Principles of Inheritance and Variations

NCERT Exemplar Solutions

Multiple Choice Questions (MCQs)

1. All genes located on the same chromosome

(a) form different groups depending upon their relative distance

(b) form one linkage group

(c) will not form any linkage group

(d) form interactive groups that affect the phenotype

Ans: (b) form one linkage group

2.Conditions of a karyotype 2n ± 1 and 2n ± 2 are called

(a) aneuploidy

(b) polyploidy

(c) allopolyploidy

(d) monosomy

Ans: (a) Aneuploidy

3. Distance between the genes and percentage of recombination shows

(a) a direct relationship

(b) an inverse relationship

(c) a parallel relationship

(d) no relationship

Ans: (a) a direct relationship

4. If a genetic disease is transferred from a phenotypically normal but carrier female to only some of the male progeny, the disease is

(a) autosomal dominant

(b) autosomal recessive

(c) sex-linked dominant

(d) sex-linked recessive

Ans: (d) sex-linked recessive.

5. In sickle-cell anaemia glutamic acid is replaced by valine. Which one of the following triplet codes for valine?

(a) GGG

(b) AAG
(c) GAA
(d) GUG
Ans: (d) GUG

6. Person having genotype I^aI^b would show the blood group as AB. This is because of
(a) pleiotropy
(b) codominance
(c) segregation
(d) incomplete dominance
Ans: (b) codominance.

7. ZZ/ZW type of sex determination is seen in
(a) platypus
(b) snails
(c) cockroach
(d) peacock
Ans: (d) peacock

8. A cross between two tall plants resulted in offspring having few dwarf plants. What would be the genotypes of both the parents?
(a) TT and Tt
(b) Tt and Tt
(c) TT and TT
(d) Tt and tt
Ans: (b) Tt and Tt

9. In a dihybrid cross, if you get 9: 3: 3: 1 ratio it denotes that
(a) The alleles of two genes are interacting with each other
(b) It is a multigenic inheritance
(c) It is a case of multiple allelism
(d) The alleles of two genes are segregating independently
Ans: (d) The alleles of two genes are segregating independently.

10. Which of the following will not result in variations among siblings?

(a) Independent assortment of genes
(b) Crossing over
(c) Linkage
(d) Mutation
Ans: (c) Linkage

11. Mendel's law of independent assortment holds good for genes situated on the
(a) non-homologous chromosomes
(b) homologous chromosomes
(c) extra nuclear genetic element
(d) same chromosome
Ans: (a) Non-homologous Chromosomes

12. Occasionally, a single gene may express more than one effect. The phenomenon is called
(a) multiple allelism
(b) mosaicism
(c) pleiotropy
(d) polygeny
Ans: (c) pleiotropy.

13. In a certain taxon of insects some have 17 chromosomes and the others have 18 chromosomes. The 17 and 18 chromosome-bearing organisms are
(a) males and females, respectively
(b) females and males, respectively
(c) all males
(d) all females
Ans: (a) males and females, respectively

14. The inheritance pattern of a gene over generations among humans is studied by the pedigree analysis. Character studied in the pedigree analysis is equivalent to
(a) quantitative trait
(b) Mendelian trait
(c) polygenic trait

(d) maternal trait
Ans: (b) Mendelian trait

15. It is said that Mendel proposed that the factor controlling any character is discrete and independent. This proposition was based on the
(a) Results of F3 generation of a cross
(b) observations that the offspring of a cross made between the plants having two contrasting characters show only one character without any blending
(c) self-pollination of F1 offsprings
(d) cross-pollination of F1 generation with recessive parent
Ans: (b) observations that the offspring of a cross made between the plants having two contrasting characters show only one character without any blending

16. Two genes, 'A' and 'B' are linked. In a dihybrid cross involving these two genes, the F1 heterozygote is crossed with homozygous recessive parental type (aa bb). What would be the ratio of offspring in the next generation?
(a) 1: 1: 1: 1
(b) 9: 3: 3: 1
(c) 3: 1
(d) 1: 1
Ans: (a) 1: 1: 1: 1

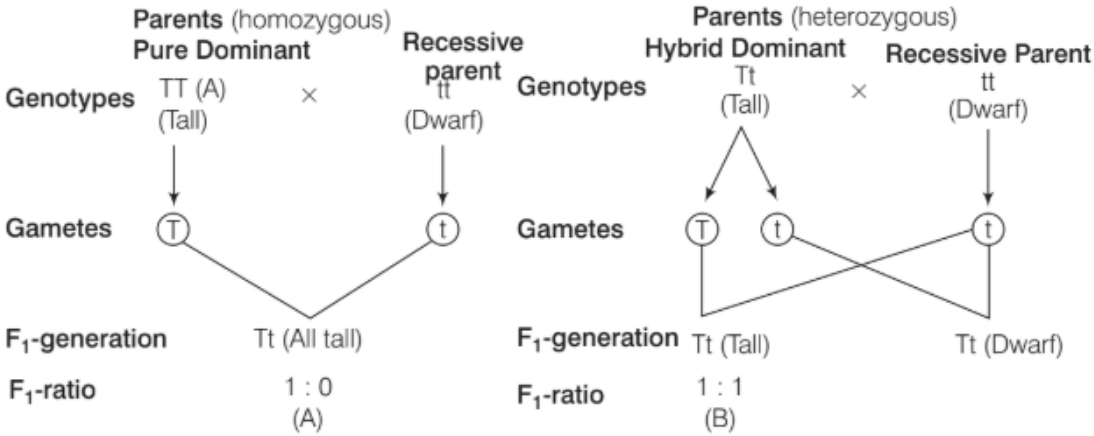
17. In the F2-generation of a Mendelian dihybrid cross the number of phenotypes and genotypes are
(a) phenotypes-4, genotypes-16
(b) phenotypes-9, genotypes-4
(c) phenotypes-4, genotypes-8
(d) phenotypes-4, genotypes-9
Ans: (d) phenotypes-4, genotypes-9

