Classical Genetics

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1 – Mark Questions

Question 1.
The term 'Genetics' was introduced by _____
(a) Gregor Mendel
(b) Bateson
(c) Hugo de vries
(d) Carl Correns
Answer:
(b) Bateson

Question 2.
Which is not a correct statements?
(A) Variations are the raw materials for evolution
(B) Variations provide genetic material for natural selection
(C) It helps the individual to adapt to changing environment
(D) Variations allow breeders to improve the crop field
(a) A and D
(b) B only
(c) C and D
(d) nono of he above
Answer:
(d) nono of he above

Question 3.
The process of removal of anthers from the flower is called _____
Answer:
Emasculation

Question 4.
An allede is _____
(a) another word for a gene
(b) alternate forms of a gene
(c) morphological expression of a gene
(d) genitic
Answer:
(b) alternate forms of a gene

Question 5.
Gregor Mendel _____
(i) was born in Czechoslovakia
(ii) did his experiments in Pisum fulvum
(iii) was the first systemic researcher in genetics
(iv) Published his results in the paper "Experiments on Plant Hybrids"
(a) All are correct
(b) (ii),(iii), (iv) are correct
(c) (i), (iii),(iv) are correct
(d) (i), (iii),(iv) are correct
Answer:
(c) (i), (iii),(iv) are correct

Question 6.

	Column I		Column II
(A)	Cotyledon color	(*i*)	Inflated / Constricted
(B)	Flower color	(*ii*)	Green / Yellow
(C)	Seed shape	(*iii*)	Round / wrinkled
(D)	Pod shape	(*iv*)	Purple / White

Answer:
A – (ii) B – (iv) C – (iii) D – (i)

Question 7.
How many characters studied by Mendel in pisum sativum
(a) Three
(b) Five
(c) Seven
(d) Nine
Answer:
(c) Seven

Question 8.
Mendel's work were rediscovered by _____
(a) Hugo de Vries
(b) Tschermak
(c) Carl Correns
(d) All the above
Answer:
(d) All the above

Question 9.
Crossing of F_1, to any one of the parent refers to _____
(a) selling
(b) back cross
(c) test cross
(d) all of the above
Answer:
(b) back cross

Question 10.
Match the following

Gene interactions	F_2 Phenotype ratio
(A) Complementary genes	(*i*) 1 : 2 : 1
(B) Supplementary genes	(*ii*) 9 : 7
(C) Co-dominance	(*iii*) 15 : 1
(D) Duplicate genes	(*iv*) 9 : 3 : 4

Answer:
A – (ii)
B – (iv)
C – (i)
D – (iii)

Question 11.
In an intergenic interaction, the gene that suppresses the pherotype of a gene is said to Crossing of F, to any one of the parent refers to _____
(a) Dominant
(b) Inhibitory
(c) Epistatic
(d) Hypostatic
Answer:
(c) Epistatic

Question 12.
Assertion (A): Test cross is done between F_2 hybrid with F_1 recessive
Reason (R): It helps to identify the homozygosity of hybrids
(a) A and R are correct R explains A
(b) A and R are incorrect
(c) A is correct R is incorrect
(d) A is incorrect R is correct

Answer:
(b) A and R are incorrect

Question 13.
Assertion (A): Codominance is an example for intragenic interaction
Reason (R): Interaction take place between the alleles of same gene
(a) A and R are correct R explains A
(b) A and R are incorrect
(c) A is correct R is incorrect
(d) A is incorrect R is correct
Answer:
(a) A and R are correct R explains A

Question 14.
Assertion (A): Pleiotropic gene affects multiple traits
Reason (R): ABO blood group is an example for Pleiotropism
(a) A and R are correct R explains A
(b) A and R are incorrect
(c) A is correct R is incorrect
(d) A is incorrect R is correct
Answer:
(c) A is correct R is incorrect

Question 15.
Assertion (A) : Cytoplasmic male sterility is a Mendelian inheritance
Reason (R) : The genes for cytoplasmic male sterility in peal maize is located at mitochondrial DNA
(a) A and R are correct R explains A
(b) A and R are incorrect
(c) A is correct R is incorrect
(d) A is incorrect R is correct
Answer:
(d) A is incorrect R is correct

