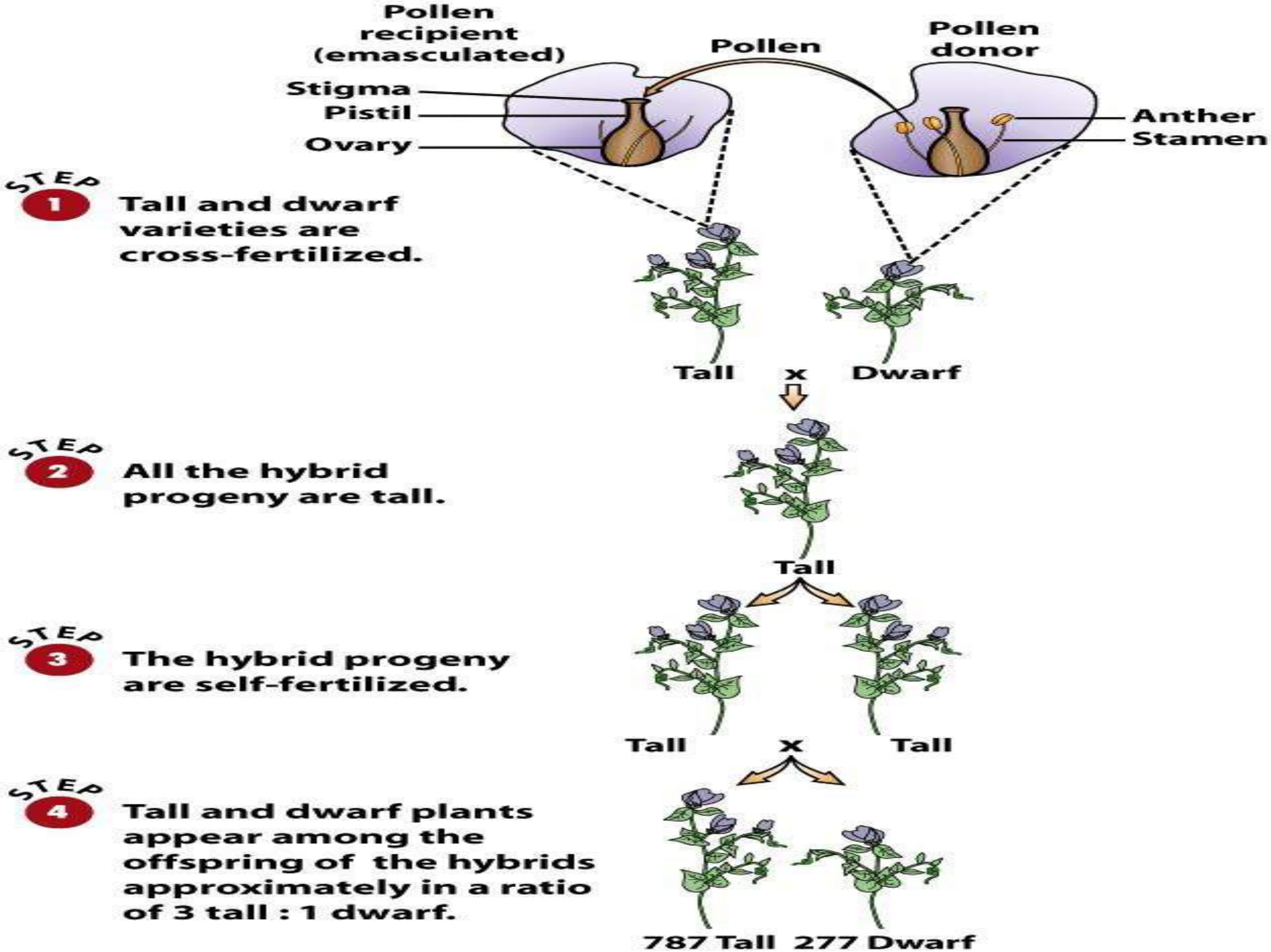
