Heredity

Previous Years' CBSE Board Questions

8.1 Accumulation of Variation During Reproduction

VSA (1 mark)

1. How many pairs of chromosomes are present in human beings? (2020 C)

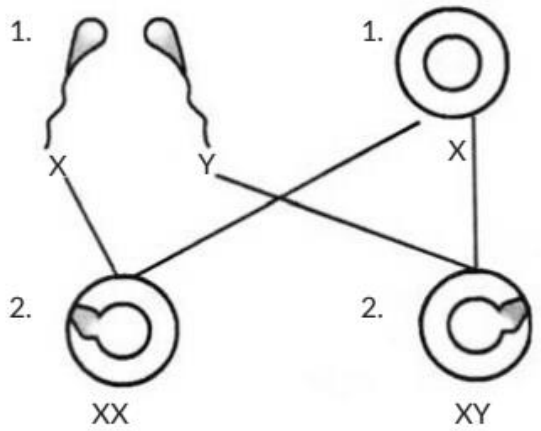
2. All the variations in a species do not have equal chances of survival. Why? (NCERT, Foreign 2014) |

SAI (2 marks)

3. Justify the statement "Sex of the children will be determined by what they inherit from their father". (Term II, 2021-22)

4. "Sex chromosomes in human males and females are XY and XX respectively. Statistical probability of getting either a male or a female child is 50%. Justify this statement giving reason. (Term II, 2021-22 C)

5. What is variation? List two main reasons that may lead to variation in a population. (Term II, 2021-22)
(a) Label (1) and (2) in the given diagram showing sex determination in human beings.
(b) If child inherits X-chromosome from the father what will be his/her gender?



(2021 C)

SA II (3 marks)

7. (a) Name the two types of gametes produced by men.
(b) Does a male child inherit X chromosome from his father? Justify.
(c) How many types of gametes are produced by a human female? (Term II, 2021-22)

LA (4/5 marks)

8. Sex of an individual is determined by different factors in various species. Some animals rely entirely on the environmental cues, while in some other animals the individuals scan change their sex during their life time indicating that sex of some species is not genetically determined. However, in human beings, the sex of an individual is largely determined genetically.
(a) In what way are the sex chromosomes 'X' and 'Y' different in size? Name the mismatched pair of sex chromosome in humans.
(b) Write the number of pair/pairs of sex chromosomes present in human beings. In which one of the parent (male/female) perfect pair/pairs of sex chromosomes are present?
(c) Citing two examples, justify the statement "Sex of an individual is not always determined genetically".

OR

9. (c) Draw a flow chart to show that sex is determined genetically in human beings. (Term II, 2021-22)
(a) "Sexual reproduction gives rise to more viable variations than asexual reproduction." Justify this statement and explain how the viable variations affect the evolution of those organisms that reproduce sexually.
(b) Does genetic combination of mothers play a significant role in determining the sex of a newborn? Give reason to justify your answer. (2019 C)

8.2 Heredity

MCQ

10. A cross between pea plant with white flowers (vv) and pea plant with violet flowers (VV) resulted in F2 progeny in which ratio of violet (VV) and white (vv) flowers will be (a) 1:1 (b) 2:1 (c) 3:1 (d) 1:3. (2023)

11. Assertion (A): In humans, if gene (B) is responsible for black eyes and gene (b) responsible for brown eyes, then the colour of eyes of the progeny having gene combination Bb, bb or BB will be black only. Reason (R): The black colour of the eyes is a dominant trait.
(a) Both (A) and (R) are true and (R) is the correct explanation of (A).
(b) Both (A) and (R) are true and (R) is not the correct explanation of (A).
(c) (A) is true but (R) is false.
(d) (A) is false but (R) is true. (2023)

12. Which one of the given statements is incorrect?
(a) DNA has the complete information for a particular characteristic.
(b) DNA is the molecule responsible for the inheritance of characters from parents to offsprings.
(c) Change in information will produce a different protein.
(d) Characteristics will remain the same even if protein changes. (2023)
13. Consider the following two statements:
(i) The trait that expresses itself in F_1 generation.
(ii) The trait that keeps on passing from one generation to another. The appropriate terms for the statements (i) and (ii) respectively are
(a) Recessive trait ; Dominant trait
(b) Dominant trait; Recessive trait
(c) Dominant trait; Inherited trait
(d) Recessive trait ; Inherited trait (2023)

13. Consider the following two statements:
(i) The trait that expresses itself in F1 generation.
(ii) The trait that keeps on passing from one generation to another.
The appropriate terms for the statements (i) and (ii) respectively are
(a) Recessive trait; Dominant trait
(b) Dominant trait; Recessive trait
(c) Dominant trait ; Inherited trait
(d) Recessive trait; Inherited trait (2023)

14. Assertion (A): Human population show a great deal of variations in traits. Reason (R): All variations in a species have equal chances of surviving in the environment in which they live.
(a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A)

(b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A)
(c) Assertion (A) is true, but Reason (R) is False.
(d) Assertion (A) is false, but Reason (R) is true. (2023)

15. Assertion (A): The sex of a child in human beings will be determined by the type of chromosome he/she inherits from the father.
Reason (R): A child who inherits 'X' chromosome from his father would be a girl (XX), while a child who inherits a 'Y' chromosome from the father would be a boy (XY).
(a) Both (A) and (R) are true and reason (R) is the correct explanation of the assertion (A).
(b) Both (A) and (R) are true, but reason (R) is not the correct explanation of the assertion (A).
(c) (A) is true, but (R) is false.
(d) (A) is false, but (R) is true. (2020)

VSA (1 mark)

16. What is heredity? (2021 C, AI 2014)

17. A Mendelian experiment consisted of breeding pea plants bearing violet flowers with pea plants bearing white flowers. What will be the result in F_1 progeny? (2018)

18. Name the information source for making proteins in the cells. (Delhi 2014)

19. What is a gene? (AI 2014)

20. Why is the progeny always tall when a tall pea plant is crossed with a short pea plant? (Foreign 2014)

SAI (2 marks)

21. (i) In a cross between violet flowered plants and white flowered plants, state the characteristics of the plants obtained in the F_1 progeny.
(ii) If the plants of F_1 progeny are self-pollinated, then what would be observed in the plants of F_2 progeny?
(iii) If 100 plants are produced in F2 progeny, then how many plants will show the recessive trait? (Term II, 2021-22)

SA II (3 marks)

22. How do Mendel's experiments show that the traits are inherited independently? Explain. (NCERT Intext, Term II 2021-22, Delhi 2017, Al 2016)

23. A cross was made between green-stemmed tomato plants denoted by (GG) and purple-stemmed tomato plants denoted as (gg) to obtain F1 progeny.
(a) What colour of the stem would you expect in their F_1 progeny and why?
(b) Give the percentage of purple-stemmed plants if F_1 plants are allowed to self-pollinate to produce F_2 progeny.
(c) Write the ratio between GG and gg plants in the F_2 progeny. (Term II, 2021-22)

24. (a) Why did Mendel carry out an experiment to study inheritance of two traits in garden pea?
(b) What were his findings with respect to inheritance of traits in F_1 and F_2 generation?
(c) State the ratio obtained in the F_2 generation in the above mentioned experiment. (2020) Ap

25. A green stemmed rose plant denoted by GG and a brown stemmed rose plant denoted by gg are allowed to undergo a cross with each other.
(a) List your observations regarding:
(i) Colour of stem in their F_1 progeny
(ii) Percentage of brown stemmed plants in F_2 progeny if plants are self pollinated.

(iii) Ratio of GG and Gg in the F_2 progeny.
(b) Based on the findings of this cross, what conclusion can be drawn? (2020)

26. (a) Why is the F_1 progeny always of tall plants when a tall plant is crossed with a short pea plant?
(b) How is F_2 progeny obtained by self-pollination of F_1 progeny different from F_1 progeny? Give reason for this observation.
(c) State a conclusion that can be drawn on the basis of this observation. (2020)

27. Name the plant Mendel used for his experiment. What type of progeny was obtained by Mendel in F_1 and F_2 generations when he crossed the tall and short plants? Write the ratio he obtained in F_2 generation plants. (Delhi 2019)

28. "It is a matter of chance whether a couple will have a male or a female child." Justify this statement by drawing a flow chart. (2019, Foreign 2015)

29. How did Mendel explain that it is possible that a trait is inherited but not expressed in an organism? (AI 2017)

OR

With the help of an example justify the following statement: "A trait may be inherited, but may not be expressed." (AI 2016)

OR

"It is possible that a trait is inherited but may not be expressed." Give a suitable example to justify this statement. (Foreign 2015, AI 2014)

30. In one of his experiments with pea plants Mendel observed that when a pure tall pea plant is crossed with a pure dwarf pea plant, in the first generation, F_1 only tall plants appear.
(a) What happens to the traits of the dwarf plants in this case?
(b) When the F_1 generation plants were self- fertilised, he observed that in the plants of second generation F_2, both tall plants and dwarf plants were present. Why it happened? Explain briefly. (Delhi 2016)

31. How did Mendel interpret his result to show that traits may be dominant or recessive? Describe briefly. (NCERT Intext, Delhi 2016)

32. In a monohybrid cross between tall pea plants (TT) and short pea plants (tt), a scientist obtained only tall pea plants (Tt) in the F_1 generation. However, on selfing the F_1 generation pea plants, he obtained both tall and short plants in F_2 generation. On the basis of above observations with other angiosperms also, can the scientist arrive at a law? If yes, explain the law. If not, give justification for your answer. (Delhi 2016)

33. List two differences in tabular form between dominant trait and recessive traits. What percentage/ proportion of the plants in the F_2 generation/progeny were round, in Mendel's cross between round and wrinkled pea plants? (Foreign 2016)

34. Explain Mendel's experiment with peas on inheritance of characters considering only one visible contrasting character. (Foreign 2016, 2014)

35. A cross was made between pure breeding pea plants, one with round and green seeds and the other with wrinkled and yellow seeds.
(a) Write the phenotype of F_1 progeny. Give reason for your answer.
(b) Write the different types of F2 progeny obtained along with their ratio when F_1 progeny was selfed. (Delhi 2014)

36. (a) Mendel crossed tall pea plants with dwarf pea plants in his experiment. Write his observations giving reasons on the F_1 and F_2 generations.
(b) List any two contrasting characters other than height that Mendel used in his experiments in pea plants.
(Delhi 2014)

LA (4/5 marks)

37. The most obvious outcome of the reproductive process is the generation of individuals of similar design, but in sexual reproduction they may not be exactly alike. The resemblances as well as differences are marked. The rules of heredity determine the process by which traits and characteristics are reliably inherited. Many experiments have been done to study the rules of inheritance.
(i) Why an offspring of human being is not a true copy of his parents in sexual reproduction?
(ii) While performing experiments on inheritance in plants, what is the difference between F_1 and F_2 generation?
(iii) Why do we say that variations are useful for the survival of a species over time?