Question 16.
What is the phenotypic ratio in case of incomplete dominance
(a) 9 : 7
(b) 3 : 1
(c) 1 : 2 : 1
(d) 1 : 1 : 1 : 1
Answer:
(c) 1 : 2 : 1

Question 17.
Identify the mismatched pair
(a) Chloroplast inheritance – Gregor Mendel
(b) Polygenic inheritance – H. Nilsson
(c) Lethal genes – E. Baur
(d) Incomplete dominance – Carl Correns
Answer:
(a) Chloroplast inheritance – Gregor Mendel

Question 18.
Statement 1 : Intergenic gene interaction occurs between alleles at same locus
Statement 2 : Co-dominance is an example for intergenic gene interaction
(a) Statement 1 is correct & Statement 2 is incorrect
(b) Statement 1 is incorrect & Statement 2 is correct
(c) Both Statements 1 & 2 are correct
(d) Both Statements 1 & 2 are incorrect
Answer:
(c) Both Statements 1 & 2 are correct

Question 19.
Statement 1 : Test cross is done between F_1 individual with homozygous recessive
Statement 2 : If F_1 individual is homozygous, the rate of a monohybrid cross will be 1:1
(a) Statement 1 is correct & Statement 2 is incorrect
(b) Statement 1 is incorrect & Statement 2 is correct
(c) Both Statements 1 & 2 are correct
(d) Both Statements 1 & 2 are incorrect
Answer:
(a) Statement 1 is correct & Statement 2 is incorrect

Question 20.
Identify the incorrect statement
Answer:
(a) In incomplete dominance, the traits are blended not the genes
(b) Incomplete dominance is noticed in Mirabilis jalapa by Carl Correns
(c) It is a type of Intragenic gene interaction
(d) Incomplete dominance F_2 ratio is 1 : 3 : 1
Answer:
(d) Incomplete dominance F_1 ratio is 1 : 3 :1

Question 21.
In case of co-dominance, monohybrid F_1 _____ is 1 : 2 : 1

(a) Genotype ratio
(b) Phenotype ratio
(c) Both genotype & Phenotype ratio
(d) Ratio is wrong
Answer:
(c) Both genotype & Phenotype ratio

Question 22.
Identify the wrong statement (s)
(i) Monohybrid cross involve the inhertance of teo alleles of a gene
(ii) The dwarf traits reappeared in F_2
(iii) Law of dominance was proved by monohybrid cross
(iv) F_1 monohybrid was an hererozygous
(a) i and ii
(b) iii and iv
(c) i only
(d) none of the above
Answer:
(d) none of the above

Question 23.
Result of incomplete dominance is _____
(a) Intermediate genotype
(b) Intermediate phenotype
(c) Recessive phenotype
(d) Epistasis
Answer:
(b) Intermediate phenotype

Question 24.
Heterozygous Tall mono hybrid is cross with homozygous dwarf. What will be characteristic of offspring?
(a) 25 % recessive 75% dominant
(b) 75 % recessive 25% dominant
(c) 50 % recessive 50% dominant
(d) All are dominance
Answer:
(c) 50 % recessive 50% dominant

Question 25.
ABO blood group is a classical example for _____
(a) Polygenic inheritance

(b) Incomplete Dominance
(c) Epistasis
(d) Dominance
Answer:
(d) Dominance

Question 26.
RR (Red) flower of Mirabilis is crossed with White (WW) flowers. Resultant offspring are pink RW. This is an example of _____
(a) Epistasis
(b) Co-dominance
(c) Incomplete dominance
(d) Pleiotropism
Answer:
(c) Incomplete dominance

Question 27.
How many genetically different gametes are produced by a plant have genotype TtYyRr?
(a) 2
(b) 4
(c) 6
(d) 8
Answer:
(d) 8

Question 28.
When a single gene influences multiple traits then the phenomenon is called _____
(a) Pleiotropy
(b) Polygenic inheritance
(c) Epistasis
(d) Atavism
Answer:
(a) Pleiotropy

