

Biological Science

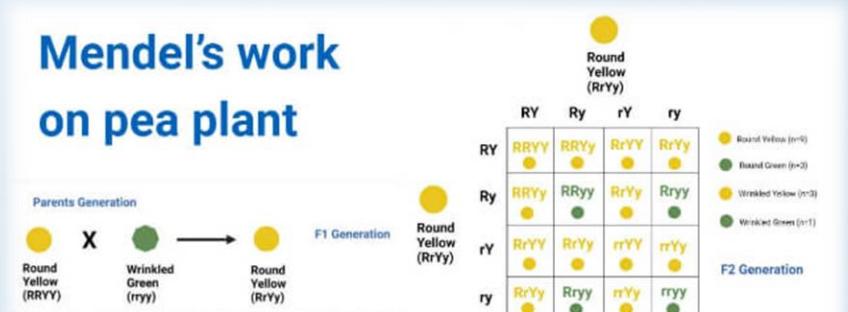
Module 2 Class 3

Mendelian Genetics

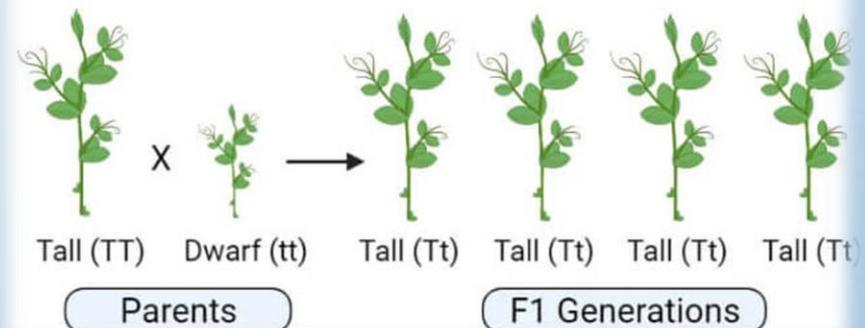
GENCOM COE

Department of Bio Sc. &
Environment

Mendel's work on pea plant



Monohybrid Cross

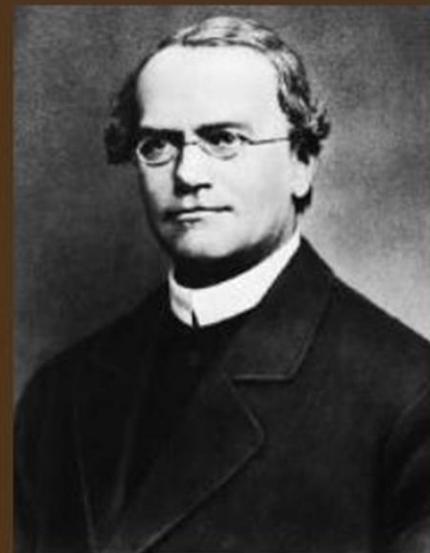




Mendelian Genetics

Who is Gregor Mendel?

- Mendel was born in 1822 in Austria
- His father was a peasant farmer, tenanted to a local aristocrat who was very interested in scientific crop improvement
- The family was very poor
- Mendel's early education was with local priest and teacher
- Showed considerable academic capability and so was sent to larger town with more opportunities
- Financial problems plagued him, affecting his health, so Mendel decided to enter monastery as means of support



Reasons behind the selection of Pea plant

Mendel, after carefully studying selected the pea plant for many reasons:

- ✓ The pea plants were easy to grow and maintain.
- ✓ It has many distinct and contrasting characters.
- ✓ The pea plant is an annual plant and so many generations of the plant can be studied in a short period.
- ✓ Peas are naturally self-pollinating but can also be cross-pollinated.
- ✓ Mendel made a list of contrasting characters which he studied:

