Chapter: Principle of Inheritance and Variations

Exercise questions

Question 1. Mention the advantages of selecting pea plants for the experiment by Mendel.

Answer: Mendel used pea plants to conduct his research on the transmission of traits from parents to offspring. Because of the following characteristics, he chose a pea plant.

- Tall/dwarf plants, round/wrinkled seeds, green/yellow pods, purple/white blooms, and so on are all observable differences in peas.
- Peas have bisexual flowers, which allows for easy self-pollination. As a result, pea plants generate children with the same characteristics from generation to generation.
- Emasculation, in which the stamen of the flower is removed without damaging the pistil, is a simple way to promote cross-pollination in pea plants.
- Pea plants live for a brief time and produce a large number of seeds in a single generation.
- Due to less time of life cycle, it provides more data to clarify things.
- Pea has observable traits like contrasting features that can be easily studied and explained.

Question 2. Differentiate between the following:

(a) Dominance and Recessive

(b) Homozygous and Heterozygous

(c) Monohybrid and Dihybrid

Answer:

a. Dominance and Recessive

	Dominance	Recessive
1	In the presence or absence of a recessive characteristic, a dominant factor or allele manifests itself.	Only in the absence of a dominant characteristic can a recessive trait be expressed.
2	A pea plant, for example, has dominant characteristics such as a tall plant, round seed, violet blossom, and so on.	Dwarf plants, wrinkled seeds, white blossoms, and so forth.

b. Homozygous and Heterozygous

	Homozygous	Heterozygous

1	It has two alleles that are similar to a specific trait.	For a given trait, it contains two distinct alleles.
2	Homozygous genotypes can have either dominant or recessive alleles, but never both. For instance, RR or rr.	Both dominant and recessive alleles exist in the heterozygous genotype. For instance, Rr

c. Monohybrid and Dihybrid

	Monohybrid	**Dihybrid**
1	Monohybrid refers to a cross between parents that differs only in one pair of opposing traits.	Dihybrid refers to a cross between parents with two sets of contrasting traits.
2	A monohybrid cross is, for example, a cross between tall and dwarf pea plants.	A dihybrid cross is, for example, a cross between pea plants with yellow wrinkled seeds and those with green spherical seeds.

Question 3. A diploid organism is heterozygous for 4 loci, how many types of gametes can be produced?

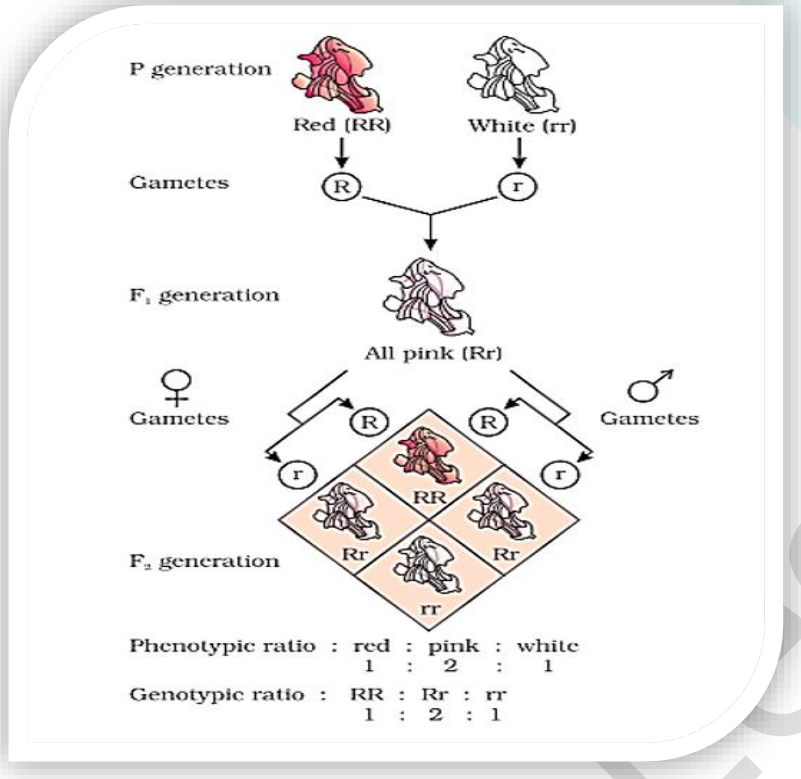
Answer: A locus is a fixed location on a chromosome where one or more genes reside. For each allelic pair, heterozygous organisms have various alleles. As a result, a diploid organism heterozygous at four loci will have four distinct opposing features at each locus. If an organism is heterozygous at four loci with four characteristics, such as Aa, Bb, Cc, and Dd, it will segregate into eight gametes during meiosis.

