

NCERT Solutions for Class-XII Biology

Chapter -4

NCERT Biology Class 12

1. Mention the advantages of selecting pea plant for experiment by Mendel.
1. Mendel selected pea plants to carry out his study on the inheritance of characters from parents to offspring.

He selected a pea plant because of the following features.

- Peas have many visible contrasting characters such as tall/dwarf plants, round/wrinkled seeds, green/yellow pod, purple/white flowers, etc.
- Peas have bisexual flowers and therefore undergo self pollination easily.
Thus, pea plants produce offsprings with same traits generation after generation.
- In pea plants, cross pollination can be easily achieved by emasculation in which the stamen of the flower is removed without affecting the pistil.
- Pea plants have a short life span and produce many seeds in one generation.

2. Differentiate between the following:

- (a) Dominance and Recessive
- (b) Homozygous and Heterozygous
- (c) Monohybrid and Dihybrid.

2. (a) The differences between dominance and recessive are:

Dominance	Recessive
<ul style="list-style-type: none">• It is the phenomenon in which the dominant trait is phenotypically expressed by masking the recessive trait.• The dominant trait is phenotypically expressed in both homozygous and heterozygous conditions.• For example, a tall plant can have either homozygous (TT) or heterozygous (Tt) genotypes.	<ul style="list-style-type: none">• The trait which gets masked in the heterozygous condition by the dominant trait is known as the recessive trait.• The recessive trait is only expressed in homozygous condition.• For example, a dwarf plant can have only homozygous (tt) genotype.

- (b) The differences between homozygous and heterozygous are:

Homozygous	Heterozygous
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<ul style="list-style-type: none"> • The organism having two similar genes for a particular trait at the same loci in the homologous pair of chromosome. • They are genetically pure for that particular trait. • It is generally observed in inbred animals. • For example, tall plants with genotype TT or dwarf plant tt. 	<ul style="list-style-type: none"> • The organism having two dissimilar genes for a particular trait at the same loci in the homologous pair of chromosome. • They are genetically hybrid for that particular trait. • It is generally observed in cross-breeds. • For example, tall plants with genotype Tt.
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(c) The differences between monohybrid and dihybrid are:

Monohybrid	Dihybrid
<ul style="list-style-type: none"> • The cross between the two parents differing in one single pair of contrasting characters is known as a monohybrid cross. • For example, the cross between two pea plants, one tall and another dwarf with height being the only contrasting character. 	<ul style="list-style-type: none"> • The cross between two parents differing in two pairs of contrasting characters is known as a dihybrid cross. • For example, the cross between two pea plants, one with round and yellow seeds and the other with green and wrinkled seeds. Here seed colour and seed shape are the two contrasting characters.

3. A diploid organism is heterozygous for 4 loci, how many types of gametes can be produced?
3. If a diploid organism is heterozygous for 4 loci the different types of gametes that can be produced can be calculated by the formula 2^n , where “n” is the number of loci. Thus, $n = 4$, therefore the number of gametes produced are $2^n = 2^4 = 16$ types. Therefore a diploid organism is heterozygous for 4 loci produces 16 different types of gametes.
4. Explain the Law of Dominance using a monohybrid cross.
4. Mendel’s law of dominance states that a dominant allele expresses itself in a monohybrid cross and suppresses the expression of recessive allele. However, this recessive allele for

a character is not lost and remains hidden or masked in the progenies of F₁ generation and reappears in the next generation.

For example, when pea plants with round seeds (RR) are crossed with plants with wrinkled seeds (rr), all seeds in F₁ generation were found to be round (Rr). When these round seeds were self-fertilized, both the round and wrinkled seeds appeared in F₂ generation in 3: 1 ratio. Hence, in F₁ generation, the dominant character (round seeds) appeared and the recessive character (wrinkled seeds) got suppressed, which reappeared in F₂ generation.