18. Mother and father of a person with 'O' blood group have 'A' and 'B' blood group respectively. What would be the genotype of both mother and father?
(a) Mother is homozygous for 'A' blood group, and father is heterozygous for 'B'
(b) Mother is heterozygous for 'A' blood group, and father is homozygous for 'B'
(c) Both mother and father are heterozygous for 'A' and 'B' blood group,

respectively
(d) Both mother and father are homozygous for 'A' and 'B' blood group, respectively
Ans: (c) Both mother and father are heterozygous for 'A' and 'B' blood group, respectively

Very Short Answer Type Questions

1. What is the cross between the progeny of F1 and the homozygous recessive parent called? How is it useful?
Ans: When a progeny of F1 is crossed with the homozygous recessive parent, it is called a test cross.
Test cross between pure dominant (A) and hybrid dominant (B) individuals with recessive parent is shown below



Such a cross is useful to determine the genotype of an unknown trait, i.e., whether it is heterozygous or homozygous dominant for the trait.

2. Do you think Mendel's Laws of inheritance would have been different in the characters that he chose were located on the same chromosome?
Ans: If the characters are present on the same chromosome, they would not assort independently as they are linked on the same chromosome. The percentage of linkage depends on the distance between the genes. With linkage, no conclusive laws can be drawn.

3. Enlist the steps of controlled cross-pollination. Would emasculation be needed in a cucurbit plant? Give reasons for your answer.

Ans: Steps of controlled cross-pollination are

- (i) Selection of parents with desired characters.
- (ii) Emasculation, i.e., if the female parent bears bisexual flowers, before dehiscence, the anther should be removed by forceps.
- (iii) Bagging, i.e., emasculated flowers have to be covered with a bag of suitable size, generally made up of butter paper, to prevent contamination of their stigma with unwanted pollen.
- (iv) When the stigma of the bagged flower attains receptivity, mature pollen grains collected from the anthers of the male parent are dusted on the stigma
- (v) The flowers are rebagged, and the fruits are allowed to develop.

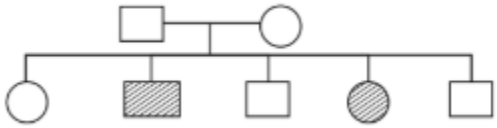
Emasculation is not always needed in a cucurbit plant. Emasculation is essential only in the case of bisexual flowers to prevent self-pollination. In the case of the cucurbit plant, the female parent usually produces unisexual flowers but may sometimes have bisexual flowers.

4. A person has to perform crosses for the purpose of studying inheritance of a few traits/characters. What should be the criteria for selecting the organisms?

Ans: The criteria for selecting the organism to study inheritance are

- (i) Easily visible and different traits
- (ii) Short life span
- (iii) Simple pollination procedure
- (iv) Organisms must be true breeds
- (v) Mating of gametes has to be random
- (vi) Can be easily manipulated

5. The pedigree chart given below shows a particular trait which is absent in parents but present in the next generation irrespective of sexes. Draw your conclusion on the basis of the pedigree.



Ans: The pedigree chart shows that the trait is autosomally linked and recessive in nature. But the parents are carriers (i.e., heterozygous), hence, among the

offspring, only a few show the trait irrespective of sex. The other offspring are either normal or carriers.

6. In order to obtain the F1-generation Mendel pollinated a pure-breeding tall plant with a pure-breeding dwarf plant. But for getting the F2-generation, he simply self-pollinated the tall F1 plants. Why?
Ans: Characters segregate during gamete formation. Pure-breeding parents give rise to an F1 with heterozygous conditions. Only self-pollination of heterozygotes can result in all possible recombinations of characters in progeny, as mating is random.

7.'Genes contain the information that is required to express a particular trait.' Explain.
Ans: Genes contain the information required to express a particular trait can be explained by the following experiment.
G Beadle and E Tatum experimented to prove that one gene possesses a particular trait and is responsible for the production of one enzyme or protein. They performed their experiment on Neurospora crassa, which was nutritionally mutant.
It was proved that a single protein contains several polypeptides, and each polypeptide is controlled by a separate gene. Thus, each gene expresses a particular trait. This theory was called the one-gene-one enzyme or one gene-one polypeptide hypothesis.
But after the discovery of the cistron (the functional unit of a gene), the theory was named as one-cistron-one polypeptide hypothesis.