The diploid organism will create 16 distinct gametes if the genes are not connected. However, if the genes are connected, the number of gametes is reduced since the genes are linked and the linked genes are inherited jointly throughout the meiosis process.

Question 4. Explain the Law of Dominance using a monohybrid cross.

Answer: A dominant allele expresses itself in a monohybrid cross and suppresses the expression of a recessive allele, according to Mendel's law of dominance. This recessive allele for a feature, on the other hand, is not lost and remains concealed or disguised in the progenies of the F1 generation, reappearing in the next.

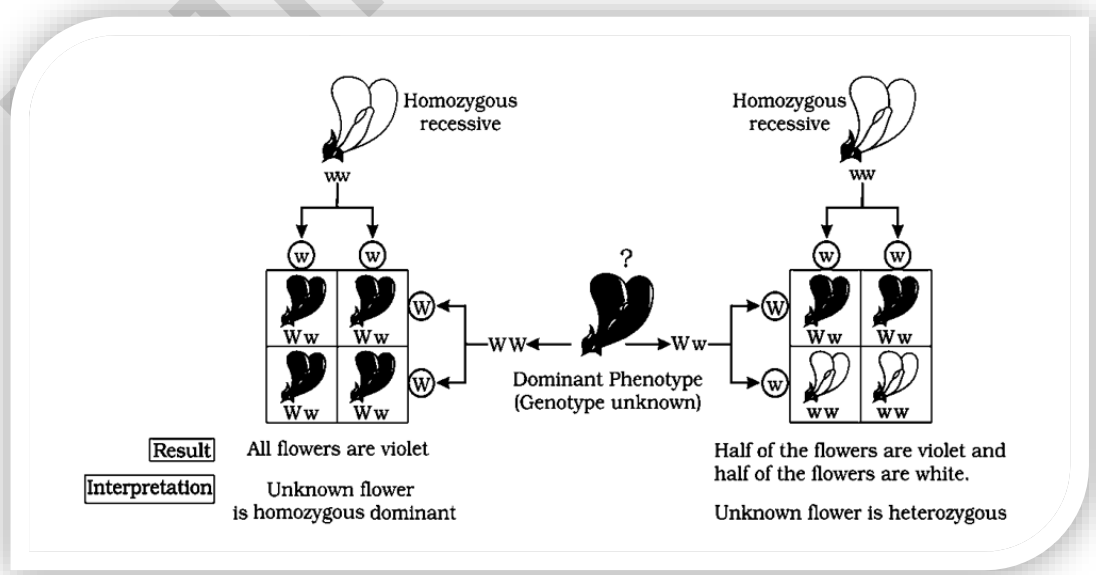
When round-seeded pea plants (RR) were crossed with wrinkled-seeded pea plants (rr), all seeds in the F1 generation were found to be round (Rr). When these round seeds were self-fertilized, a 3:1 ratio of round and wrinkled seeds developed in the F2 generation.



Question 5. Define and design a test − cross?

