THE VILLAGE INTERNATIONAL SCHOOL
"We Nurture Dreams"

AIM HIGH, TOGETHER WE FLY

Grade 12 Biology

Chapter 5: Principles of inheritance and variation

Question bank part 1

Q. 1. State a difference between a gene and an allele.

Ans. Gene contains information that is required to express a particular trait whereas alleles are alternating forms of a gene and are the code for a pair of contrasting traits for e.g., for plant height has two alleles – for tallness and dwarfness.

Q. 2. Name the respective pattern of inheritance where F1 phenotype

(a) does not resemble either of the two parents and is in between the two.

(b) resembles only one of the two parents.

Ans. (a) Incomplete dominance (b) Dominance

Q. 3. A garden pea plant (A) produced inflated yellow pod, and another plant (B) of the same species produced constricted green pods. Identify the dominant traits.

Ans. Inflated green pod is the dominant trait.

Q. 4. A garden pea plant produced axial white flowers. Another of the same species produced terminal violet flowers. Identify the dominant traits.

Ans. Axial, violet flower.

Q. 5. A garden pea plant produced round green seeds. Another of the same species produced wrinkled yellow seeds. Identify the dominant traits.

Ans. Round, yellow seed are the dominant traits.

Q. 6. A geneticist interested in studying variations and patterns of inheritance in living beings prefers to choose organisms for experiments with shorter life cycle. Provide a reason.

Ans. This is because many generations can be obtained (in a short time) and selection of character becomes faster.

Q. 7. Write the possible genotypes, Mendel got when he crossed F1 tall pea plants with a dwarf pea plant.

Ans. Possible genotypes: Tt and tt.

Q. 8. How many kinds of phenotypes would you expect in F2 generation in a monohybrid cross?

Ans. Two (e.g., Tall and dwarf).

Q. 9. Mention any two contrasting traits with respect to seeds in pea plant that were studied by Mendel.

Ans. Round/Wrinkled, Yellow/Green

Q. 10. When a tall pea plant was self-pollinated, one-fourth of the progeny were dwarf. Give the genotype of the parent and dwarf progenies.

Ans. Genotype of parent is Tt and the genotype of dwarf progenies is tt.

Q. 11. Discuss is the genetic basis of wrinkled phenotype of pea seeds.

Ans. Wrinkled seed shape is a recessive trait. It expresses only under homozygous condition of alleles.

Q. 12. How many type of gametes are produced by the individual with genotype AABBCCDD and AaBbCcDd?

Ans. One type of gamete by individual (AABBCCDD) ABCD and sixteen (= 24 = 16) type of gametes by individual AaBbCcDd.

Q. 13. Mention the type of allele that expresses itself only in homozygous state in an organism.

Ans. Recessive allele.

Q. 14. Write the percentage of F2 homozygous and heterozygous populations in a typical monohybrid cross.

Ans. The ratio of a typical monohybrid cross is 1 : 2 : 1 where 50% are homozygous and 50% are heterozygous populations. (25% homozygous dominant, 25% homozygous recessive)

Q. 15. Name the type of cross that would help to find the genotype of a pea plant bearing violet flowers.

Ans. Test cross.

Q. 16. A cross was carried out between two pea plants showing the contrasting traits of height of the plant. The result of the cross showed 50% of parental characters. Name the type of cross.

Ans. Test cross

Q. 17. Why, in a test cross, did Mendel cross a tall pea plant with a dwarf pea plant only?

Ans. To determine the genotype of the tall plant, whether it is homozygous dominant or heterozygous, as dwarfness is a recessive trait which is expressed only in homozygous condition and he was sure of genotype of dwarf plant.

Q. 18. Name the stage of cell division where segregation of an independent pair of chromosomes occurs.

Ans. Anaphase-I of Meiosis-I.

Q. 19. If the frequency of a parental form is higher than 25% in a dihybrid test cross, what does that indicate about the two genes involved?

Ans. It shows that the two genes are linked.

Q. 20. For the expression of traits, genes provide only the potentiality and the environment provides the opportunity. Comment on the veracity of the statement.

Ans. Phenotype = Genotype + Environment (Trait) (Potentiality) (Opportunity)

Q. 21. Mention the combination(s) of sex chromosomes in a male and a female bird.

Ans. Male bird – ZZ, Female bird – ZW

Q. 22. Write the types of sex determination mechanisms the following crosses show. Give an example of each type.

(i) Female XX with Male XO

(ii) Female ZW with Male ZZ

Ans. (i) Male heterogamety, Grasshopper

(ii) Female heterogamety, Birds

Q. 23. How many chromosomes do drones of honeybee possess? Name the type of cell division involved in the production of sperms by them.

