FATHER OF MODERN GENETICS

GREGOR JOHANN MENDEL
(1822-1880)

About Mendel:

- Gregor Mendel was born by **22nd July 1822** in Heizendorf then part of Austro-Hungarian Empire (today Hynice in the Czech Republic).
- The first person to trace the characteristics of successive generations of a living thing.
- Graduated from High School 1840.
- Attended the Augustinian Monastery at Brunn in 1843 and became a monk after 5 years.
- Worked as part time teacher in high school and taught Greek & Mathematics.

• From 1851 to 1853, studied zoology, botany, chemistry, and physics at the University of Vienna.

• He became a member of the Zoologico- Botanical Society of Austria and has published two scientific treatises (1853 and 1854).

• Probably due to health reasons, Mendel has returned to Brno without formally finishing the University in Vienna.

•1856 – 1863 Gregor J. Mendel, done experiments with edible pea plants at the garden in the grounds of the **Augustinian Monastery in Old Brno.**

- Experimentation in the monastery garden results in laws of inheritance.

- He reported on the results of his observations at the meetings of the **Association for Natural Research in Brno in 8th February 1865** & concluded his discussions after a month.

- The Association published the written accounts of these observations in proceedings in 1866.

- But these findings lay dormant for 34 years until they were rediscovered in 1900.

The rediscovery of Mendel's Laws :

• It was to take thirty-four years before Mendel's prediction came true.

•The year 1900, Carl Correns in Germany, Hugo deVries in the Netherlands and Erich von Tschermak- in Austria.

• Their achievement was to realize that Mendel had not merely conducted experiments in successful hybridization

• But had in fact studied the heredity of specific characteristics as they were passed on from parent plants to their offspring.

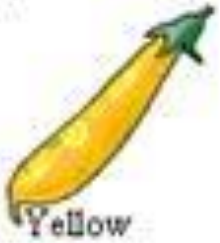
Mendel's Experiments with Peas : (Pisum sativum)

Reasons why Mendel has selected the pea plants (Pisum sativum) for his experiments.

- Under natural conditions the pea plants exhibited only self-pollination. This is because the flowers exhibit a condition called cliestogamy (petals remain closed).
- Life cycle - very short.
- Every pea plant produced a large number of seeds.
- Possible to conduct cross pollination.
- Hybrids resulting from two varieties are perfectly fertile.

Seven Pairs of Characters Mendel Studied :

Parameters	Contrasting Characters
1. Length of the stem	Tall and dwarf
2. Position of the flowers	Axial and terminal
3. Nature of the pod (fruit)	Inflated and constricted
4.Colour of the unripe pod	Green and yellow
5. Colour of the seed coat	Grey and white
6. Nature of the seed coat	Round (smooth) and wrinkled
7. Colour of the cotyledons	Yellow and green

Character	Dominant trait	Recessive trait
Seed shape	 Spherical	 Wrinkled
Seed color	 Yellow	 Green
Flower color	 Purple	 White
Pod shape	 Inflated	 Constricted
Pod color	 Green	 Yellow

Character	Dominant trait	Recessive trait
Flower position	 Axial	 Terminal
Stem height	 Tall	 Dwarf

Reasons for Mendel's Success

- The pea plant which Mendel chose for conducting experiments, is the most ideal for controlled breeding, since it can easily be subjected to cross pollination.
- He identified very clear contrasting characters in the pea plants.
- He selected pure breeding plants for his experiments.
- Mendel concentrated at a time only on the inheritance on one particular trait, with the two contrasting conditions, instead of attempting the inheritance of entire set of characters in the plant.

- Maintained an accurate record of all the observations he made on the breeding experiments that he had designed.
- He pooled the data obtained from similar experiments for different characteristics and analyzed the results by using statistical methods and applying the law of probability.
- Able to effectively check the flowers under investigation from contamination by unwanted pollen grains.
- Mendel was fortunate enough in choosing the seven pairs of contrasting characters in pea plants. It was later discovered that the genes responsible for these characters are located on separate chromosomes.