OR

(iii) Study Mendel's cross between two plants with a pair of contrasting characters.
RRYY x rryy
Round Yellow Wrinkled Green
He observed 4 types of combinations in F_2 generation. Which of these were new combinations? Why do new features which are not present in the parents, appear in F_2 generation? (2023)

38. In some families, either rural or urban, females are tortured for giving birth to a female child. They do not seem to understand the scientific reason behind the birth of a boy or a girl. Infact the mother is not responsible for the

sex of the child and it has been genetically proved that the sex of a newborn is determined by what the child inherits from the father.
(a) State the basis on which the sex of a newborn baby is determined in humans.
(b) Why is the pair of sex chromosomes called a mismatched pair in males?
(c) How is the original number of chromosomes present in the parents restored in the progeny?

OR

(c) Explain by giving two examples of the organisms in which the sex is not genetically determined. (2023)

39. A student crossed pea plants having round and yellow seeds with pea plants having wrinkled and green seeds. He found that only one type of seeds were produced in the F_1 generation. When these F_1 generation pea plants were self-pollinated with each other, then in addition to the seed type of F_1 generation, some new types of seed combinations were also obtained in the F_2 generation.
(a) Mention the dominant traits observed in F_1 generation.
(b) What are the new possible combinations of seeds likely to be observed in F_2 generation?
(c) Give reason why the traits which were not visible in the seeds of F_1 generation reappeared in the seeds of F_2 generation. Write the ratio of different types of seeds obtained in F2 generation in this case.

OR

(c) What is meant by the terms (1) dominant, and (II) recessive traits? Explain. (Term II, 2021-22 C)

40. The mechanism by which the sex of an individual is determined is called sex-determination. In human beings, sex of a newborn is genetically determined, whereas in some others it is not. There are 46 (23 pairs) chromosomes in human beings. Out of these, 44 (22 pairs) control the body characters and 2 (one pair) are known as sex chromosomes. The sex chromosomes are of two types - X chromosome and Y chromosome. At the time of fertilisation, depending

upon which type of male gamete fuses with the female gamete, the sex of the newborn child is decided.
(a) Why is a pair of sex chromosomes in human beings called a mismatched pair in terms of type and size?
(b) If the gametes always have half the number of chromosomes, then how is the original number of chromosomes restored in the organism?
(c) Name two animals whose sex is not genetically determined. Explain the process of their sex determination.

OR

(c) With the help of a flowchart only, show how sex is genetically determined in human beings. (Term II, 2021-22)

41. Mendel blended his knowledge of Science and Mathematics to keep the count of the individual exhibiting a particular trait in each generation. He observed a number of contrasting visible characters controlled in pea plants in a field. He conducted many experiments to arrive at the laws of inheritance.
(a) What do the F_1 progeny of tall plants with round seeds and short plants with wrinkled seeds look like?
(b) Name the recessive traits in above case.
(c) Mention the type of the new combinations of plants obtained in F_2 progeny along with their ratio, if F_1 progeny was allowed to self pollinate.

OR

(c) If 1600 plants were obtained in F2 progeny, write the number of plants having traits:
(i) Tall with round seeds
(ii) Short with wrinkled seeds Write the conclusion of the above experiment. (Term II, 2021-22)

42. How do Mendel's experiments show that
(a) traits may be dominant or recessive?
(b) inheritance of two traits is independent of each other? (NCERT Intext, 2019, Delhi 2017)

43. (a) Why did Mendel choose garden pea for his experiments? Write two reasons.
(b) List two contrasting visible characters of garden pea Mendel used for his

experiment.
(c) Explain in brief how Mendel interpreted his results to show that the traits may be dominant or recessive. (Foreign 2016)

CBSE Sample Questions

8.1 Accumulation of Variation During Reproduction

SAI (2 marks)

In an asexually reproducing species, if a trait X exists in 5% of a population and trait Y exists in 70% of the same population, which of the two traits is likely to have arisen earlier? Give reason. (Term II, 2021-22)

8.2 Heredity

MCQ

2. If a pure tall pea plant is crossed with a pure dwarf pea plant then, what percentage of F_1 and F_2 generation respectively will be tall?
(a) 25%, 25%
(c) 75%,100%
(b) 50%, 50%
(d) 100%, 75% (2022-23)

3. Assertion (A): Height in pea plants is controlled by efficiency of enzymes and is thus genetically controlled.
Reason (R): Cellular DNA is the information source for making proteins in the cell.
(a) Both (A) and (R) are true and (R) is the correct explanation of (A).
(b) Both (A) and (R) are true and (R) is not the correct explanation of (A).
(c) (A) is true, but (R) is false.
(d) (A) is false but (R) is true. (2022-23)

4. Assertion (A): A geneticist crossed a pea plant having violet flowers with a pea plant with white flowers, he got all violet flowers in first generation.
Reason (R): White colour gene is not passed on to next generation.
(a) Both (A) and (R) are true and (R) is the correct explanation of (A).
(b) Both (A) and (R) are true but (R) is not the correct explanation of (A).

(c) (A) is true, but (R) is false.
(d) (A) is false, but (R) is true. (2020-21)

SA II (3 marks)

5. Two pea plants - one with round yellow seeds (RRYY) and another with wrinkled green (rryy) seeds produce F_1 progeny that have round, yellow (RrYy) seeds. When F_1 plants are self-pollinated, which new combination of characters is expected in F_2 progeny?

How many seeds with these new combinations of characters will be produced when a total 160 seeds are produced in F2 generation? Explain with reason. (Term II, 2021-22)

6. After self-pollination in pea plants with round yellow seeds, following types of seeds were obtained by Mendel:

Seeds	Number
Round, yellow	630
Round, green	216
Wrinkled, yellow	202
Wrinkled, green	64

Analyse the result and describe the mechanism of inheritance which explains these results. (2020-21)

7. In humans, there is a 50% probability of the birth of a boy and 50% probability that a girl will be born. Justify the statement on the basis of the mechanism of sex-determination in human beings. (2020-21)

LA (4 marks)

8. Pooja has green eyes while her parents and brother have black eyes. Pooja's husband Ravi has black eyes while his mother has green eyes and father has black eyes.
(a) On the basis of the above given information, is the green eye colour a dominant or recessive trait? Justify your answer.

(b) What is the possible genetic makeup of Pooja's brother's eye colour?
(c) What is the probability that the offspring of Pooja and Ravi will have green eyes? Also, show the inheritance of eye colour in the offspring with the help of a suitable cross.

OR

(c) 50% of the offspring of Pooja's brother are green eyed. With help of cross show how this is possible. (2022-23)

9. Sahil performed an experiment to study the inheritance pattern of genes. He crossed tall pea plants (TT) with short pea plants (tt) and obtained all tall plants in F1 generation.
(a) What will be set of genes present in the F_1 generation?
(b) Give reason why only tall plants are observed in F_1 progeny.
(c) When F_1 plants were self-pollinated, a total of 800 plants were produced. How many of these would be tall, medium height or short plants? Give the genotype of F_2 generation.

OR

(c) When F_1 plants were cross-pollinated with plants having tt genes, a total of 800 plants were produced. How many of these would be tall, medium height or short plants? Give the genotype of F2 generation. (Term II, 2021-22)

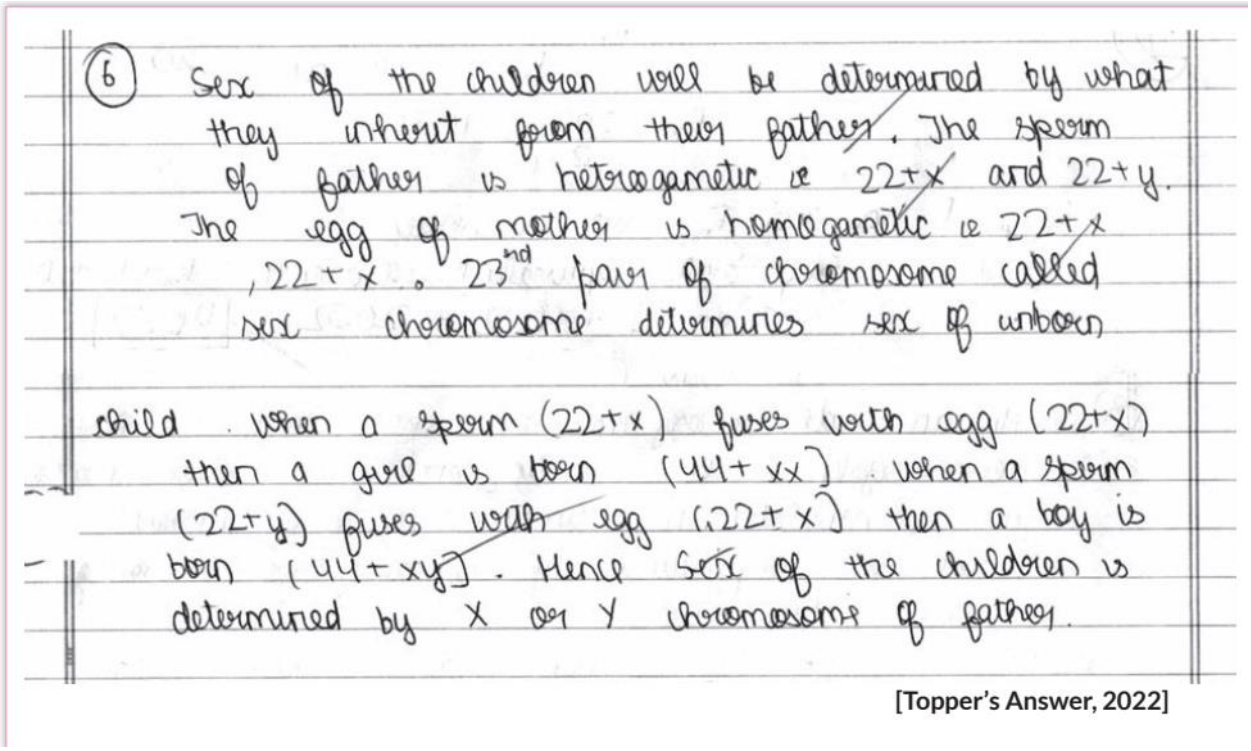
SOLUTIONS

Previous Years' CBSE Board Questions

1. In human beings, 23 pairs of chromosomes are present in each cell. Out of 23 pairs, 22 pairs of chromosomes carry genes which control somatic traits, these chromosomes are called autosomes. The 23rd is called sex chromosomes. pair

2. All the variations do not have equal chances of survival in the environment in which they live. Depending on the nature of variations, different individuals would have different kinds of advantages. The organisms which are most adapted to the environment will survive.