Ans. Drones possess 16 chromosomes. Mitosis is involved in the production of sperms.

Q. 24. A male honeybee has 16 chromosomes whereas its female has 32 chromosomes. Give one reason.

Ans. Male honeybee develops from unfertilised female gamete (Parthenogenesis) and thus has 16 chromosomes whereas female develops by fertilisation and thus has 32 chromosomes.

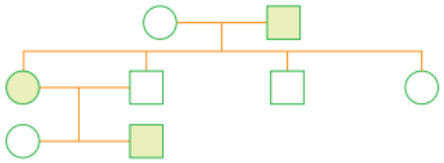
Q. 25. Give an example of a human disorder that is caused due to a single gene mutation.

Ans. Sickle-cell anaemia.

Q. 26. The egg of an animal contains 10 chromosomes, of which one is X-chromosome. How many autosomes would there be in the karyotype of this animal?

Ans. There will be 9 pairs of autosomes in the karyotype of this animal.

Q. 27. Observe the pedigree chart and answer the following questions:



(a) Identify whether the trait is sex-linked or autosomal.

(b) Give an example of a disease in human beings which shows such a pattern of inheritance.

Ans. (a) The trait is sex-linked.

(b) Haemophilia, Colour blindness (Any one)

Q. 28. A haemophilic man marries a normal homozygous woman. What is the probability that their daughter will be haemophilic?

Ans. 0% because only one X chromosome will carry the haemophilia gene. So, she will be a carrier.

Q. 29. A haemophilic son was born to normal parents. Give the genotypes of the parents and son.

Ans. Father : 44 + XY

Mother : 44 + XX^h

Son : 44 + X^hY. (X^h= X chromosome with gene for haemophilia)

Q. 30. State the chromosomal defect in individuals with Turner's syndrome.

Ans. Monosomy of sex chromosome in females (XO condition).

Q. 31. Name the event, during cell division cycle that results in the gain or loss of chromosome.

Ans. Failure of segregation of chromosomes.

Q. 32. Name one autosomal dominant and one autosomal recessive Mendelian disorder in humans.

Ans. Huntington's disease is an autosomal dominant disorder and sickle-cell anaemia is an autosomal recessive disorder.

Q. 33. A human being suffering from Down's syndrome shows trisomy of 21st chromosome. Mention the cause of this chromosomal abnormality.

Ans. Due to non-disjunction i.e., 21st pair of chromosomes fail to separate during gametogenesis. Therefore, the gamete possesses 24 chromosomes instead of 23. When such a gamete fuses with another gamete, the zygote will have three copies of chromosome 21 causing trisomy.

Q. 34. Why is it that the father never passes on the gene for haemophilia to his sons? Explain.

Ans. Haemophilia is a sex-linked recessive disease and the defective gene is present on X chromosome only and not on Y chromosome. Father never passes X chromosome to the son as father only contributes Y chromosome to the son.

Q. 35. Why do normal red blood cells become elongated sickle shaped structures in a person suffering from sickle cell anaemia?

Ans. Due to point mutation, glutamic acid (Glu) is replaced by valine (Val) at the sixth position of β-globin chain of haemoglobin molecule. Under oxygen stress erythrocytes lose their circular shape and become sickle-shaped.

Q. 36. Give an example of a chromosomal disorder caused due to non-disjunction of autosomes.

Ans. Down's Syndrome.

Q. 37. Name a human genetic disorder due to the following:

(i) An additional X-chromosome in a male

(ii) Deletion of one X-chromosome in a female

Ans. (i) Klinefelter's Syndrome (ii) Turner's Syndrome

Q. 38. State what does aneuploidy lead to.

Ans. Aneuploidy leads to individuals with abnormal number of chromosomes. Some disorder due to aneuploidy are Down's Syndrome, Turner's Syndrome, Klinefelter's Syndrome.

Short Answer Questions

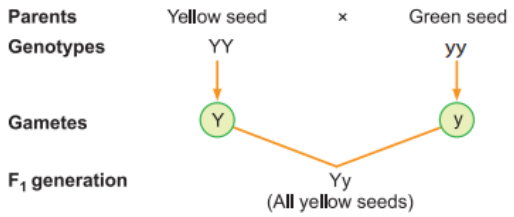
Q. 1. What are the characteristic features of a true-breeding line?