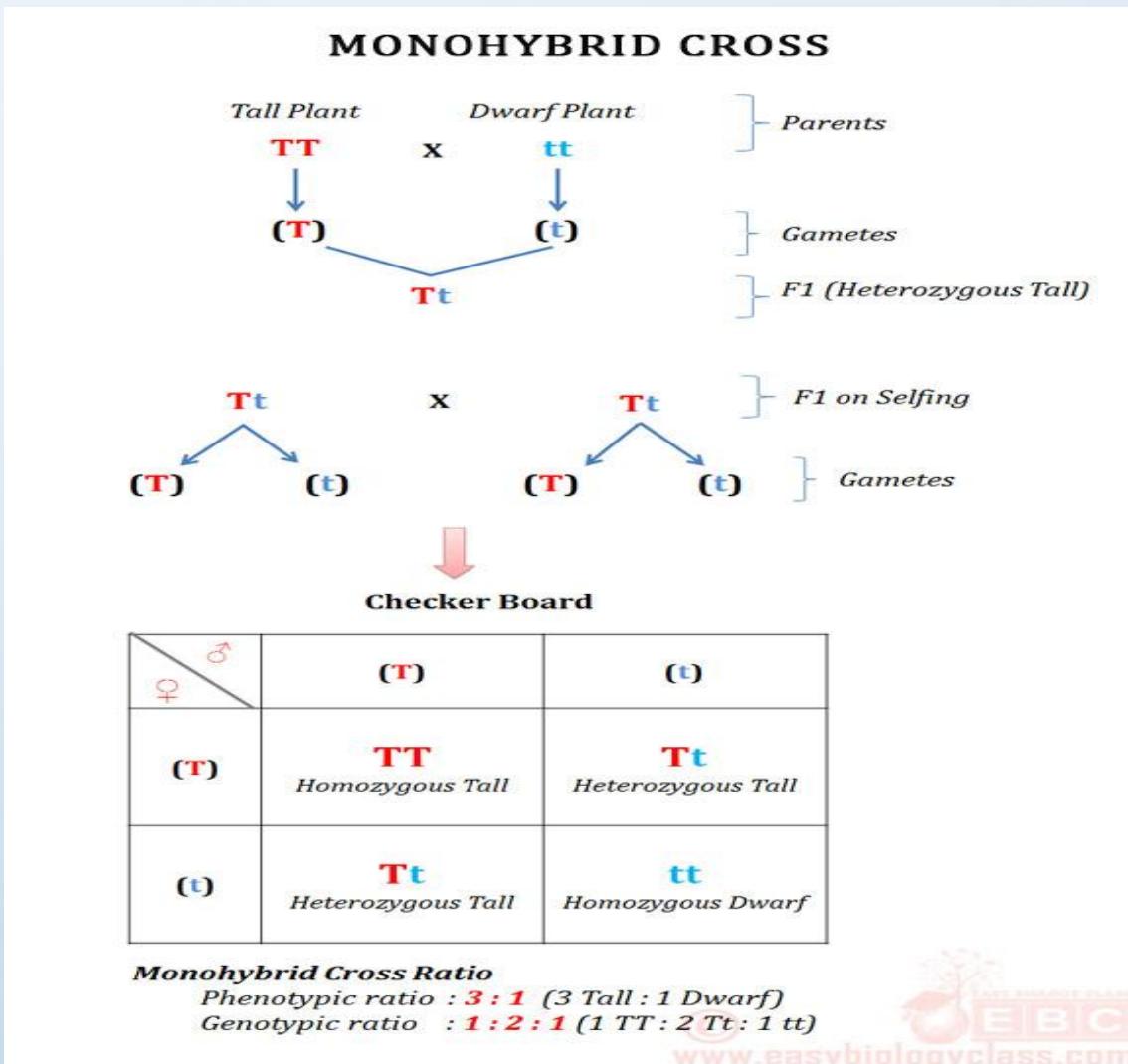


7 pair of characters

	Height	Seed Shape	Seed Color	Seed Coat Color	Pod Shape	Pod Color	Flower Position
Dominant	 Tall	 Round	 Yellow	 Green	 Inflated (full)	 Green	 Axial
Recessive Trait	 Short	 Wrinkled	 Green	 White	 Constricted (flat)	 Yellow	 Terminal