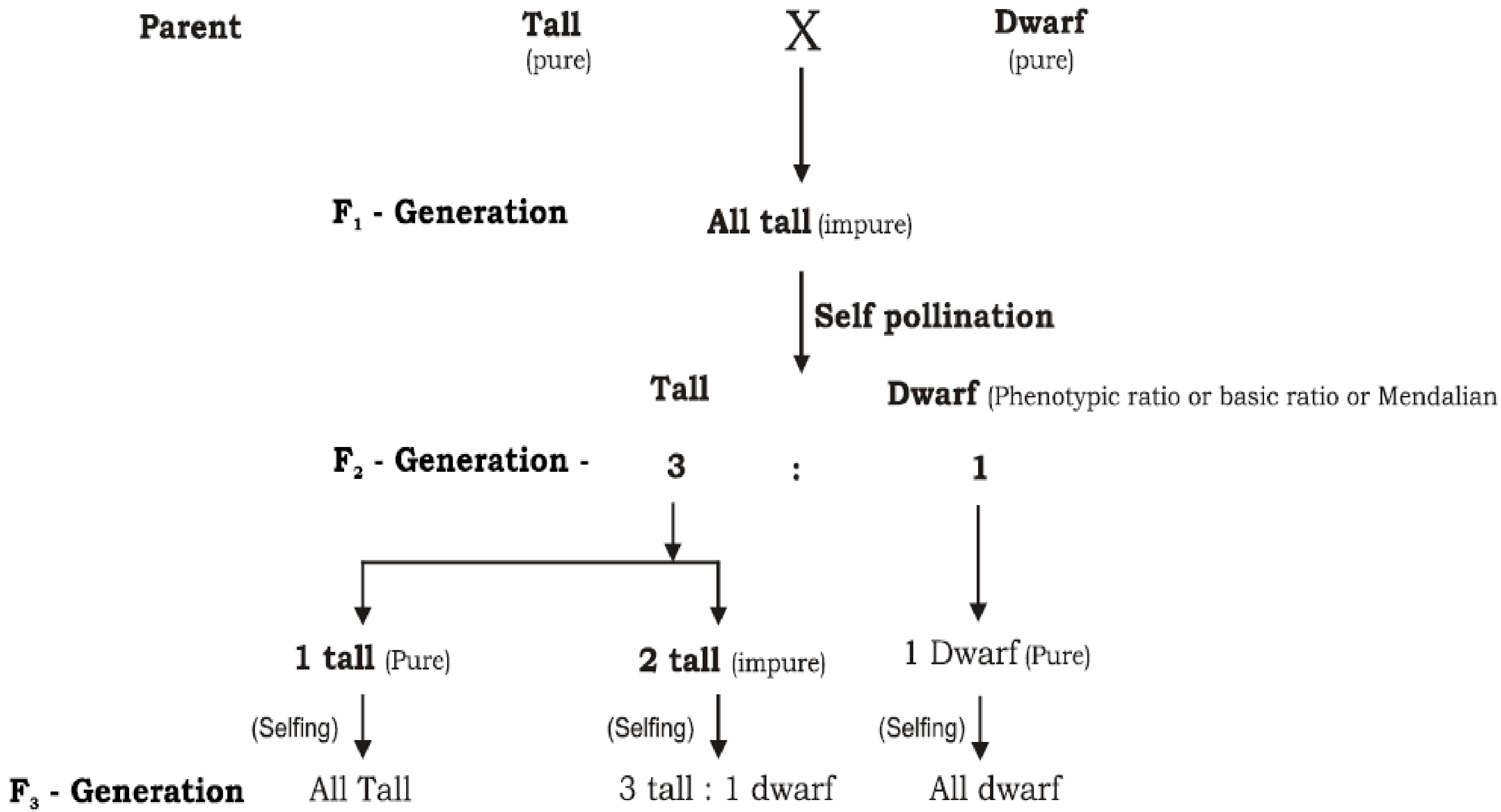


