

## NCERT solutions for class 12 biology chapter 5 Principles of Inheritance and Variation

**Q1 .** Mention the advantages of selecting pea plant for experiment by Mendel.

**Answer:**

The advantages of selecting garden pea ( *Pisum sativum* ) for experiments by Mendel were –

1. Pea has many visibly distinct contrasting characters.
2. The life span of the pea plant is short and they produce many seeds in one generation.
3. Pea flowers are bisexual and show self-pollination, reproductive whorls being enclosed by corolla.
4. It is easy to artificially cross-pollinate the pea flowers. The hybrids thus produced were fertile.

**Q2.** Differentiate between the following &ndash;

**(a)** Dominance and Recessive

**Answer:**

Dominance	Recessive
The phenomenon wherein a factor (allele) expresses itself in the presence or absence of its	It can only express itself in the absence of its dominant factor.

dominant factor, is called dominance.	
It forms a complete functional enzyme that perfectly expresses it.	It forms an incomplete defective enzyme which fails to express itself when present with its dominant allele, i.e., in heterozygous condition.

**(b) Homozygous and Heterozygous**

**Answer:**

Homozygous	Heterozygous
It contains two similar alleles for a particular trait. E.g TT, tt	It contains two dissimilar alleles for a particular trait. E.g. Tt
It can produce only one gametes	It can produce two types of gametes

**(c) Monohybrid and Dihybrid**

**Answer:**

Monohybrid	Dihybrid
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It involves a cross between individuals differing in only one pair of characters	It is a cross between individuals differing in two pairs of contrasting characters.
The cross between tall (TT) and dwarf (tt) pea plants is monohybrid	The cross between plants having yellow round (YYRR) seeds with those having green wrinkled (yyrr) seeds is dihybrid

**Q3.** A diploid organism is heterozygous for 4 loci, how many types of gametes can be produced?

**Answer:**

Loci refer to the place on the chromosome where genes are positioned. So, we can say that loci and genes are synonyms of each other. If a diploid organism is heterozygous for 4 loci then it will have four contrasting traits Aa, Bb, Cc, Dd and during meiosis 16 different kinds of gametes will be formed.

**Q4.** Explain the Law of Dominance using a monohybrid cross.

**Answer:**

According to Mendel's law of dominance. traits are controlled by two different forms of the same gene. These alternative forms of a gene are called alleles. Among the two alleles, one is dominant while the other one is recessive. The dominant allele suppresses the expression of the recessive allele. Therefore whenever the two alleles are present together, the dominant one masks the expression of the recessive allele. However, it

doesn't mean that the recessive allele has lost its existence. It remains hidden in F1 generation and reappears in the next generation. A monohybrid cross is given below.

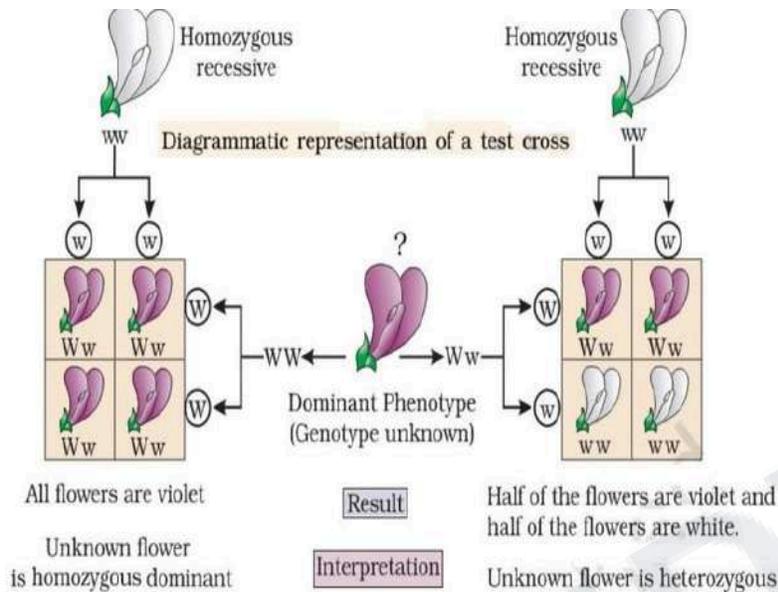
In this cross, it can be seen that in F1 generation only tall plants were seen, no plant was dwarf. However in the F2 generation, the F1 progeny was self crossed, three genotypes were observed, among these, the hybrids were showing the dominant trait.