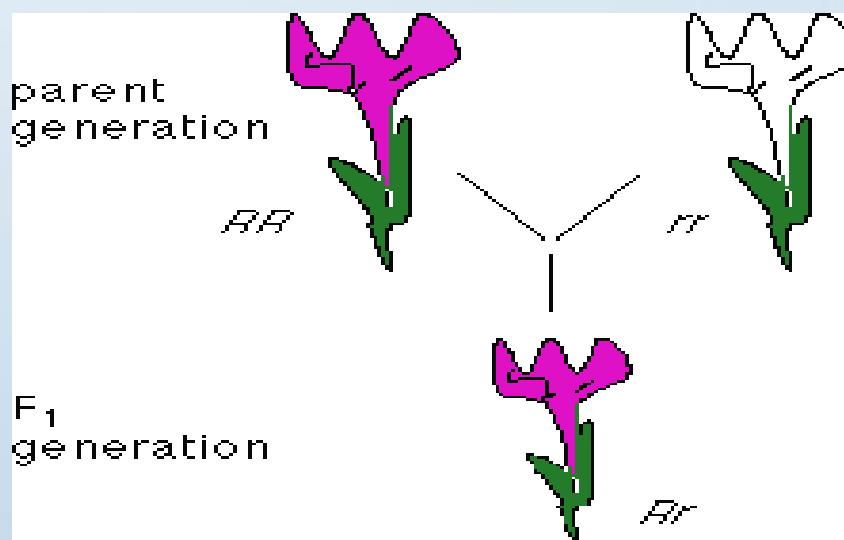
Monohybrid cross





Law of Dominance

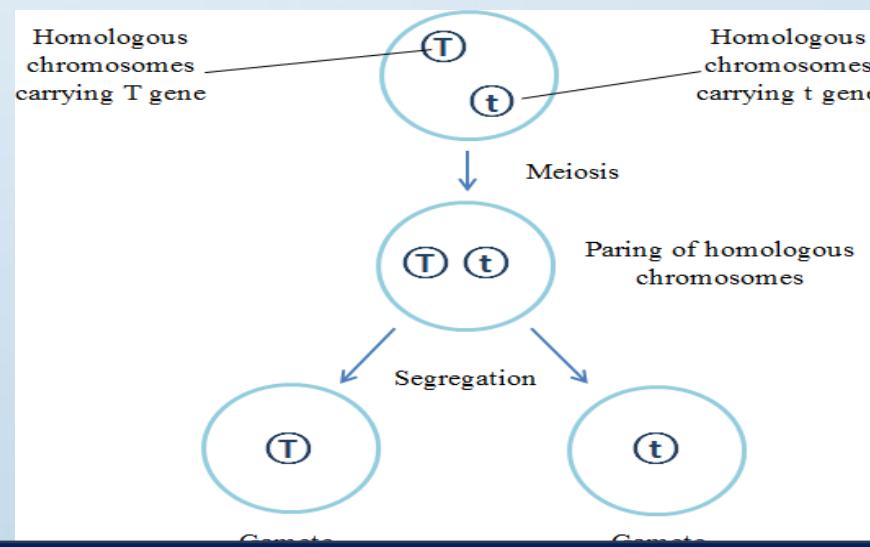
Law of Dominance- This law states that in a heterozygous condition, the allele whose characters are expressed over the other allele is called the dominant allele and the characters of this dominant allele are called dominant characters. The characters that appear in the F1 generation are called as dominant characters. The recessive characters appear in the F2 generation.





Law of Segregation

The Law of Segregation- This law states that when two traits come together in one hybrid pair, the two characters do not mix with each other and are independent of each other. Each gamete receives one of the two alleles during meiosis of the chromosome. Mendel's law of segregations supports the phenotypic ratio of 3:1 i.e the homozygous dominant and heterozygous offsprings show dominant traits while the homozygous recessive shows the recessive trait.