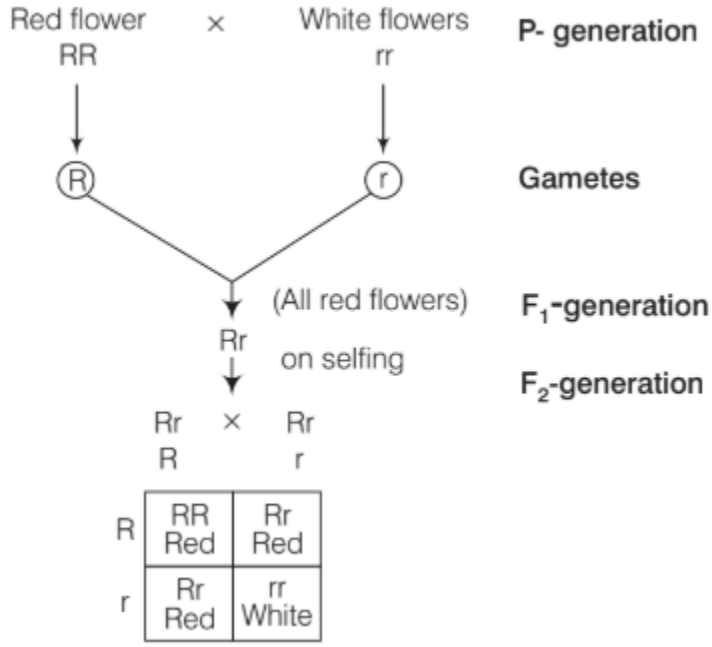
8. How are alleles of particular gene differ from each other? Explain its significance.
Ans: Alleles are polymorphs that differ in their nucleotide sequence, resulting in contrasting phenotype expression. Alleles are the alternative forms of the same gene, e.g., genes for height have two alleles, one for dwarfness (t) and one for tallness (T).
Significance

- (i) A character may have two or more contrasting phenotypic expressions, thus resulting in variation in the population.
- (ii) These are used in the studies of inheritance and in understanding their

behaviour.

9. In a monohybrid cross of plants with red and white flowered plants. Mendel got only red-flowered plants. On self-pollinating, these F1 plants got both red and white flowered plants in 3:1 ratio. Explain the basis of using RR and rr symbols to represent the genotype of plants of parental generation.

Ans:



Phenotypic ratio Red flower: White flower 3: 1

Genotype ratio RR: Rr: rr 1: 2: 1

Generally, upper-case letters are used as symbols for dominant and lower-case letters for recessive traits of the same gene (alleles). The experiment shows that it is a monohybrid cross with 3: 1 ratio in the F2 generation.

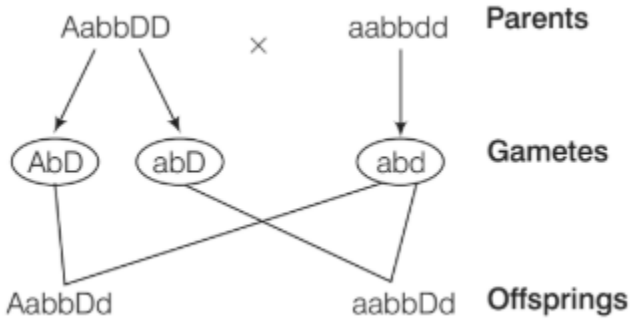
This shows parents must be true-breeds. As parents are diploid and homologous chromosomes carry alleles of similar type, they are represented with RR and rr.

10. For the expression of traits genes provide only the potentiality, and the environment provides the opportunity. Comment on the veracity of the statement.

Ans: Obviously, genes are not the only factors that determine phenotype. The

environment also plays an important role in the expression of traits. Genes are actually quite active throughout our lives, switching their expression on and off in response to the environment.
Besides the effect of internal factors like hormones and metabolism on gene expression, external factors like temperature, light, nutrition, etc., also affect gene expression and ultimately exhibit phenotypic changes.
So, we can say that genes provide only the potentiality, and the environment provides the opportunity for the expression of traits.

11. A, B, D are three independently assorting genes with their recessive alleles a, b, d, respectively. A cross was made between individuals of Aa bb DD genotype with aa bb dd. Find out the type of genotypes of the offspring produced.
Ans: The given cross AabbDD X aabbdd is a trihybrid cross. Accordingly, the type of offspring produced would be,



12. In our society a woman is often blamed for not bearing male child. Do you think it is right? Justify.
Ans: It is unfortunate that in our society, women are blamed for giving birth to female children and have been ostracised and ill-treated because of this false notion. Out of 23 pairs of chromosomes present, 22 pairs are exactly the same in both males and females; these are the autosomes.
A pair of X chromosomes is present in the female, whereas the presence of an X and Y chromosome is determinant of the male characteristic. During spermatogenesis in males, two types of gametes are produced.
50 per cent of the total sperm produced carry the X chromosome, and the rest 50% have the Y chromosome, besides the autosomes. Females, however, produce

only one type of ovum with an X chromosome. There is an equal probability of fertilisation of the ovum with the sperm carrying either the X or Y chromosome. In case the ovum is fertilised by a sperm carrying an X chromosome, the zygote develops into a female (XX) and the fertilisation of the ovum with Y-chromosome carrying sperm results in a male offspring. Thus, it is evident that it is the genetic makeup of the sperm (male) that determines the sex of the child. It is also evident that in each pregnancy there is always a 50% probability of having either a male or a female child.

13. Discuss the genetic basis of wrinkled phenotype of pea seed.

Ans: Seed shape is determined by a single gene, with the allele (R) for round peas dominant over the allele (r) for wrinkled peas (recessive trait).

