NCERT Class 12 Biology Exercise Solutions

Chapter 4 – Principles of Inheritance and Variation

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

Ans: Gregor Mendel, often referred to as the father of modern genetics, chose to conduct his groundbreaking experiments on pea plants (Pisum sativum). The selection of pea plants offered several advantages that contributed to the success of Mendel's work. Mendel select garden pea (Pisum Sativum) for the following reasons.

(i) It is an annual plant with short life span and gives results within 3 months.

(ii) The plant is grown easily and does not require after care except at the time of pollination.

(iii) F1 hybrids are fertile.

(iv) Seven pairs of contrasting characters easily detectable.

(v) True breeding self-pollination.

2. Differentiate between the following –

(a) Dominance and Recessive

(b) Homozygous and Heterozygous

(c) Monohybrid and Dihybrid.

Ans: (a)The difference between dominance and recessive me:

Dominance	**Recessive**
In the presence or absence of a recessive trait, a dominant factor or allele expresses itself.	A recessive trait expresses itself only in the absence of a dominant trait.
Example: In a pea plant, round seeds and violet flowers are dominant characters.	Example: In a pea plant, white flower, dwarf plant, etc., are recessive characters

(b) Differences between homozygous and heterozygous individuals :

Homozygous	**Heterozygous**
For a particular trait, homozygous contains two similar alleles.	For a particular trait, heterozygous contains two different alleles.

Only one type of gamete is produced.	It produces more than one type of gamete – two different types of gametes, to be precise.
For homozygous, the genotype contains either recessive or dominant, never both alleles. Example: TT or tt	For heterozygous, the genotype possesses both recessive and dominant alleles. Example: Tt

(c) The differences between Monohybrid and Dihybrid:

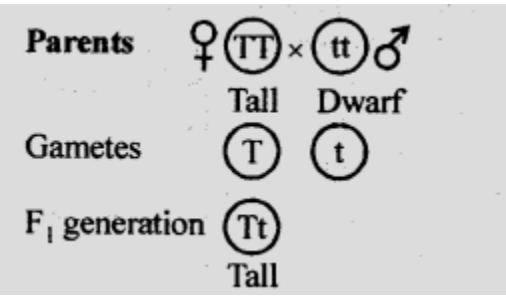
Monohybrid	**Dihybrid**
It is a cross between parents differing in only one pair of contrasting characters.	It is a cross between parents differing in two pairs of contrasting characters.
Example: A cross between a dwarf and a tall pea plant	Example: A cross between a yellow wrinkled seed and a green rounded seed

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

Ans: For a diploid organism, which is heterozygous for 4 loci, then 2^4 i.e. 2 x 2 x 2 x 2 = 16 types of gametes can be produced if the genes are not linked because for each heterozygous pair of genes there are two possibilities. So, for 4 pair the number of combinations will be 16 gametes.

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

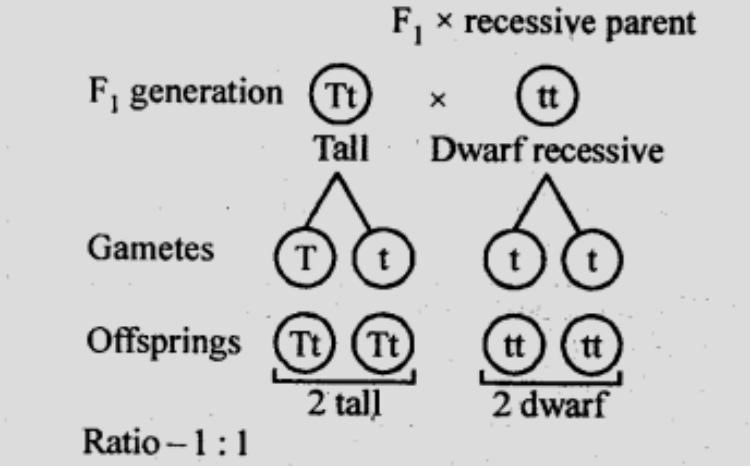
Ans: When two different factors (genes) or a pair of contrasting forms of a character are present in an organism, only one expresses itself in the F, generation and is termed as dominant while the other remains unexpressed and called recessive factors (gene).
A tall (TT) true breeding plant is crossed with a dwarf (tt) plant. The character of height is represented by'T' for tall't' for dwarf are the alternate form as character of height. The Fj hybrid 'Tt' is Tall, showing that tall is dominant over dwarf while dwarf remains unexpressed in F, offspring due to phenomenon of dominance by tall factor or gene.In this Tt heterozygous has tall phenotype showing T is dominant over t allele.