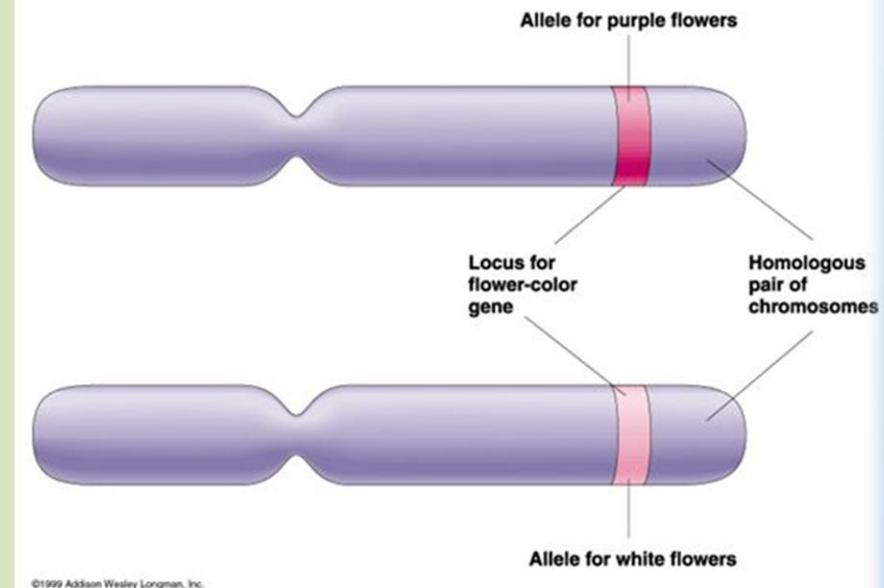




What is allele?

Alleles

- Most genes exist in many forms called alleles.
- **An allele is any of the alternative forms of a gene that may occur at a specific locus.**
 - our cells have two alleles for each gene, one from each parent.

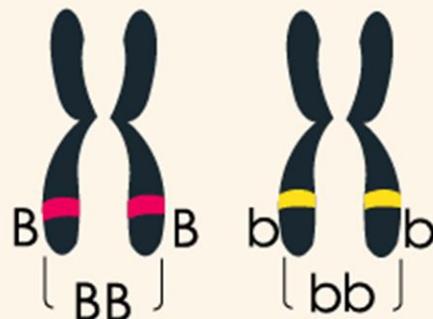


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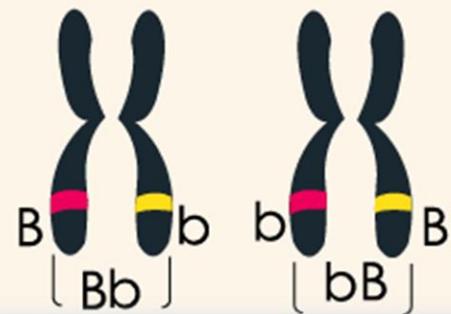
Homozygous vs Heterozygous

Homozygous VS Heterozygous



Homozygous

An Organism is said to be homozygous for a particular gene when identical alleles of the gene are present on both homologous chromosomes. The cell or organism in question is called a homozygote.



Heterozygous

A diploid organism is heterozygous at a gene locus when its cell contain two different alleles of a gene. The cell or organism is said to be a heterozygote.

Hemizygous

Definition:

Hemizygous refers to the condition in which an individual possesses only one allele of a gene in a diploid organism, typically because the gene is located on a sex chromosome where the second allele is absent.