Figure 3-1 Principles of Genetics, 4/e



1st Conclusion (Postulates of paired factors):

✓ According to Mendel each genetic character is controlled by a pair of unit factor. It is known as conclusion of paired factor or unit factor.

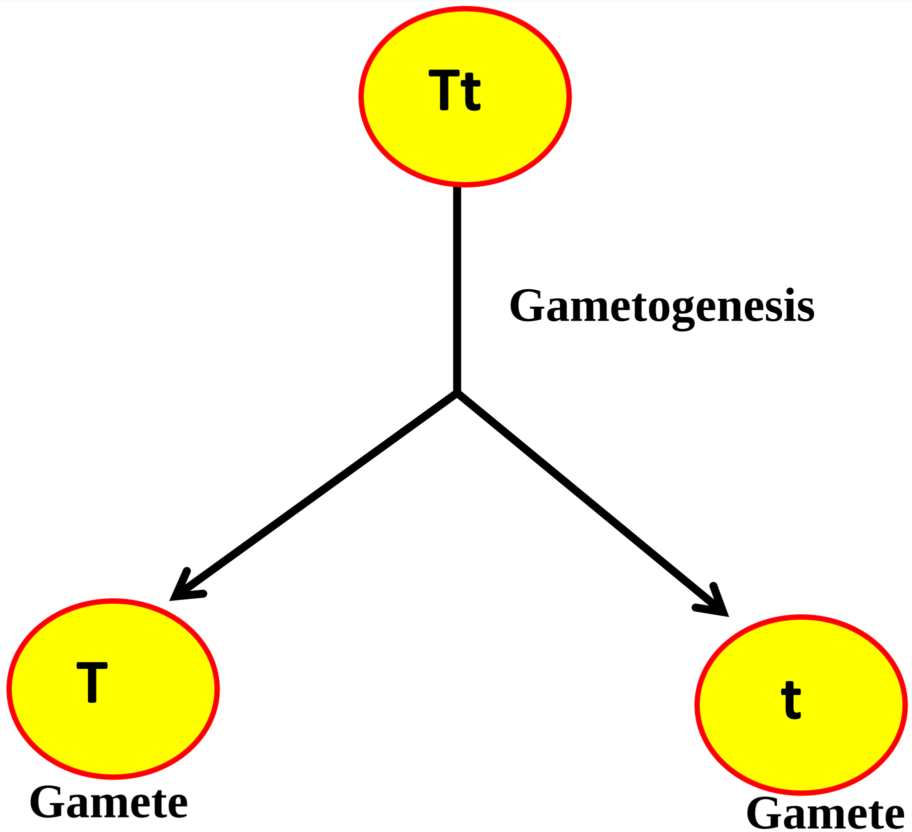
IInd Conclusion (Postulates of Dominance):

✓This conclusion is based on F1 – generation. When two different unit factors are present in single individual, only one unit factor is able to express itself and known as dominant factor.

factor. Another unit factor fails to express is the recessive factor. In the presence of dominant unit factor recessive unit factor cannot express and it is known as conclusion of dominance.

IIIrd Conclusion (Law of segregation):

✓ During gamete formation; the unit factors of a pair segregate randomly and transfer inside different gamete. Each gamete receives only one factor of a pair; so gametes are pure for a particular trait. It is known as conclusion of purity of gametes or segregation.



Dihybrid cross : (Crosses involving two pairs of contrasting characters)

✓ A cross in which study of inheritance of two pairs of contrasting traits.

✓ Mendel wanted to observe the effect of one pair of heterozygous on other pair.

✓Mendel crossed yellow and round seeded plants with green and wrinkled seeded plants.

✓ All the plant in F1 – generation had yellow and round seeds.