5. Define and design a test-cross.

Ans: When an individual is crossed with the homozygous recessive parent. It is called test

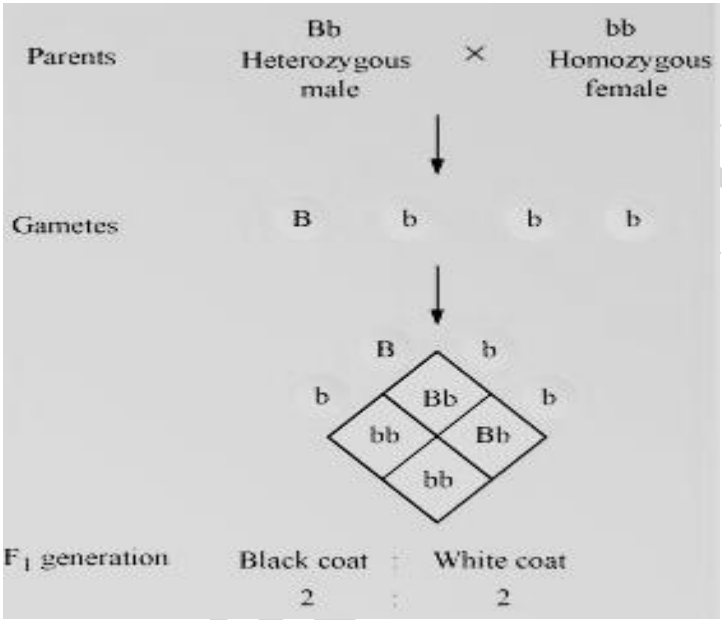
cross.



Test cross helps in establishing hetero/ homozygosity of dominant trait.

6. Using a Punnett Square, workout the distribution of phenotypic features in the first filial generation after a cross between a homozygous female and a heterozygous male for single locus.

Ans:



Phenotype: All tall

Genotype ratio : TT: Tt 2:2 or 1:1

7. When a cross is made between tall plant with yellow seeds (TtYy) and tall plant with green seed (Ttyy), what proportions of phenotype in the offspring could be expected to be (a)tali and green.

(b)dwarf and green.

Ans: A cross between tall plant with yellow seeds (TtYy) & tall plant with green seed **(Ttyy)**

is given below.

Parents → Tall Yellow Tt Yy × Tall Green Tt yy

Gametes → TY, Ty, tY, ty Ty ty

♂ \ ♀	Ty	ty
TY	TT Yy (Tall, yellow)	Tt Yy (Tall, yellow)
Ty	Tt yy (Tall, green)	Tt yy (Tall, green)
tY	Tt Yy (Tall, yellow)	tt Yy (Dwarf, yellow)
ty	Tt yy (Tall, green)	tt yy (Dwarf, green)

Phenotype ratio :

(a) Tall and green = 3/8 or 37.5%

(b) Dwarf and green = 1/8 or 12.5%

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?

Ans: Consider 2 characters Blue (B), long (L) seeds of a plant – both characters linked.

Crossing Parents :

Parents ♀ BbL/ × BbL/ ♂

Gametes BL, b/ × BL, b/

No B/, bL as B and L are **linked**

F_1 generation

♀ ♂	BL	b/
BL	BBLL	BbL/
b/	BbL/	bb//

Phenotype : BBLL : BbL/ : BbL/ : bb// (BBLL : BbL/ : BbL/ = Blue long; bb// = White small)

All parental combination, No recombinants.

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

Ans: Thomas Hunt Morgan (1866-1945), an American geneticist and Nobel Prize winner of 1933, is considered as "Father of experimental genetics" for his work on and discovery of linkage, crossing over, sex linkage, cress cross inheritance, linkage maps, mutability of genes,

etc. He is called fly man of genetics because of selecting fruit fly (Drosophila melanogaster) as research, material in experimental genetics. It was largely due to his book, "The Theory of Gene", that genetics was accepted as a distinct branch of biology. In 1910, he discovered linkage and distinguished linked and unlinked genes. Morgan and Castle (1911) proposed "Chromosome Theory of Linkage" showing that genes are located on the chromosomes and arranged in linear order. Morgan and Sturtevant (1911) found that frequency of crossing over (recombination) between two linked genes is directly proportional to the distance between the two. 1% recombination is considered to be equal to 1 centi Morgan (cM) or 1 map unit. He worked on sex linked inheritance and reported a white eyed male Drosophila in a population of red eyed and proved that gene of eye colour is located on X-chromosome. The male passed its genes on X-chromosomes to the daughter while the son gets genes on X-chromosome from the female (mother): It is called criss-cross inheritance.