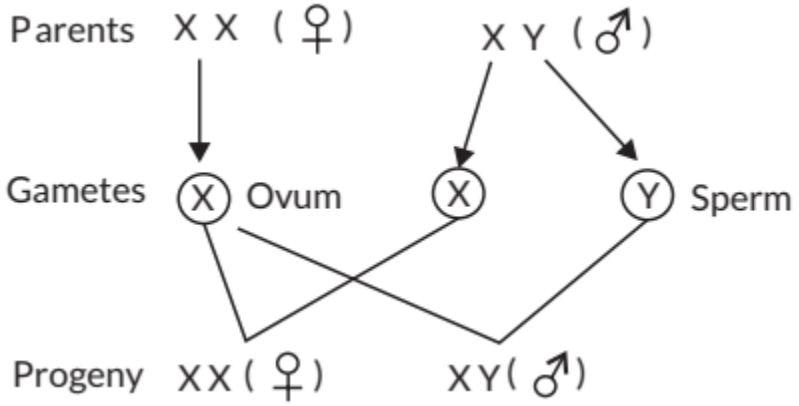
3.



(6) Sex of the children will be determined by what they inherit from their father. The sperm of father is heterogametic ie 22+x and 22+y. The egg of mother is homogametic ie 22+x, 22+x. 23rd pair of chromosome called sex chromosome determines sex of unborn child. When a sperm (22+x) fuses with egg (22+x) then a girl is born (44+xx). When a sperm (22+y) fuses with egg (22+x) then a boy is born (44+xy). Hence sex of the children is determined by X or Y chromosome of father.

[Topper's Answer, 2022]

Human female (XX) produces all gametes (ova) with X-chromosomes, while human male (XY) produces 50% gametes (sperms) with X-chromosome while 50% gametes with Y-chromosome. If sperm having X chromosome fertilises the ovum with X chromosome then a female child will be produced, otherwise a male child will be produced.



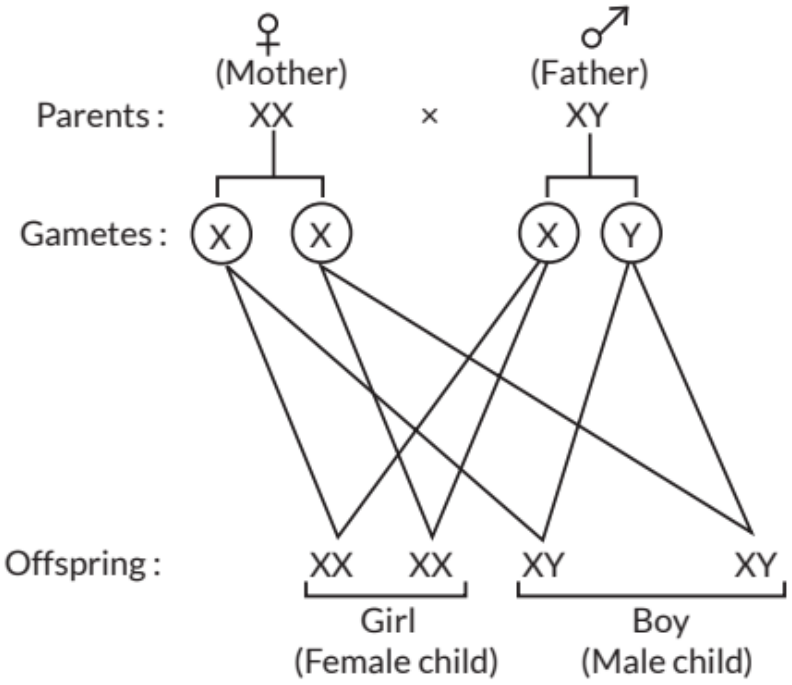
Sex of the child (offspring) is determined by the type of sperm that fuses with ovum at the time of fertilisation. Therefore, there is 50% chance of a male child being born and a 50% chance of a female child being born.

5. Variation is the degree of differences in the progeny (offsprings) and

between the progeny and parents. Two main reasons of variations are mutations and genetic recombination during sexual reproduction.

6. (a) Label (1) - Gametes; Label (2) - Zygote
(b) If a child inherits X-Chromosome from the father then the sex of the child will be female.

7. (a) The gametes produced by human males are of two types, (22 + X) and (22 + Y).
(b) No, a male child does not inherit X chromosome from his father. A male child can inherit 'X' chromosome from his mother only. Mother has XX chromosome whereas, father has XY. The X chromosome of male child can be inherited from mother only and the Y-chromosome can be inherited only from father.



(c) A human female produces only one type of gamete (22 + X).

8. (a) X chromosome is morphologically distinct from Y chromosome. Y chromosome is smaller than X chromosome. Hence, they are dissimilar or heteromorphic. Men have mismatched pair of sex chromosome in humans in which one is normal size X while other is a short one called Y.
(b) Human beings have 22 pair of autosomal chromosomes and one pair of sex chromosome. Women have a perfect pair of sex chromosomes both called X.

(c) (i) Sex of the individual is not always determined genetically. In some organisms, gender may be determined by environmental factors. For example snails, turtles and lizards sex is determined by the temperature at which fertilised egg are kept.

OR

(ii) Refer to Answer 4.

9. (a) During sexual reproduction, at the time of gamete formation, meiotic cell division takes place. During meiosis, crossing over between fragments of homologous chromosomes which brings about new gene combinations to be transferred to new generation. Crossing over is the fundamental cause of origin of variations in sexually reproducing organisms. Asexual reproduction does not involve meiosis and crossing over because of one parent lineage. Hence, only minute variations may occur in them due to mutation. The variations caused by crossing over in sexually reproducing organisms are subjected to the selection process. Natural selection selects those variations which have more adaptive value and guide them towards evolution of new species. In this way, sexual reproduction gives rise to more viable variations for evolution.
(b) Mothers have the combination of XX chromosomes. Thus, mother is homogametic and produces only one type of gametes, having X chromosomes. Boy or girl, thus, inherit X chromosome from mother. Therefore, mother does not play any important role in determination of sex of the new born.

10. (a): Parents:

VV (Violet) × vv (White)

Gametes : V × v

F_1 : Vv (Violet)

Selfing

F_2 :

♂ \ ♀	V	v
V	VV (violet)	Vv (violet)
v	Vv (violet)	vv (white)

F_2 Ratio : VV : vv

(Violet) (White)

1 : 1

11. (d)

Parents : BB (Black) × bb (Brown)

Gametes : B × b

F_1 : Bb (black)

F_2 :

♀ \ ♂	B	b
B	BB (Black)	Bb (Black)
b	Bb (Black)	bb (Brown)

Genotypic Ratio : BB : Bb : bb

(Black) (Black) (Brown)

1 : 2 : 1

Phenotypic Ratio : Black : Brown

3 : 1

12. (d)

13. (c)

14. (c): Variations get accumulated or discarded as combined effect of environmental factors and reproduction process.

15. (a)

16. The inheritance of characters (or traits) from the parents to their offsprings is called heredity.

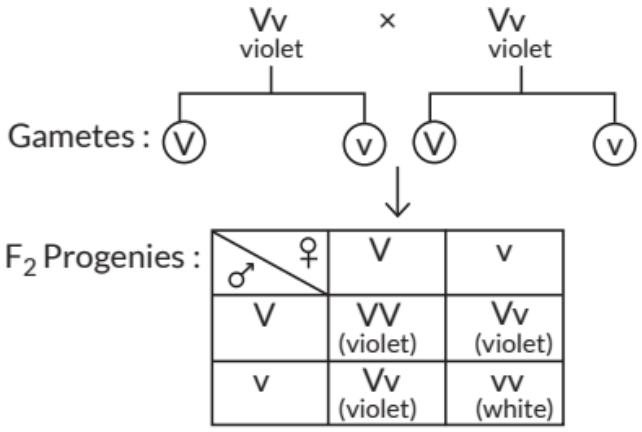
17. According to the Mendelian experiment, violet colour (VV) is a dominant trait while white colour (vv) is a recessive trait. Hence, the colour of the flower in F1 progeny will be violet (Vv). Concept Applied (G Law of dominance

18. Deoxyribonucleic acid (DNA) present in the chromosomes of cell nucleus is the information source for making proteins.

19. A gene is a unit of DNA on a chromosome which governs the synthesis of particular protein that controls specific characteristics (or traits) of an organism.

20. When a tall pea plant is crossed with a short pea plant, the resultant progeny is always tall because tall is dominant trait and short is recessive trait. Therefore, dominant trait expresses itself in the progeny.

21. (i) The plants obtained in F_1 progeny will be violet since violet is a dominant trait.
(ii) If the plants of F_1 progeny are self pollinated then the F_2 generation will have violet and white flowers in the ratio of 3: 1. Self pollination of F_1 generation is shown as follows:

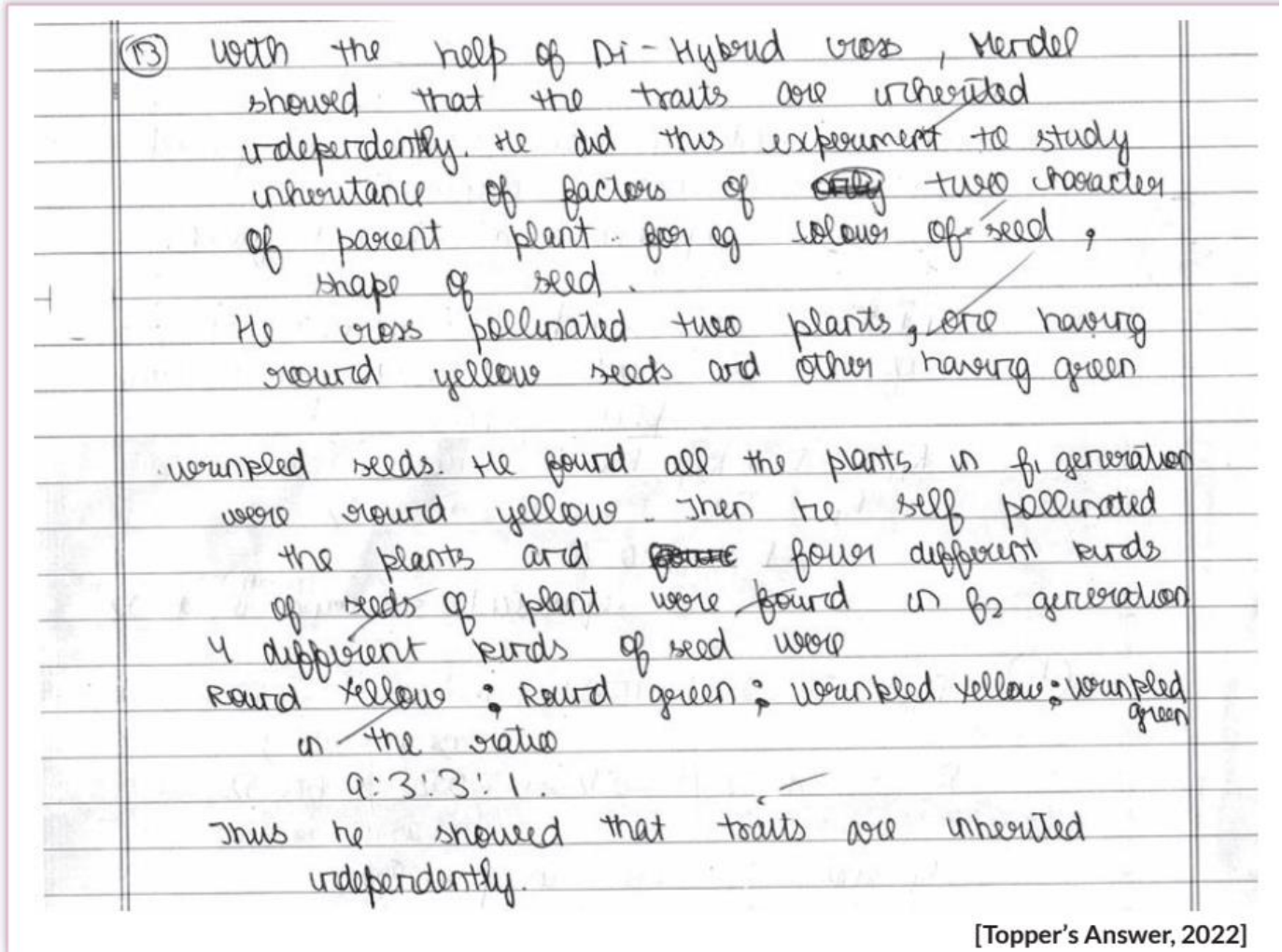


Phenotypic: 3 : 1
ratio Violet : White

(iii) The ratio of progeny produced in F_2 generation is 3: 1. i.e., 3 violet flowers and 1 white flower. Hence, the