Question 29.
According to Mendel which character shown dominance.
(a) Yellow flower color
(b) Yellow cotyledon color
(c) Wrinkled seeds
(d) Inflated pod

Answer:
(d) Inflated pod

Question 30.
Ratio of recessive epistasis is _____
(a) 12 : 3 : 1
(b) 9 : 7
(c) 9 : 3 : 4
(d) 9 : 6 : 1
Answer:
(c) 9 : 3 : 4

Question 31.
According to Mendel, which is not a dominant trait?
(a) Wrinkled seeds
(b) Purple flower
(c) Inflated pod form
(d) Axial flower portion
Answer:
(a) Wrinkled seeds

Question 32.
Identify the allelic interaction.
(a) Domination epistasis
(b) Co – dominance
(c) Recessive epistasis
(d) Duplicate genes
Answer:
(b) Co – dominance

Question 33.
Gametes are never hybrid' is concluded by _____
(a) Law of dominance
(b) Law of segregation
(c) Law of independent environment
(d) Law of lethality
Answer:
(b) Law of segregation

Question 34.
Factor hypothesis was proposed by _____
(a) Reginald Punnett

(b) W. Bateson
(c) Gregor Mende
(d) Carl Correns
Answer:
(b) W. Bateson

Question 35.
The 1:2:1 ratio of co-dominance process Mendel's _____
(a) Law of dominance
(b) Law of recessiveness
(c) Law of segregation
(d) Law of independent assortment
Answer:
(b) Law of recessiveness

Question 36.
Match the following:
Epistatic interaction Example
(A) Complementary genes (i) Seed capsule in xxxxx
(B) Supplementary genes (ii) Leaf color in rice plant
(C) Inhibitory genes (iii) Grain color in maize
(D) Duplicate genes (iv) Flower color in sweet peas
Answer:
A – (iv)
B – (iii)
C – (ii)
D – (i)

2 – Mark Questions

Question 1.
Who coined the term genetics? Also define it.
Answer:
"Genetics" is the branch of biological science which deals with the mechanism of transmission of characters from parents to off springs. The term Genetics was introduced by W. Bateson in 1906.

Question 2.
Name the four major subdisciplines of genetics.
Answer:
(a) Classical genetics
(b) Molecular genetics

(c) Population genetics
(d) Quantitative genetics

Question 3.
Define Heredity and variations.
Answer:
Heredity: Heredity is the transmission of characters from parents to off springs.
Variations: The organisms belonging to the same natural population or species that shows a difference in the characteristics is called variation.

Question 4.
Mendel's theory is a particulate theory – justify.
Answer:
Mendel's theory of inheritance, known as the Particulate theory, establishes the existence of minute particles or hereditary units or factors, which are now called as genes.

Question 5.
Which organism was studied by Gregor Mendel? How many traits does he considered on his experiments?
Answer:
Gregor Mendel selected seven pairs of characters in Pisum sativum (garden pea)

Question 6.
Name any four characters of pisum sativum that was studied by Mendel.
Answer:
Seed shape, flower color, flower position & pod color.

Question 7.
Define the terms

1. Emasculation
2. Alleles.

Answer:

1. Emasculation: Removal of anthers from the flower
2. Alleles: Alternate forms of a gene

Question 8.
Name the first and second law of Mendel.
Answer:

1. The Law of Dominance
2. The Law of Segregation

Question 9.
What is genotype & phenotype?
Answer:
genotype & phenotype

1. The term genotype is the genetic constitution of an individual.
2. The term phenotype refers to the observable characteristic of an organism.

Question 10.
Write the phenotypic and genotypic ratio of monohybrid cross.
Answer:
(a) Phenotypic ratio = 3:1.
(b) Genotypic ratio =1 : 2 : 1

Question 11.
What is test cross? Why it is done?
Answer:

1. Test cross is crossing an individual of unknown genotype with a homozygous recessive.
2. Test cross is used to identify whether an individual is homozygous or heterozygous for dominant character.