Ans. A true-breeding line for a trait is one that has undergone continuous self-pollination, showing a stability in the inheritance of the trait for several generations.

Q. 2. In order to obtain the F1 generation, Mendel pollinated a true-breeding, say, tall plant with a true-breeding dwarf plant. But for getting the F2 generation, he simply self-pollinated the tall F1 plants. Why?

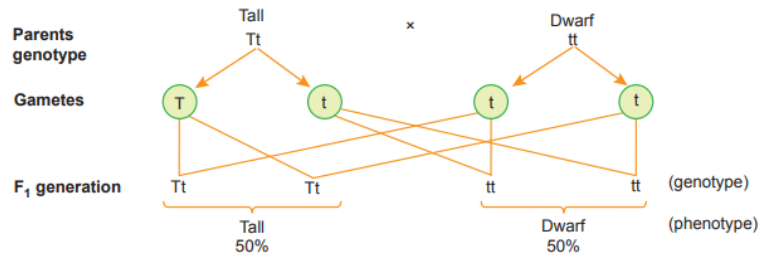
Ans. All the F1 offsprings of the cross are heterozygous so allowing self-pollination is sufficient to raise F2 offspring. Also he intended to understand the inheritance of the selected trait over generations.

Q. 3. Mendel crossed plants that bred true for yellow seeds with plants that bred true for green seeds. All seeds in the F1 generation were yellow. Work out the inheritance involved in this cross by using symbols for the trait. Which trait was dominant?



Conclusion: The yellow seed colour is dominant over green as it is expressed in the F1 generation.

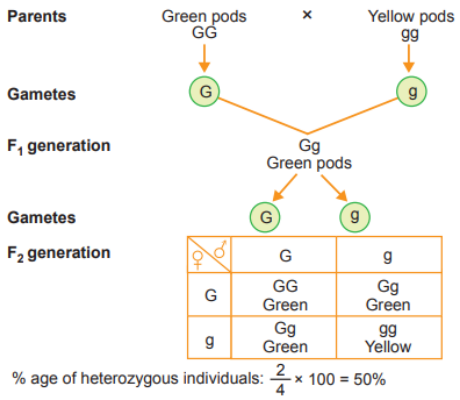
Q. 4. During a monohybrid cross involving a tall pea plant with a dwarf pea plant, the offspring populations were tall and dwarf in equal ratio. Work out a cross to show how it is possible.



Q. 5. With the help of a Punnett square, find the percentage of homozygous talls in a F2 population involving a true breeding tall and a true breeding dwarf pea plant.

Percentage of homozygous tall = 1/4×100 = 25%

Q. 6. With the help of a Punnett square, find the percentage of heterozygous individuals in a F2 population in a cross involving a true breeding pea plant with green pods and a true breeding pea plant with yellow pods respectively.



Q. 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 by 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 types of four offsprings.

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:

♀ ♂	TR	Tr	tR	tr
tr	TtRr Tall and red	Ttrr Tall and white	ttRr Dwarf and red	ttrr Dwarf and white

Q. 8. In a typical monohybrid cross the F2 population ratio is written as 3:1 for phenotype but expressed as 1:2:1 for genotype. Explain with the help of an example.

Ans. This is a case of Mendel's monohybrid cross.

Q. 9. In snapdragon, a cross between true-breeding red flowered (RR) plants and true-breeding white flowered (rr) plants showed a progeny of plants with all pink flowers.

(a) The appearance of pink flowers is not known as blending. Why?

(b) What is this phenomenon known as?

Ans. (a) R (dominant allele red colour) is not completely dominant over r (recessive allele white colour). r maintains its originality and reappears in F2 generation. Therefore, it is not blending.

(b) Incomplete dominance.

Q. 10. The phenotypic and genotypic ratio in F2 generation are same in a certain kind of inheritance. Name an organism in which it occurs and mention the kind of inheritance involved.

Ans. This kind of inheritance occurs in Mirabilis jalapa (4 O'clock plant) and the type of inheritance is called incomplete dominance.

Q. 11. In a particular plant species, majority of the plants bear purple flowers. Very few plants bear white flowers. No intermediate colours are observed. If you are given a plant bearing purple flowers, how would you ascertain that it is a pure breed for that trait? Explain.

