NCERT Solutions for Class 12 Biology Chapter 4 – Principles of Inheritance and Variation

4.1

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

Ans: The pea plant (Pisum sativum) has been deliberately picked by Mendel due to several factors:

1. The pea has a short growth period and is a yearly crop. This makes it possible to arrive at the results quickly.
2. Peas have 7 unique characteristics that are easy to identify, including oval and yellow seeds, tall and diminutive height, etc.
3. Peas may be propagated through two methods: self-pollination & cross-pollination. Mendel had the ability to perform several crossings across plants with opposing traits and produce immaculate genotypes.
4. The pea plant yields an extensive amount of seeds per cycle. It offers a large amount of insight that could be of greater precision and can be examined quantitatively.

4.2

Differentiate between the following –

(a) Dominance and Recessive

(b) Homozygous and Heterozygous

(c) Monohybrid and Dihybrid.

Ans: (a)

Dominance	**Recessive**
1. An attribute that mitigates the impacts associated with different features, such dwarfism being suppressed by height.	1. A characteristic that is inhibited due to the influence of a different characteristic. For instance, height suppresses dwarfism.

2. An aspect that will show up even in the presence of a recessive gene.	2. A characteristic that appears only in the absence of the dominant feature.
3. A characteristic is exhibited by homozygous along with heterozygous people.	3. An attribute confined to homozygous people who possibly exhibits.

(b)

Homozygous	**Heterozygous**
1. The genetic makeup for a characteristic is composed of alleles that are identical to one another. The most common acronyms include TT (for tall) and tt (for short).	1. A collection of genes has distinct mutations for a characteristic. For instance, Tt.
2. The individual may be weak or strong for the people who have the TT genotype. For instance, plants with the TT gene are all going to be short enough, but tall plants will have that trait.	2. The individual is not recessive but often dominant or moderately dominant.
3. People are going to generate only one kind of gamete. As an example, T or t.	3. The individual will produce two distinct kinds of gametes, including T and t gametes.

(c)

Monohybrid	**Dihybrid**
1. A person who is developed by combining parents with differing traits for only one personality trait, like height, is called a monohybrid. For instance, Tt (plant height monohybrid).	1. A first-generation dihybrid is an individual produced by mating parents with diverse traits, like the color of seeds and germ structure. For instance, RrYy (dihybrid in terms of seed form and colour).
2. A hybrid created among two distinct parents who are homozygous for opposite traits regarding personality is known as a monohybrid cross. For instance, a hybrid of short (S) tt and tall TT.	2. Whenever a pair of parents become homozygous for contrasting characteristics in two distinct qualities, including seed color and form, a dihybrid cross takes place. A hybrid of rryy and RRYY (a rounded and

	yellow seeds). For instance, green and curled grains.
3. To examine the genetic transmission of an individual trait, a monohybrid cross between two species is employed.	3. The inherited nature of two traits is examined using a dihybrid cross.

4.3

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

Ans: The places on chromosomes where genomes are located are known as gene loci. Therefore, it is possible to think of loci and genes being convertible. An organism with a diploid genome that is heterozygous with 4 loci would generate two gametes throughout the meiosis process that exhibit four unique traits: Aa, Bb, Cc & Dd. The total amount of loci equals n. In the end, 16 distinct kinds of gametes would consequently arise.

4.4

Explain the Law of Dominance using a monohybrid cross.

Ans: According to the concept of Mendel's Law of Dominance states that distinct components that occur in pairs are often referred to as factors is the one which are responsible for controlling personalities. In two different components, one of them is more dominant than the other component. Consequently, the offspring (F1) will only demonstrate any one of the traits once the two parents (P) having contrasting characteristics are mated. In contrast to the recessive trait, which can be identified as the recessive trait, the dominant trait is the one that is manifested in the offspring and is referred to as the dominant trait.

The recessive trait appears in the following offspring (F2) because the (F1) progeny becomes selfed. This implies that the dominant allele decreased the physical manifestation of the weak characteristic rather than it disappearing. This can be expressed via a monohybrid cross. A mutation that occurs among two parents whose genes are homozygous for opposite traits in personality is known as a monohybrid cross. A hybrid of tall TT & short(s) TT is named as an example.