number of white flowers will be $\frac{1}{4} \times 100 = 25$. Hence, 25 plants will show the recessive trait.

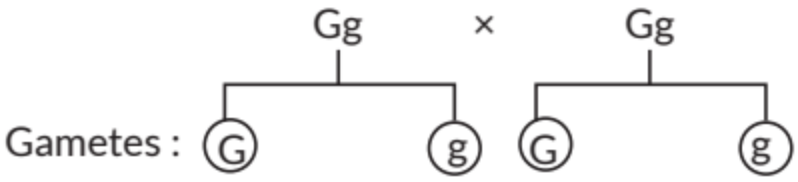
22.



(13) With the help of Di-Hybrid cross, Mendel showed that the traits are inherited independently. He did this experiment to study inheritance of factors of two character of parent plant. for eg colour of seed, shape of seed.
He cross pollinated two plants, one having round yellow seeds and other having green wrinkled seeds. He found all the plants in f_1 generation were round yellow. Then he self pollinated the plants and four different kinds of seeds of plant were found in f_2 generation. 4 different kinds of seed were Round Yellow ; Round green ; Wrinkled Yellow ; Wrinkled green in the ratio
9:3:3:1.
Thus he showed that traits are inherited independently.

[Topper's Answer, 2022]

23. (a) F1 progeny will have green stemmed tomato plants as green is dominant over purple stemmed tomato plants.
(b) If F_1 plants are self pollinated, then the percentage of purple stemmed plant in F_2 progeny will be 25%.



F_2 Progenies :

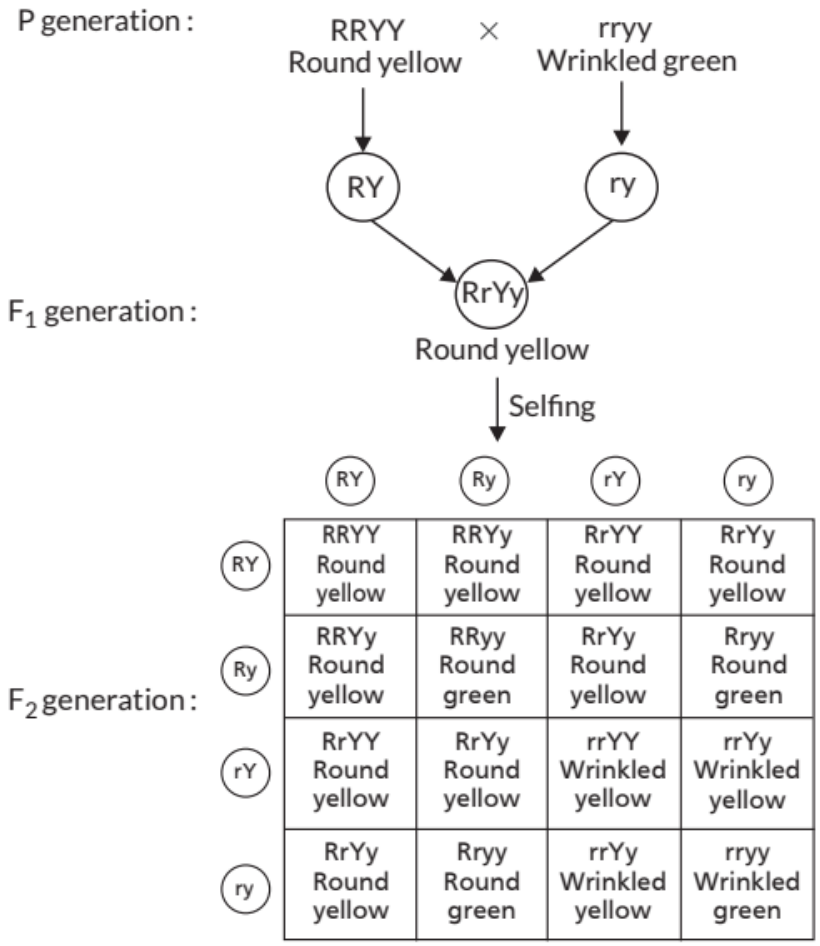
♀ / ♂	G	g
G	GG Green stemmed	Gg Green stemmed
g	Gg Green stemmed	gg Purple stemmed

Phenotypic ratio : 3 : 1
Green Stemmed : Purple Stemmed

(c) Ratio of GG and gg plant in F_2 generation will be 1 : 1.

24. (a) Mendel carried out crosses with two traits to see the interaction and basis of inheritance between them. In a dihybrid cross given by Mendel, it was observed that when two pairs of characters were considered each trait expressed independent of the other.

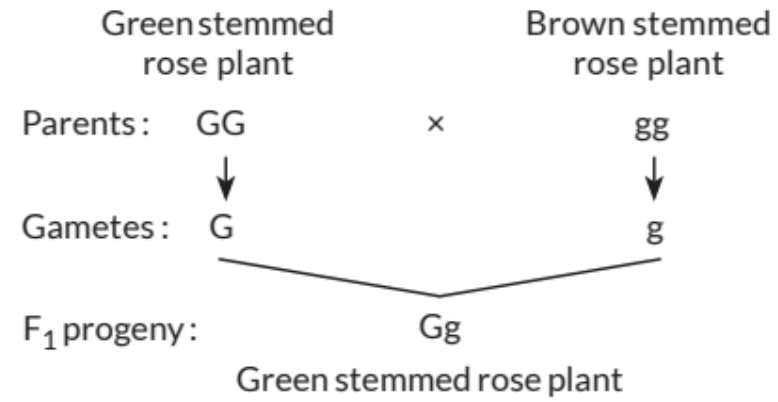
(b) To study inheritance of traits in F_1 and F_2 generation, a cross was made between round yellow and wrinkled green parents.



(c) In F_1 generation, all plants are with round yellow seeds. But in F2 generation, we find all types of plants : Round yellow, Round green, Wrinkled yellow, Wrinkled green. F_2 generation ratio: Round-yellow = 9; Round-green = 3; Wrinkled-yellow = 3; Wrinkled-green =1

25.

(a) (i) Colour of stem in F_1 progeny :



The colour in the F_1 progeny is green stemmed as green stem colour is dominant.

(ii) F1 progeny on self pollination:

Gg × Gg

↓

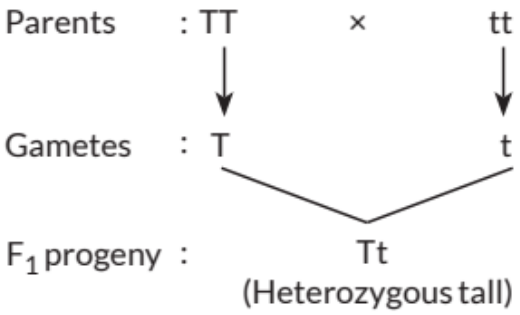
	G	g
G	GG	Gg
g	Gg	gg

F_2 generation : Green stemmed : Brown stemmed
3 : 1

(iii) Ratio of GG and Gg in F_2 progeny :
Genotype of F_2 progeny - GG: Gg
1: 2

(b) This is a monohybrid cross. This shows that out of two contrasting traits only one dominant trait appears in F_1 generation and the trait which does not express is recessive. On selfing the F_1 plants, both the traits appear in next generation but in a definite proportion.

26. (a) When a tall plant (TT) is crossed with a short pea plant (tt), only tall plants are obtained in F_1 progeny. It is because out of two contrasting traits only one appears in the progeny of first generation. This means that the trait which appears in F1 generation is dominant and the trait which does not express is recessive. The character TT for tall plant is dominant, so all the plants are tall.



(b) On selfing F_1 progeny

F_1 generation Tt × Tt

Selfing

	T	t
T	TT	Tt
t	Tt	tt

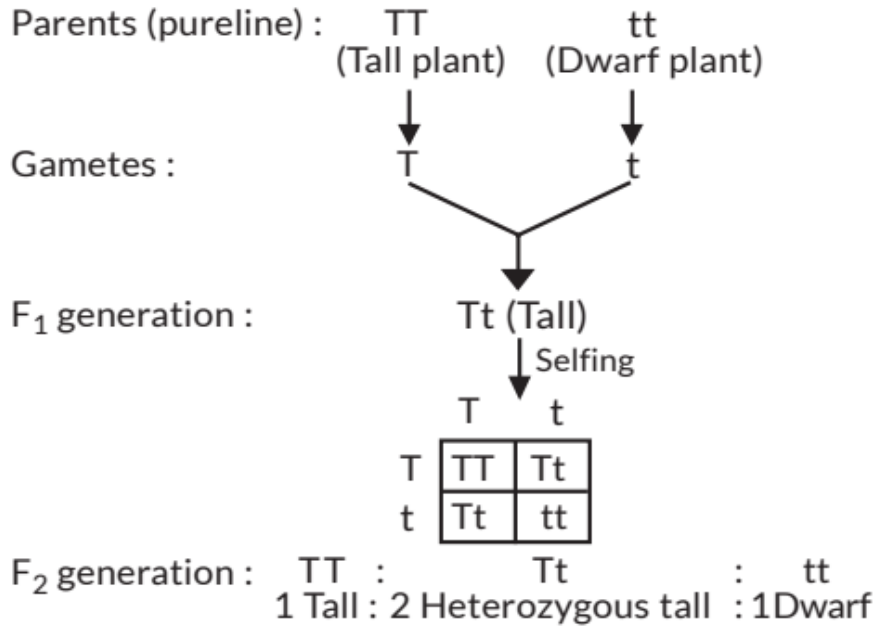
F_2 generation Tall : Dwarf

3 : 1

In F_2 generation both tall and dwarf plants are obtained. Appearance of suppressed recessive trait in individuals of F_2 generation in Mendelian cross indicates that characters of recessive traits are not lost. When the F_1 generation plants were allowed to self-fertilise both the parental trait were expressed in definite proportion in F_2 generation.