✓ When F1 plants were self pollinated to produce four kinds of plants in F2 generation such as yellow round, yellow-wrinkled, green round and green wrinkled, there were in the ratio of 9:3:3:1. This ratio is known as **dihybrid ratio.**

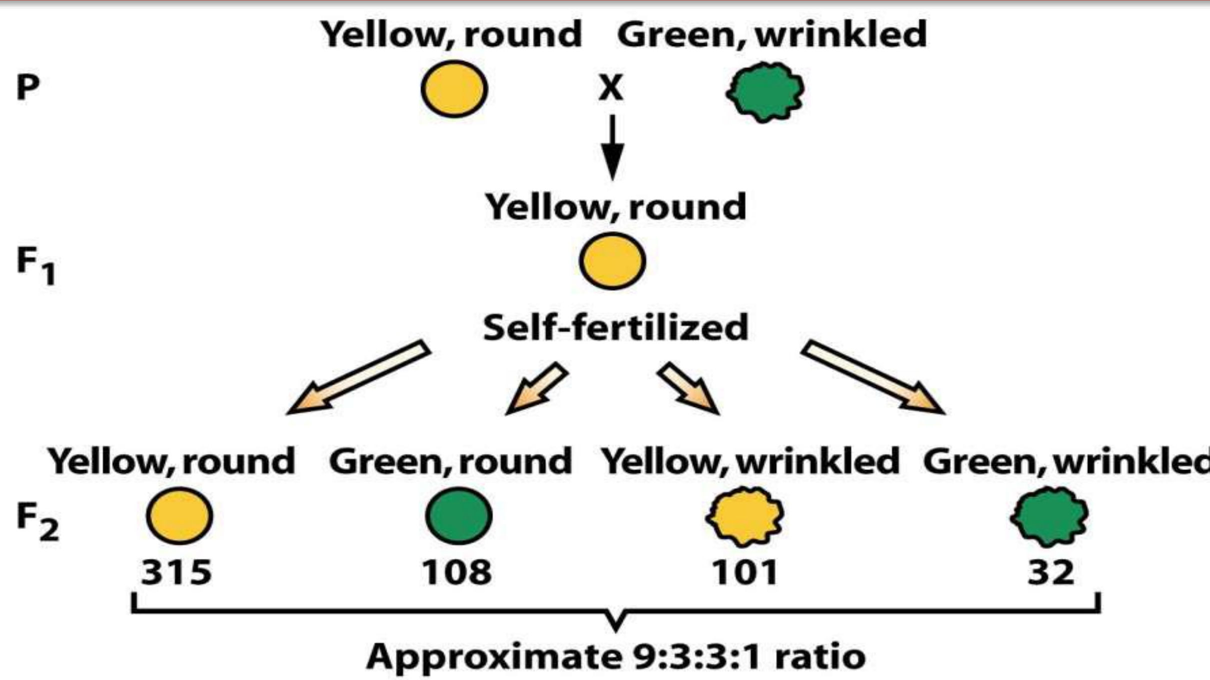
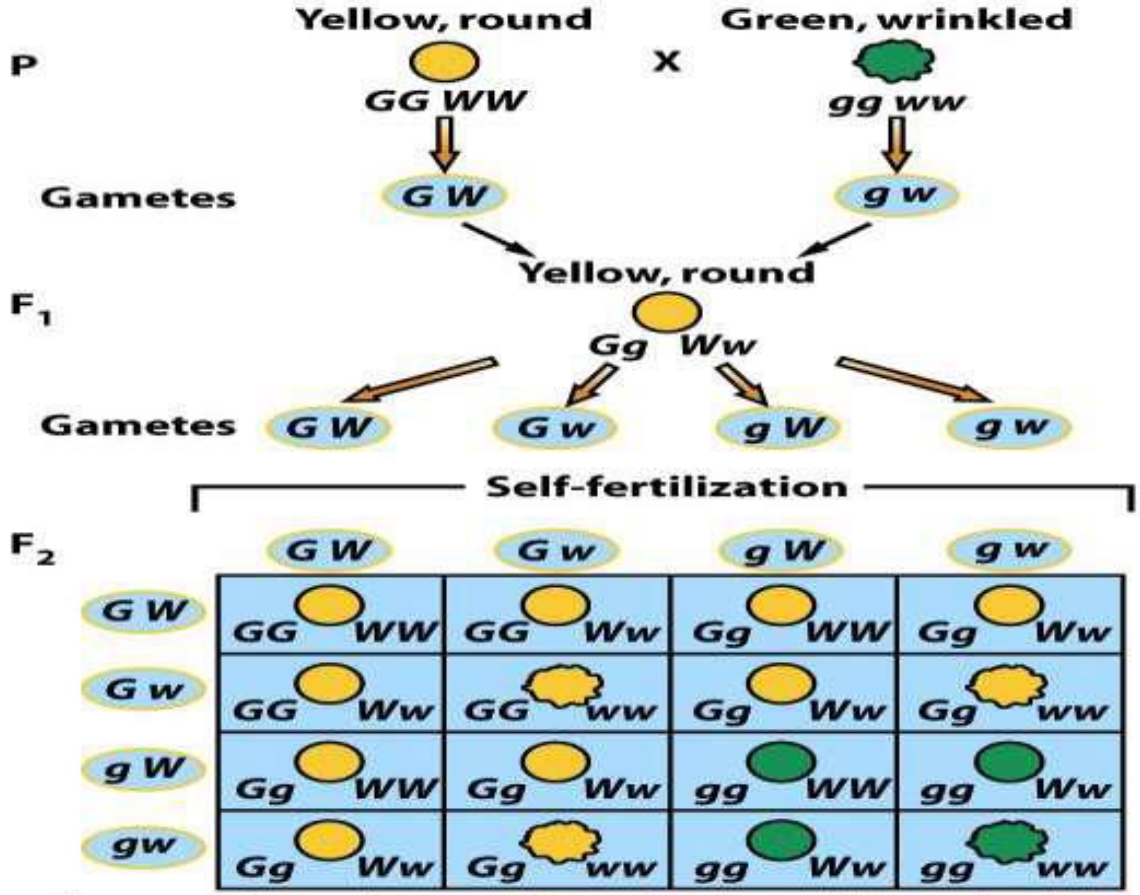


