CHAPTER 5-PRINCIPLES OF INHERITANCE AND VARIATION

A. Category of Questions (Very Short Answer Type) 1 mark each

1. Name any one plant that shows the phenomenon of incomplete dominance during the inheritance of its flower colour.

Ans. Dog flower (Snapdragon or Antirrhinum sp.)

2. Name the base change and the amino acid change, responsible for sickle cell anaemia.

Ans. GAG changes as GUG, Glutamic acid is substituted by valine.

3. Give any two reasons for the selection of pea plants by Mendel for his experiments.

Ans. (i) Many varieties with contrasting forms of characters

(ii) Can easily be cross pollinated as well as self pollinated.

4. What type of allele produces its effects only in homozygous individual . a) dominant, b) recessive, c) incomplete dominant , d) incomplete recessive.

Ans. b. recessive

5. Write the phenotypic ratio of di hybrid cross.

Ans. 9:3:3:1

6. Name two organisms where males are heterogametic.

Ans. Human and Drosophilla

7. Scientific name of garden pea is _____

Ans. *Pisum sativum*

8. Tendency of gene to link together in a same locus is called _____

Ans. Linkage

9. Name two Mendelian disorder that are sex- linked

Ans. Haemophilia , colour blindness

10. On self pollination of a tall pea plant , it was found that one fourth of the progeny were dwarf. What is the genotype of the parent and the dwarf progenies?

Ans. Parent - Tt , Dwarf progeny – tt

B. Category of Questions (Short Answer Type-I) 2 marks each

1. Identify the sex of organism as male or female in which the sex chromosome are found as

(i) ZW in bird (ii) XY in Drosophila (iii) ZZ in birds. (iv) XO in grasshopper.

Ans. (i) Female; (ii) Male; (iii) Female (iv) Male

2. Mention two differences between Turner ’s syndrome and Klinefelter's syndome.

Ans. Turners Syndrome : The individual is female and it has 45 chromosomes i.e., one X chromosome is less.

Klinefelters Syndome : The individual is male and has 47 chromosomes i.e., one extra X chromosome.

3. The human male never passes on the gene for haemophilia to his son. Why is it so?

Ans. The gene for haemophilia is present on X chromosome. A male has only one X chromosome which he receives from his mother and Y chromosome from father. The human male passes the X chromosome to his daughters but not to the male progeny (sons).

4. Mention four reasons why Drosophila was chosen by Morgan for his experiments in genetics.

Ans. (i) Very short life cycle (2-weeks)

(ii) Can be grown easily in laboratory

(iii) In single mating produce a large no. of flies.

(iv) Male and female show many hereditary variations

(v) It has only 4 pairs of chromosomes which are distinct in size and Shape.

5. Differentiate between point mutation and frame shift mutations.

Ans. Point Mutations : Arises due to change in a single base pair of DNA e.g., sickle cell anaemia. Frame shift mutations : Deletion or insertion/duplication/addition of one or two bases in DNA.

C. Category of Questions (Short Answer Type-II) 3 marks each

1. A woman with O blood group marries a man with AB blood group

(i) work out all the possible phenotypes and genotypes of the progeny.

(ii) Discuss the kind of dominance in the parents and the progeny in this case.

Ans. (i) Blood group AB has alleles as IA, IB and O group has ii which on cross gives the both blood groups A and B while the genotype of progeny will be IAi and IBi.

(ii) IA and IB are equally dominant (co-dominant). In multiple allelism, the gene I exists in 3 allelic forms, IA, IB and i.

2. Explain the cause of Klinefelter's syndrome. Give any four symptoms shown by sufferer of this syndrome.

Ans. Cause : Presence of an extra chromosome in male i.e., XXY. Symptoms : Development of breast, Female type pubic hair pattern, poor beard growth, under developed testes and tall stature with Feminized physique.

3. In Mendels breeding experiment on garden pea, the offspring of F2 generation are obtained in the ratio of 25% pure yellow pod, 50% hybrid green pods and 25% green pods State (i) which pod colour is dominant (ii) The Phenotypes of the individuals of F1 generation. (iii) Workout the cross.