For example, we can consider sex-linked Genes:

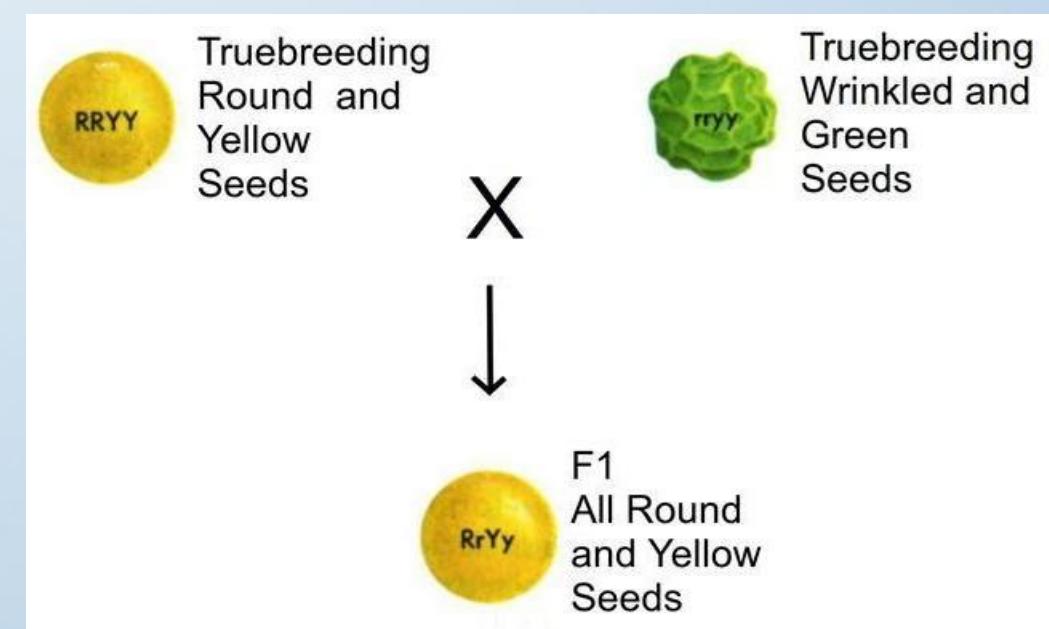
Males in species with XY sex determination (like humans) are hemizygous for genes on the X chromosome, as they only have one X chromosome.

Example: Males have only one allele for the gene causing hemophilia on the X.



Law of Independent Assortment

✓ **Law of independent assortment-** This means that at the time of gamete formation, the two genes segregate independently of each other as well as of other traits. Law of independent assortment emphasizes that there are separate genes for separate traits and characters and they influence and sort themselves independently of the other genes. This law also says that at the time of gamete and zygote formation, the genes are independently passed on from the parents to the offspring.





Incomplete Dominance & Co- Dominance

Codominance: Both equally expressed
Red flowers + White flowers =



Incomplete Dominance: alleles blend
Red flowers + White flowers =



Linkage

In genetics, linkage refers to the tendency of genes that are located close to each other on a chromosome to be inherited together. The closer the genes are, the less likely they are to be separated by recombination during meiosis.

- **Complete Linkage:** No recombination; genes are inherited together 100% of the time.
- **Incomplete Linkage:** Some recombination occurs; genes are inherited together most of the time, but recombination can produce new combinations of alleles.

Back cross

A back cross is the mating of an F1 hybrid (first-generation offspring of two genetically distinct parents) with one of its parental genotypes (either homozygous dominant or homozygous recessive). It helps to recover the parental traits in the offspring.

- Purpose:** To reinforce desired traits by reintroducing one parent's genetic material into the hybrid.
- Example:** If you cross a tall (TT) plant with a dwarf (tt) plant, producing an F1 hybrid (Tt), then crossing the F1 hybrid (Tt) with either the tall (TT) or dwarf (tt) parent is a back cross.

Test cross

A test cross involves mating an individual showing the dominant phenotype (but with an unknown genotype) with a homozygous recessive individual. This helps to determine the genotype of the individual with the dominant phenotype (whether it is homozygous dominant or heterozygous).

- Purpose:** To reveal the genotype of the dominant phenotype.
- Example:** If you have a tall plant (which could be TT or Tt) and you cross it with a dwarf plant (tt), the offspring phenotypes will help determine if the tall plant was homozygous (TT) or heterozygous (Tt). If all offspring are tall, the genotype was TT; if there is a mix of tall and dwarf, the genotype was Tt.