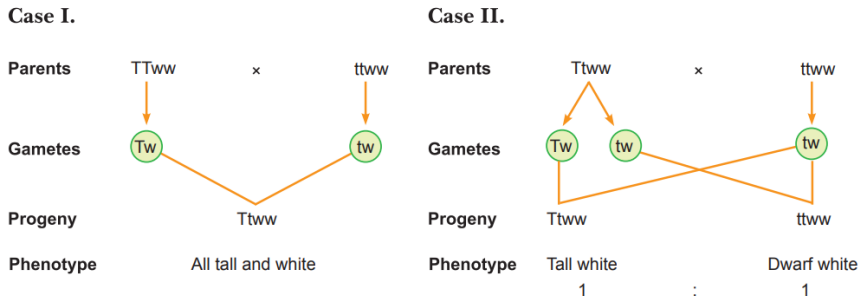
Ans. By test cross. Cross, purple flower plant with a (homozygous) recessive plant with white flowers, if all the flowers of the progeny are purple, the plant is homozygous dominant, i.e. pure breed.

Q. 12. In snapdragon (Antirrhinum majus), a cross between varieties with red and white flowers produces all pink progeny. Explain how it is a case of incomplete dominance and not of blending inheritance.

Ans. In incomplete dominance, the genes of an allelomorphic pair are not expressed as dominant and recessive, but express themselves partially when present together in a hybrid and is an intermediate between the two genes. As a result an intermediate character is obtained. e.g., Two types of flowers occur in Mirabilis jalapa (4 o' clock plant) and Antirrhinum majus (snapdragon/dog flower). The red flower colour is due to gene RR, white flower colour is due to gene rr but pink flower colour appears in case of genotype Rr. It is not a case of blending inheritance because the parental characters reappear in the F2 generation without any modification.

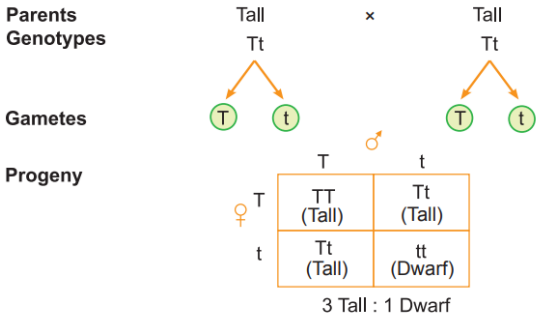
Q. 13. How would you find genotype of a tall pea plant bearing white flowers? Explain with the help of a cross. Name the type of cross you would use.

Ans. It can be done by a test cross. This is done by crossing the plant with homozygous recessive parent. If the ratio of progeny is 1 : 1, then the genotype of the plant is heterozygous.



Q. 14. When a tall pea plant was selfed, it produced one-fourth of its progeny as dwarf. Explain with the help of a cross.

Ans. Production of one-fourth dwarf progeny on selfing of a tall pea plant indicates that the plant is heterozygous. This can be explained with the cross as follows:



Q. 15. A teacher wants his/her students to find the genotype of pea plants bearing purple coloured flowers in their school garden. Name and explain the cross that will make it possible.

Ans. Test cross will be done.

Q. 16. Explain co-dominance with the help of one example.

Ans. The alleles which are able to express themselves independently, even when present together are called co-dominant alleles and this biological phenomenon is called co-dominance.

For example, ABO blood grouping in humans. O ABO blood groups are controlled by gene I. Gene I has three alleles I A, I B and I O/i. O I A and I B produce RBC surface antigens which are sugar polymers A and B, respectively, whereas i does not produce any antigen. O I A and I B are dominant over i hence I A and I B are dominant alleles and i is recessive allele as in I Ai and I B i. O When I A and I B are present together, both express equally and produce both the surface antigens A and B, hence show co-dominance. O Since humans are diploid, each person possesses any two of the three 'I' gene alleles, resulting into six different genotypic combinations and four phenotypic expressions.

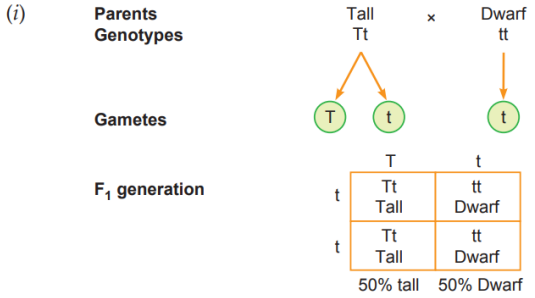
Q. 17. When does a geneticist need to carry a test cross? How is it carried?