Question 12.
State the law of independent assortment.
Answer:
When two pairs of traits are combined in a hybrid, segregation of one pair of characters is independent to the other pair of characters. Genes that are located in different chromosomes assort independently during meiosis.

Question 13.
Give the phenotypic ratio of
(a) Dihybrid cross
(b) Dihybrid test cross
Answer:
(a) Dihybrid cross ratio = 9 : 3 : 3 : 1
(b) Dihybrid test cross ratio = 1 : 1 : 1 : 1

Question 14.
RrYyf (F_1 hybrid) rryy (recessive parent). Name the type of cross. Mention its ratio.

Answer:
Dihybrid test cross and the ratio is 1 : 1 : 1 : 1

Question 15.
How many types of gametes are produced by a dihybrid plant. If the same plant is self fertilized, how many second generation offsprings are developed?
Answer:
Four different gametes are produced by a dihybrid plant and on selfing, it yield 16 off springs.

Question 16.
Write the phenotypic ratio of trihybrid cross.
Answer:
27 : 9 : 9 : 9 : 3 : 3 : 3 : 1

Question 17.
Define gene interaction.
Answer:
A single phenotype is controlled by more than one set of genes, each of which has two or more alleles. This phenomenon is called Gene Interaction.

Question 18.
Classify gene interactions with an example.
The gene interactions may be
(a) Intragenic gene interaction. E.g.: Codominance
(b) Intergenic gene interaction. E.g.: Epistasis

Question 19.
Provide any four intergenic gene interactions.
Answer:
(a) Incomplete dominance
(b) Codominance
(c) Multiple alleles
(d) Pleiotropic genes are common examples for intragenic interaction.

Question 20.
Define intragenic interaction
Answer:
Interactions take place between the alleles of the same gene i.e., alleles at the same locus is called intragenic or intralocus gene interaction.

Question 21.
In which plant does the incomplete dominance was studied by Carl Correns? Write

the ratio of the cross.
Answer:
Mirabilis Jalapa (4 o' clock plant). Incomplete dominance ratio is 1 : 2 : 1

Question 22.
What are lethal alleles? Give example.
Answer:
An allele which has the potential to cause the death of an organism is called a Lethal Allele.
E.g : Recessive lethality in Antirrhinum species.

Question 23.
Give the proper terminologies for the following statement
(a) Single gene affecting multiple traits
(b) Single trait affected by many genes.
Answer:
(a) Pleiotropism
(b) Poly genic inheritance

Question 24.
What is intergenic gene interactions? Give example
Answer:
Interlocus interactions take place between the alleles at different loci i.e. between alleles of different genes.
Eg: Dominant Epistasis

Question 25.
Name any two extranuclear inheritance.
Answer:
(a) Chloroplast inheritance
(b) Mitrochondrial inheritance

Question 26.
What are plasmogenes?
Answer:
Plasmogenes are independent, self-replicating, extra-chromosomal units located in cytoplasmic organelles, chloroplast and mitochondrion

Question 27.
What are extra nuclear inheritance?
Answer:
Certain characters/traits are governed and inherited by genes located in

cytoplasmic organelles (chloroplast or mitochondrion) other than nucleus. This is called extra nuclear inheritance.

Question 28.
Why extranuclear inheritance is called as cytoplasmic inheritance.
Answer:
Extra nuclear inheritance is due to genes located on the cytoplasmic organelles such as chloroplast and mitochondrion hence it is called cytoplasmic inheritance.

Question 29.
What is cytoplasmic male sterility?
Answer:
In Sorghum vulgare (Pearl maize), the gene located for the sterility pollens are located in the mitochondrial DNA. This phenomenon is called as cytoplasmic male sterility.

3 – Mark Questions

Question 30.
Point out any three importance of variations.
Answer:

1. They help the individuals to adapt themselves to the changing environment.
2. Variations allow breeders to improve better yield, quicker growth, increased resistance and lesser input.
3. They constitute the raw materials for evolution.