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

Ans: Pedigree analysis is study of pedigree for the transmission of particular trait and finding the possibility of absence or presence of that trait in homozygous or heterozygous state in a particular individual. Pedigree analysis helps-

(i) in analysis of transmission of character in family over generation.

(ii) in genetic counselling of disease like haemophilia.

(iii) to identify whether a particular genetic disease is due to recessive gene or a dominant gene.

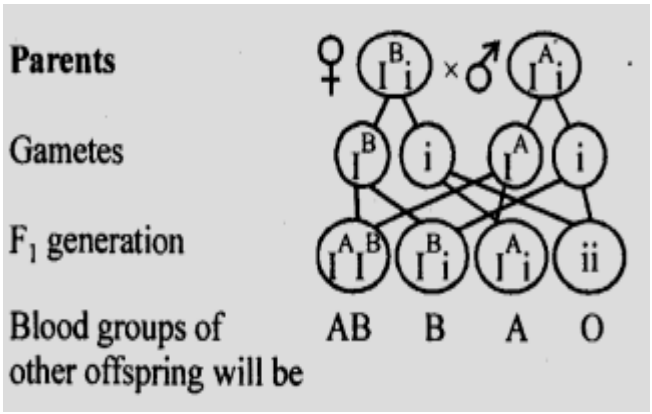
(iv) to identify the possible origin of the defective gene in the family or in a population.

11. How is sex determined in human beings?

Ans: Sex determination refers to the mechanisms employed by organisms to produce offsprings that are of two different sexes. The sex of an individual is determined by the genetic information present in the individual's sex chromosomes. Sex determination in human is done by XY type chromosome. In humans, females have two XX chromosomes and males have two different chromosomes (XY).

12. A child has blood group O. If the father has blood group A and mother of blood group B, work out the genotypes of the parents and the possible genotypes of the other off springs.

Ans:



13. Explain the following terms with example
(a) Co-dominance
(b) Incomplete dominance
Ans: (a) Codominance: Codominance is the phenomenon of two contrasting alleles of the same gene lacking dominant recessive ratio and expressing themselves simultaneously when present together. E.g. ABO blood group system – Human blood group AB is formed when alleles of blood groups A and B are present together (IAIB). Such RBCs carry both antigen A & B showing that both die alleles are expressing their effect phenotypically & codominant.
(b) Incomplete dominance: Incomplete dominance may be defined as the partial /expression of both alleles in a heterozygote so that the phenotype is intermediate between those of two homozygotes. In this none of the allele is completely dominant, e.g., pink colour flower in dog flower. In Mirabilis Jalapa & Snapdragon or dog flowers, there are two types of flower colour in pure state-red & white. When the two types of plant are crossed, the hybrid or plants of Fj generation have pink flowers. The pink colour apparently appears either due to mixing of red & white colours (incomplete dominance) or expression of a single gene for pigmented flower which produces only pink colour.

14. What is point mutation? Give one example.
Ans: Mutations arising due to change in single base pair of DNA is called point mutation. Eg., sickle cell anaemia, haemophilia.

15. Who had proposed the chromosomal theory of the inheritance?
Ans: Chromosomal theory of inheritance was proposed by Sutton and Boveri independently in 1902. The two workers found a close similarity between the transmission of Mendelian hereditary factors (genes) and behaviour of chromosomes during gamete formation and fertilisation. They proposed that chromosomes were the carriers of the Mendelian factors. It is the chromosome and not genes which segregate and assort independently during meiosis and recombine at the time of fertilisation in the zygote. Chromosomal theory of inheritance was expanded by Morgan, Sturtevant and Bridges.

16. Mention any two autosomal genetic disorders with their symptoms.
Ans: Sickle cell anaemia: Haemoglobin has less 02 transport, sickle shaped RBCs etc. Phenylketonuria: Mental retardation (due to accumulation of phenylalanine in brain), hypopigmentation of skin & hair, eczema etc.