Ans. (i) Green pod colour is dominant

(ii) Green pod colour

(iii)

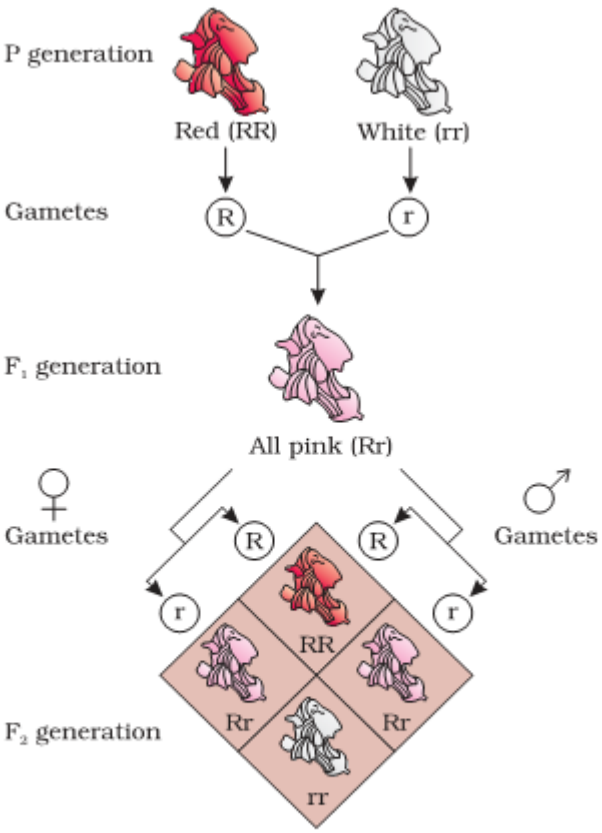
Parents	GG(green)	X	gg (yellow)			
Gametes	(G)		(g)			
F1 generation	Gg (Hybrid green)					
Gametes	(G)	(g)	X	(G)	(g)	
F2 generation	GG	Gg	Gg	gg		

Phenotypic ratio 3 : 1

Genotypic ratio 1 : 2 : 1

4. In Antirrhinum majus a plant with red flowers was crossed with a plant with white flowers. Work out all the possible genotypes & phenotypes of F1 & F2 generations comment on the pattern of inheritance in this case?

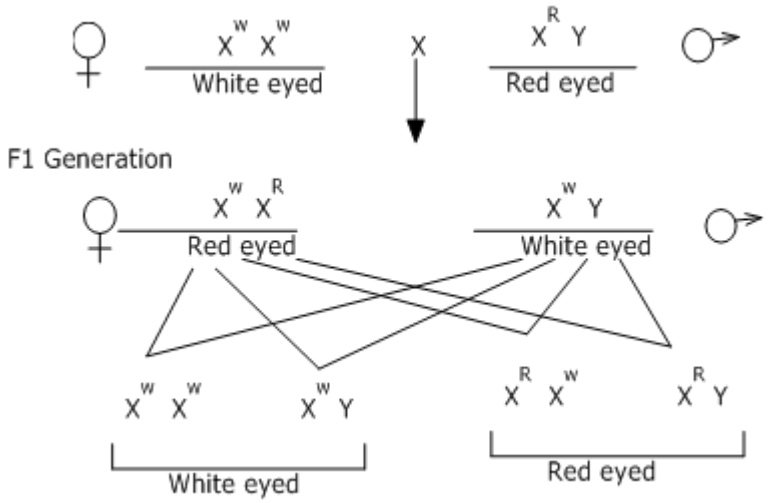
Ans. The inheritance of flower colour in snapdragon or Antirrhinum majus is an example of incomplete dominance. When a cross was made between a red flowered plant & a white flowered plant, the F1hybrid was pink i-e-an intermediate between red & white which means that both red & white are incompletely dominant. When F1 individuals was self – pollinated, the F2 generation consists of red, pink & white flower appears in ratio 1:2:1 respectively.



5. A red eyed male fruitfly is crossed with white eyed female fruitfly. Work out the possible genotype & phenotype of F1 & F2 generation. Comment on the pattern of inheritance in this cross?