Important Terminologies:

- **Genetics**: The scientific study of heredity
- **Allele**: Alternate forms of a gene/factor.
- **Genotype**: combination of alleles an organism has.
- **Phenotype**: How an organism appears.
- **Dominant**: An allele which is expressed (masks the other).
- **Recessive**: An allele which is present but remains unexpressed (masked)
- **Homozygous**: Both alleles for a trait are the same.
- **Heterozygous**: The organism's alleles for a trait are different.

Mendels 1st Law - Law of Segregation

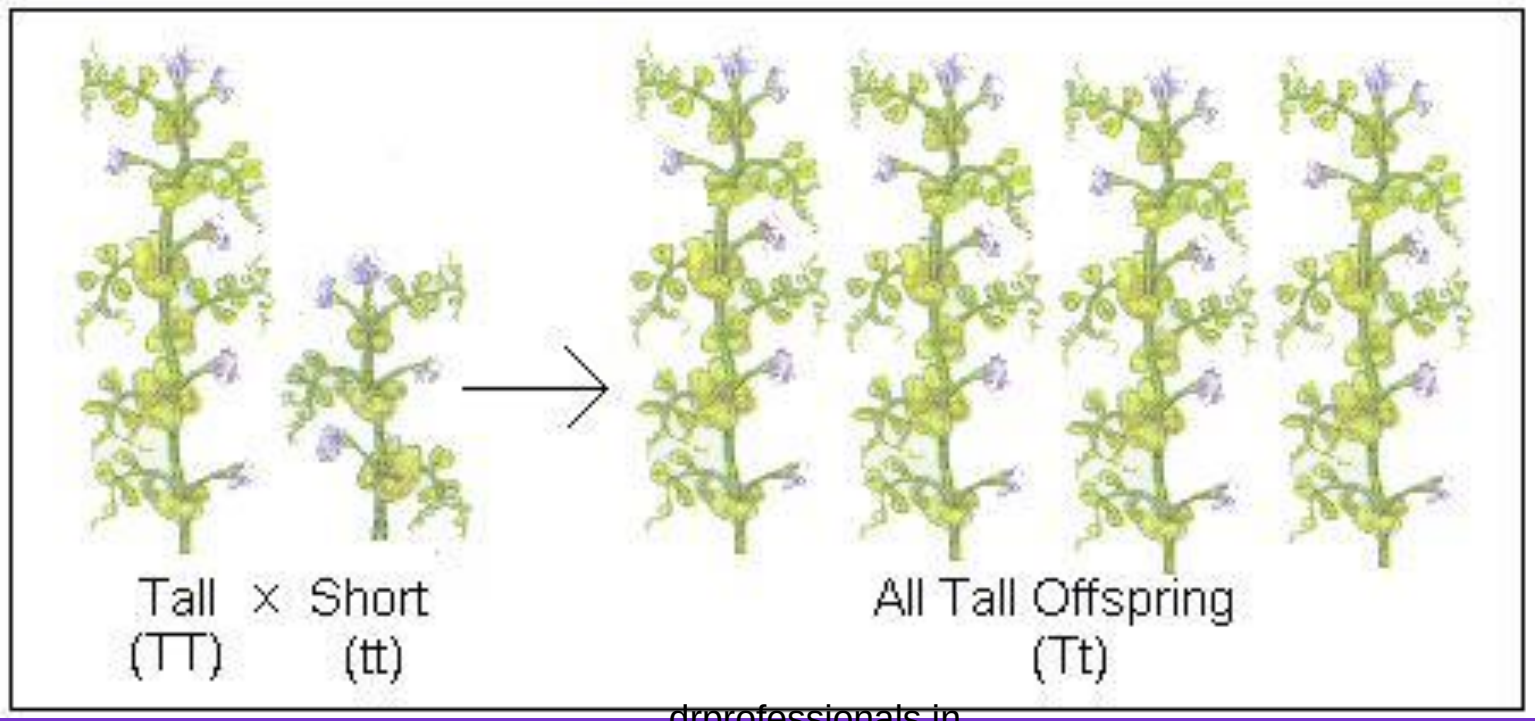
"Members of pairs of contrasting characters (genes) segregates out during gametes formation without their admixture in the hybrid."