4.5

Define and design a test-cross.

Ans: A test cross remains a cross involving a weak parent and a plant whose genotype remains uncertain. A test cross is used to ascertain if an unknown seedling is homozygous or heterozygous or its genotype. The unidentified plant is considered heterozygous when the offspring of the test cross have a 1:1 dominant: recessive proportion. When all of the offspring are dominant then the unidentified plant ends up being homozygous.

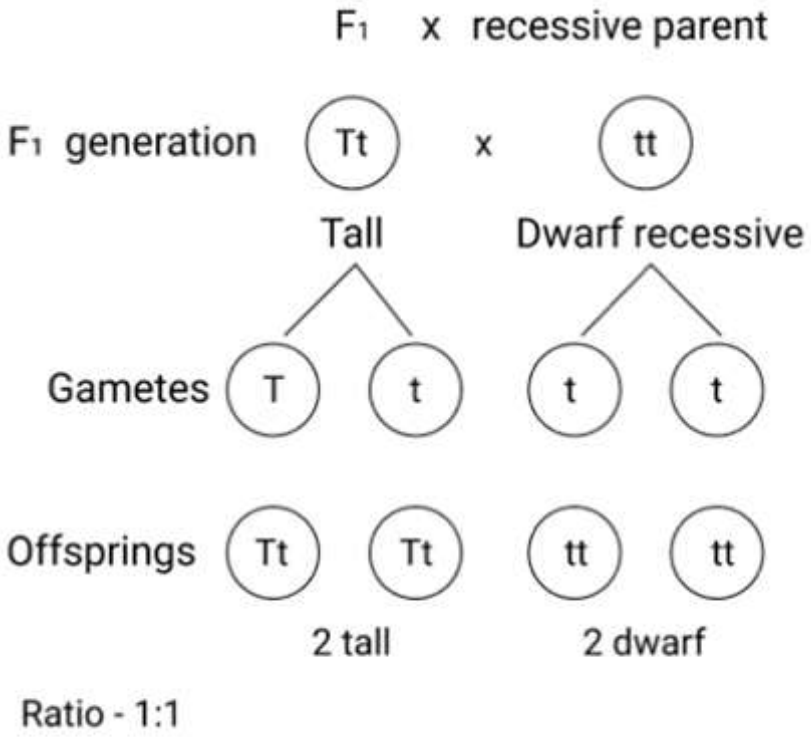
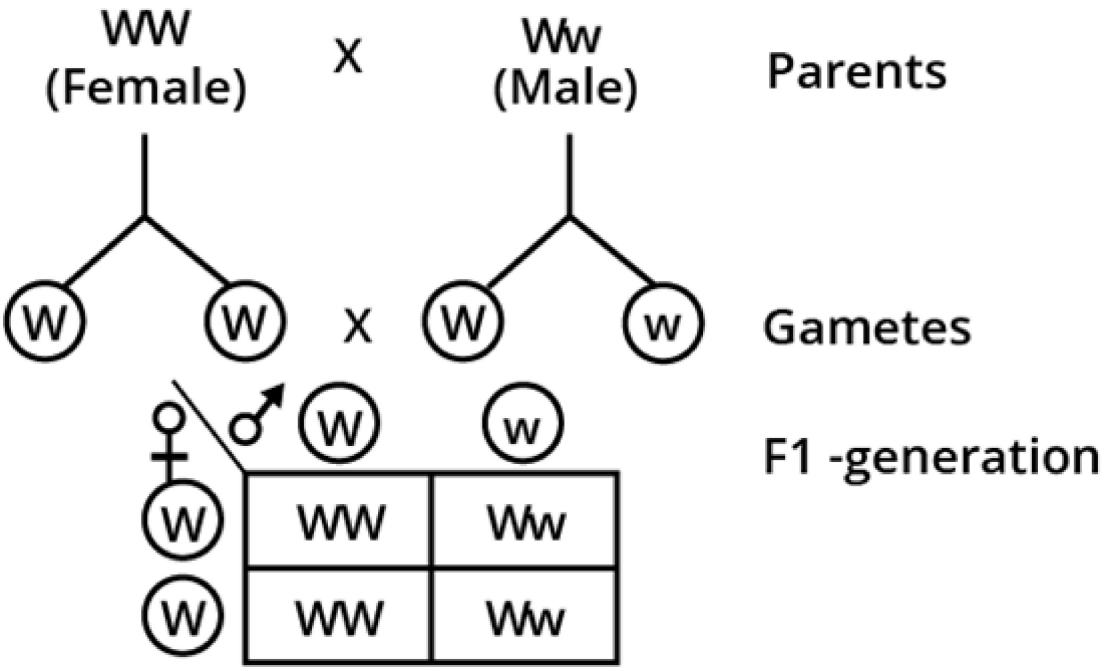