Ans. When a red eyed is crossed with white eyed female fruitfly, offspring will have both white eyed male & red eyed female in 1:1 ration in F1 generation. In F2 generation, 50% females will be red – eyed & 50% will be white eyed, similarly, in males 50% will be red eyed & 50% will be white eyed. This result indicates that in sex-linked genes, males transmit their sex-linked

characters to their grandson through their daughter; such type of inheritance is called criss-cross inheritance –



D. Category of Questions (Long Answer Type) 5 marks each

1. A dihybrid heterozygous round, yellow seeded garden pea (Pisum sativum) was crossed with a double recessive plant.

(i) What type of cross is this?

(ii) Work out the genotype and phenotype of the progeny.

(iii) What principle of Mendel is illustrated through the result of this cross?

Ans.(i) It is a dihybrid test cross

(ii)

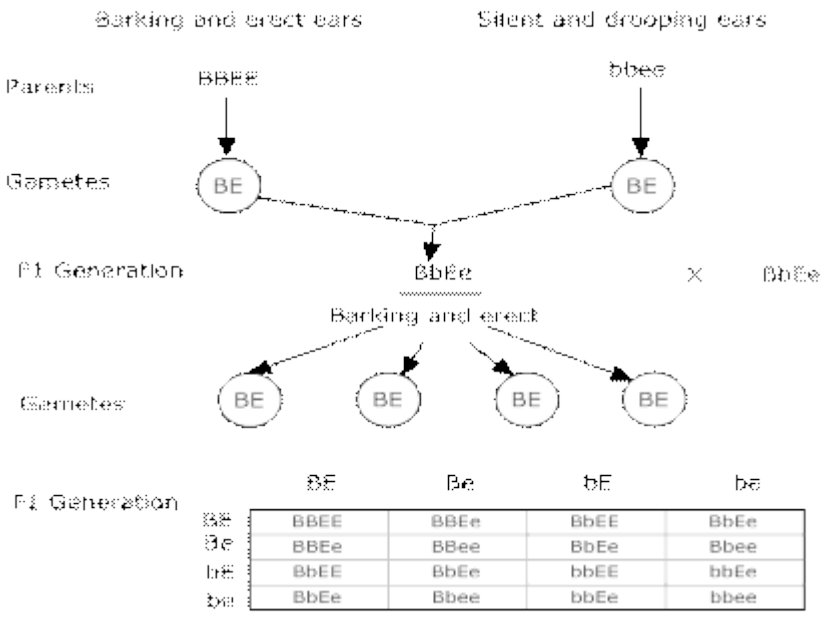
Gametes (RY), (Ry), (rY), (ry) X (ry)

	Gametes	RY	Ry	rY	ry
F_1 progeny	ry	RrYy Round, Yellow	Rryy Round and Green	rrYy Wrinkled Yellow	rryy Wrinkled, Green
Phenotypic ratio		: 1	: 1	: 1	: 1
Genytopic ratio		: 1	: 1	: 1	: 1

(iii) It illustrates the Principle of independent assortment.

2. In dogs, barking trait is dominant over silent trait & erect ears are dominant over drooping ears. What is the expected phenotypic ratio of offspring when dogs heterozygous for both the traits are crossed?

Ans.