If the alleles for the gene controlling the seed shape are homozygous in a plant, it will show the character or phenotype of the same alleles, i.e.,-RR- round seed, rr-wrinkled seed.

On the other hand, if the alleles of the gene are heterozygous. They will express the phenotype of the dominant allele.

Rr - Round seed (r- wrinkled is recessive)

This is the genetic basis of the wrinkled phenotype of pea seed.

14. Even if a character shows multiple allelism, an individual will only have two alleles for that character. Why?

Ans: Multiple alleles are the multiple forms of a gene which occur on the same gene locus, but are distributed in different organisms in the gene pool, with an organism which carries only two alleles, and the gamete has only one allele. Despite multiple allelism, an individual will have only two alleles because an individual develops from a zygote, which is the result of the fusion of sperm (carrying the father's set of n haploid chromosomes and an egg (carrying the mother's set of haploid chromosomes).

Sperm and an egg have only one gene (allele) for each trait. A zygote that becomes diploid has two alleles for each trait. It is the maximum number of alleles an individual can have. e.g., genes of blood groups.

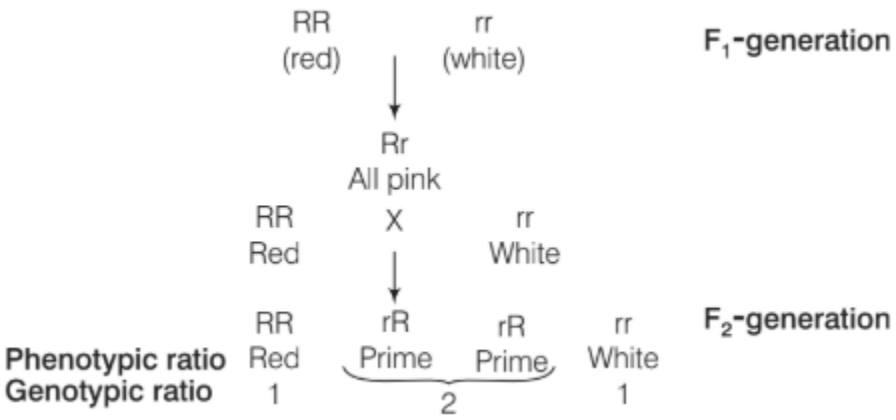
15. How does a mutagen induce mutation? Explain with example.

Ans: Mutagens may be physical, i.e., ionising radiations, X-ray, UV rays, gamma rays, DNA reactive chemicals, i.e., hydroxyl radicals, H_2O_2, etc., or biological,

such as a virus.
A mutagen can induce mutation by inducing a change in the base sequence by insertion, deletion or substitution. e.g., a single base sequence substitution at the sixth codon of the β-globin gene changes the codon from GAG to GUG. This results in the substitution of glutamic acid (Glu) by valine (Val) at the sixth position of the β-globin chain of the haemoglobin molecule. The mutant haemoglobin molecule undergoes polymerisation under low oxygen tension, causing a change in the shape of the RBC from biconcave disc to the elongated sickle, or a structure which is not functional.

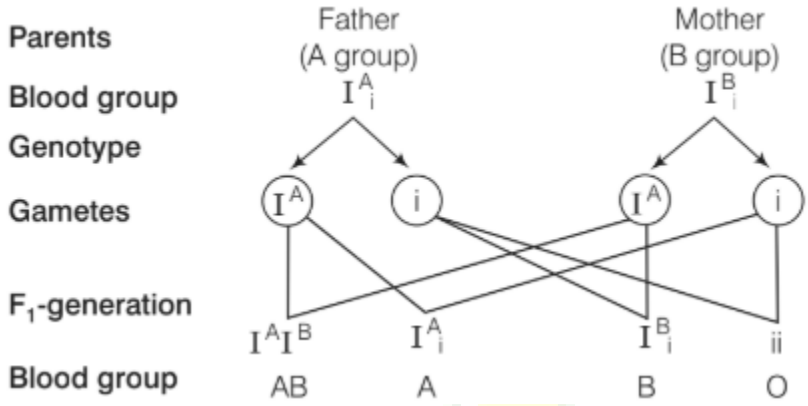
Short Answer Type Questions

1. In a Mendelian monohybrid cross, the F2-generation shows identical genotypic and phenotypic ratios. What does it tell us about the nature of alleles involved? Justify your answer.
Ans: In case of incomplete dominance, a monohybrid cross shows the result as follows



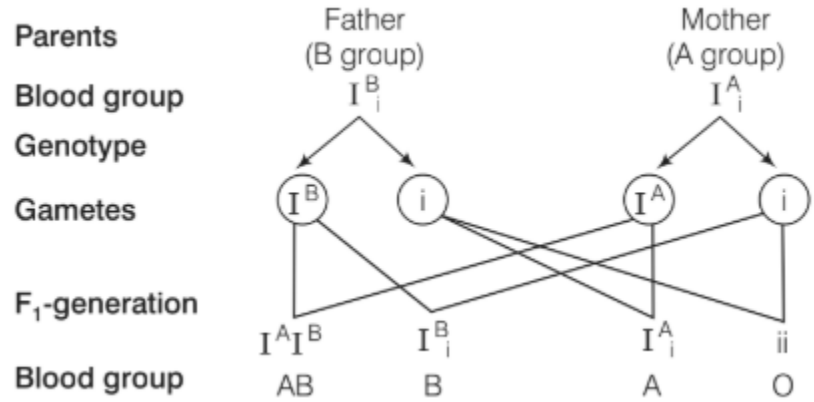
Here, both the phenotypic and genotypic ratios are the same. So, we can conclude that when genotypic and phenotypic ratios are the same, alleles show incomplete dominance. i.e., neither of the two alleles shows dominance, thus producing a hybrid intermediate from the expression of two homozygous alleles.

