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Heredity & Evolution

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Heredity

Heredity is the process of passing the traits and characteristics from parent to offspring. This heredity is very evidently seen in sexual reproduction, as the variation of characteristics that are inherited is high.

During the sexual reproduction process Variation occurs due to some error in DNA copying. Variation is important because it contributes to evolution and forms the basis of heredity. Variation is caused due to positive gene mutations, the Interaction of genes with the environment and various combination of genetic material.

Gregor Mendel -The father of Genetics

Acquiring characteristic or traits from one generation to the other is nothing but inheritance. Here, both the parents contribute equally to the inheritance of traits. It was Gregor Mendel, knows as father of Genetics, who conducted immense research and studied this inheritance of traits.

It was with his research on plants breeding and hybridization that he came up with the laws of inheritance in living organisms. He conducted his experiments on pea plant to show the inheritance of traits in living organism.

He observed the pattern of Inheritance from one generation to the other in these plants. And thus he came up with Mendel's Law of inheritance, which can be summarise under the following headings:

- **law of Dominance**
- **law of Segregation**
- **Principle of Independent Assortment.**

Termology

Gene: It is the basic unit of inheritance. It consists of a sequence of D.N.A, which is the genetic material. A point to be noted here is that genes can mutate and can take two or more alternative forms.

Alleles: The alternative forms of gene which arises as a result of mutation. They are found In the same place on the chromosome and effect the same Characteristic or trait but in alternative forms.

Chromosome: These are thread like structure of nucleic acids and protein that are found in the nucleus of most living cells. They carry the hereditary or genetics information in the form of genes.

Genotype: It is the complete heritable genetic identify of an organism.

Phenotype: It is the description of the actual physical characteristic of an organism, the way the genotype is expressed.

Dominant alleles: when an allele affects the phenotype of an organism, then it is a dominant allele. It is denoted by a capital letter
eg "T" to express tallness

Recessive alleles: An allele that affects the genotype in the absence of the dominant, allele is called a recessive allele. It will express itself in the small letter.
e.g. "t" for tallness.

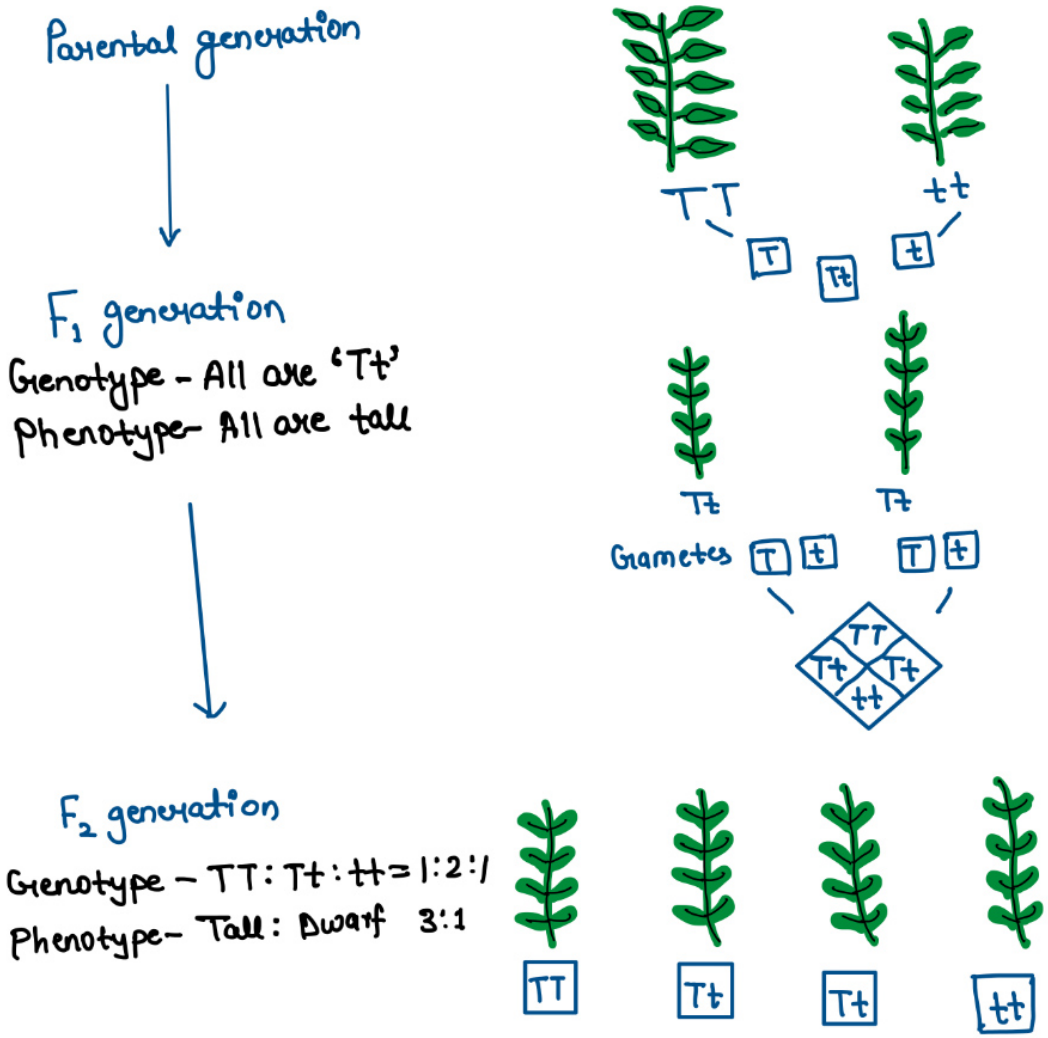
Homozygous: Each organism has two alleles for every gene. If both the alleles are same then it is called homozygous. If tallness is the trait, then it is expressed as "TT".