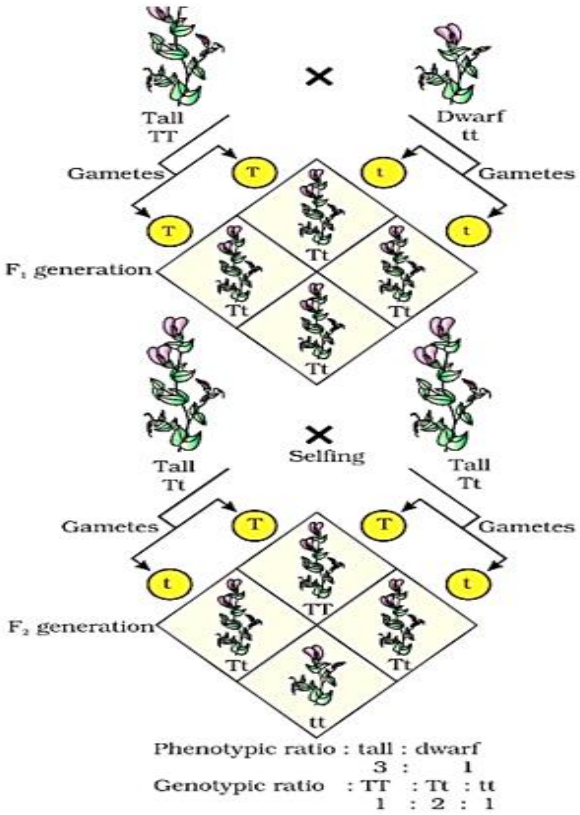
Answer: A test cross is a cross between a recessive parent and an organism with an unknown genotype. It's used to see if someone is homozygous or heterozygous for a particular trait.

If a test cross produces progenies with 50% dominant trait and 50% recessive trait, the unknown individual is heterozygous for that trait. If the progeny produced has a dominant trait, the unknown individual is homozygous for that trait.



Question 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.

Answer: A heterozygous male with a black coat color (Bb) is crossed with a female with a white coat color in guinea pigs (bb). The male will generate two types of gametes, B and b, whereas the female will only produce one type, r. In the progenies of the F1 generation, the genotypic and phenotypic ratios will be the same, i.e. 1:1.



Question 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.

Answer: A cross between a tall plant with yellow seeds and a tall plant with green seeds will yield