2. Can a child have blood group 'O' if his parents have blood group 'A' and 'B'. Explain.
Ans: A child has blood group O in the following two cases
Case I: When father is I^Ai and mother is I^Bi.



The offspring will have the above possible blood groups. i.e., AB, A, B and O.

Case II: When the father is I^Bi and the mother is I^Ai.



The offspring will have the above possible blood groups, i.e., AB, A, B and O. Thus, a child can have blood group 'O' if parents have heterozygous alleles for group 'A' and 'B'.

3. What is Down's syndrome? Give its symptoms and cause. Why is it that the chances of having a child with Down's syndrome increase if the age of the mother exceeds forty years?

Ans: Down syndrome is a human genetic disorder caused due to trisomy of chromosome number 21. Such individuals are aneuploid and have 41 chromosomes, i.e., (2n+1). Symptoms of Down syndrome are

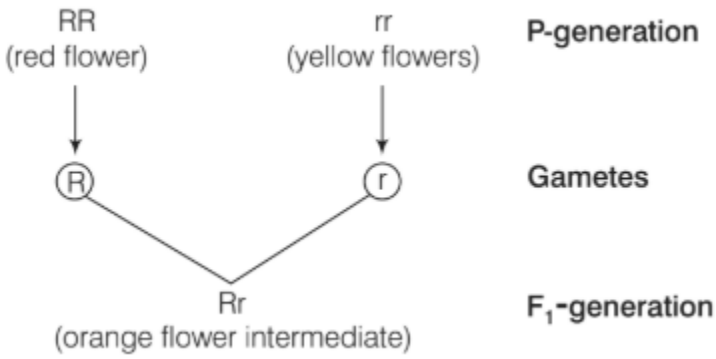
- (i) Mental retardation
- (ii) Growth abnormalities
- (iii) Constantly open the mouth

- (iv) Dwarfness, etc., gonads and genitalia underdeveloped

The reason for the disorder is the non-disjunction (failure to separate) of the homologous chromosome (pair 21 during meiotic division. The chances of having a child with Down's syndrome increase with the age of the mother (+40) because age adversely affects meiotic chromosome behaviour.
Meiosis in the egg cells is not completed until after fertilisation. During this long gap (till meiosis is completed), egg cells are arrested in prophase I and chromosomes are unpaired. The greater the time they remain unpaired greater the chance for unpairing and chromosome non-disjunction.

4. How was it concluded that genes are located on chromosomes?
Ans: Chromosome theory of inheritance was proposed by Sutton and Boveri independently in 1902. The theory believes that chromosomes are vehicles of hereditary information, possess Mendelian factors or genes, and it is the chromosomes which segregate and assort independently during transmission from one generation to the next.

5. A plant with red flowers was crossed with another plant with yellow flowers. If F1 showed all flowers orange in colour, explain the inheritance.
Ans: Incomplete dominance is the phenomenon where neither of the two alleles shows dominance, thus producing an intermediate hybrid between the expression of two alleles in a homozygous state. In this case, a new phenotype between the two original phenotypes appears.



6. What are the characteristic features of a true-breeding line?

Ans: True breeding is a stable trait inherited and expressed for several generations as a result of continuous self-pollination.

Characteristic features of a true-breeding line

- (i) They are used as parents in artificial hybridisation as they provide gametes with all similar traits.
- (ii) Homozygous recessive plants are used in a test cross to determine the genotype.

7. In peas, tallness is dominant over dwarfness, and red colour of flowers is dominant over the white colour. When a tall plant bearing red flowers was pollinated with a dwarf plant bearing white flowers, the different phenotypic groups were obtained in the progeny in numbers mentioned against them

Tall, Red = 138

Tall, White = 132

Dwarf, Red = 136

Dwarf, White = 128

Mention the genotypes of the two parents and of the four offspring types.

Ans: The result shows that the four types of offspring are in a ratio of 1:1:1:1. Such a result is observed in a test cross progeny of a dihybrid cross.

The cross can be represented as

Parents Tall and red (TtRr) × Dwarf and white (ttrr)

Offsprings

Gametes	TR	Tr	tR	tr
tr	TTRr (Tall red)	Ttrr (tall white)	ttRr (Dwarf red)	Ttrr (Dwarf white)

8. Why is the frequency of red-green colourblindness is many times higher in males than that in the females?

Ans: Colourblindness is an X-linked sex inheritance. For becoming colourblind, the female must have the allele for it in both her X chromosomes, and if only one X chromosome of the female possesses the allele for colour blind character, she becomes the carrier for this characteristic. But males develop colourblindness when their sole X chromosome has the allele for it. Thus, males are more prone to colour blindness, while females are carriers.