OR

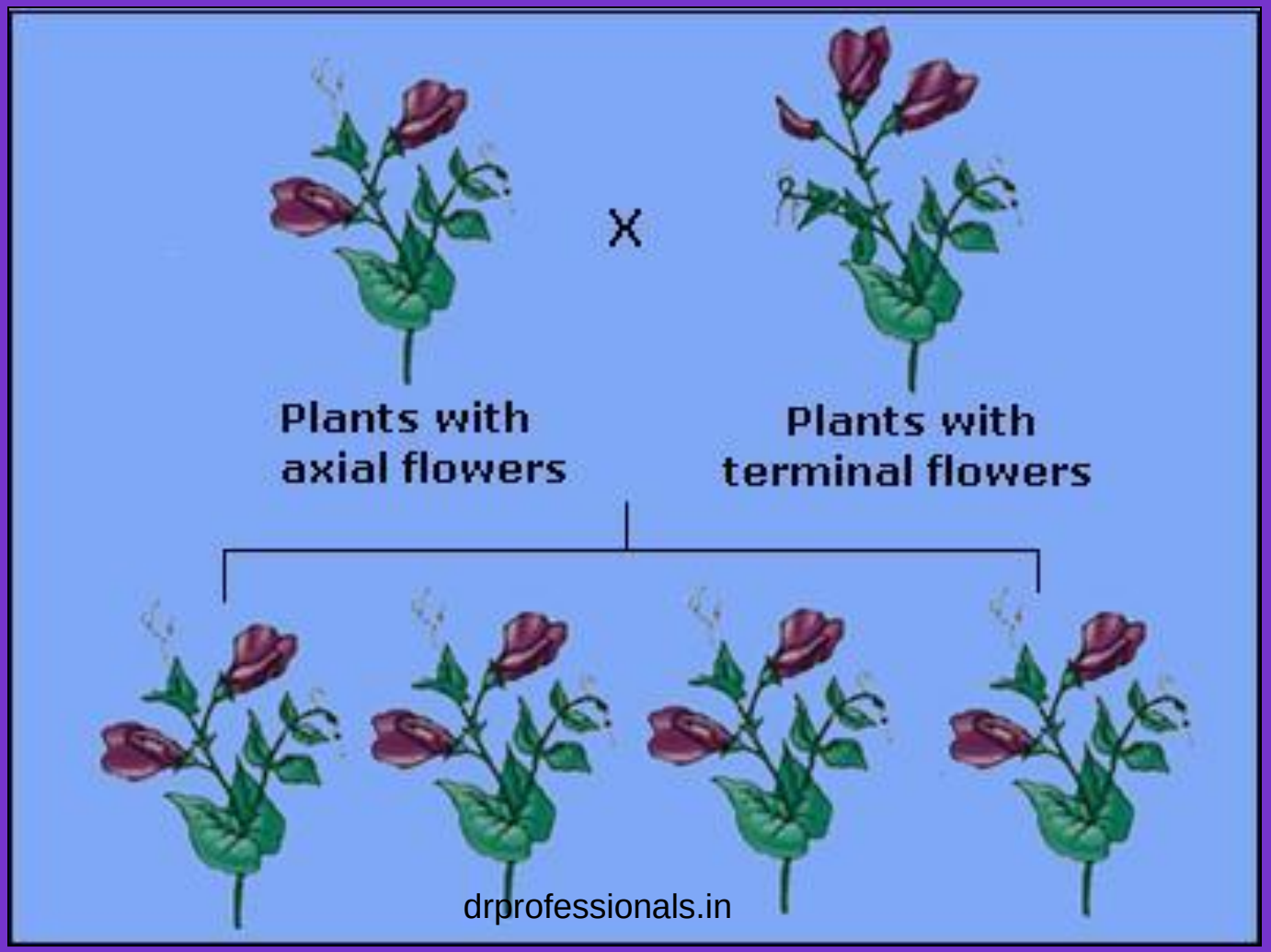
"Different paired factors of characters derived from two parents , although they may be intimately associated together , yet retain their individuality, separate out uncontaminated by each other and are able to form new combinations , when they unite to make new zygote".