(a) Three tall and green plants, and

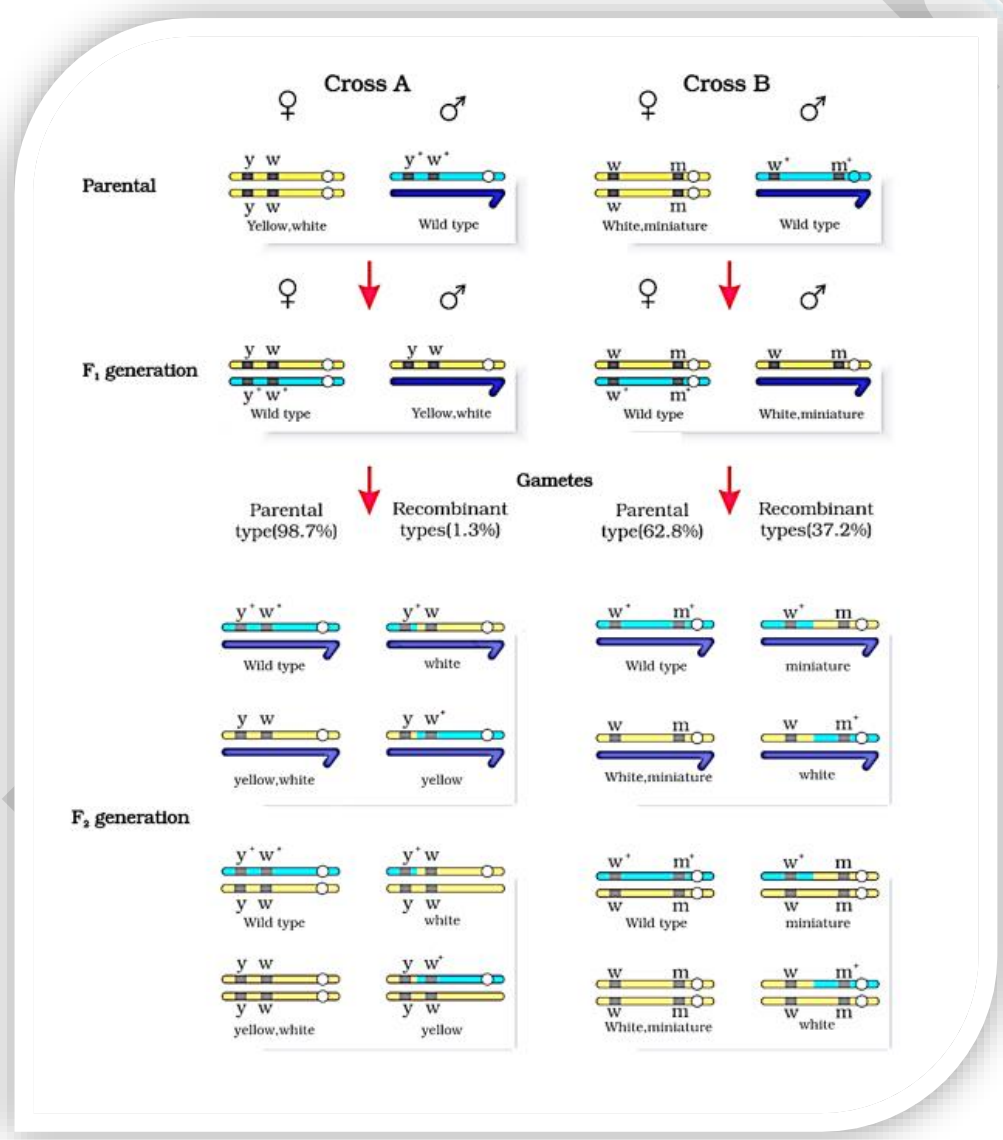
(b) One dwarf and green plant.

Question 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?

Answer: The coexistence of two or more genes on the same chromosome is known as linkage. If two genes are found on the same chromosome and are close to each other, they are considered to be related genes since they are inherited together.

In a Drosophila, for example, a cross between a yellow body and white eyes parent and a wild type parent will result in wild type and yellow-white progenies.

It's because the genes for yellow-bodied people and white-eyed people are related. As a result, they are inherited in progenies together.



Question 9. Briefly mention the contribution of T.H. Morgan in genetics.

Answer: Fruit flies are the inspiration for Morgan's work (Drosophila melanogaster). He proposed the chromosomal linkage theory. He defined linkage as the presence of two or more genes on the same chromosome and used Drosophila dihybrid crossings to show that linked genes are inherited together and are found on the X-chromosome. His tests also revealed that tightly coupled genes experience relatively little recombination, but loosely linked genes experience more.

Question 10. What is pedigree analysis? Suggest how such an analysis can be useful.

Answer: A record of the presence of a trait throughout numerous generations of a family is called pedigree analysis. It is predicated on the fact that some face characteristics, such as eye color, skin color, hair shape and color, and other facial characteristics, are heritable in a family. Along with these characteristics, there are additional genetic illnesses, such as Mendelian disorders that are passed down the generations. As a result, by utilising the pedigree analysis to analyse certain features or problems generation after generation the pattern of inheritance can be traced. The inheritance of a trait is represented as a tree in this study which is referred to as a family tree.

Question 11. How is sex determined in human beings?

Answer: Male heterogamy is a trait found in humans. Males (XY) create two different types of gametes in humans: X and Y. The human female (XX) only generates one sort of X-chromosome-containing gametes. The sort of male gamete that unites with the female gamete determines the baby's sex.

If the fertilising sperm includes the X chromosome, the resulting baby will be a girl, and if the fertilising sperm contains the Y chromosome, the resulting baby will be a boy. As a result, a baby's sex is determined solely by chance. There's a 50/50 chance that the fertilising sperm has an X or Y chromosome. As a result, the sex of the newborn is determined by the genetic makeup of the sperm.