Image: Test Cross

4.6

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 a single locus.



Ans: We may observe that whenever homozygous female guinea pigs (ww) having white coats are mixed having heterozygous male guinea pigs (Ww) with black coats, the female generates just one kind of gamete (w), whilst the male creates two distinct kinds of gametes (W and w). In a computation of the Punnett square (1:1), you can observe that the ratios of genotypic to phenotypic variation for the first (F1) generations tend to be identical.

4.7

When a cross in 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.

(b) dwarf and green.

Ans: Finding a connection among the various allelic pairings became the primary goal in creating the dihybrid crossover. A mutation that occurs across two separate families or genotypes that vary between the two measurable features is known as a dihybrid cross. The phenotypic ratio of the offspring ought to consist of 3 tall and green with a single dwarf and green whenever tall plants containing yellow seeds (TtYy) are crossed, bearing tall plants without green seeds (TtYy).

	TY	Ty	tY	ty
TY	TTYY	TTYy	TtYY	TtYy
Ty	TTYy	TTyy	TtYy	Ttyy
tY	TtYY	TtYy	ttyy	ttYy
ty	TtYy	Ttyy	ttYy	ttyy

Tall and greèn ratio is: $\frac{3}{8}$

Dwarf and green ratio is: $\frac{1}{8}$

4.8

Two heterozygous parents are crossed. If the two loci are linked what would be the distribution of phenotypic features in F1 generation for a dibybrid cross?

Ans: Correlation is the word employed when referring to the mechanism by which two genes get passed down together; these genes have the designation linked genes. Whenever two genes are linked, all of the alleles are going to be transmitted as the same gene while there won't be any distinction between any across the genomes. The F1 generation's phenotypic will only have parental traits and without variants when the two genomes are linked. Insufficient connectivity will result in an increased percentage of parental phenotypes yet fewer mutations.

4.9

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

Ans: During his studies with the fruit fly species Drosophila melanogaster, T.H. Morgan offered vital improvements to the field of genetics. Among the major achievements he made in the field of genetics, here are some crucial factors that need to be considered:

1. He provided factual support for the Chromosomal Theory of Transmission. This perspective holds that genes can be discovered on chromosomes, which daughter cells acquire.
2. He proved that linked genes exist. Genes on identical chromosomes are referred to as related genes. Genes on identical chromosomes are passed down together and have a lower chance of recombining, in accordance with the linkage theory.
3. He demonstrated that the speed at which crossover is influenced by the amount of space that exists among genes within a chromosome. The likelihood that two distinct genes will ultimately be transmitted onto descendants of the same family increases with their degree

of connectivity. The likelihood of recombinants developing increases with the distance between those two genes across a chromosome.
4. He had chromosomal crossovers throughout meiosis. He illustrated inheritance via X-linked genes in the fruit fly. One species of Drosophila was named as Drosophila melanogaster.

4.10

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

Ans: One kind of genetic research that tracks a gene's transmission across a person's family tree is called a pedigree examination. A pedigree graph is a scientific representation made by our ancient predecessors who created exact signs to distinguish male, female, transporter, illness, and the list goes on. Some advantages of pedigree analysis include the ones that follow:

1. Find out precisely whether the specific gene structure is homozygous/heterozygous or homozygous/heterozygous for heterozygous/homozygous or heterozygous/homozygous or heterozygous for homozy.
2. A detailed analysis of how a specific gene is passed down through the same family's descendants.
3. Ascertain if an inherited dominant or weak genetic material is responsible for a certain genetic disease.
4. To investigate the source of the illness in the immediate family and determine where it came from.
5. To ascertain if and how likely it is that this particular gene will eventually be handed on via generations that follow.
6. To offer genetic assistance to household members that are at increased danger for a number of hereditary conditions, including sickle cell disorders, hemophilia, and others.

