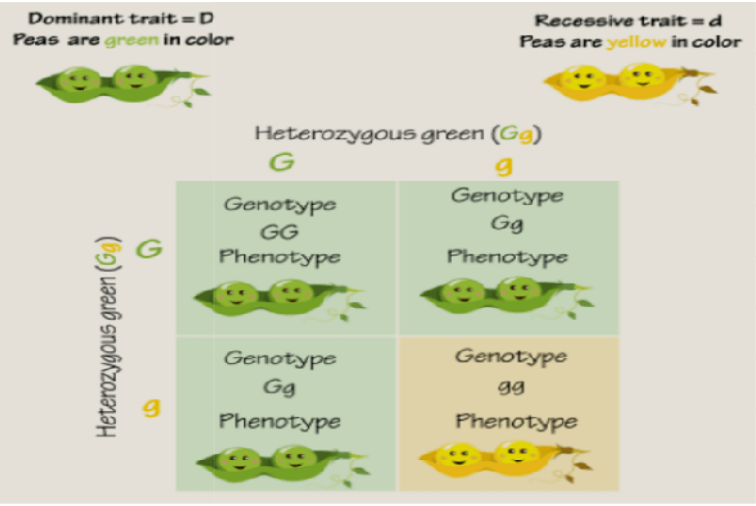
Principles of Inheritance: Mendel's laws

Introduction

- Principles of inheritance are related to all sexually reproducing eukaryotic organisms.
- On the basis of breeding experiments on *Pisum sativum*, Mendel concluded the principles of inheritance *i.e.,* Mendel's laws as law of dominance, law of segregation and law of independent assortment.
- One interesting thing is that, Mendel himself initially did not postulate any genetical law or the principles which we study in the genetics books.
- Later studies in Mendelian genetics by Correns laid him to represent Mendel's work with the help of three laws of heredity.
- These laws are 'law of dominance', 'law of segregation' and the 'law of independent assortment.'