Monohybrid Inheritance

In the first set of experiments, Mendel conducted cross-pollination between a pure breeding tall plant and a pure breeding dwarf plant. All the resulting plants were found to be tall.



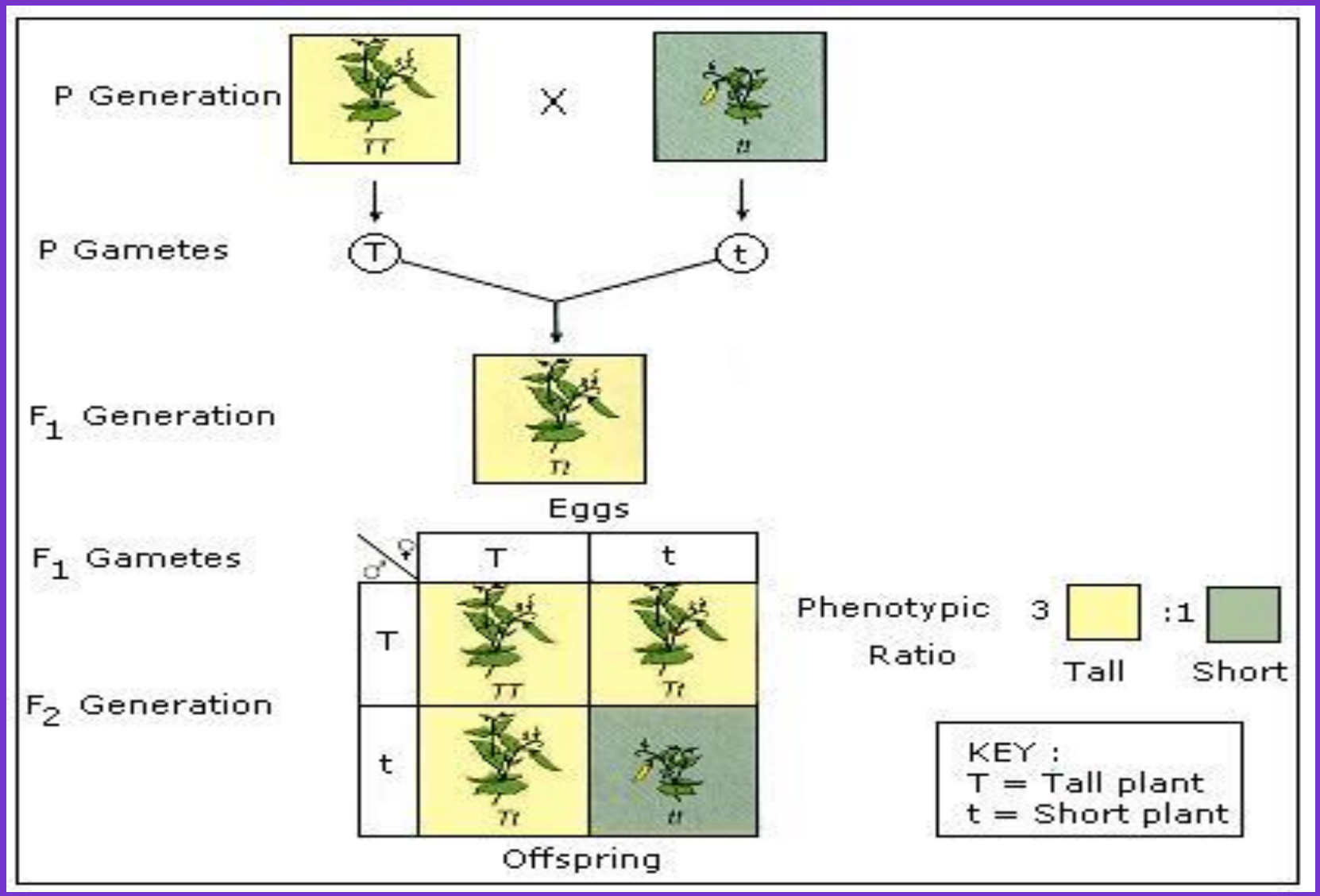
In a similar pollination between a pure breeding plant with axial flowers and a pure breeding plant with terminal flowers, all the resulting plants of the next generation produced only axial flowers.