Figure 3-3 Principles of Genetics, 4/e

STEP 1 Each parental homozygote produces one kind of gamete.

STEP 2 The F_1 hetero-zygotes produce four kinds of gametes in equal proportions.

STEP 3 Self-fertilization of the F_1 hetero-zygotes yields four phenotypes in a 9:3:3:1 ratio.



F_2

Phenotypes	Genotypes	Genotypic ratio	Phenotypic ratio
Yellow, round	*GG WW*	1	9
	GG Ww	2	
	Gg WW	2	
	Gg Ww	4	
Yellow, wrinkled	*GG ww*	1	3
	Gg ww	2	
Green, round	*gg WW*	1	3
	gg Ww	2	
Green, wrinkled	*gg ww*	1	1

Figure 3-4 Principles of Genetics, 4/e

- ✓ Expression of yellow round (9) and green wrinkled (1) traits shows as their parental combination.
- ✓Green Round and yellow wrinkled type of plants are produced by the results of new combination.

Conclusion:-

- ➢ The F2 generation plant produce two new phenotypes, so inheritance of seed colour is independent from the inheritance of shape of seed. Otherwise it can not possible to obtain yellow wrinkled and green round type of seeds.
- ➢This observation leads to the Mendel’s conclusion that different type of characters present in plants assorted independently during inheritance.
- ➢ This is known as Conclusion of Independent Assortment. It is based on F2 generation of dihybrid cross. The nonhomologous chromosome show random distribution during anaphase-1 of meiosis.

A pure yellow and round seeded plant crossed with green and wrinkled seeded plant which are having genotype GGWW and ggww to produce F1 generation having GgWw genotype.

✓ Both the characters recombine independently from each other during gamete formation in F1 generation. Factor (W) of pair factor (Ww) is having equal chance to (G) factor or (g) factor of gametes to form a two type gametes – (Gw) and (gw).