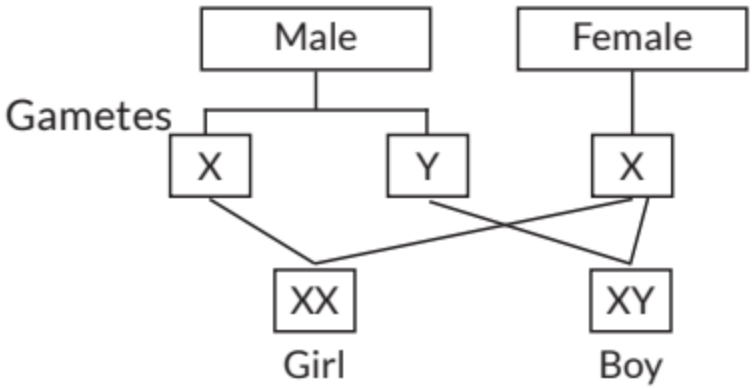
(c) Above observation shows that only one dominant allele is expressed. This is called law of dominance. In a heterozygous individual, two dissimilar alleles remain together and do not get mixed up. At the time of gamete formation, they separate so that each gamete receives only one allele and is always pure. This is called "law of purity of gametes".

27. Mendel selected garden pea (Pisum sativum) for his series of hybridisation experiments. He first selected two pureline plants (tall plant having gene TT and short plant having gene tt) and then crossed such plants having contrasting characters. In the F_1 generation, he observed that only one of the two contrasting character appeared, he called this character as dominant and the one which does not get expressed in F_1 was called as recessive. He later selfed the F_1 plants and observed that both the traits appear in next generation but in a definite proportion. This can be explained by the following cross:

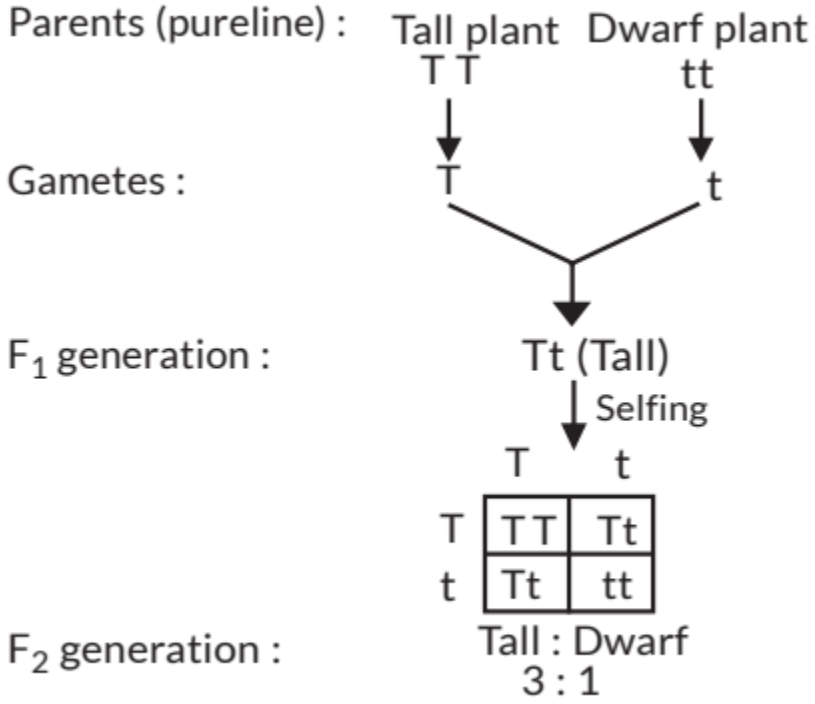


So, the plants of F_1 generation will be all tall plants and after selfing, both tall and dwarf plants are obtained in F_2 generation. The ratio of tall and dwarf plants that Mendel obtained in F_2 generation is 3: 1.

28. Sex is determined at the time of fertilisation when male and female gametes fuse. Male produces two types of gametes, i.e., having X or Y chromosome and female produces same type of gametes containing X chromosomes. The sex of the child is determined at the time of fertilisation when male and female gametes fuse to form zygote. If a sperm (male gamete) carrying X chromosome fertilises an egg or ovum (female gamete) carrying X chromosome, then the offspring will be a girl (female). This is because the offspring will have XX combination of sex chromosomes. If a sperm (male gamete) carrying Y chromosome fertilises an egg or ovum (female gamete) which has X chromosome, then the offspring will be a boy (male). This is because the offspring will have XY combination of sex chromosomes. Therefore, there are 50% chance of a male child and 50% chance of a female child.

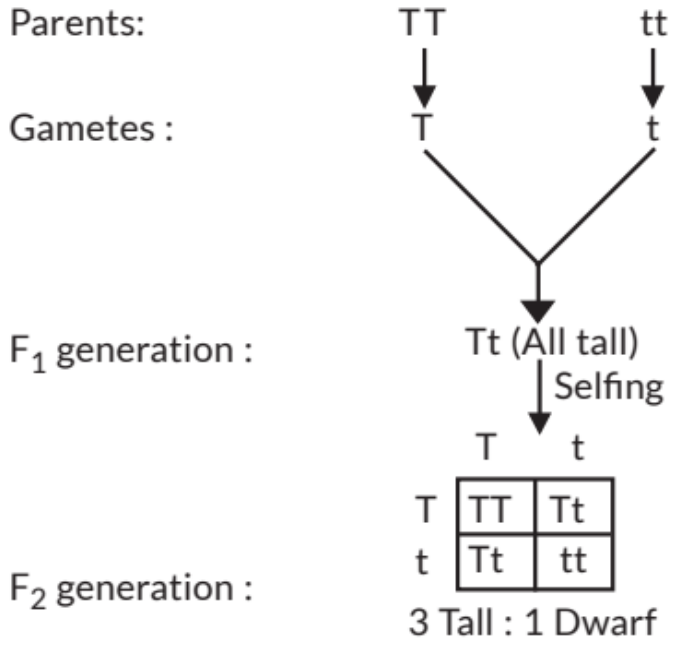


29. Mendel first selected two pure line plants. He then crossed such plants having contrasting characters. In the F_1 generation, he observed that only one of the two contrasting character appeared, he called it dominant and the one which does not get expressed in F_1 was recessive. He later selfed the F_1 plants and observed that both the traits appear but in a definite proportion. It can be explained by the following cross:

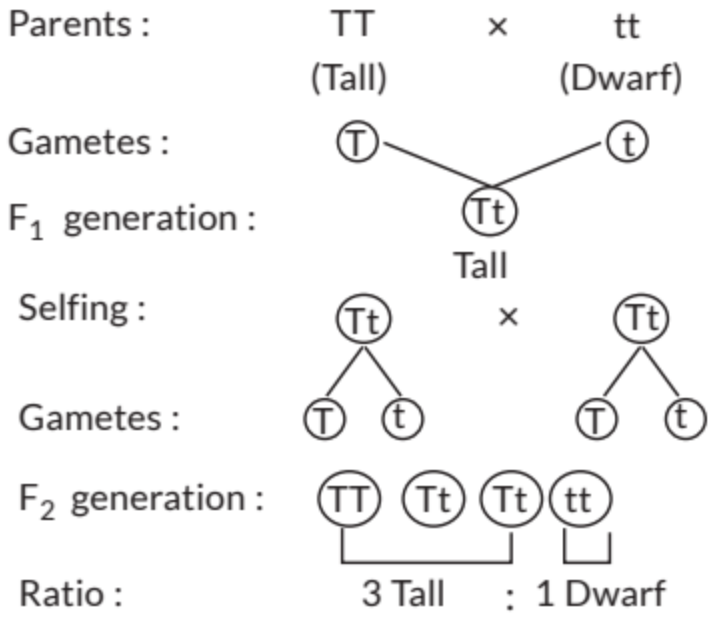


This is how Mendel explained that a trait may be inherited but not expressed in the organism.

30. (a) Mendel's monohybrid cross indicated that out of two contrasting traits only one appears in the progeny of first generation. This implies that the trait which appears in F_1 generation is dominant and the trait which does not express is recessive. We can also say that gene controlling the dominant trait is dominant gene or allele and gene controlling the recessive trait is recessive gene or allele. In F_1 progeny although the dominant trait is expressed but genes for both dominant and recessive traits are present in a heterozygous condition. The recessive trait has a chance to express in next generation only if recessive genes come in homozygous condition. So the trait for dwarf plant is not expressed in F_1 generation. This can be illustrated by the given cross:



32. In the situation discussed in the question the scientist can arrive at two different laws, i.e., law of dominance and law of segregation (or law of purity of gametes). This can be explained with the help of following crosses :



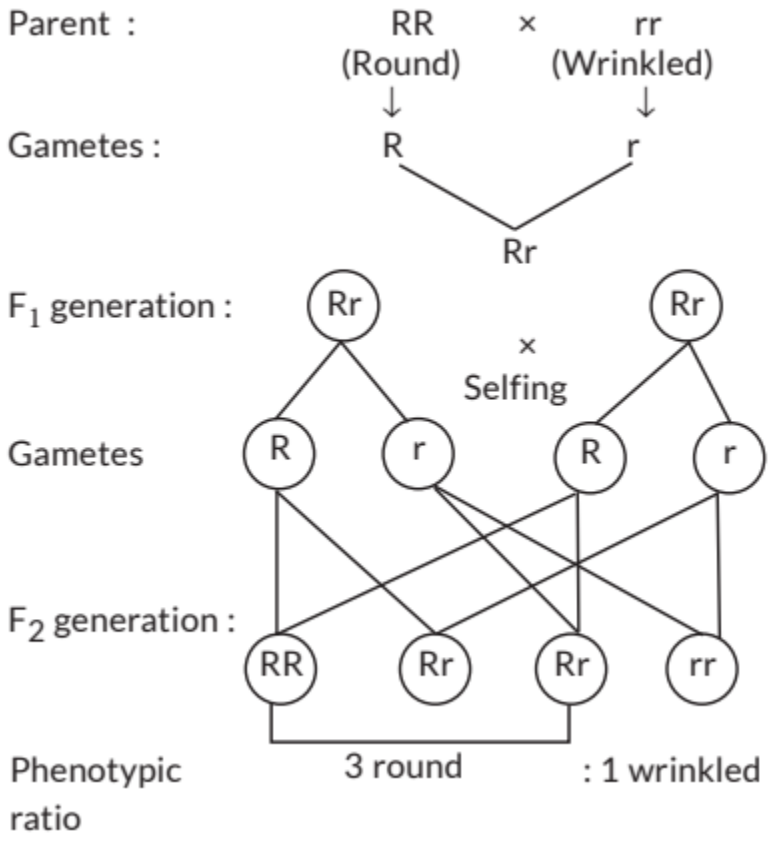
In F_1 hybrid, two dissimilar alleles are present for one character, i.e., height T is for tallness and t is for dwarfness, out of which only one allele called dominant allele expresses itself and the one which remains unexpressed is called recessive allele. This is called "law of dominance". Also the two dissimilar alleles that remain together in a heterozygous individual do not get mixed up and keep their distinct identity. Hence, at the time of gamete formation they separate so that each gamete receives only one allele and is always pure which enables reappearance of recessive trait in F2 progenies when the two recessive alleles come together. This is called "law of purity of gametes."