Based on these results, Mendel concluded that in a cross-involving two contrasting characters, only one character expresses itself in the next generation.

Mendel called the character, which expressed as **dominant** character and the character, which failed to express, as recessive character. This idea came to be known as the principle of dominance.

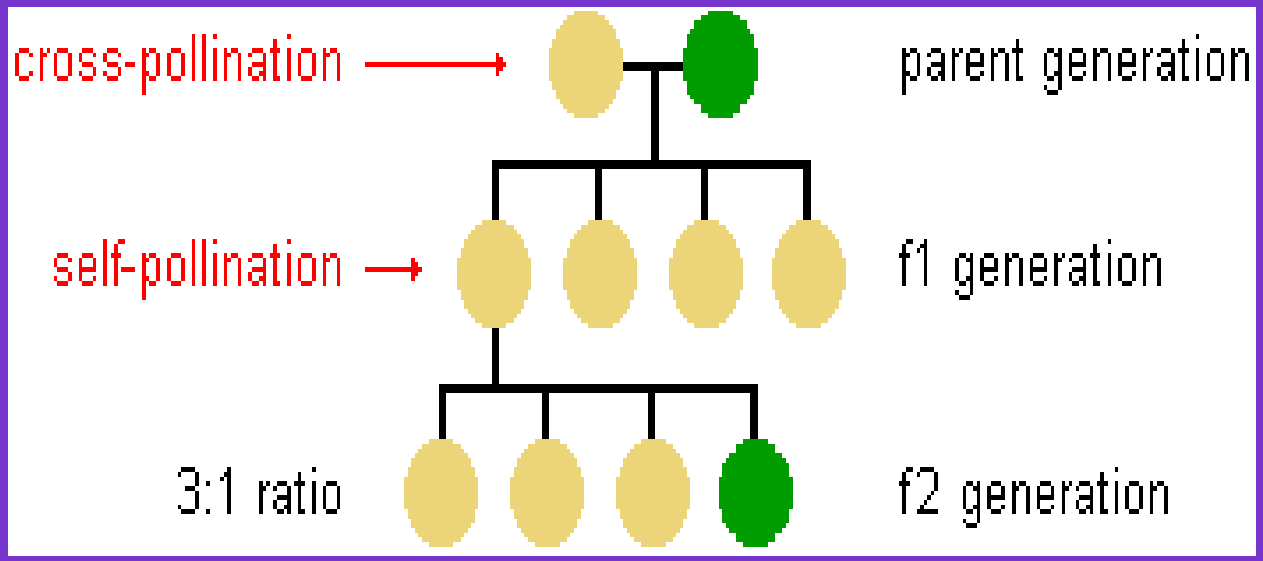
Mendel allowed the tall plants of the F_1 generation to undergo self-pollination. In the next generation, Mendel found both tall plants and dwarf plants, approximately in the ratio 3:1. The results were most surprising since the recessive character dwarfness had reappeared in the next generation.
(F_2 generation)