Ans. Geneticists carry out a test cross to find out the genotype of the unknown parent. This is carried out by crossing the progeny with the homozygous recessive parent.

Q. 18. A cross was carried out between two pea plants showing the contrasting traits of height of the plant. The result of the cross showed 50% of parental characters.

(i) Work out the cross with the help of a Punnett square.

(ii) Name the type of the cross carried out.



(ii) Test cross

Q. 19. What is a test cross? How can it decipher the heterozygosity of a plant?

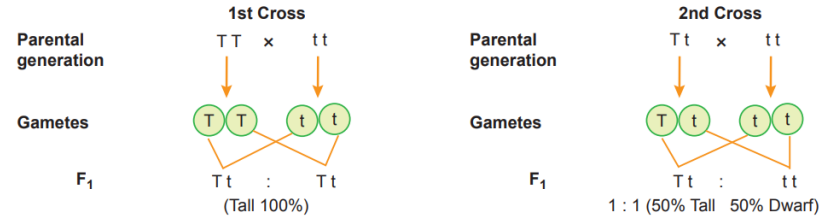
Ans. A cross to analyse whether genotype of dominant individual is homozygous or heterozygous is called test cross. On crossing with a recessive parent, if 50% of progeny have dominant trait and 50% have recessive trait then the plant is said to he heterozygous.

Q. 20. Two independent monohybrid crosses were carried out involving a tall pea plant with a dwarf pea plant. In the first cross, the offspring population had equal number of tall and dwarf plants, whereas in the second cross it was different. Work out the crosses, and explain giving reasons for the difference in the offspring populations.

OR

Work out a cross to find the genotype of a tall pea plant. Name the type of cross.

Ans. This type of cross called a test cross.



In the first cross the tall parent plant is heterozygous for the trait, in second cross tall parent plant is homozygous for the trait, hence the respective observation.

Q. 21. How does a test cross help to determine the genotype of an individual?

Ans. In a test cross the individual of unknown genotype is crossed with the recessive parent. If all progenies are dominant, then the genotype exhibits homozygosity and if the progenies have a dominant to recessive ratio 1 : 1, then the genotype exhibits heterozygosity.

Q. 22. With the help of one example, explain the phenomena of co-dominance and multiple allelism in human population.

Ans. ABO blood group in human being is an example of multiple allelism and co-dominance. There are three alleles for the gene I, i.e., IA, IB, and i, thus, exhibiting multiple allelism. When IA and IB are present together the blood group is AB. Both A and B blood groups are expressed. This is called co-dominance.

Q. 23. Explain pleiotropy with the help of an example.

Ans. Pleiotropy is the phenomenon in which a single gene exhibits multiple phenotypic expression. The pleiotropic gene affects the metabolic pathways, resulting in different phenotypes. For example, phenylketonuria is caused by mutation in the gene coding the enzyme phenylalanine hydroxylase. It also leads to mental retardation & reduction in hair & skin pigmentation.

Q. 24. Who proposed chromosomal theory of inheritance? Point out any two similarities in the behaviour of chromosomes and genes.

Ans. It was proposed by Sutton and Boveri.

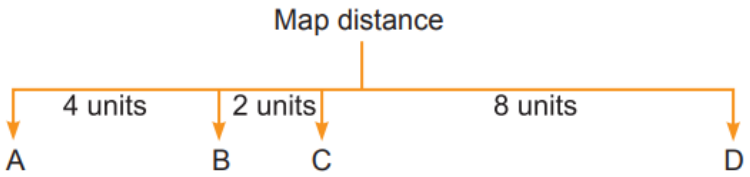
Similarities:

(i) Both genes and chromosomes occur in pairs in a diploid cell (2n).

(ii) Both of them separate out during gametogenesis to enter into different gametes.

(iii) Paired condition is again restored by fusion of gametes. (Any two)

Q. 25. The map distance in certain organisms between gene A and B is 4 units, B and C is 2 units and between C and D is 8 units which one of these gene pairs will show more recombination frequency? Give reasons in support of your answer.



The recombination frequency is directly proportional to the distance between the genes. The distance between C and D is more, i.e., 8 units in the above condition, so recombination frequency will be more between them.