9. If a father and son are both defective in red-green colour vision, is it likely that the son inherited the trait from his father? Comment.

Ans: The Gene for colourblindness is X chromosome-linked, and sons receive their sole X chromosome from their mother, not from their father. Male-to-male inheritance is not possible for X-linked traits in humans:

In the given case, the mother of the son must be a carrier (heterozygous) for the colour blindness gene, thus transmitting the gene to her son.

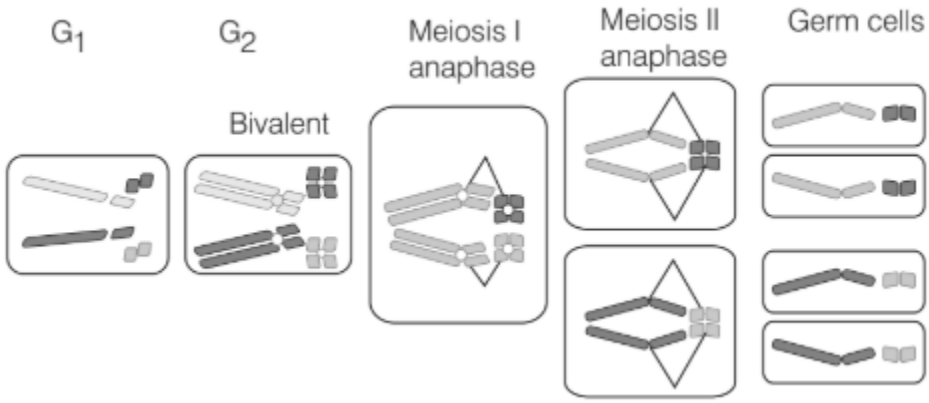
10. Discuss why Drosophila has been used extensively for genetical studies?

Ans: Morgan worked with the tiny fruit flies, Drosophila melanogaster, which were found to be suitable for genetic studies due to the following characteristics

- (i) They could be grown on a simple synthetic medium in the laboratory.
- (ii) They complete their life cycle in about two weeks.
- (iii) A single mating could produce a large number of progeny flies.
- (iv) A clear differentiation of the sexes– the male and female flies are easily distinguishable.
- (v) It has many types of variations (hereditary) that can be seen with low-power microscopes.

11. How do genes and chromosomes share similarity from the point of view of genetical studies?

Ans: By 1902, the chromosome movement during meiosis had been worked out. Walter Sutton and Theodore Boveri (1902) noted that the behaviour of chromosomes was parallel to the behaviour of genes and used chromosome movement to explain Mendel's Laws.



They studied the behaviour of chromosomes during mitosis (equational division)

and during meiosis (reduction division). The chromosomes, as well as genes, occur in pairs, and the two alleles of a gene pair are located at homologous sites of homologous chromosomes.
Chromosome movement in meiosis and germ cell formation occurs in a cell with four chromosomes. Chromosomes segregate when germ cells are formed.

12. What is recombination? Discuss the applications of recombination from the point of view of genetic engineering.
Ans: Recombination refers to the generation of a new combination of genes which is different from the parental types. It is produced due to crossing over that occurs during meiosis before gamete formation.
Applications of Recombination

- (i) It is a means of introducing new combinations of genes and hence new traits.
- (ii) It increases variability, which is useful for natural selection and in a changing environment.
- (iii) Since the frequency of crossing over depends upon the distance between the two genes, the phenomenon is used for preparing linkage chromosome maps.
- (iv) It has been proven that genes lie linearly in the chromosome.
- (v) Breeders have to select a small or large population to obtain the required crossovers. For obtaining crossovers between closely linked genes, a very large population is required.
- (vi) Useful recombinations produced by crossing over are picked up by breeders to produce useful new varieties of crop plants and animals. The green revolution has been achieved in India due to this selective picking up of useful recombinations. Operation Flood, or the white revolution, is also being carried out on similar lines.

13. What is artificial selection? Do you think it affects the process of natural selection? How?
Ans: Artificial selection (or selective breeding) describes intentional breeding for certain traits or a combination of traits by humans, for exploiting the variations existing among species. It is of three types-mass selection, pure-line selection and clonal selection.
Yes, it affects the process of natural selection. Natural selection selects for/or

against traits based on their effect on the fitness of the organism. In artificial selection, traits are selected based on human preference for improving traits. The process of natural selection leads to evolutionary change in the expression of the trait in the population, whereas artificial selection, though being the same process, involves the traits preferred by humans for their own benefit. It is a much faster process than natural selection, but it may impose a threat on diversity in the long run, making it unfit for the environment.

14. With the help of an example differntiate between incomplete dominance and co-dominance.

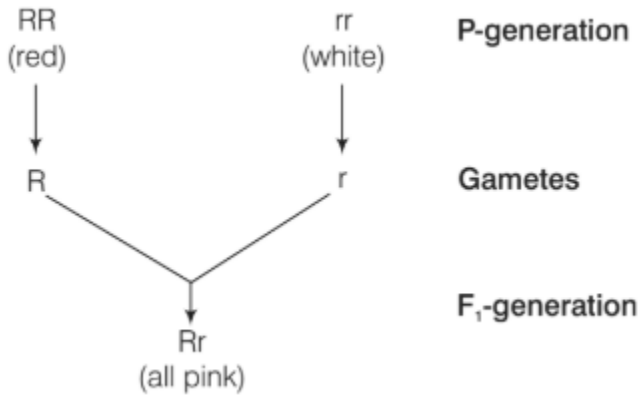
Ans: Incomplete dominance is a phenomenon where two contrasting alleles are present together, but neither of the alleles is dominant over the other, and the phenotype formed is intermediate between the two alleles.

e.g., the kind of inheritance in the dog flower (Snapdragon or Antirrhinum species) in which the intermediate trait is expressed in the F1 generation.