33. Differences between dominant traits and recessive trait are as follows:

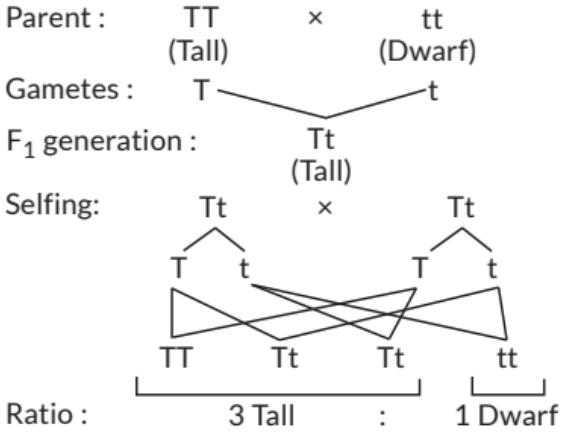
S. No.	Dominant trait	Recessive trait
(i)	It is the trait controlled by dominant allele.	It is the trait controlled by recessive allele.
(ii)	It is the trait which is expressed in F_1 generation.	It is the trait which remains suppressed in F_1 generation and appears in F_2 generation.

When Mendel crossed round and wrinkled seeds, F_1 plants produced were tall. On selfing, heterozygous tall plants, offsprings produced in a ratio of 3(Tall): 1

(dwarf). So, the percentage of plants with round seeds will be 75%. This can be illustrated as follows:



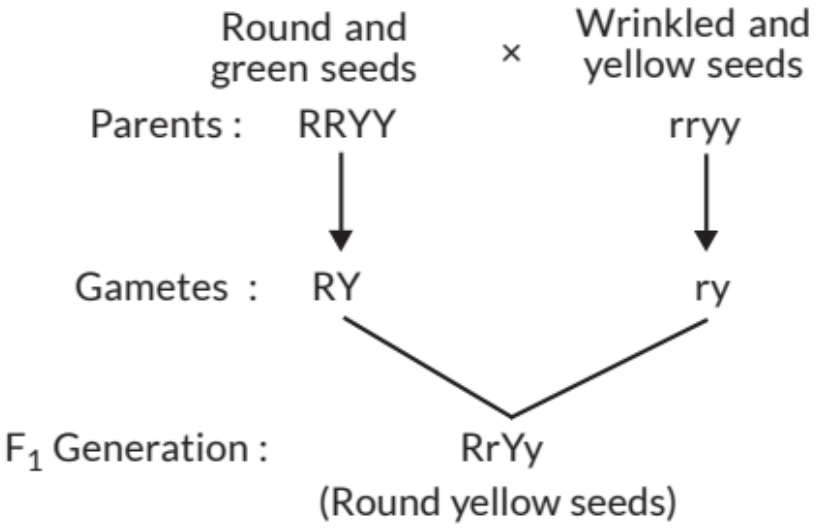
34. Mendel crossed a pure tall pea plant with pure dwarf pea plant. All the plants obtained in F_1 generation were tall. When Mendel selfed plants from F_1 generation then he obtained both tall and dwarf plants in F_2 generation in the ratio of 3:1.
This can be illustrated as follows:



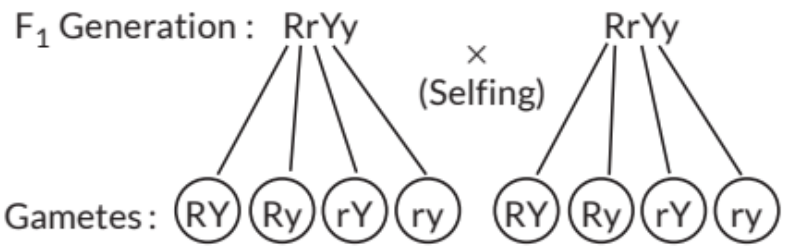
This explains that for each pair of contrasting characters there are two alleles. The trait which is expressed in F_1 is dominant trait and is controlled by dominant allele and

the trait which remains unexpressed in F_1 is the recessive trait and is controlled by recessive gene. When both the contrasting alleles are present together in F_1 individuals, no mixing of alleles occurs and they again segregate at the time of gamete formation. Therefore, when the recessive alleles come together they result in reappearance of recessive trait in F2 generation.

35. (a) The given cross was made between pure breeding pea plants, one with round and green seeds and the other with wrinkled and yellow seeds. Yellow seed colour and round seed shape is dominant over green seed colour and wrinkled seed shape. In F_1 generation, dominant traits express itself, whereas recessive traits get suppressed.



Therefore, the phenotype of F1 progeny is round and yellow.
(b) The different types of F_2 progeny obtained along with their ratio when F_1 progeny was selfed could be illustrated by the given cross:

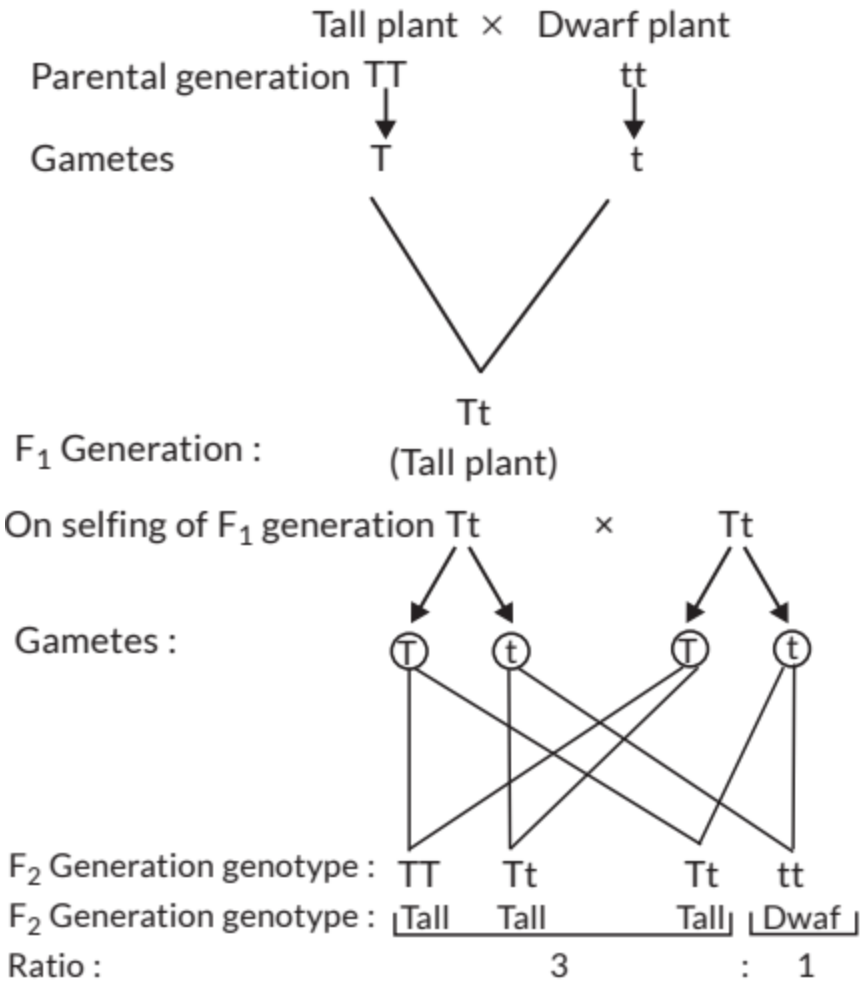


♂ \ ♀	RY	Ry	rY	ry
RY	RRYY Round yellow	RRYy Round yellow	RrYY Round yellow	RrYy Round yellow
Ry	RRYy Round yellow	RRyy Round green	RrYy Round yellow	Rryy Round green
rY	RrYY Round yellow	RrYy Round yellow	rrYY Wrinkled yellow	rrYy Wrinkled yellow
ry	RrYy Round yellow	Rryy Round green	rrYy Wrinkled yellow	rryy Wrinkled green

Phenotypic ratio : 9 : 3 : 3 : 1

Round yellow seeds - 9; Round green seeds - 3; Wrinkled yellow seeds - 3; Wrinkled green seeds – 1 Round green and wrinkled yellow seeds were new combinations produced in F2 generation.

36. (a) The possible cross of Mendel's experiment is :



Hence, tall (T) is dominant whereas dwarf (t) is recessive. In F_1 generation, only dominant trait expresses itself, whereas recessive trait gets suppressed. In F_2 generation, both traits, i.e., dominant and recessive express themselves. In this way, Mendel's experiment showed that the traits (tall and dwarf) are inherited independently.

(b) The two contrasting characters other than height that Mendel used in his experiment in pea plants are round/wrinkled seeds and violet/white flowers.

37. (i) In sexual reproduction offspring of human being is not a true copy of his parents because it inherits half of its genetic material from each parent. During the formation of gametes (sperm and egg cells), the genetic material undergoes recombination that leads to shuffling or mixing of genetic material from both parents, resulting in offspring with unique combination of genes.

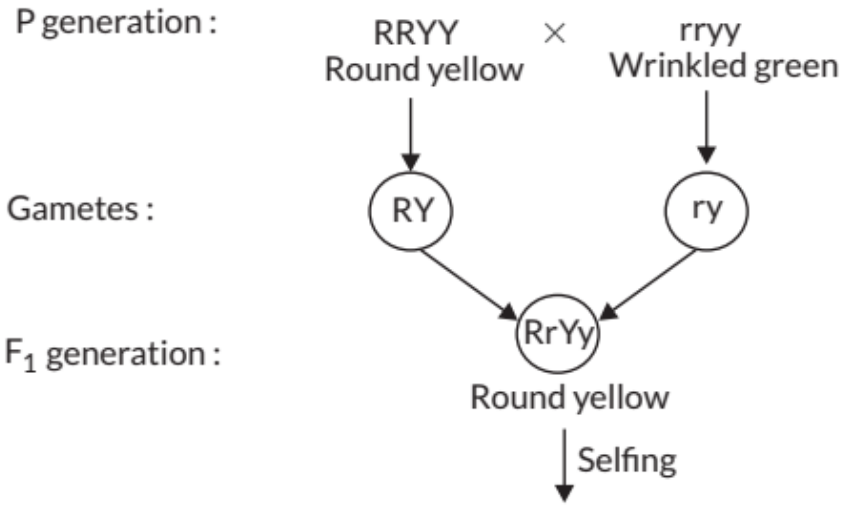
(ii) F_1 generation is the first filial generation of the offspring from the parents whereas F_2 generation is the second filial generation of the offspring,

generated through inbreeding of F_1 generation. F_1 generation can be distinctly different from the parental type whereas F_2 generation always exhibit some parental genotypes.