**Q5.** Define and design a test-cross.

**Answer:**

**A test cross** is a cross between an individual showing a dominant trait with the one having its homozygous recessive trait in order to know whether the dominant trait is

homozygous or heterozygous. If the ratio of a test cross is 1:1, it shows that the dominant trait is heterozygous.



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**Q6.** 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 a single locus.

**Answer:**

In guinea pigs, homozygous female with white coat colour (bb) is cross with the heterozygous male having black coat colour (Bb). The male gamete will produce two types of gametes i.e. B and b while female will produce only one type of gamete which is b. The F1 progeny will show both individuals with black coat colour and white coat colour in a ratio of 1:1. Here, the phenotypic, as well as the genotypic ratio, will be 1:1.

Parents(male/female) Bb bb

Gametes B b b

Crossing Bb : bb

Black coat colour : White coat colour

Genotypic ratio- Bb:bb 1:1

Phenotypic ratio- Black coat colour : white coat colour 1:1

**Q7.** 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)** tall and green.

**Answer:**

The cross between a tall plant with yellow seeds (TtYy) and tall plant with green seeds (Ttyy) is as follows:

Parents: Tall yellow seed plant (TtYy) × Tall green seed plant (Ttyy)

Gametes: TY, Ty, tY, ty (from TtYy) and Ty, ty (from Ttyy)

♂ \ ♀	TY	ty
TY	TTYy Tall yellow	TtYy Tall yellow
Ty	TTyy Tall green	Ttyy Tall green
tY	TtYy Tall yellow	ttYy Dwarf yellow
ty	Ttyy Tall green	ttyy Dwarf green

Phenotypes : Tall and green = 3  
Dwarf and green = 1

Hence, there will be plants showing three tall and green seed trait.

(b) dwarf and green.

**Answer:**

The cross between tall plant with yellow seeds (TtYy) and tall plant with green seed (Ttyy), will look like

Parents: Tall yellow seed plant (TtYy) × Tall green seed plant (Ttyy)

Gametes: TY, Ty, tY, ty (from TtYy) and Ty, ty (from Ttyy)

♀ \ ♂	TY	ty
TY	TTYy Tall yellow	TtYy Tall yellow
Ty	TTyy Tall green	Ttyy Tall green
tY	TtYy Tall yellow	ttYy Dwarf yellow
ty	Ttyy Tall green	ttyy Dwarf green

Phenotypes: Tall and green = 3  
Dwarf and green = 1

Hence there will be only one plant with dwarf and green seed trait.

**Q8.** 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:**

Linkage refers to the physical association of genes on the same chromosomes. The genes that show linkage are called linked genes. These linked genes show the same kind of inheritance pattern and are inherited together in the next generation. For example, a cross between yellow body and white eyes and wild type parent in a *Drosophila* will produce wild type and yellow-white progenies. It is because yellow bodied and white-eyed genes are linked. Therefore, they are inherited together in progenies. The percentage of parental types and recombinant types is 98.7% and 1.3% respectively.

**Q9.** Briefly mention the contribution of T.H. Morgan in genetics.

**Answer:**

Contribution of T.H. Morgan in genetics

1. T.H Morgan discovered the chromosomal theory of inheritance.
2. He carried out many dihybrid crosses on *Drosophila* to study sex-linked disease.
3. Morgan discovered the phenomena called linkage to define the physical association of genes and recombination to describe the origin of non-parental gene combination.

**Q10.** What is pedigree analysis? Suggest how such an analysis, can be useful.

**Answer:**

The analysis of inherited traits in several generations of a family is called the pedigree analysis. The inheritance of a particular trait is represented in a family tree over several generations. It is used to trace the inheritance of a particular trait, abnormality and disease. By pedigree analysis, genetic counsellors can help in preventing certain genetic disorders like haemophilia, sickle cell anaemia in the future generation of that family.

**Q11.** How is sex determined in human beings?

**Answer:**

Sex determination in human beings

In humans, out of 23 pairs of chromosomes, 22 pairs are exactly the same in males and females called autosomes. However, a pair of the X chromosome is present in females and XY in males. During spermatogenesis, male produce two types of gametes (sperms),

50% carries Y chromosome and remaining 50% contain X chromosome. On the other hand, female produces only one kind of gamete (ovum) having X chromosomes only. When sperm having Y chromosome fertilizes the ovum the sex of the baby is male and when sperm carrying X chromosome fertilizes the egg, the sex of the baby is female.

heterogametic.