Ratio:- Barking & erect = 9

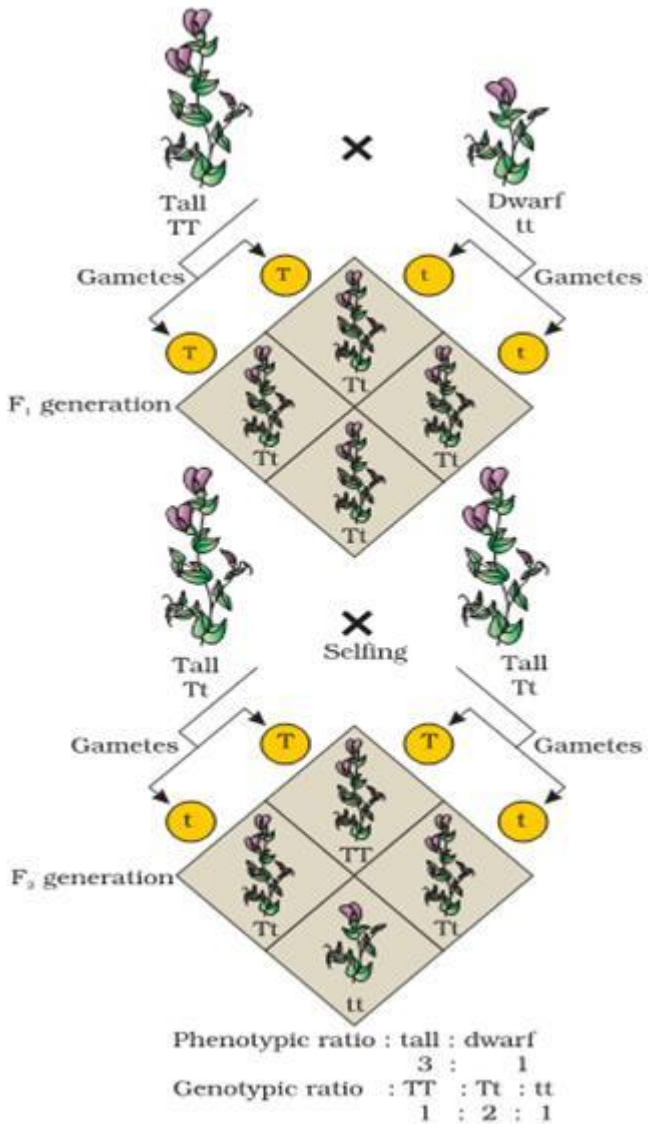
Barking & drooping =3

Silent & erect = 3

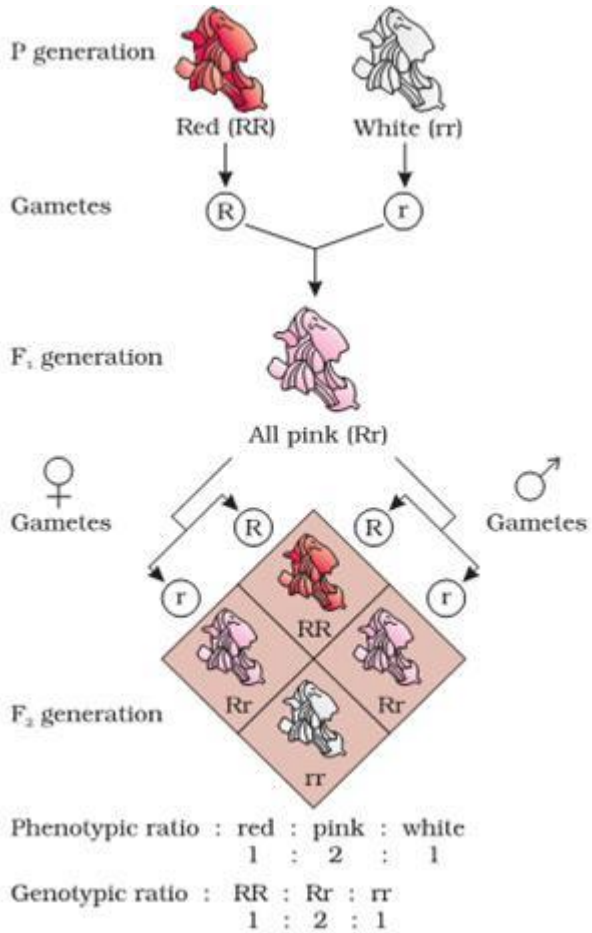
Silent & drooping =1

Phenotypic ratio = 9 : 3 : 3 : 1

3. Differentiate between dominance, co-dominance & Incomplete dominance with one example each.



Ans. (i) Dominance :- When a cross is made between true – breeding tall pea plant & true – breeding dwarf pea plant, all the plants in F1 generation are tall this sows that tall character is dominant over dwarf



(ii) Co-dominance :- If the two equally dominant genes are present together, both of them will be equally expressed, this phenomena is called co-dominance eg alleles of blood group IA & IB ore dominant over IO but when both the alleles are present together, both of them will equally express & forms a phenotype AB.