Question 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 offspring.

Answer: Three sets of alleles, notably I^A, I^B, and i govern the blood group characteristic in humans. I^A and I^B are both dominant alleles, however allele i is recessive to the other alleles. Individuals with genotypes $I^A I^A$ and I^A I belong to blood group A, whereas those with genotypes $I^B I^B$ and i I^Bbelong to blood group B. Blood group AB belongs to people with genotype $I^A I^B$, while blood group O belongs to people with genotype ii.

Thus father has A blood group and mother has blood group B then the possible genotype of the parents will be Father Mother.

Homozygous parents if A crossed then progeny with AB blood group produce.

Question 13. Explain the following terms with example

(a) Codominance

(b) Incomplete dominance

Answer:

Answer:

(a) Codominance- The phenomenon of codominance occurs when both alleles of a contrasting character are exhibited in a heterozygous state. Both alleles of a gene are present and equally powerful. In humans, the ABO blood group is an example of codominance. Three sets of alleles control the blood group personality. Specifically, IA and IB, and i. IA and IB are alleles. Because they are expressed in the AB blood type, they are considered to be codominant. Both of these alleles create their own antigens and do not interfere with each other's expression. As a result, co-dominance can be seen in the AB blood type.

(b) Incomplete dominance- For a character, imperfect dominance occurs when one allele has incomplete dominance over the other member of the allelic pair. For example, in the Antirrhinum species, a monohybrid cross between plants with red flowers and plants with white flowers will result in all pink flower plants in the F1 generation. The F1 generation progeny bears no resemblance to either of the parents and has intermediate traits. This is due to the partial dominance of the dominant allele, R, over the other allele, r. As a result, the recessive allele, r, is expressed in the F1 generation, resulting in intermediate pink blooming progenies with the Rr genotype.

Question 14. What is point mutation? Give one example.

Answer: A point mutation occurs when a single nitrogenous nucleotide is substituted, deleted, or inserted in a single base pair of DNA. Sickle cell anemia is an example of a point mutation. Sickle cell anemia is a disorder caused due to change in the shape of red blood cells. In this disease, RBCs become sickle-shaped instead of being biconcave due to which there occurs a reduction in the supply of oxygen throughout the body. A single point mutation in the beta hemoglobin gene causes it. As a result, the GAG codon is converted to GUG on mRNA, which encodes the amino acid valine instead of glutamic acid.

Question 15. Who had proposed the chromosomal theory of inheritance?

Answer: The chromosomal hypothesis of inheritance was presented by Sutton and Boveri in 1902.They discovered a relationship between chromosomes and the inheritance of traits.

Question 16. Mention any two autosomal genetic disorders with their symptoms.

Answer: The following are two autosomal genetic illnesses.

Sickle cell anemia-Anemic disorder affecting many humans.It's an autosomal recessive condition caused by a point mutation in the beta-globin chain of the blood's hemoglobin pigment. Sickle-shaped red blood cells characterize the disorder, which are caused by a mutated hemoglobin molecule. The HbA and HbS alleles are in charge of controlling the disease. Homozygous individuals with the genotype HbS HbS exhibit illness symptoms, but heterozygous persons with the genotype HbA HbS are unaffected. They do, however, serve as carriers of the disease.

Symptoms - The main symptoms of sickle cell anemia disease are rapid heart rate, dyspnea, delayed growth and puberty, jaundice, weakness, fever, excessive thirst, chest pain, and impaired fertility.

Down's syndrome- The trisomy of chromosome 21 is the cause of this inherited condition.

Symptoms - With a round head, open mouth, projecting tongue, short neck, slanting eyes, and broad short hands, the individual is small in stature. The person's mental and physical development is also slowed.Down’s syndrome is caused by trisomy(2n+1) in the 21st chromosome.There is an extra copy of chromosome number 21.Trisomy is caused by nondisjunction during oogenesis. Nondisjunction is the failure of the disjoining process, where both chromatids move to one pole, and none moves to the other pole during meiosis.