CROSS: Homozygous tall (male) Homozygous dwarf (female)
 Parent: **TT** **tt** [Selfing]
 Gamete: **T** **t**

F₁ generation: **Tt** 100% tall plants (heterozygous)

Selfing of the F₁ generation plants

Parent: **Tt** **Tt**
 gamete: **T** **t** **T** **t**

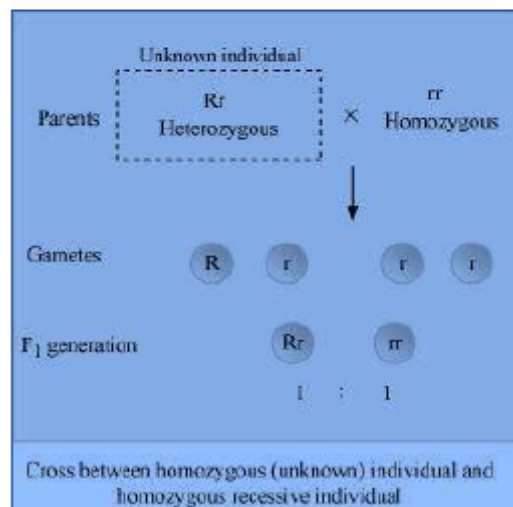
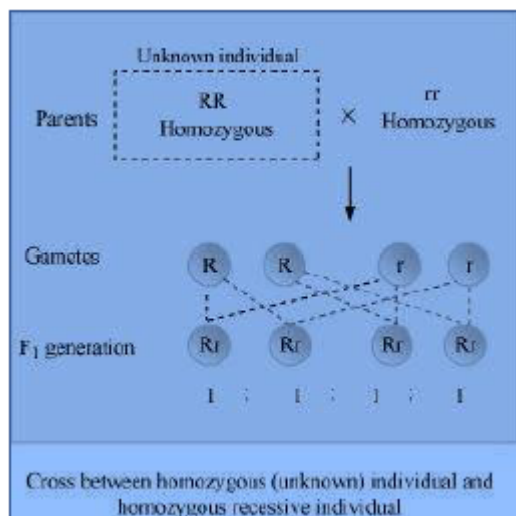
punette square:
 (crossing)

	T	t
T	TT	Tt
t	Tt	tt

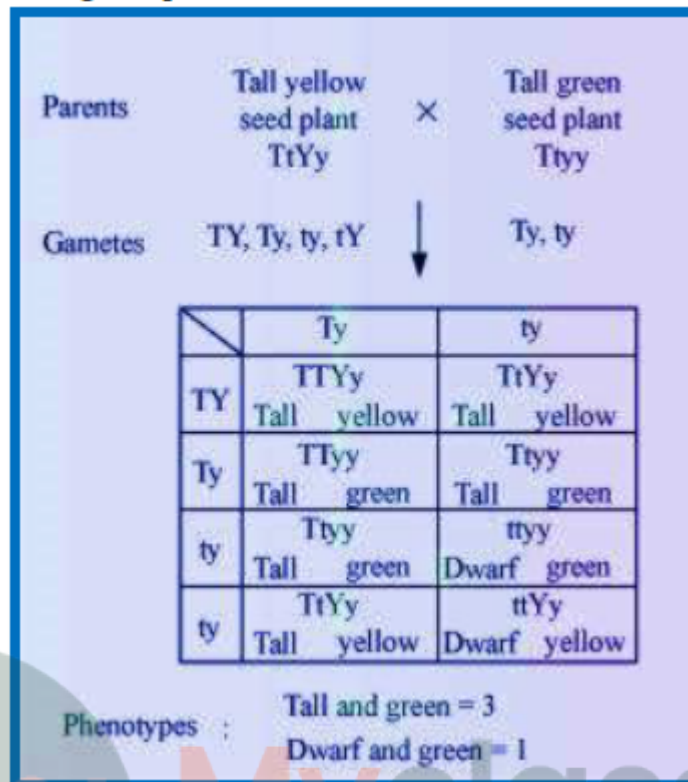
Phenotype: Tall (**T**) : Dwarf (**t**) = 3 : 1

Genotype: **TT** : **Tt** : **tt** = 1 : 2 : 1

- Define and design a test – cross?
- A test cross can be defined as the cross between the offsprings of any generation with its recessive parent so as to determine the composition of the offspring. The progenies of such a cross can be easily analysed to predict the genotype of the test organism.