Heterozygous: If the two alleles are different from each other, then they are heterozygous in nature. If tallness is the trait, then it is expressed as "Tt".

Mendel's Experiment

Monohybrid cross

It is the cross between two pea plant which have one pair of contrasting character. E.g. a cross between a tall pea plant and a short(dwarf) plant.



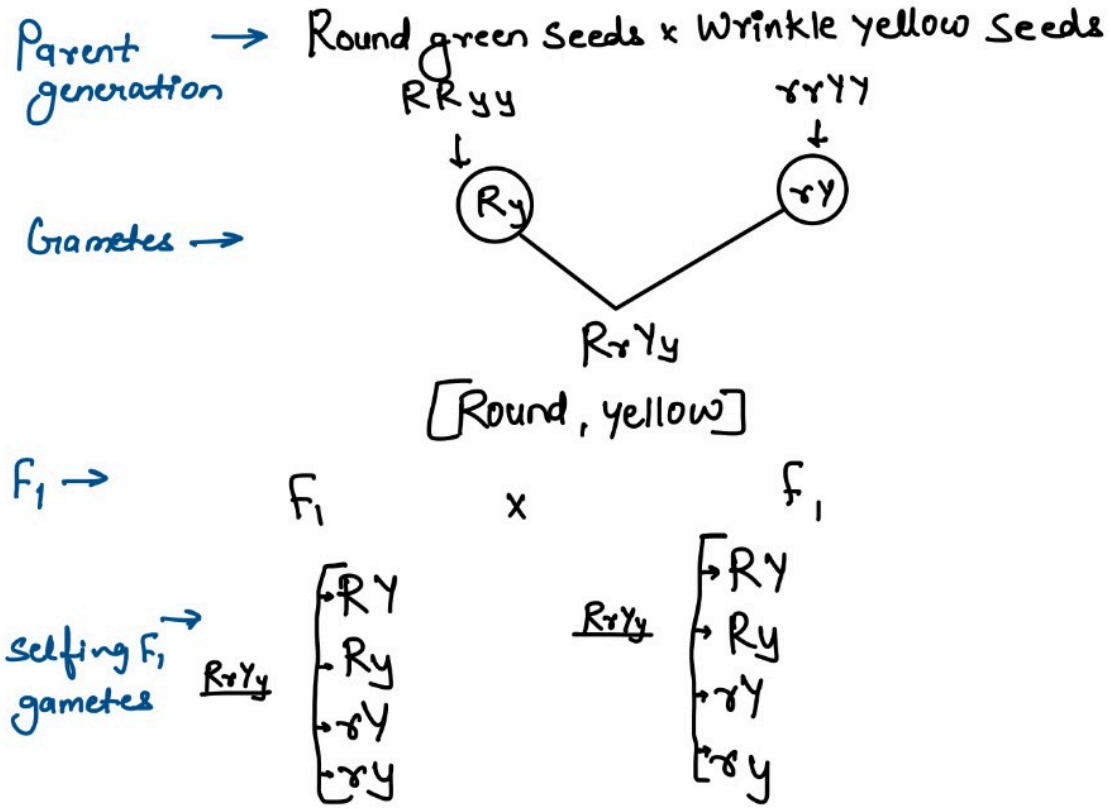
Observation and Conclusion

- In the first generation (F1) the progeny were tall. There was no medium height plant.
- In the second generation (F2), 1/4th of the offspring were short and 3/4th were tall.
- The phenotypic ratio in F2 is 3:1. (3 tall: 1 short).
- The genotypic ratio in F2- 1:2:1 - (TT:Tt:tt)
- For a plant to be tall, a single copy of "T" is enough, but if a plant has to be short, both the copies should be "t".

Characters like 'T' are the dominant traits as they are expressed and 't' are recessive traits as they remain suppressed.

Dihybrid cross

It is the cross between two plants which have two pairs of contrasting characters. This takes Into Consideration alternative traits of two different character. E.g. a cross between 1 pea plant with around and green seed and the other pea plant having wrinkled and yellow seeds.



Observation and Conclusion

- The F1 generation is 100% hybrid when Rryy cross with rrYY, all were RrYy with round and yellow seeds in the first generation. The round and yellow seeds are the dominant characters.
- In F2, the phenotype ratio is 9:3:3:1. The genotype ratio is very complex one.
- This shows that the gene are inherited independently of each other.

activity 9.2

Answer: It is possible through an experiment called Test cross. It is the cross between plants of unknown genotypes with recessive plants (tt). Here, the genotypes of tall plants are unknown. So they are crossed with recessive (short) plants.