Question 31.
Why Mendel selected pea plants for his experiments.
Answer:
He choose pea plant because,

1. It is an annual plant and has clear contrasting characters that are controlled by a single gene separately.
2. Self-fertilization occurred under normal conditions in garden pea plants. Mendel used both self-fertilization and cross-fertilization.
3. The flowers are large hence emasculation and pollination are very easy for hybridization.

Question 32.
State the law of segregation.
Answer:
The Law of Segregation (Law of Purity of gametes): Alleles do not show any

blending. During the formation of gametes, the factors or alleles of a pair separate and segregate from each other such that each gamete receives only one of the two factors. A homozygous parent produces similar gametes and a heterozygous parent produces two kinds of gametes each having one allele with equal proportion. Gametes are never hybrid.

Question 33.
How many types of gametes are produced by heterozygous dihybrid plant with a genotypeRrYy? Write them.
Answer:
Four gametes – RY, Ry, rY, ry

Question 34.
Define trihybrid cross. Mention its F_2 phenotypic ratio.
Answer:
A cross between homozygous parents that differ in three gene pairs (i.e. producing trihybrids) is called trihybrid cross, F_2 Phenotypic ratio -27 : 9 : 9 : 9 : 3 : 3 : 3 : 1

Question 35.
Define co-dominance. How it is proved by using Gossypium species?
Answer:
The phenomenon in which two alleles are both expressed in the heterozygous individual is known as codominance. The codominance was demonstrated in plants with the help of electrophoresis or chromatography for protein or flavonoid substance.

Example: Gossypium hirsutum and Gossypium sturtianum, their F_1 hybrid (amphiploid) was tested for seed proteins i by electrophoresis. Both the parents have different banding patterns for their seed proteins. In hybrids, additive banding pattern was noticed. Their hybrid shows the presence of both the types of proteins similar to their parents.

Question 36.
Give an account on cytoplasmic male sterility.
Answer:
Male sterility found in pearl maize (Sorgum vulgare) is the best example for mitochondrial cytoplasmic inheritance. So it is called cytoplasmic male sterility. In this, male sterility is inherited maternally. The gene for cytoplasmic male sterility is found in the mitochondrial DNA.

Question 37.
Write a short note on Atavism.
Answer:

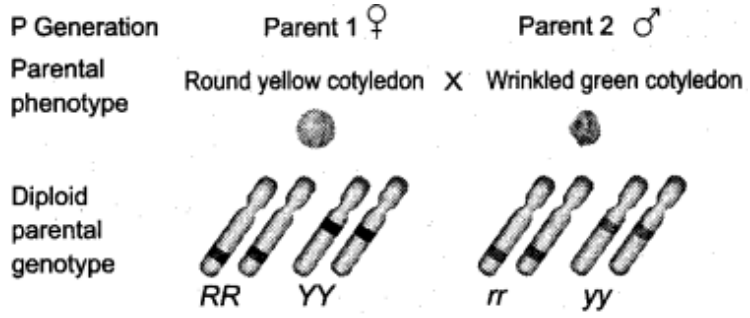
Atavism is a modification of a biological structure whereby an ancestral trait reappears after having been lost through evolutionary changes in the previous generations. Evolutionary traits that have disappeared phenotypically do not necessarily disappear from an organism's DNA. The gene sequence often remains, but is inactive.

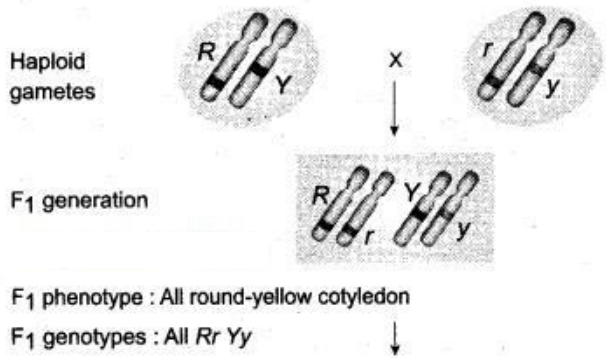
Such an unused gene may remain in the genome for many generations. As long as the gene remains intact, a fault in the genetic control suppressing the gene can lead to the reappearance of that character again. Reemergence of sexual reproduction in the flowering plant Hieracium pilosella is the best example for Atavism in plants.