4.11

How is sex determined in human beings?

Ans: The XY sex-determination trait is present in human beings. The sex chromosomes for males and females are XY and XX, respectively. Men are capable of producing gametes with both X and Y chromosomes, but women are limited to creating gametes containing X chromosomes. A male infant is produced whenever a female gamete having X chromosomes develops into a male gamete containing Y chromosomes. The embryo that develops is a girl once a male gamete consisting of an X chromosome crosses with a female or another male gamete.

4.12

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.

Ans: Each of the 3 distinct kinds of alleles that define human blood classes are I, IB, and i. I grows into recessive, whereas IA and IB remain codominant. Blood groups A and B are denoted by the letters IA and IB, respectively. Each member of the O blood group is encoded by the I allele. Blood group A individuals can have one of two allele pairings. IAIA or IAi are what they are as individuals. Furthermore, some individuals possessing blood group B may have two different allele sequences. IBIB or IBi are the two. Whenever both IA and IB happen to exist, the blood group AB is created; when neither has been detected, the blood group O is created.

For a heterozygous condition, the dominant A and B alleles of the parents must have been represented since both the mother and the father possess strong alleles, but the kid has a recessive phenotype. This happens because the kid would have exhibited the dominant appearance instead of the recessive phenotype when the alleles remained homozygous for each parent. The other child might, therefore possess the blood type A, B, or AB in the case described above.

4.13

Explain the following terms with example

(a) Co-dominance

(b) Incomplete dominance

Ans: (a)

Ans: A genetic occurrence known as codominance happens when each of the alleles of a particular gene displays itself equally, giving rise to several features in a single person. It happens whenever a genetic pair's opposing alleles exhibit themselves equally. For instance, both A and B are evenly dominant in the human blood category; whenever both have been present, the AB category of blood manifests rather than either A or B.

(b)

Once a dominant allele fails to completely counteract the detrimental effects of an allele that is recessive, insufficient dominance takes place, causing the physical characteristics of the creature to mix the impacts associated with the two alleles. Another name for it is semi-dominance or half-dominance. Consider the hue of a snapdragon plant's flowers. The predominant position of the red blossom color (R) versus the white flower color (r) is not flawless. A pink flower phenotype results from the inability of the allele (R) to entirely suppress (r) whenever the two alleles have been identified in a single plant.

4.14

What is point mutation? Give one example.

Ans: A point mutation (PM) is a kind of genetic alteration in which an individual nitrogenous base is added or removed, changing any one of the base pairs within the sequence of bases in DNA. A precise arrangement of nucleotides encodes all the data needed to perform every function of a cell. For instance, sickle cell anemia produces sickle-shaped red blood cells (RBCs) instead of biconcave ones because valine replaces glutamic acid in the sixth spot within the hemoglobin beta globin link.

4.15

Who had proposed the chromosomal theory of the inheritance?

Ans: According to the chromosomal hypothesis regarding heredity, which was separately put into practice by Walter Sutton and Theodor Boveri during 1902, genes are found on chromosomes, and Mendelian inheritance trends are explained through the activity of chromosomes throughout meiosis. According to this, chromosomes act as carriers of genes. According to them, genes serve as chromosomes' collective form of inheritance.

4.16

Mention any two autosomal genetic disorders with their symptoms.

Ans:

1. Sickle Cell Anemia – Hemoglobin's biconcave structure shifts to what looks like a sickle form once a point alteration causes valine to swap out glutamic acid in the 6th spot of the beta globin strand. Failure, exhaustion, and a decrease in the plasma supply of oxygen are direct results of this occurrence.

2. Phenylketonuria – An enzymatic process that converts amino acids and phenylalanine into tyrosine is absent in people with phenylketonuria. After that, phenylalanine accumulates and is transformed into phenyl pyruvic acid, along with various compounds. One of the symptoms of this illness is cognitive impairment. Because of insufficient renal intake, they are removed in the urinary stream.