(iii) Variations allow genetic diversity that is important for the development of new traits and increasing adaptability towards changes in the environment. It makes the organisms better adapted for survival under changing conditions.

OR

(iii) The given dihybrid cross between round yellow (RRYY) and wrinkled green (rryy) seeds Explains that the inheritance of two traits is independent of each other.



	RY	Ry	rY	ry
RY	RRYY Round yellow	RRYy Round yellow	RrYY Round yellow	RrYy Round yellow
Ry	RRYy Round yellow	RRyy Round green	RrYy Round yellow	Rryy Round green
rY	RrYY Round yellow	RrYy Round yellow	rrYY Wrinkled yellow	rrYy Wrinkled yellow
ry	RrYy Round yellow	Rryy Round green	rrYy Wrinkled yellow	rryy Wrinkled green

F_2 generation: Round-yellow = 9, Round-green = 3,
Wrinkled-yellow = 3, Wrinkled-green = 1
Round green and wrinkled yellow seeds were new combinations that appeared in F_2 generation. New combinations that appeared can be explained by law of independent assortment. According to Mendel's law of independent assortment more than one pair of traits are considered in a cross simultaneously, the factors responsible for each pair of trait are distributed independently to the gametes.

38. (a) Sex of child is determined by what it inherits from the father. A child who inherits X chromosome from her father will be a girl and one who inherits a Y chromosome from father will be a boy.
(b) Human beings have 22 pairs of autosomes and one pair of sex chromosomes. The females possess two homomorphic sex chromosomes, named XX while males contain two heteromorphic sex chromosomes, i.e., XY. The Y chromosome is shorter than X chromosome. Therefore a pair of sex chromosomes in human beings is called mismatched pair in terms of type and size.
(c) Gametes contain half the number of chromosomes of parent. But, when the two gametes (male and female) fuse to form the zygote, the normal diploid condition is restored. Hence, the formation of gametes by meiosis and fusion of male and female gamete help to maintain the number of chromosomes in organism.

OR

(c) Two animals in which sex is not determined genetically are turtle and crocodile. The type of sex in them is determined by environmental factors. In turtles, the temperature of egg incubation has a significant effect on the sex of developing embryos. Males are predominant below 28°C, females above 33°C and equal number of the two sexes between 28-33°C. In crocodiles, high temperature induces maleness and low temperature femaleness.

39. (a) Refer to answer 35 (a)
(b) Refer to answer 35 (b)
(c) In a dihybrid cross given by Mendel, it was observed that when two pairs of traits or characters were considered, each trait expressed independent of the other. Thus, Mendel was able to propose the Law of Independent

Assortment which says about independent inheritance of traits. This could be explained clearly from the given cross:
In F_2 generation, different types of seed obtained are
in the ration of 9 Round-yellow 3 Round-green :
3 Wrinkled-yellow: 1 Wrinkled-green

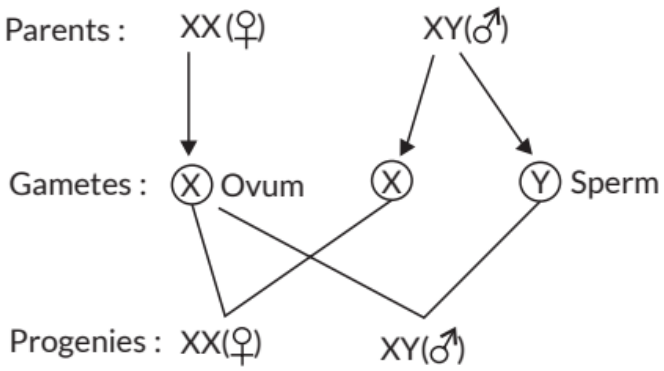
OR

(c) (i) Dominant trait: It is the trait controlled by dominant allele. It is the trait which is expressed in F1 generation.
(ii) Recessive trait : It is the trait controlled by recessive allele. It is the trait which remains suppressed in F_1 generation and appears in F_2 generation.

40. (a) Human beings have 22 pairs of autosomes and one pair of sex chromosomes. The females possess two homomorphic sex chromosomes, called XX while males have a mismatched pair in which one is a normal sized X while the other is a short-one called Y.
(b) Gametes contain half the number of chromosomes. But, when the gametes fuse to form the zygote, the normal diploid condition is restored. Hence, the formation of gametes by meiosis helps to maintain the number of chromosomes in organism.
(c) Two animals in which sex is not determined genetically are turtle and crocodile. The type of sex in them is determined by environmental factors. In turtles, the temperature of egg incubation has a significant effect on the sex of developing embryos. Males are predominant below 28°C, females above 33°C and equal number of the two sexes between 28-33°C. In crocodiles, high temperature induces maleness and low temperature induces femaleness.

OR

(c) Flow chart of sex determination in human beings is as follows:



41. (a) The F_1 progeny will be tall plant with round seeds.
(b) Recessive traits are short plant and wrinkled seed.
(c) The new combinations will be tall plant with wrinkled seeds and short plant with round seeds. The ratio will be 9:3:3:1:: Tall plant with round seed : Tall plant with wrinkled seeds: Short plant with round seed: Short plant with wrinkled seed.

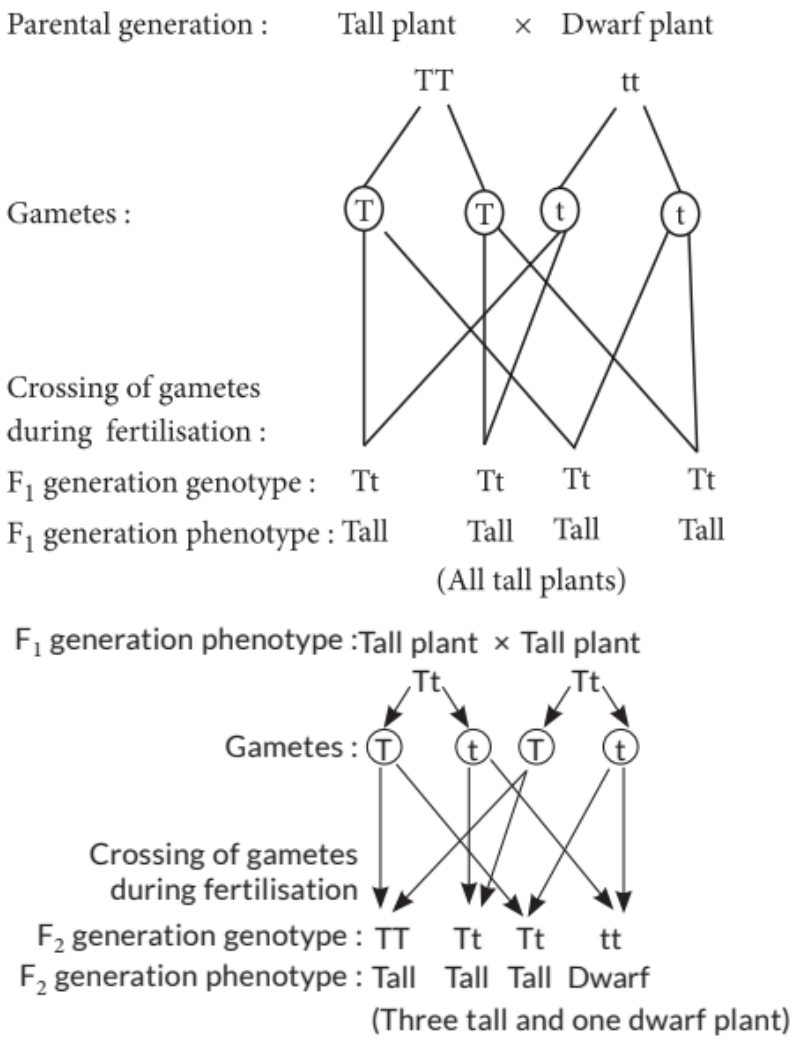
OR

(c) (i) The F_2 ratio will be 9:3:3:1:: Tall plant with round seed Tall plant with wrinkled seeds: Short plant with round seed: Short plant with wrinkled seed.

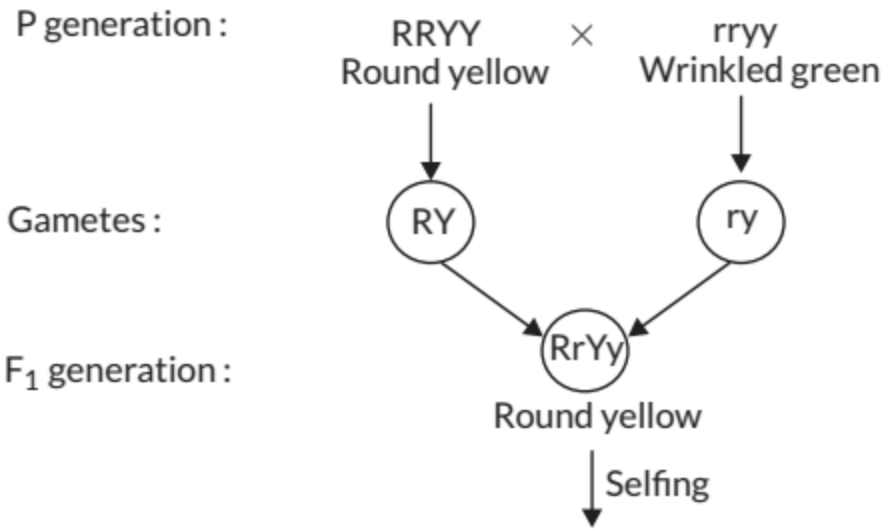
Tall plant with round seeds $= \frac{9}{16} \times 1600 = 900$

(ii) Short plant with wrinkled seed $= \frac{1}{16} \times 1600 = 100$

42. (a) Mendel first crossed pure-bred tall pea plants with pure-bred dwarf pea plants and found that only tall pea plants were produced in the first generation (F_1). He then self crossed the tall pea plants of the F_1 generation and found that tall plants and dwarf plants were obtained in the second generation or (F_2) in the ratio of 3:1. Mendel said that the trait of dwarfness of one of the parent pea plant had not been lost, it was suppressed in the first generation to re-emerge in the second generation. He called the suppressed trait of 'dwarfness' as 'recessive trait' and the expressed trait of 'tallness' as the 'dominant trait'. In this way, Mendel's experiments with tall and dwarf pea plants showed that the traits may be dominant or recessive. Hence, this could be explained by the given cross:



(b) Mendel observed that he had started with two combinations of characteristics in seeds, round-yellow and wrinkled-green, and two new combinations of characteristics had appeared in the F_2 generation, round-green and wrinkled-yellow. According Mendel's second law of inheritance more than one pair of traits are considered in a cross simultaneously, the factors responsible for each pair of trait are distributed independently to the gametes. The cross given below showing dihybrid cross explains that the inheritance of two traits is independent of each other.