Epistasis

Epistasis refers to a genetic interaction where the expression of one gene (the epistatic gene) interferes with or suppresses the expression of another gene (the hypostatic gene) at a different locus. Essentially, one gene can "mask" the effect of another, altering the expected phenotypic ratios in offspring.

Key Points About Epistasis:

- **Non-allelic interaction:** Epistasis occurs between genes at different loci (not between alleles of the same gene).
- **Phenotypic expression:** The epistatic gene can suppress or modify the phenotypic effect of the hypostatic gene.

Pleiotropy

Pleiotropy is a phenomenon where a single gene influences multiple, seemingly unrelated phenotypic traits. In other words, one gene controls or affects more than one characteristic in an organism.

Key Features of Pleiotropy:

- 1. Single gene, multiple effects:** A single gene can affect various tissues, organs, or functions within the body.

- 2. Common in genetic disorders:** Many genetic diseases are examples of pleiotropy, where a mutation in a single gene leads to a range of symptoms that affect different parts of the body. Eg.- Marfan syndrome, Sickle cell anemia etc.

Some previous year questions from this chapter

1. Mendel's principles of inheritance are based on (BPSC Prelims 2011)

- a. Vegetative reproduction
- b. Asexual reproduction
- c. Sexual reproduction
- d. All of the above

Answer: c (Sexual reproduction)

Explanation: *Mendel performed his experiments on garden pea plants by cross-pollinating them to derive the principles of inheritance. Hence, sexual reproduction is correct answer.*

2. Colour blindness is a/an (Manipur PCS Preli 2005, CGPSC Preli 2012)

- a. Genetic disorder
- b. Metabolic disorder
- c. Infectious disease
- d. Contagious disease which can be corrected using proper power of spectacles

Answer: a (Genetic disorder)

Explanation: *Colour blindness is a genetic disorder. It is a X-chromosome linked recessive disorder.*

3. “Particulate theory of inheritance” was proposed by- (WBCS Prelims 2017)

- a. Charles Darwin
- b. Gregor Johann Mendel
- c. Herman Muller
- d. T. H. Morgan

Answer: c) Gregor Johann Mendel

Explanation: *Mendel proposed that traits are inherited as discrete units or “particles”, known as factors or genes, rather than blending. This theory contrasted with the blending theory, where offspring were thought to be a smooth mix of parental traits.*

4. If a colorblind man marries with normal woman, then the symptoms of color blindness is generated in - (WBCS Prelims 2009)

- a. Sons
- b. Daughters
- c. Sons of sons
- d. Sons of daughters

Answer: d (Sons of daughters)

Explanation: *If a colorblind man marries with normal woman, then the symptoms of color blindness are generated in sons of daughters, while daughters will not suffer from it. It is an X-linked homozygous recessive disorder. When a carrier female marries a man she can pass an X-affected chromosome to both daughter and sons. Daughter can be a carrier, but not affected and sons will be affected.*

5. A man of blood group A marries a woman of blood group AB, which type of progeny would indicate that a man is heterozygous? [WBCS Mains, 2019]

- a. O
- b. B
- c. A
- d. AB

Correct answer: b) B

Explanation: *If the father is heterozygous (AO) only, offspring having blood group B is a possibility.*

Some important book references

1. Encyclopedia of General Sciences by Arihant Publication
2. Encyclopedia of General Sciences by Disha Publication
3. NCERT Notes 6-12 by Arihant/Mcgrawhill Publication
4. Competitive Bigyan by Santra Publications (For Bengali Medium)
5. Class 9-10 Biology Text Book Bengali Version (Santra/Prantik)
6. WBCS General Studies Manual- Mcgrawhill (Good for other PSC Exams also)



Thank You

*In the next class, we will learn about the
concepts of Plant & Animal Tissues*