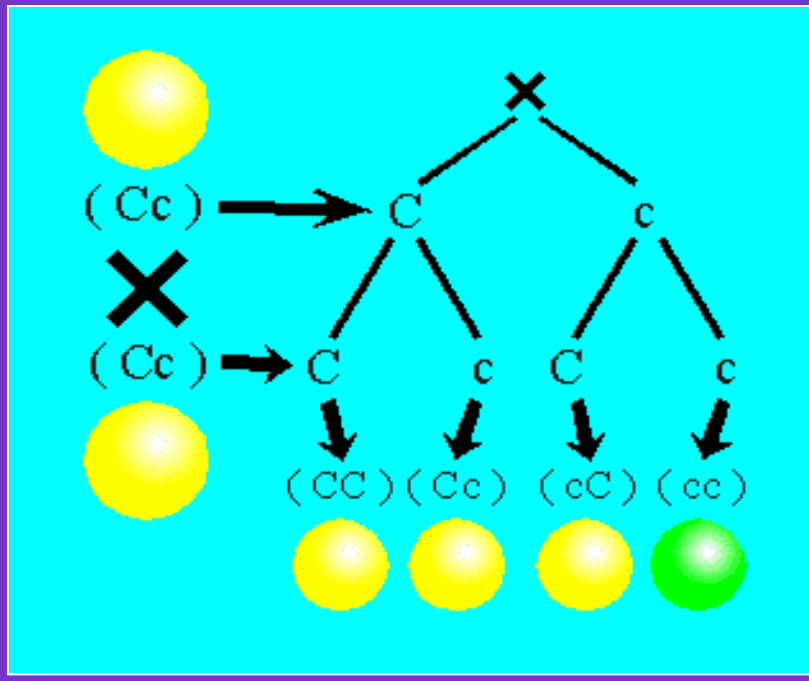
Genotypic Ratio : T T : T t : t t

1 : 2 : 1

Seed Colour



C = dominant = yellow
c = recessive = green



Results from Mendel's Experiments

Parental Cross	F_1 Phenotype	F_2 Phenotypic Ratio	F_2 Ratio
Round x Wrinkled Seed	Round	5474 Round : 1850 Wrinkled	2.96:1
Yellow x Green Seeds	Yellow	6022 Yellow : 2001 Green	3.01:1
Axial x Terminal Flower Position	Axial	705 Axial : 224 Terminal	3.15:1
Tall x Dwarf Plants	Tall	l787 Tall : 227 Dwarf	2.84:1

Testcross

The cross of any individual to a homozygous recessive parent; used to determine if the individual is homozygous dominant or heterozygous.

Parental cross :

TT X tt

F1 genotype Tt

F1 are crossed with homozygous recessive plant

T t X t t

T t : t t 1 Tall : 1 Dwarf

Mendels 2nd Law – Law of Independent Assortment

DIHYBRID CROSS :

A cross between two parents that differ by two pairs of alleles (AABB x aabb).

Dihybrid :

An individual heterozygous for two pairs of alleles (AaBb).