If the tall plant is pure (homozygous), it produces only tall offspring (TT x tt → Tt).

If the tall plant is impure (heterozygous), it produces 50% tall offspring & 50% dwarf offspring (Tt x tt → Tt & tt). Thus we can confirm the F2 genotypic ratio is 1:2:1.

P.Y.Qs

Question: **In one of his experiments with pea plants Mendel observed that when a pure tall pea plant is crossed with a pure dwarf pea plant, in the first generation, F_1 only tall plants appear.**
(a) What happens to the traits of the dwarf plants in this case?
(b) When the F_1 generation plants were self-fertilized, he observed that in the plants of second generation, F_2 both tall plants and dwarf plants were present. Why it happened? Explain briefly.

Answer: (a) The dwarf traits of the plants is not expressed in the presence of the dominant tail trait.
(b) In the F2 generation, both the tall and dwarf traits are present in the ratio of 3: 1. This showed that the traits for tallness and dwarfness are present in the F_2 generation, but the dwarfness, being the recessive trait does not express itself in the presence of tallness, the dominant trait.

Sex Determination

There are 23 pairs of chromosomes in the cell of human body. Out of these, 22 pairs do not take part in sex-determination in human beings. The 23rd pair in gonadal cell called sex chromosome which is not always a perfect pair. Women have perfect pair having XX a chromosomes. But men have a pair having XY chromosomes. This cell is divided meiotically in both men and women to form gametes. All children will inherit an X-chromosome from mother and an X- or Y-chromosomes from their father. Thus, the sex of children is determined by the chromosomes they inheriting from their father.

A child inheriting X-chromosome from father will be a girl and one inheriting
Y-chromosome from him will be a boy.

PYQ : How is the sex of a baby determined?