✓ Similarly (w) factor also having equal chance with (G) factor or (g) factor of gametes to form a two type gametes – (Gw) and (gw).

✓ Thus, total four type of gametes – (GW), (gW), (Gw), and (gw) are formed.

Therefore, during the gametes formation in F1 generation, independent recombination is possible.

✓The law of independent assortment is most criticized. Linkage is the exception of this

Back Cross:

A back cross is a cross in which F1 individuals are crossed with any of their parents.

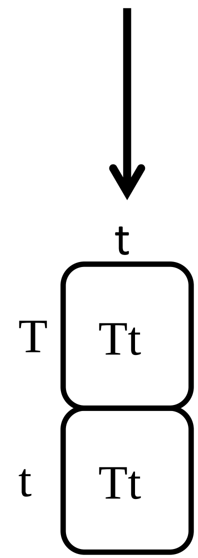
Test Cross - When F1 progeny is crossed with recessive parent then it is called test cross.

✓ The total generations obtained from this cross, 50% having dominant character and 50% having recessive character.

Monohybrid Test Cross:- The progeny obtained from the monohybrid test cross are in equal proportion, means 50% is dominant phenotypes and 50% is recessive phenotypes. It can be represented in symbolic forms as follows.

F1 progeny (hybrid) X Recessive Parent

(Tt) (tt)



Monohybrid test ratio = 1:1

Fig: Monohybrid test cross

Dihybrid Test Cross: - The progeny is obtained from dihybrid test cross are four types and each of them is 25%.

F1 -dihybrid (TtRr) X Recessive parent (ttrr)

↓

	TR	Tr	tR	tr
tr	TtRr	Ttrr	ttRr	ttrr

The ratio of Dihybrid test cross = 1:1:1:1

✓ In test cross phenotypes and genotypes ratio are same.

Reciprocal Cross:-

- When two parents are used in two experiments in such a way that in one experiment “A” is used as the female parent and “B” is used as the male parent, in the other experiment “A” will be used as the male parent and “B” as the female parent. Such type of a set of two experiments is called Reciprocal cross.

Exception of Dominance: - There are two exceptions of law of dominance.

[1] Incomplete dominance

[2] Co-dominance

[1] Incomplete dominance:

✓ According to Mendel's law of dominance, dominant character must be present in F1 generation. But in some organisms, F1 generation is different from the both parents.

✓Both factors such as dominant and recessive are present in incomplete dominance but dominance factors are unable to express their character completely, resulting different type of generation is formed which is different from the both parents.

Example: Flower colour in *Mirabilis jalapa*.

✓ Incomplete dominance was first discovered by Correns in *Mirabilis jalapa*. This plant is called as '4 O' clock plant 'or' Gul-e-Bans'. Three different types of plant are found in Mirabilis on the basis of flower colour, such as red, white and pink.

✓When plants with red flowers is crossed with white flower plants, with pink flower obtained in F1 generation. The reason of this is that the genes of red colour incompletely dominant over the genes of white colour.