5 – Mark Questions

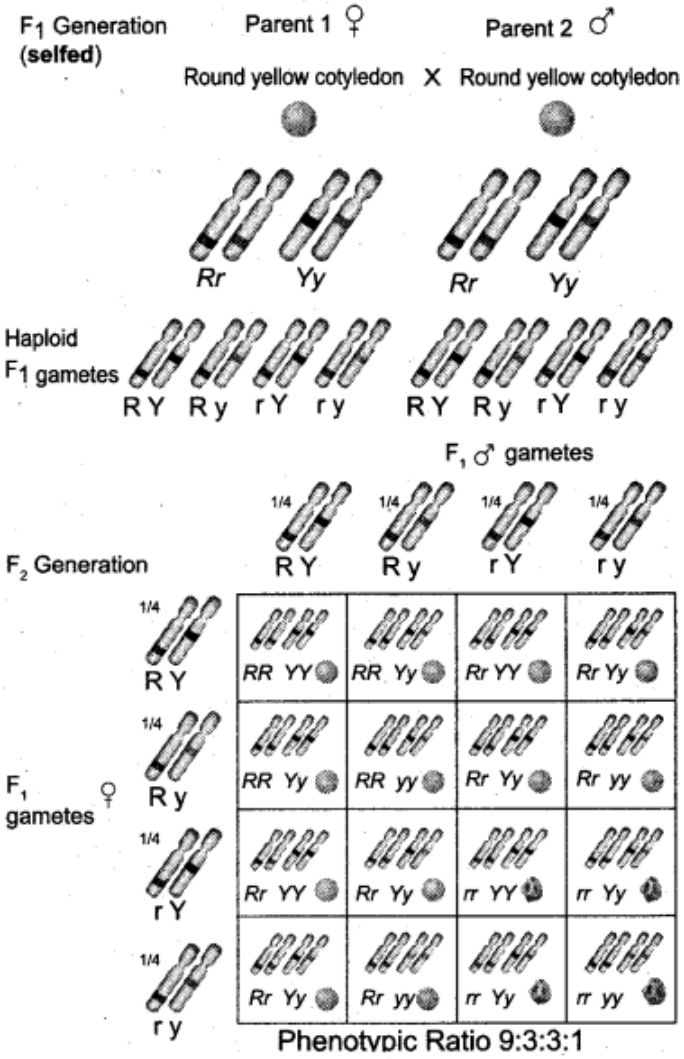
Question 38.
Explain Dihybrid cross in pea plant.
Answer:
The crossing of two plants differing in two pairs of contrasting traits is called dihybrid cross. In dihybrid cross, two characters (colour and shape) are considered at a time. Mendel considered the seed shape (round and wrinkled) and cotyledon colour (yellow & green) as the two characters. In seed shape round (R) is dominant over wrinkled (r); in cotyledon colour yellow (Y) is dominant over green (y).

Hence the pure breeding round yellow parent is represented by the genotype RRYY and the pure breeding green wrinkled parent is represented by the genotype rryy. During gamete formation the paired genes of a character assort out ' independently of the other pair. During the F_1 x F, fertilization each zygote with an equal probability receives one of the four combinations from each parent. The resultant gametes thus will be genetically different and they are of the following four types:





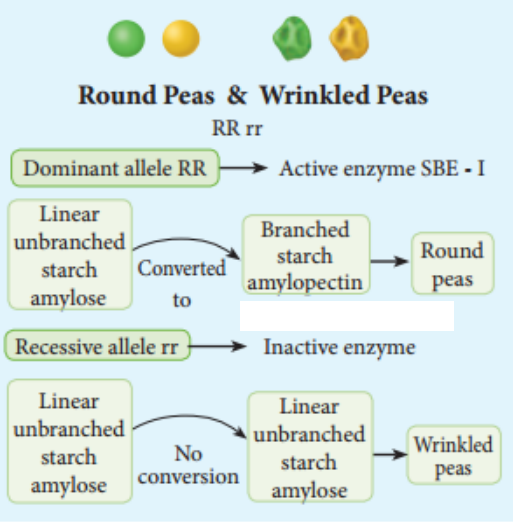
(1) Yellow round (YR) – 9/16
(2) Yellow wrinkled (Yr) – 3/16
(3) Green round (yR) – 3/16
(4) Green wrinkled (yr) -1/16