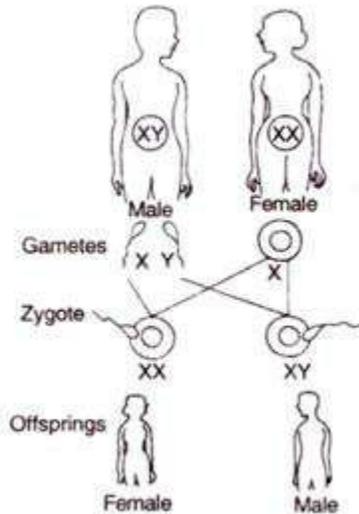
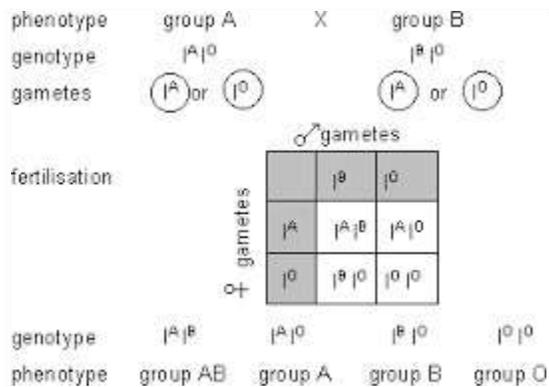


Fig. Human sex-determination mechanism.

**Q12.** 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 offsprings.

**Answer:**

If the child has O blood group then it is evident that parents are heterozygous. Thus, the genotype of the father will be  $I^A i$  and that of the mother will be  $I^B i$ . The child having blood group O will have genotype  $ii$ . The other children may have genotypes (A  $I^A i$  blood group), (B  $I^B i$  blood group) and (AB  $I^A I^B$  blood group).



**Q13 .**Explain the following terms with example

**(a)** Co-dominance

**Answer:**

**Codominance-**

It refers to the phenomenon of two alleles lacking dominance-recessive relationship and both expressing themselves in the heterozygous condition. In human beings, ABO blood grouping is controlled by gene  $I$ . The gene has three alleles  $I^A$ ,  $I^B$  and  $i$ . One person may have any two of these three alleles. Among these alleles,  $I^A$ ,  $I^B$  are dominant over  $i$ . Alleles  $I^A$  and  $I^B$ . When  $I^A$  and  $I^B$  are present together, both express themselves because of co-dominance.

**(b)** Incomplete dominance

**Answer:**

**Incomplete dominance-**

Incomplete dominance is the phenomenon of neither of the two alleles being dominant so that expression in the hybrid is a fine mixture or intermediate between the expressions

of two alleles. In snapdragon ( *Mirabilis jalapa* ), there are two types of pure breeding plants, red flowered and white flowered. On crossing the two, F1 plants possess pink flowers. On selfing them, F2 generation has 1red: 2 pink: 1white. The pink flower is due to incomplete dominance

**Q14.** What is point mutation? Give one example.

**Answer:**

**Point mutation** - When a mutation occurs in a single base pair of DNA, it is termed as a point mutation.e.g. Sickle cell anaemia.

**Q15.** Who had proposed the chromosomal theory of the inheritance?

**Answer:**

Sutton and Baveri in 1902 proposed the chromosomal theory of the inheritance.

**Q16.** Mention any two autosomal genetic disorders with their symptoms.

**Answer:**

The two autosomal genetic disorders are as follows

1. **Sickle cell anaemia** – It is an autosome linked recessive trait in which mutant haemoglobin molecules undergo polymerization under low oxygen tension causing a change in the shape of the RBC from biconvex disc to elongated sickle like structure. The defect is caused by the substitution of Glutamic acid (Glu) by Valine (Val) at the sixth position of the beta globin chain of the haemoglobin molecule. The substitution of amino acid in the globin protein results due to the single base substitution at the sixth codon of

the beta-globin gene from GAG to GUG. Symptoms include rapid heart rate, breathlessness, delayed growth and puberty, weakness, fever, decreased fertility etc.

2. **Down syndrome** - It is an autosomal genetic disorder caused by trisomy of chromosome 21. Symptoms of Down syndrome include short stature with a round head, protruding tongue, slanting eyes, broad short hands etc.