Allele from Parent 1	Allele from Parent 2	Genotype of offspring	Blood types of offspring
I^A	I^A	$I^A I^A$	A
I^A	I^B	$I^A I^B$	AB
I^A	i	$I^A i$	A
I^B	I^A	$I^A I^B$	AB
I^B	I^B	$I^B I^B$	B
I^B	i	$I^B i$	B
i	i	$i\,i$	O

(iii) In complete dominance :- When a cross is made between two characters of which none of them is completely dominant then an intermediate character develops in the progeny eg. when

a cross is made between red flower & white flower in snapdragon flower an intermediate pink colour appears in the progeny

E. Category of Questions (Assertion and Reasoning Type) 1 mark each

Directions: In the following questions, a statement of assertion is followed by a statement of reason. Mark the correct choice as:

(a) If both Assertion and Reason are true and Reason is the correct explanation of Assertion.

(b) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

(c) If Assertion is true but Reason is false.

(d) If both Assertion and Reason are false.

1. Assertion : Mendel was successful in his hybridization.

Reason : Garden pea proved ideal experimental material.

Ans: (b) Mendel chose garden pea as plant material for his experiments, since it had the following advantages:

(i) Well defined characters.

(ii) Bisexual flowers.

(iii) Predominantly self-fertilization.

(iv) Easy hybridization.

Besides these features, garden pea, being self-fertilized, had pure lines due to natural self-fertilization for a number of years.

Therefore, any variety used was pure for the characters it carried. Mendel's success was mainly based on the fact that he considered a single character at one time.

2. Assertion: Mendel used true-breeding pea lines for artificial pollination experiments for his genetic studies.

Reason: For several generations, a true-breeding line shows the stable trait inheritance and expression.

Ans: (a) On garden pea for many years Mendel carried out hybridization experiments. He performed various types of cross breeding and then allowed the offspring for self breeding. He selected varieties and used pure lines of ture breeding lines, i.e., they produce offspring resembling the parents. these lines show the stable trait inheritance and expression for several generations making them suitable for genetic studies.

3. Assertion: On true breeding lines, Mendel conducted cross pollination experiments.

Reason: For several generations, true breed lines have stable trait inheritance.

Ans. (a) True breeding lines have inheritance of pure characters for several generations.

4. Assertion : Cross of F1 individual with recessive homozygous parent is test cross.

Reason : No recessive individual are obtained in the monohybrid test cross progeny.

Ans. (c) In the monohybrid test cross progeny both heterozygous and recessive individuals are

obtained in 1 : 1 ratio.

5. Assertion: The progeny produced have both the characters of parents.

Reason: The process by which characters pass from parent to progeny is known as inheritance.

Ans. (b) According to Mendelian inheritance, genes come in different varieties called alleles. Somatic cells contain 2 alleles with one allele provided by each parent of an organism.

6. Assertion: The progeny in F2-generation traits were identical to their parental type.

Reason: The progeny show no blending of traits.

Ans. (a) Both the characters appear during the formation of F2-generation, so no blending occurs.

7. Assertion: Genes pass from one generation to another.

Reason: The units of inheritance are genes.

Ans. (b) Chromosomes carry gene that passes on the traits of parents to the offsprings during genetic recombination.

8. Assertion : In a monohybrid cross, F1 generation indicate dominant characters.

Reason : Dominance occurs only in heterozygous state.

Ans. (c) Monohybrid cross is a cross between two organisms of a species which is made to study the inheritance of a single pair of alleles or factors of a character. Dominant character is one of a pair of alleles which can express itself whether present in homozygous or heterozygous state. In F1, generation, the generation of hybrids produced from a cross between the genetically different homozygous individuals called parents the progenies are heterozygous dominant.

9. Assertion: In monohybrid cross, at F2 stage, both parental traits are expressed in 3 : 1 proportion.

Reason: At F2 stage, the contrasting parental traits show blending.

Ans. (c) Both the parental traits of a character in F2 generation are expressed in the ratio of three dominant to one recessive. Whereas, in F1 generation only one of the parental traits is expressed and the other lies hidden or unexpressed. However, in the hybrid there is no mixing of two characters. At the time formation of gamete, two factors separate or segregate and passes into different gametes, that hence have one factor of a pair. During fertilization, gametes fuse randomly so that factors come together in new generation and freely express themselves.