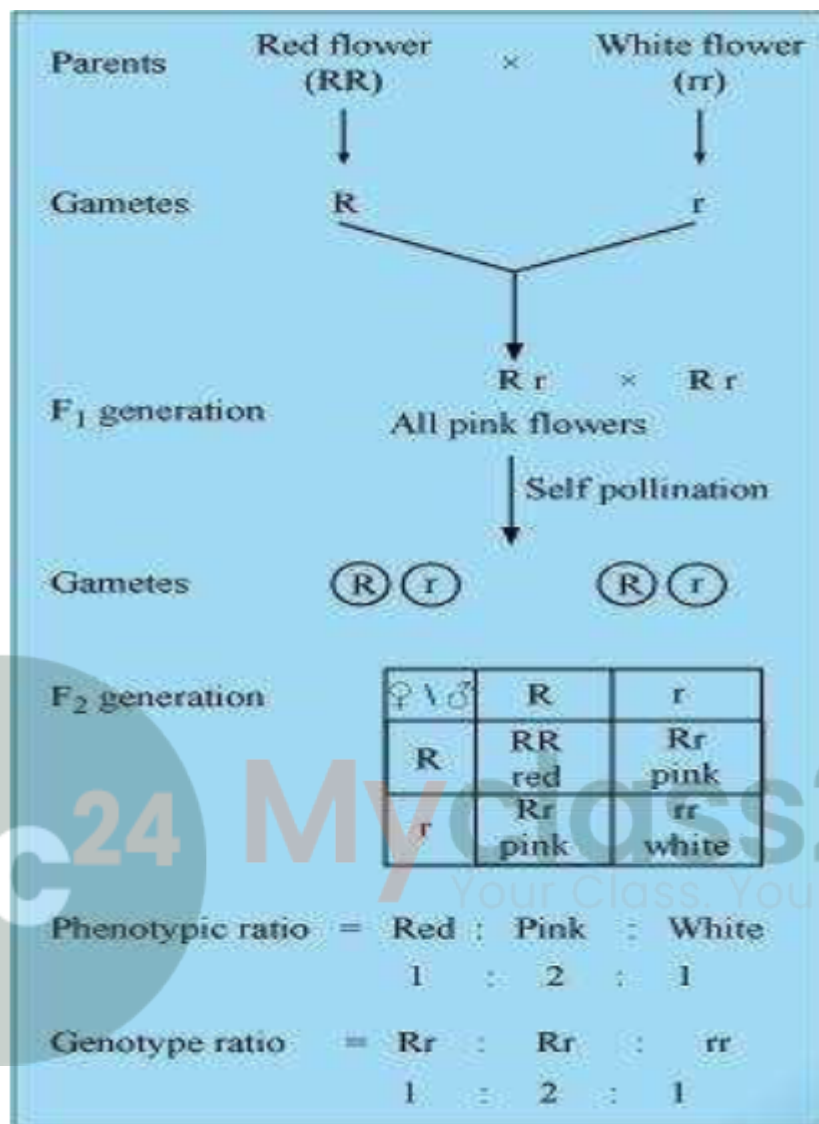
6. Using a Punnett square, work out the distribution of phenotypic features in the first filial generation after a cross between a homozygous female and a heterozygous male for a single locus.
6. In guinea pigs, heterozygous male with black coat colour (Bb) is crossed with the female having white coat colour (bb). The male will produce two types of gametes, B and b, while the female will produce only one kind of gamete, r. The genotypic and phenotypic ratio in the progenies of F₁ generation will be same i.e., 1:1.
7. When a cross is made between tall plants with yellow seeds (TtYy) and tall plant with green seed (TtYy), what proportions of phenotype in the offspring could be expected to be
 - (a) Tall and green.
 - (b) Dwarf and green.
7. If we design the cross between the tall plants with yellow seeds (TtYy) and tall plants with green seed (Ttyy) the proportion can be determined thus,



8. Two heterozygous parents are crossed. If the two loci are linked what would be the distribution of phenotypic features in F1 generation for a dihybrid cross?
8. If the two loci of characters are linked then the distance separating them will be very small and recombination will not be able to take place in between them. Thus no segregation can be observed. As the parent is heterozygous thus both dominant and recessive alleles are present on the two homozygous chromosomes and one chromosome is obtained by the gamete. Thus, in the F1 generation for a dihybrid cross, if this gamete contains the dominant traits and is fertilized by either dominant or recessive alleles of the same trait from the other parent the dominant phenotypic character are observed. The recessive linked phenotype of the traits are only observable only when the both the gametes from the parents that are fertilized contains the recessive trait. Also due to no segregation between the two linked traits, they are always found together in both the cases.
9. Briefly mention the contribution of T.H. Morgan in genetics.
9. Morgan's work is based on fruit flies (*Drosophila melanogaster*). He formulated the chromosomal theory of linkage. He defined linkage as the co-existence of two or more genes in the same chromosome and performed dihybrid crosses in *Drosophila* to show that linked genes are inherited together and are located on X-chromosome. His

experiments have also proved that tightly linked genes show very low recombination while loosely linked genes show higher recombination.