	RY	Ry	rY	ry
RY	RRYY Round yellow	RRYy Round yellow	RrYY Round yellow	RrYy Round yellow
Ry	RRYy Round yellow	RRyy Round green	RrYy Round yellow	Rryy Round green
rY	RrYY Round yellow	RrYy Round yellow	rrYY Wrinkled yellow	rrYy Wrinkled yellow
ry	RrYy Round yellow	Rryy Round green	rrYy Wrinkled yellow	rryy Wrinkled green

F_2 generation: Round-yellow = 9, Round-green = 3, Wrinkled-yellow = 3, Wrinkled-green =1

43. (a) Mendel choose garden pea for his experiments because:
(i) Pea plants were easy to grow and it shows some clear contrasting traits like some pea plants are tall whereas others are dwarf.
(ii) Pea plants are self pollinating and many generation of pea plants can be produced in comparatively less time.
(b) The contrasting characters of garden pea plant studied by Mendel are:

	Character	Plant	
		Dominant	Recessive
1.	Plant height	Tall	Dwarf
2.	Colour of the seed	Yellow	Green

CBSE Sample Questions

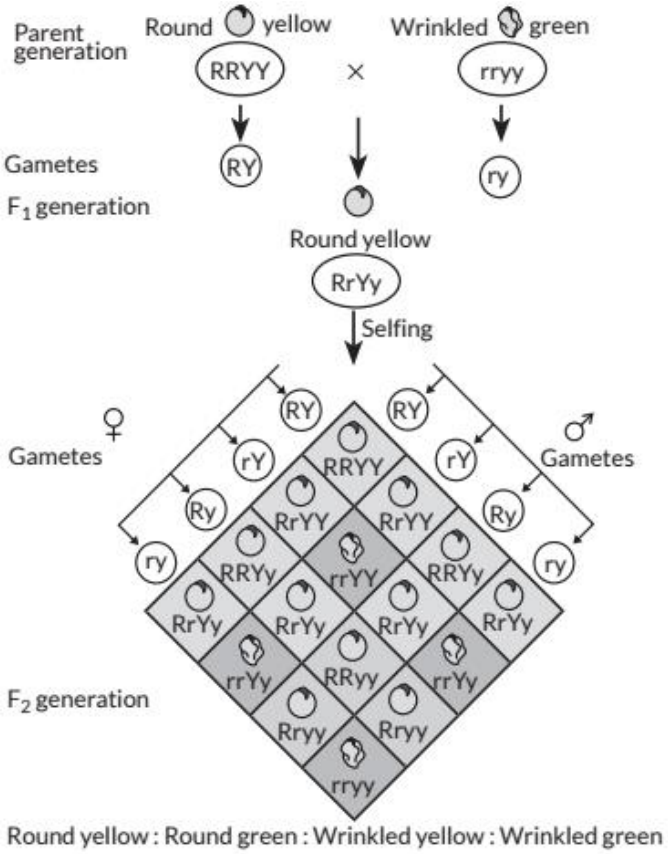
If trait X exists in 5% (smaller fraction) and trait Y exists in 70% (larger fraction) of the population then the larger fraction i.e., trait Y must have arisen earlier because in asexual reproduction variation do not occur, as the cell produces identical copies of DNA. (1/2)
New trait come in the population only due to sudden mutation and further inherited. 70% of the population with trait Y is likely to have been replicating that trait for longer period than 5% of population with trait X. (1/2)

2. (d) (1)

3. (a): Cellular DNA is the information source for making proteins in the cell. A section of DNA that gives information for one protein is called the gene for that protein. Height in pea plant is regulated by hormones. Hormone production in turn is controlled by genes which control activity of enzyme. (1)

4. (a) (1)

5.



Round yellow : Round green : Wrinkled yellow : Wrinkled green

Phenotypic ratio : 9 : 3 : 3 : 1

Calculations : 9 : 3 : 3 : 1

$= \frac{9}{16} \times 160 : \frac{3}{16} \times 160 : \frac{3}{16} \times 160 : \frac{1}{16} \times 160$

= 90 : 30 : 30 : 10

= Round yellow : Round green : Wrinkled yellow : Wrinkled green

Out of 160 seeds, 30 round green and 30 wrinkled yellow seeds are new combination of characters in F_2 progenies. The new combination of the characteristics are produced because of the independent assortment of seed shape and seed colour trait. (3)

6. On analysing the result, the ratio obtained is 9:3:3:1 in which parental as well as new combinations are observed. This indicates that progeny plants have not inherited a single whole gene set from each parent. Every germ cell takes one chromosome from the pair of maternal and paternal chromosomes.

When two germ cells combine, segregation of one pair of characters is independent of other pair of characters. (3)

7. In human beings, the genes inherited from the parents decide whether the child will be boy or girl. Women have a same pair of sex chromosomes (XX). But, men have a mismatched pair (XY). All children will inherit an X chromosome from their mother regardless of whether they are boys or girls. Thus, the sex of the children will be determined by what they inherit from their father. A child who inherits an X chromosome from father will be a girl and one who inherits a Y chromosome from father will be a boy. (3)

8. (a) Green eye colour is recessive as it will express only in homozygous condition. (1)
(b) Pooja's brother have black eyes, hence he can have either genotype, BB (homozygous alleles) or Bb (heterozygous alleles). (1)
(c) 50% of the offsprings will have green eye colour. Pooja has bb genotype while Ravi has Bb. Offsprings will have either black or green eye colour. This can be illustrated by following cross:

♀ \ ♂	B	b
b	Bb	bb
b	Bb	bb

Black eye : Green eye
1 1

(2)

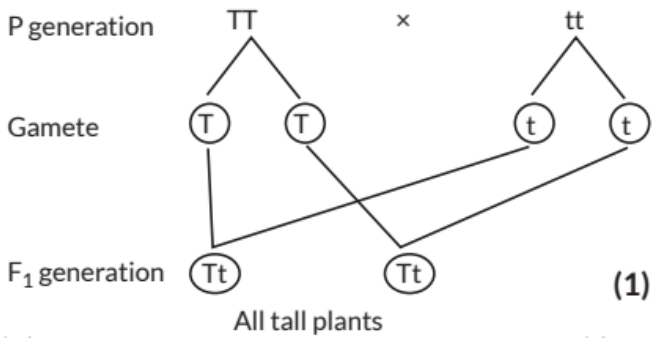
OR

(c) Brother is heterozygous(Bb) and wife is green(bb)

♀ \ ♂	B	b
b	Bb	bb
b	Bb	bb

Therefore, 50% of the offsprings can have green eye colour as per the given cross. (2)

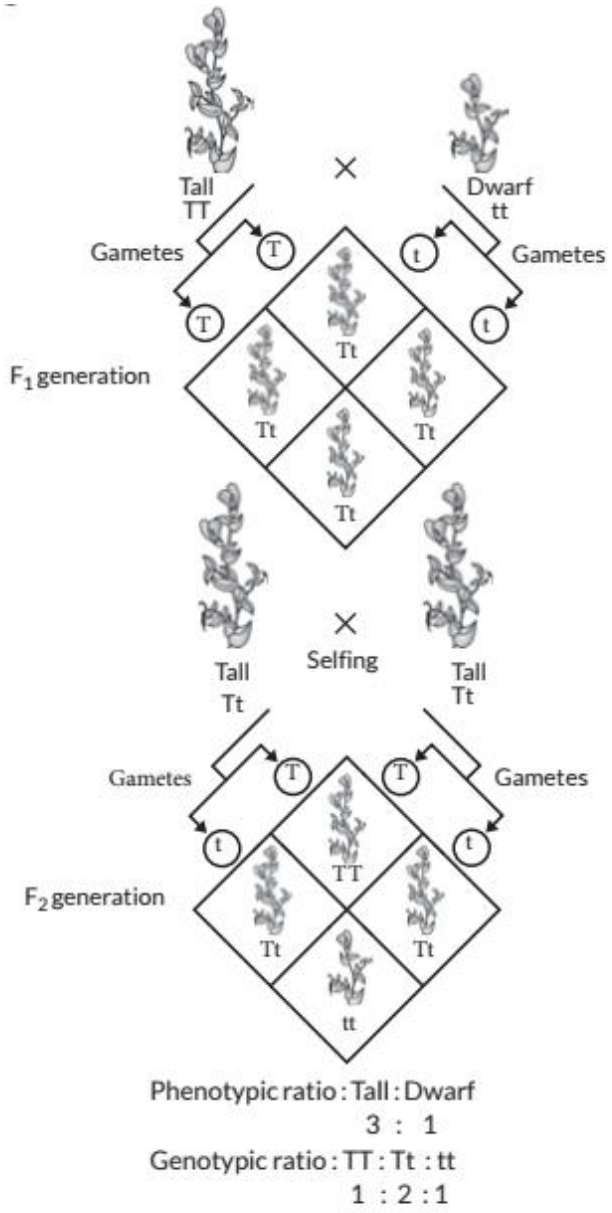
(a)



(1)

(b) Tall (T) is a dominant trait whereas short (t) is a recessive trait and the gene corresponding to the recessive trait fails to express itself in presence of the gene representing dominant trait (TT or Tt). Therefore, all the plants appear tall in the F1 generation. (1)

(c) When F_1 plants are self pollinated, cross is illustrated as following

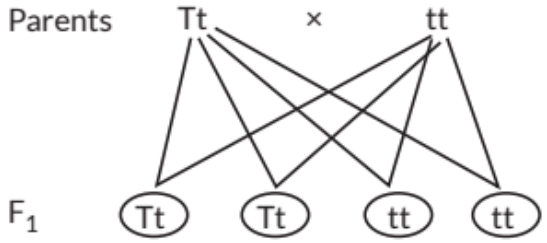


Genotypic ratio :	Tall (TT)	:	Medium height (Tt)	:	Dwarf (tt)
	1	:	2	:	1
Calculation :	$\frac{1}{4}\times 800$	:	$\frac{2}{4}\times 800$	:	$\frac{1}{4}\times 800$
	200	:	400	:	200

Out of 800 plants, 200 tall plants, 400 medium height plants and 200 short plants are produced. (2)

OR

(c) In a cross between Tt x tt, 400 tall (TT) and 400 short (tt) plants will be produced.



Genotypic and phenotypic ratio	Medium height (Tt)	:	Dwarf (tt)
	2	:	2

Calculation :

$$\frac{2}{4}\times 800 : \frac{2}{4}\times 800 \quad = 400 : 400$$

Out of 800 plants, 400 tall and 400 short plants are produced. No tall plants are produced in F_1 generation. (2)