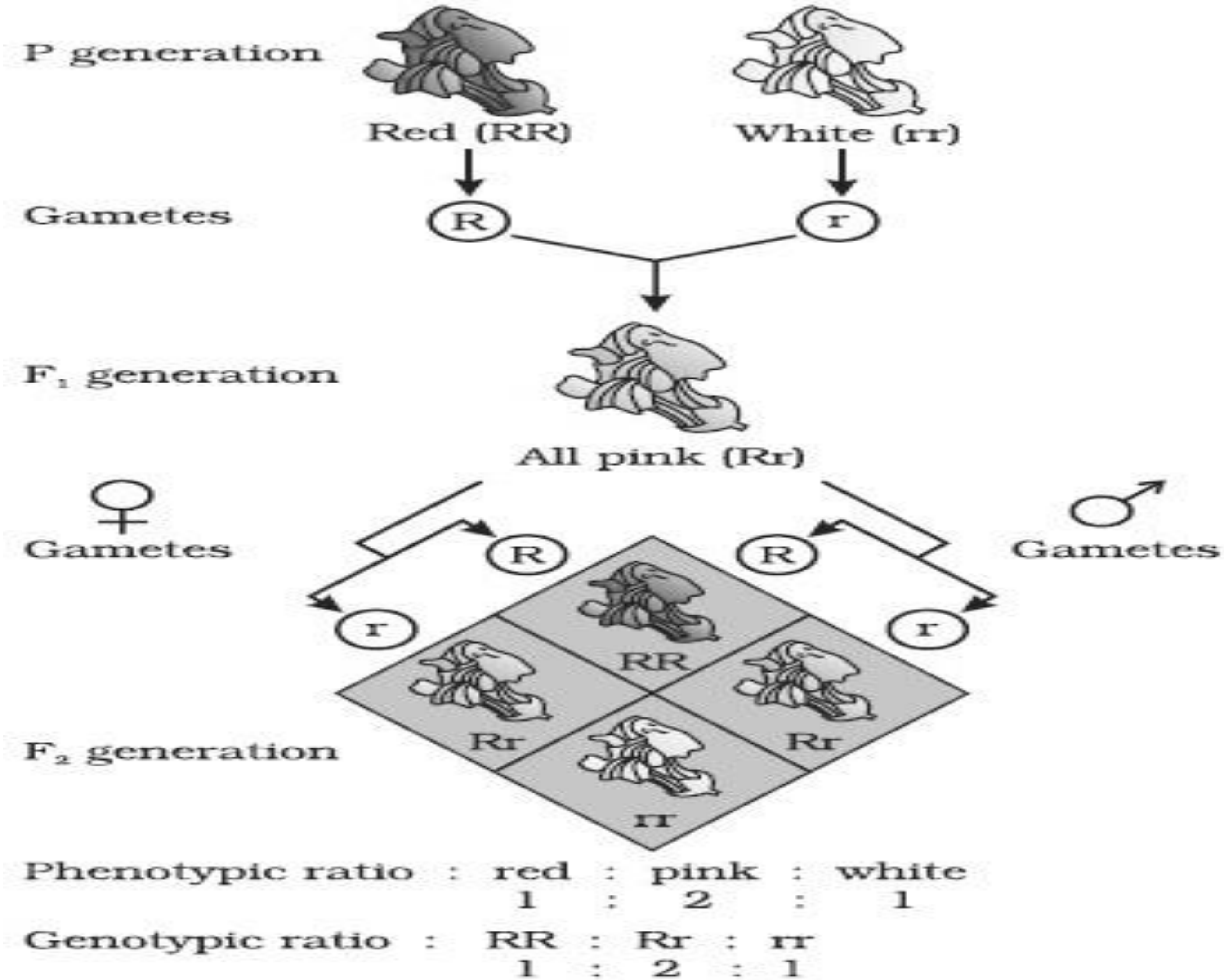


Figure: Incomplete dominance in *Mirabilis jalapa*

CO-DOMINANCE:- In this phenomenon, both the gene expressed for a particular character in F1 hybrid progeny.

➢ There is no blending of characters, whereas both the characters expressed equally.

Examples: - Co-dominance is seen in animals for coat colour.

Black X White

R1 R1 R2R2

↓

F1 genration - R1R2 (Roan color)

↓ Sib-mating cross

	R1	R2
R1	R1R1	R1R2
R2	R1R2	R2R2

R1R1 = Black – 1 R2R2 = Roan – 2 R2R2 = White – 1

- When a black parent is crossed with white parent, a **roan colour F1 progeny is produced.**
- When we obtain F2 generation from the F1 generation, the ratio of black ; black-white (Roan) ; white of animals is 1 : 2 : 1

Note:-

In incomplete dominance, characters are blended phenotypically, while in co-dominance, both the genes of a pair exhibit both the characters side by side and effect of both the character is independent from each other.

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Thank You!!!