10. What is pedigree analysis? Suggest how such an analysis, can be useful.
10. Pedigree analysis is a record of occurrence of a trait in several generations of a family. It is based on the fact that certain characteristic features are heritable in a family, for example, eye colour, skin colour, hair form and colour, and other facial characteristics. Along with these features, there are other genetic disorders such as Mendelian disorders that are inherited in a family, generation after generation. Hence, by using pedigree analysis for the study of specific traits or disorders, generation after generation, it is possible to trace the pattern of inheritance. In this analysis, the inheritance of a trait is represented as a tree, called family tree. Genetic counselors use pedigree chart for analysis of various traits and diseases in a family and predict their inheritance patterns. It is useful in preventing hemophilia, sickle cell anemia, and other genetic disorders in the future generations.
11. How is sex determined in human beings?
11. Humans have 46 chromosomes thus they have 23 pairs of chromosomes. Of these 23 pairs 22 pairs are autosomes and the remaining 1 pair is the sex chromosome that determines the sex of the child. In humans sex chromosome is of two types X and Y. The genetic composition of females is 44+XX whereas males have a genetic composition of 44+XY. As humans are diploid organisms and during fertilization the child receives half of its chromosomes from one parent and the other half from another the diploid state is restored. Now, the gametes formed by the female is all 22+X where as males produce two types of gametes, 22+X and 22+Y. During fertilization if the female gamete with 22+X chromosome is fertilized by the sperm bearing 22+X chromosome the resulting zygote has the genetic composition as 44+XX thus giving rise to a female child. But, if the female gamete with 22+X chromosome is fertilized by the sperm bearing 22+Y chromosome the resulting zygote has the genetic composition as 44+XY thus giving rise to a male child. Thus the sex of the child is determined by the type of sperm that fertilizes the ovum and not the other way round.
12. A child has blood group O. If the father has blood group A and mother blood group B, work out the genotypes of the parents and the possible genotypes of the other offsprings.
12. If a child has blood group O it has the genotype of “ii” which is recessive to both blood group A (I^A) and blood group B (I^B). As we know recessive traits only occur in homozygous condition thus both the parents must have the recessive allele making them heterozygous for their blood group. Thus the following punnett square can determine the possible genotypes and phenotypes of the other offsprings.



14. What is point mutation? Give one example.
14. Point mutation is often caused by chemicals or malfunction of DNA replication where exchange of a single nucleotide occurs. For example, sickle cell anaemia where defect is caused by the substitution of a single amino acid Glutamic acid by Valine at the sixth position of the β globin chain of the haemoglobin molecule.
15. Who had proposed the chromosomal theory of inheritance?
15. Sutton and Boveri proposed the chromosomal theory of inheritance in 1902. They linked the inheritance of traits to the chromosomes.
16. Mention any two autosomal genetic disorders with their symptoms.

16. Sickle cell anaemia: This is an autosomal linked recessive trait that can be transmitted from parents to offsprings only when both the parents are the carrier for the gene governing the trait. Thus only homozygous recessive individuals show the diseased phenotype. This defect is caused by the substitution of the amino acid Glutamic acid by Valine at the sixth position of the β globin chain of the haemoglobin molecule.

Symptoms: The different symptoms of sickle cell anaemia are- rapid heart rate, breathlessness, weakness, excessive thirst, chest pain, prone to diseases such as jaundice, delayed growth and puberty and decreased fertility.

Down's Syndrome: It was first discovered and published in 1866 by a British physician John Langdon Brown. This is a trisomic condition of chromosome 21 where an extra copy of chromosome 21 is found. It is the result of asymmetrical division in meiosis of the parents.

Symptoms: They are characteristically short; have protruding, furrowed tongue; short and broad hands with fingers showing characteristic palm and fingerprint patterns. Physical psychomotor and mental development is retarded and poor muscle tone is characteristic. Children affected by Down's syndrome are prone to respiratory diseases and heart malfunctions and they show incidence of leukemia approximately 20 times higher than the normal population. Its estimated occurrence is approximately 1 in every 800 live births.

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