Dihybrid Cross in Garden peas

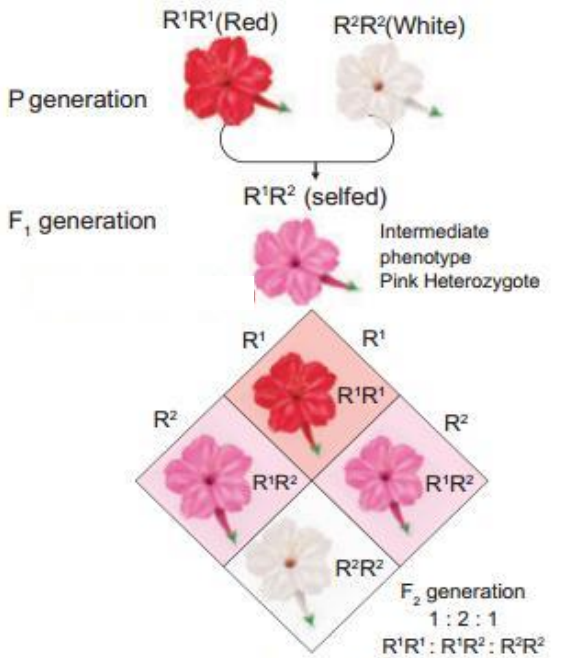
These four types of gametes of F_1 dihybrids unite randomly in the process of fertilization and produce sixteen types of individuals in F_2 in the ratio of 9:3:3:1 as shown in the figure. Mendel's 9:3:3:1 dihybrid ratio is an ideal ratio based on the probability including segregation, independent assortment and random fertilization. In sexually reproducing organism / plants from the garden peas to human beings, Mendel's findings laid the foundation for understanding inheritance and revolutionized the field of biology. The dihybrid cross and its result led Mendel to propose a second set of generalisations that we called Mendel's Law of independent assortment.

Question 39.
How does the wrinkled gene make Mendel's peas wrinkled? Find out the molecular explanation.
Answer:
The protein called starch branching enzyme (SBEI) is encoded by the wild-type allele of the gene (RR) which is dominant. When the seed matures, this enzyme SBEI catalyzes the formation of highly branched starch molecules. Normal gene (R) has become interrupted by the insertion of extra piece of DNA (0.8 kb) into the gene, resulting in allele. In the homozygous mutant form of the gene (R) which is recessive, the activity of the enzyme SBEI is lost resulting in wrinkled peas.



The wrinkled seed accumulates more sucrose and high water content. Hence Ore osmotic pressure inside the seed rises. As a result, the seed absorbs more water and when it matures it loses water as it dries. So it becomes wrinkled at maturation. When the seed has at least one copy of normal dominant gene heterozygous, the dominant allele helps to synthesize starch, amylopectin an insoluble carbohydrate, with the osmotic balance which minimises the loss of water resulting in smooth structured round seed.

Question 40.
Describe incomplete dominance exhibited by Mirabilis jalapa.
Answer:
The German Botanist Carl Correns's (1905) Experiment – In 4 O' clock plant, Mirabilis jalapa when the pure breeding homozygous red (R^1R^1) parent is crossed with homozygous white (R^2R^2), the phenotype of the F_1 hybrid is heterozygous pink (R^1R^2). The F_1 heterozygous phenotype differs from both the parental homozygous phenotype. This cross did not exhibit the character of the dominant parent but an intermediate colour pink. When one allele is not completely dominant to another allele it shows incomplete dominance. Such allelic interaction is known as incomplete dominance. F_1 generation produces intermediate phenotype pink coloured flower.