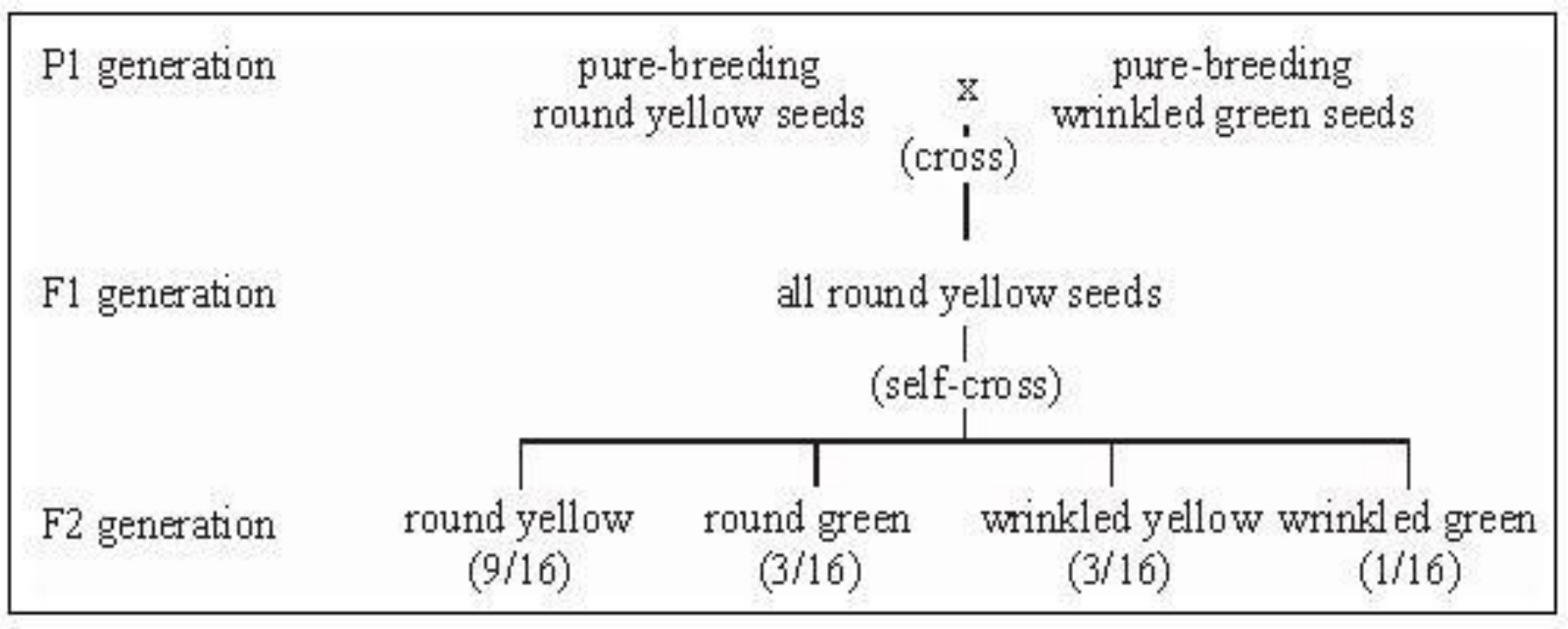
Law of Independent Assortment :

'The member of different pairs of genes segregate independently of one another during gamete formation and recombine in every possible combination in subsequent generation.

DIHYBRID CROSS :