10. Assertion: The cross between the F1 progeny and either of the parent types is a test cross.

Reason: The cross between F1 progeny and the double recessive genotype is back cross.

Ans. (d) Back cross is a cross of F1 hybrid with either of the two parents. When F1 offsprings are crossed with the dominant parents, all the F2 generation offsprings develop dominant character. On the other hand, when F1 hybrids are crossed with recessive parent, individuals with both the phenotypes appear in equal proportions. Crossing of F1 individual with dominant phenotype with its homozygous recessive parent is called test cross. It is used to determine whether the individuals exhibiting dominant characters are homozygous or heterozygous.

F. Category of Questions (Case study based) 1 mark each

Read the following and answer the questions from 1 to 5 given below:

Sickle cell anemia is a genetic disorder where the body produces abnormal hemoglobin called hemoglobin S. Red blood cells are normally flexible and round, but when the hemoglobin is defective, blood cells take on a “sickle” or crescent shape. Sickle cell anemia is caused by mutations in a gene called HBB.

It is an inherited blood disorder that occurs if both the maternal and paternal copies of the HBB gene are defective. In other words, if an individual receives just one copy of the defective HBB gene, either from mother or father, then the individual has no sickle cell anemia but has what is called “sickle cell trait”. People with sickle cell trait usually do not have any symptoms or problems but they can pass the mutated gene onto their children.

There are three inheritance scenarios that can lead to a child having sickle cell anemia:

- Both parents have sickle cell trait
- One parent has sickle cell anemia and the other has sickle cell trait
- Both parents have sickle cell anemia

1. Sickle cell anemia is a/ an_____disease.

a. X linked

b. autosomal dominant
c. autosomal recessive
d. Y linked

Ans: b. autosomal recessive

2. If one parent has sickle cell trait, then there is_____of the child having sickle cell anemia.

a. 25 % risk

b. 50 % risk

c. 75% risk

d. No risk

Ans: d. No risk

3. If both parents have sickle cell trait, then there is_____of the child having sickle cell trait.

a. 25 % risk

b. 50 % risk

c. 75% risk

d. No risk

Ans: b. 50% risk

4. If one parent has sickle cell anemia and the other has sickle cell trait, there is_____that their children will have sickle cell anemia and_will have sickle cell trait.

a. 25 % risk, 75% risk

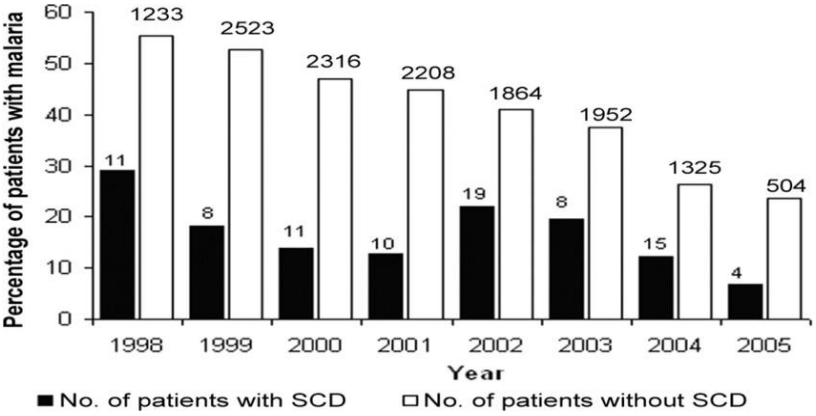
b. 50 % risk, 100% risk

c. 75% risk, 25% risk

d. No risk

Ans. b. 50 % risk, 100% risk

5.



The following statements are drawn as conclusions from the above data (Kenya).

I. Patients with SCD (Sickle Cell Disease) are less likely to be infected with malaria.

II. Patients with SCD (Sickle Cell Disease) are more likely to be infected with malaria.

III. Over the years the percentage of people infected with malaria has been decreasing.

IV. Year 2000 saw the largest percentage difference between malaria patients with and without SCD.

Choose from below the correct alternative.

a. only I is true
b. I and IV are true
c. III and II are true
d. I and III are true

Ans. d. I and III are true