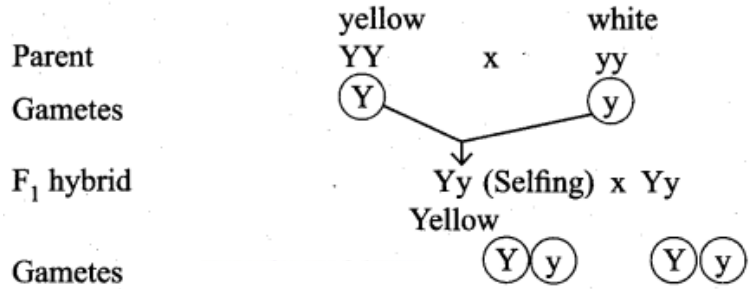
Incomplete dominance in 4 O' clock plant

When pink coloured plants of F_1 generation were interbred in F_2 both phenotypic and genotypic ratios were found to be identical as 1 : 2 :1(1 red: 2 pink: 1 white). Genotypic ratio is 1 R^1 R^1 : 2 R^1R^2 : 1 R^2R^2. From this we conclude that the alleles themselves remain discrete and unaltered proving the Mendel's Law of Segregation. The phenotypic and genotypic ratios are the same. There is no blending of genes. In the F^1 generation R^1 and R^2 genes segregate and recombine to produce red, pink and white in the ratio of 1 : 2 : 1. R^1 allele codes for an enzyme responsible for the formation of red pigment. R^2 allele codes for defective enzyme.

R^1 and R^2 genotypes produce only enough red pigments to make the flower pink. Two R^1 R^2 are needed for producing red flowers. Two R^2R^2 genes are needed for white flowers. If blending had taken place, the original pure traits would not have appeared and all F_2 plants would have pink flowers. It is very clear that Mendel's particulate inheritance takes place in this cross which is confirmed by the reappearance of original phenotype in F_2.

Higher Order Thinking Skills (HOTs) Questions

Question 1.
A yellow colour flower plant indicated by YY is crossed with white color flower plant denoted by yy.
(a) following the Mendelian inheritance pattern, what would be the flower color is first filial generation?
(b) Which Mendelian principle is illustrated in this cross?
(c) Derive the cross and state the phenotypic ratio of yellow flowers to white flowers in F_2 generation?
Answer:
(a) F_1 plants produce yellow colour flower plants.
(b) Law of dominance and Law of segregation
(c)



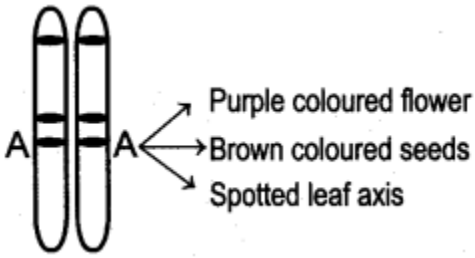
	Y	y
Y	YY (yellow)	Yy (yellow)
y	Yy (yellow)	yy (white)

Phenotypic ratio: 3 : 1

Question 2.
Mala is a genetic research student. She was given a plant to identify whether it is a homozygous or heterozygous for a particular trait. How will she proceed further?
Answer:
To identify the plant genotype whether homozygous or heterozygous Mala can perform test cross, where the individual is crossed with homozygous recessive for

the trait. If the plant is heterozygous then the resultant progenies would be in the ratio 50:50

Question 3.
In the chart given below, 'AA' are the genes located in a chromosome of Pisum sativum.
Answer:



Observe the chart and mention the genetic phenomenon does it indicates.
Pleitrophy – A single gene affecting many traits. Here the single gene AA controls the traits – for flower colour, seed colour and leaf axil spot.

Question 4.
Give the F_2 phenotypic ratio of
(a) Supplementary genes
(b) Complementary genes
(c) Dominant epistasis
Answer:
(a) Supplementary genes – 9 : 3 : 4
(b) Complementary genes – 9 : 7
(c) Dominant epistasis -12 : 3 : 1

Question 5.
Name the respective pattern of inheritance where F_1 phenotype
(a) resembles any one of the two parents
(b) is an intermediate between two parental traits.
Answer:
(a) Dominance
(b) Incomplete dominance