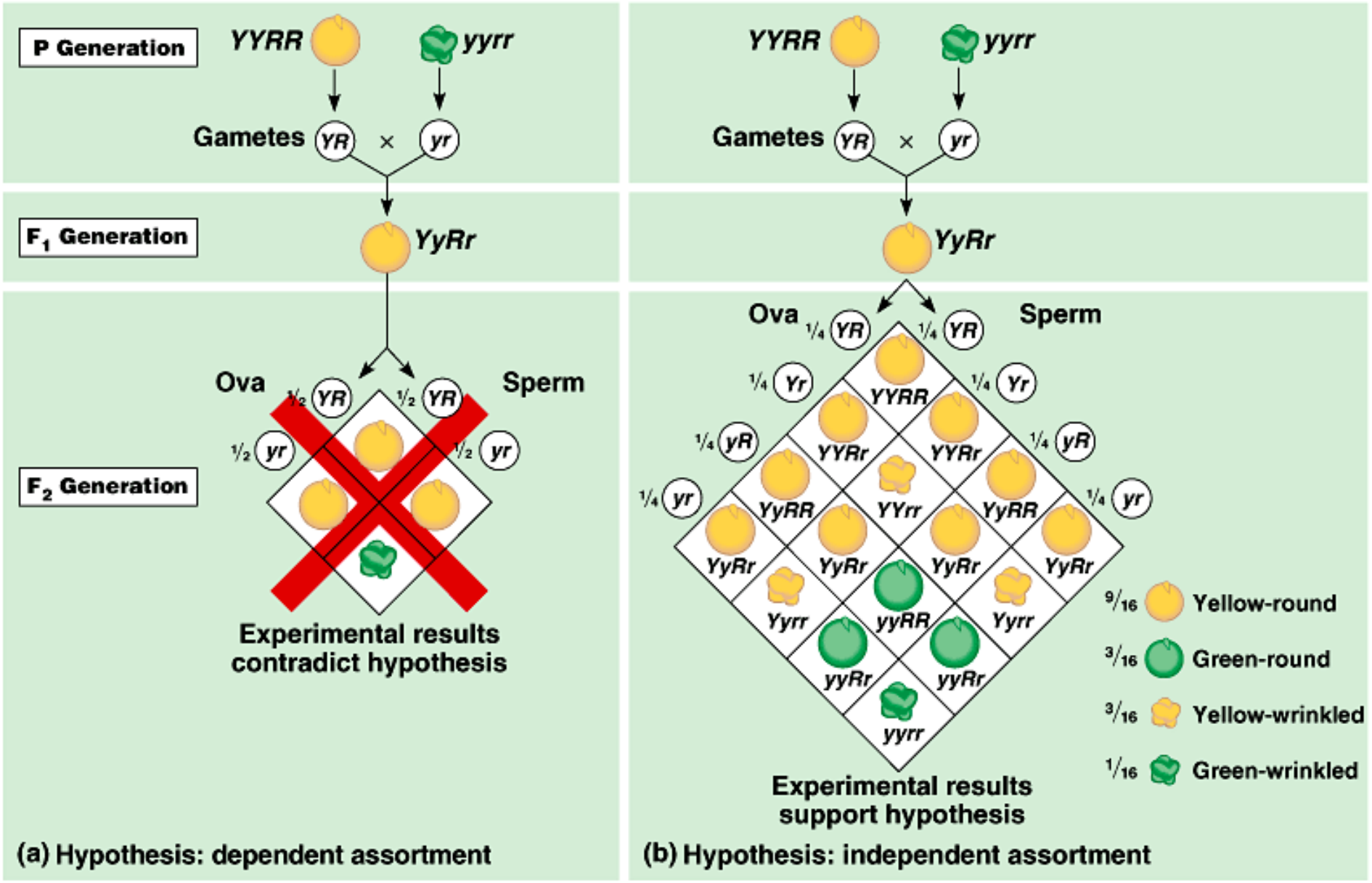
It is a cross involving two pairs of contrasting characters. For this experiments on dihybrid inheritance Mendel selected the contrasting characters in the seed coat and cotyledons. He conducted a cross pollination between a pure breeding plant with round seed coat and yellow coloured cotyledons and a pure breeding plant with wrinkled seed coat and green coloured cotyledons. In the F1 generation, all the resulting plants had **round seed coat and yellow coloured cotyledons.**

When he allowed these F1 plants to undergo self pollination, in the F2 generation, four types of plants were obtained with **round yellow, round green, wrinkled yellow and wrinkled green seeds in the ratio of 9:3:3:1**.



Law of Independent Assortment :

'In a dihybrid cross, the factors responsible for the two pairs of contrasting characters stay together in the F1 generation, but assort independently during the formation of gametes'.



The phenotypes, general genotypes, and general genotypic ratios from this cross can be represented in the following manner:

Phenotype	General Genotype
9 Yellow, Round Seed	9 *Y _ R _*
3 Yellow, Wrinkled Seed	3 *Y _ r r*
3 Green, Round Seed	3 *y y R _*
1 Green, Wrinkled Seed	1 *r r y y*

Backcross confirmation of Mendel's 2nd law

Let's use the example of the yellow, round seeded F1.

Backcross *YyRr* x yyrr

↓

Gametes *YR Yr yR yr*

Punnett Square for the backcross

Female Gametes

Male Gametes	**YR**	**Yr**	**yR**	**yr**
yr **Yellow, round**	**YyRr** **Yellow, Round**	**Yyrr** **Yellow, wrinkled**	**yyRr** **Green, round**	**yyrr** **Green, wrinkled**

The phenotypic ratio of the test cross is:

1 Yellow, Round Seed; 1 Yellow, Wrinkled Seed;
1 Green, Round Seed; 1 Green, Wrinkled Seed

Di-hybrid Ratio :

Tri-hybrid Ratio :

Yellow Round Seeds, Red Flower X Green, Wrinkled Seed,White Flower