Codominance is a phenomenon in which two contrasting alleles are present together and both alleles express themselves.

e.g., the AB blood group in humans, where both alleles are expressed to produce RBC surface antigens A and B.

(i) Coss showing incomplete dominance



(ii) Blood group showing co-dominance

Genotype	Surface Antigen	Blood Group
I^Ai (dominance)	A	A

I^AI^A	A	A
I^Bi (dominance)	B	B
I^BI^B	B	B
I^AI^B (co-dominance)	AB	AB
ii	-	O

15. It is said, that the harmful alleles get eliminated from population over a period of time, yet sickle-cell anaemia is persisting in human population. Why?

Ans: Sickle-cell anaemia is an autosomal recessive disease caused by haemoglobin, an oxygen-carrying protein in blood cells.

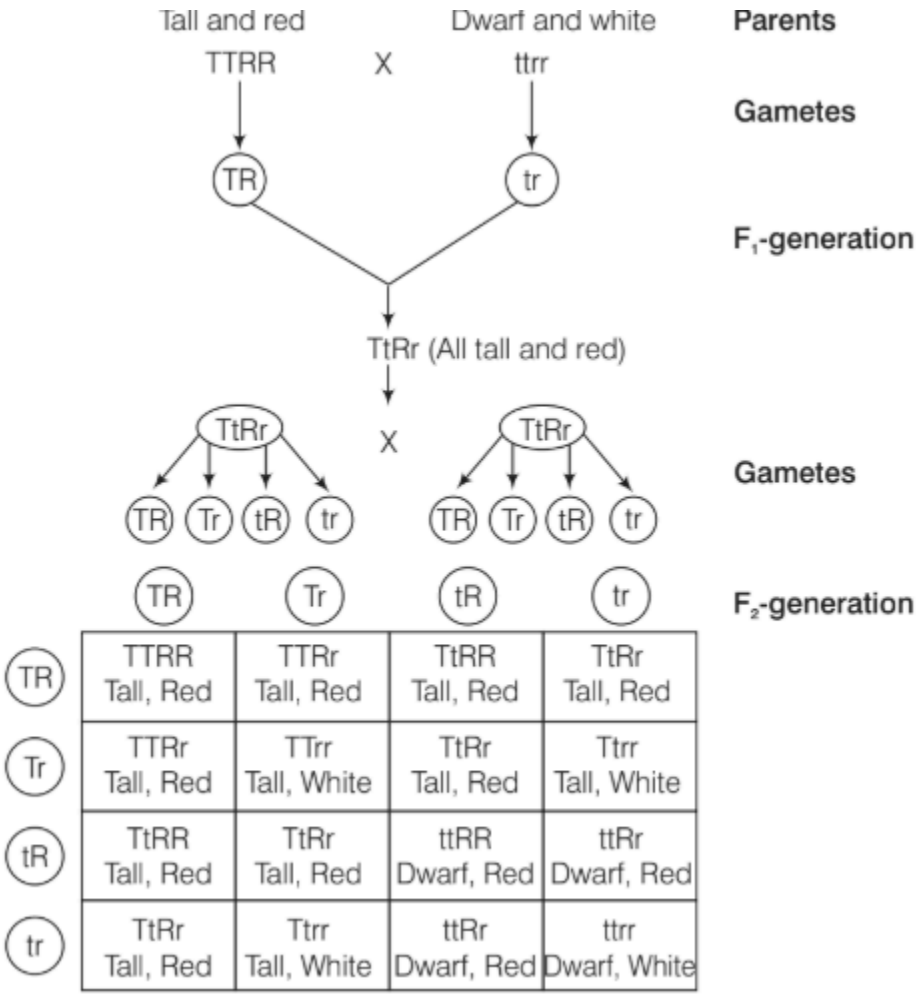
Despite the disease's lethal symptoms, it protects the carrier from malaria. Its allele is most common in people of African descent (about 7% people of African descent carry an allele), and in some other areas where malaria is prevalent.

It provides vital protection from malaria. Individuals with HbAS heterozygotes tend to survive better than individuals with HbSS (homozygotes) as they are not exposed to the same severity of risk.

Long Answer Type Questions

1. In a plant, tallness is dominant over dwarfness, and red flower is dominant over white. Starting with the parents work out a dihybrid cross. What is standard dihybrid ratio? Do you think the values would deviate if the two genes in question are interacting with each other?

Ans:



The standard dihybrid ratio is 9:3:3:1. Yes, the values will show deviation if the two genes in the above case are interacting with each other. When the genes are linked, they do not assort independently but remain together in the gametes and the offspring, giving a dihybrid ratio of 3:1 and showing a test cross ratio of 1:1 instead of 1:1:1:1.