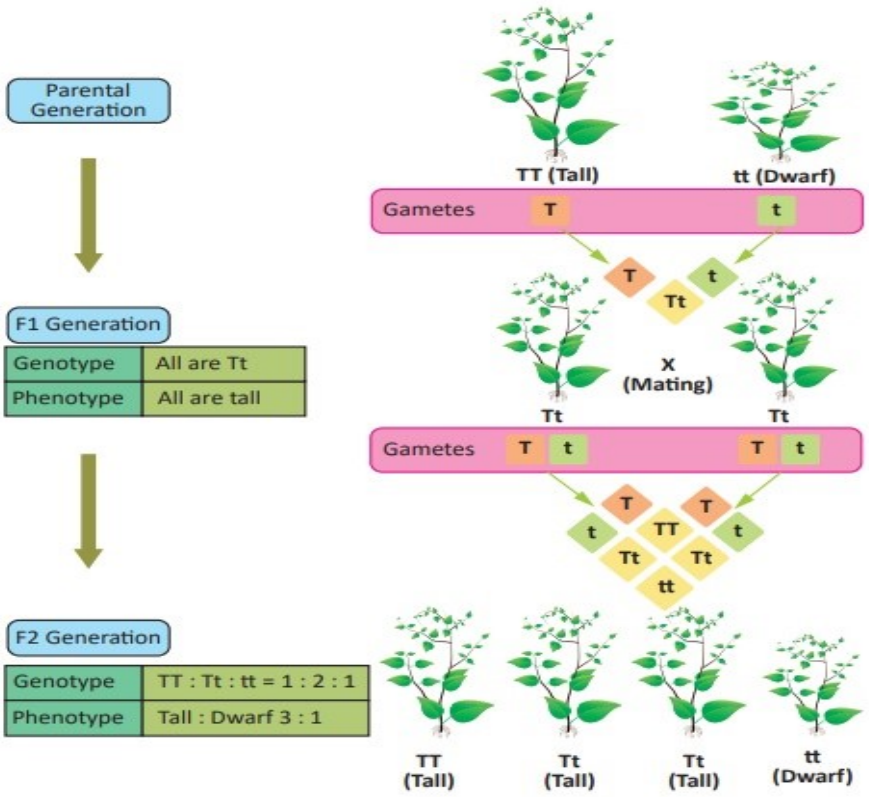
Mendel's Law of Dominance

- Mendel's law of dominance states that, ***"When parents with pure, contrasting traits are crossed together, only one form of trait appears in the next generation. The hybrid offspring's will exhibit only the dominant trait in the phenotype."***
- Law of dominance is known as the first law of inheritance.
- In this law, each character is controlled by distinct units called factors, which occur in pairs.
- If the pairs are heterozygous, one will always dominate the other.
- Law of dominance explains that in a monohybrid cross between a pair of contrasting traits, only one parental character will be expressed in the F1 generation and both parental characters will be expressed in the F2 generation in the ratio 3:1.
- The one which is expressed in the F1 generation is called the dominant trait and the one which is suppressed is called a recessive trait.
- In simple words, the law of dominance states that recessive traits are always dominated or masked by the dominant trait.
- This law can be described by Mendel's experiment.



Mendel's Law of Segregation or Law of Purity of Gametes

- On the basis of monohybrid cross, Mendel proposed the law of inheritance *i.e.,* Law of segregation.
- The Mendel's law of segregation states that, "***In an individual, a pair of alleles which controls particular character remains together in unchanged form in F_1 hybrid and is separated at the time of gamete formation"***.
- Monohybrids cross in between homozygous tall sweet pea (TT) and homozygous dwarf sweet pea (tt) results in production of heterozygous tall hybrid sweet pea (Tt).
- The letters 'T' and 't' are used to denote the alleles of the gene which govern plant height; 'T' (uppercase letter) represents the dominant allele and the 't' (lowercase letter) represents recessive allele.
- When heterozygous F_1 hybrids (Tt) are self-crossed, each of the parent plant produces gametes.
- Among the total gametes formed by each parental plant, half of the gametes receives allele 'T' for tallness and remaining half receives allele 't' for dwarfness.
- Thus, each gamete has only one allele either 'T' or 't'.
- The formed gametes mix randomly to produce 3 tall [TT (1) and Tt (2)] and 1 dwarf (tt) genotype in F_2 generation.
- Thus, the obtained phenotypic ratio with respect to studied phenotypic character is 3:1.
- This phenotypic ratio is called monohybrid ratio.



- From the results it is clear that, in an individual diploid organism, for any particular character, two alleles are present.
- These two alleles get separated at the time of gamete formation and each gamete receives only one allele. Thus, the gametes produced are pure for a specific character; hence law of segregation is also called as law of purity of gametes.

Mendel's Law of Independent Assortment

- On the basis of dihybrid cross, Mendel proposed the second law of inheritance *i.e.,* Law of independent assortment.
- The law of independent assortment states that, ***"when two homozygous individuals differing in two or more pairs of contrasting characters are crossed, each character inherits independently in F_2 generation".***
- A dihybrid cross between homozygous dominant sweet pea, for yellow and round seeds (YYRR) and homozygous recessive sweet pea for green and wrinkled seeds (yyrr) produces heterozygous F_1 hybrids with yellow and round seeds (YyRr).
- The letters 'Y' and 'y' are used to denote the alleles of the gene which govern seed colour and the letters 'R' and 'r' are used to denote the seed shape.
- 'Y' and 'R' (uppercase letters) represents the dominant allele and the 'y' and 'r' (lowercase letters) represents recessive allele for particular trait.
- When F_1 hybrids are selfed, in F_2 generation 9 yellow round, 3 yellow wrinkled, 3 green round and 1 green wrinkled phenotypes produced.
- Thus, the obtained phenotypic ratio with respect to studied phenotypic character is 9:3:3:1. This phenotypic ratio is called dihybrid ratio.