2. (a) In humans, males are heterogametic and females are homogametic. Explain. Are there any examples where males are homogametic and females heterogametic?
(b) Also, describe as to who determines the sex of an unborn child? Mention whether temperature has a role in sex determination.
Ans: (a) The term homogametic and heterogametic refers to the organism depending upon whether all the gametes contain one type of sex chromosome

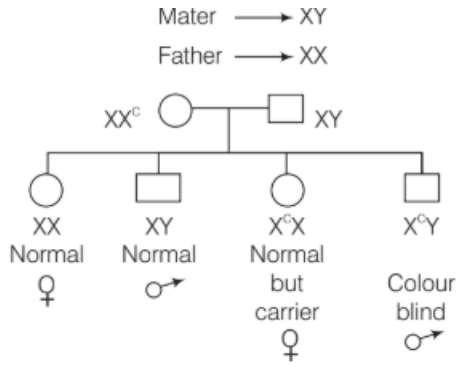
(homo same) or two different types of sex chromosomes (hetero different).

- Humans show XX/XY type of sex determination, i.e., females contain 2 copies of the X chromosome and males contain 1 X and 1 Y chromosome. Therefore, ova are produced by females that contain the same sex chromosome, i.e., X.
- On the other hand, the sperms contain 2 different types of chromosomes, i.e., 50% sperms have X chromosomes and 50% have Y chromosomes (meiosis). Therefore, the sperm are different with respect to the composition of the sex chromosome.
- In case of humans, females are considered to be homogametic while males are heterogametic. Yes, there are examples where males are homogametic and females are heterogametic. In some birds, the mode of sex determination is denoted by ZZ (males) and ZW (females). Certain moths and butterflies also show homogametic males and heterogametic females.

(b) As a rule, the heterogametic organism determines the sex of the unborn child. In the case of humans, since males are heterogametic, it is the father and not the mother who decides the sex of the child. In some animals like crocodiles, lower temperatures favour hatching of female offspring and higher temperatures lead to hatching of male offspring.

3. A normal visioned woman, whose father is colour blind, marries a normal visioned man. What would be probability of her sons and daughters to be colour blind? Explain with the help of a pedigree chart.

Ans: The genotype of parents is



50% daughters are normal visioned, but 50% will be carriers, and 50% of sons are likely to be colour blind, and 50% are normal visioned.

4. Discuss in detail the contributions of Morgan and Sturvant in the area of genetics.

Ans: T H Morgan (1866-1945) was given the Nobel Prize in 1933. His contributions are

- (i) Morgan worked on the fruit fly *Drosophila melanogaster* and proposed the chromosomal theory of linkage.
- (ii) He stated and established that genes are located on the chromosome.
- (iii) He established the principle of linkage, crossing over, sex-linked inheritance and
- discovered the relation between gene and chromosome.
- (iv) He established the technique of chromosome mapping.
- (v) He observed and worked on mutation.

Alfred Henry Sturtevant (1891-1970) student of Morgan, was given the National Medal of Science in 1967. His contributions are

- (i) He constructed the first genetic map of a chromosome while working on the Drosophila genome.
- (ii) His main contributions to science include his analysis of genetic 'linkage groups,' which became a classical method of chromosome mapping that is still used today. In 1913, he determined that genes were linearly arranged on chromosomes, like beads on a necklace. He also showed that the gene for any specific trait was in a fixed location (locus).
- (iii) His work on Drosophila proved that two closely related species showed newly recurring mutations that were allelic and thus probably identical. His work also helped to determine the genetic role in sexual selection and development, and displayed the importance of chromosomal crossing over in mutations.
- (iv) One of Sturtevant's principal contributions was his introduction to the concept that the frequency of crossing over between two genes could help to determine their proximity on a linear genetic map. His experiments determined that the frequency of double crossing over can be used to deduce gene order.

5. Define aneuploidy. How is it different from polyploidy? Describe the individuals having following chromosomal abnormalities.
(a) Trisomy of 21st Chromosome (b) XXY (c) XO

Ans: Aneuploidy is a phenomenon which occurs due to non-disjunction, resulting in the gain or loss of one or more chromosomes during meiosis. Aneuploidy is different from polyploidy. Polyploidy is a phenomenon in which organisms contain more than two monoploid value or basic sets of chromosomes. i.e., –3n, 4n, etc.

Examples of such organisms are certain fish and salamanders, and are commonly found in plants like grapes, bananas.

Chromosomal Abnormalities

- (a) Down syndrome is an autosomal disorder that is caused by the trisomy of chromosome 21. The individual is short-statured with a round head, an open mouth, a protruding tongue, a short neck, slanting eyes, and broad, short hands. The individual also shows retarded mental and physical growth, underdeveloped gonads and genitals, etc.
- (b) Klinefelter's syndrome is a chromosomal disorder that is caused by the presence of an additional copy of the X chromosome, resulting in the karyotype 45+XXY. In this disorder sex of the individual is masculine but possess feminine characteristics also. The individual shows gynaecomastia, i.e., development of breasts. The individual will often be sterile, having poor beard growth and a feminine-pitched voice.
- (c) Turner's syndrome is a chromosomal disorder that is caused by the absence of one of the X chromosomes, resulting in the karyotype 45+XO. In this disorder, the individual (female) will be sterile with rudimentary ovaries. Other symptoms include a shield-shaped thorax, a webbed neck, and poor development of breasts, short stature, a small uterus and puffy fingers.