# Heredity and Evolution

## OBJECTIVE TYPE QUESTIONS

### Multiple Choice Questions (MCQs)

**1.** Mendel conducted his famous breeding experiments by working on
(a) *Drosophila* (b) *Pisum sativum*
(c) *Escherichia coli* (d) all of these.

**2.** The main reason for Mendel's success in discovering the principles of inheritance was
(a) he considered each character separately
(b) he was lucky not to encounter with linkage problem
(c) the plant was pure breeding
(d) all of these.

**3.** Why were pea plants more suitable than dogs for Mendel's experiments ?
(a) There were no pedigree records of dogs.
(b) Pea plants can be self-fertilised.
(c) All pea plants have only two chromosomes.
(d) Dogs have many genetic traits.

**4.** An allele is said to be dominant if
(a) it is expressed in both homozygous and heterozygous conditions
(b) it is expressed only in second generation
(c) it is expressed only in heterozygous condition
(d) it is expressed only in homozygous condition.

**5.** In a dihybrid cross four phenotypes form in the ratio of 9 : 3 : 3 : 1, because of
(a) dominance of one phenotype in each pair of contrasting traits
(b) independent assortment of the genes of contrasting traits
(c) crossing over of genes
(d) mixed effect of dominance and independent assortment.

**6.** Which of the following represents the characteristic of a pleiotropic gene?
(a) Controls sexual characters.
(b) Present only in prokaryotes.
(c) Controls one character in association with the other.
(d) Control more than one character.

**7.** A segment of DNA providing information for a protein is called
(a) nucleus (b) chromosomes
(c) trait (d) gene.

**8.** Recessive mutations are expressed
(a) always since it is a mutation
(b) in heterozygous condition
(c) neither in homozygous nor in heterozygous condition
(d) in homozygous condition.

**9.** The reason why some mutations, which are harmful, do not get eliminated from gene pool is that
(a) they are recessive and carried by heterozygous individuals
(b) they are dominant and show up more frequently
(c) genetic drift occur because of a small population
(d) they have future survival value.

**10.** In *Drosophila*, red eye character is dominant over white eye character. When a homozygous red-eyed individual is crossed with a homozygous white-eyed individual, and individuals of $F_1$ generation are intercrossed, 12 individuals are produced. White-eyed individuals of these will be
(a) three (b) six
(c) nine (d) twelve.

**11.** A true breeding tall and smooth-seeded pea plant was crossed with a true breeding dwarf and wrinkled-seeded plant. All the $F_1$ plants were tall and demonstrate
(a) principle of assortment of characters
(b) that recombination of characters appears in $F_2$ generation
(c) that P tall plants were heterozygous
(d) that tallness was dominant over dwarfness.

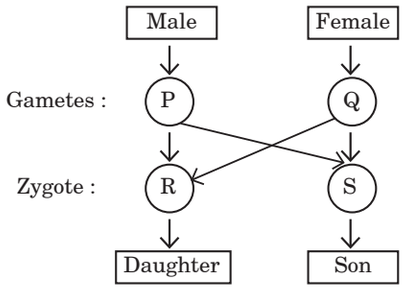
**12.** Two variants found in human population are shown in the given figure. Identify them and select the correct option.

(A)

(B)

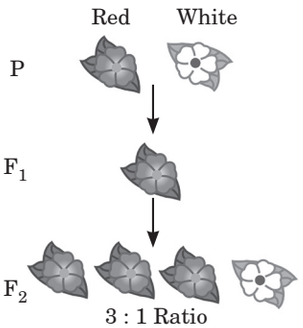
(i) This is an inherited character.
(ii) This is acquired during lifetime.
(iii) This is a non-genetic trait.
(a) (ii) and (iii) (b) Only (i)
(c) (i) and (iii) (d) Only (ii)

**13.** Identify *P*, *Q*, *R* and *S* in the case of normal human from given flow chart and select the correct option.



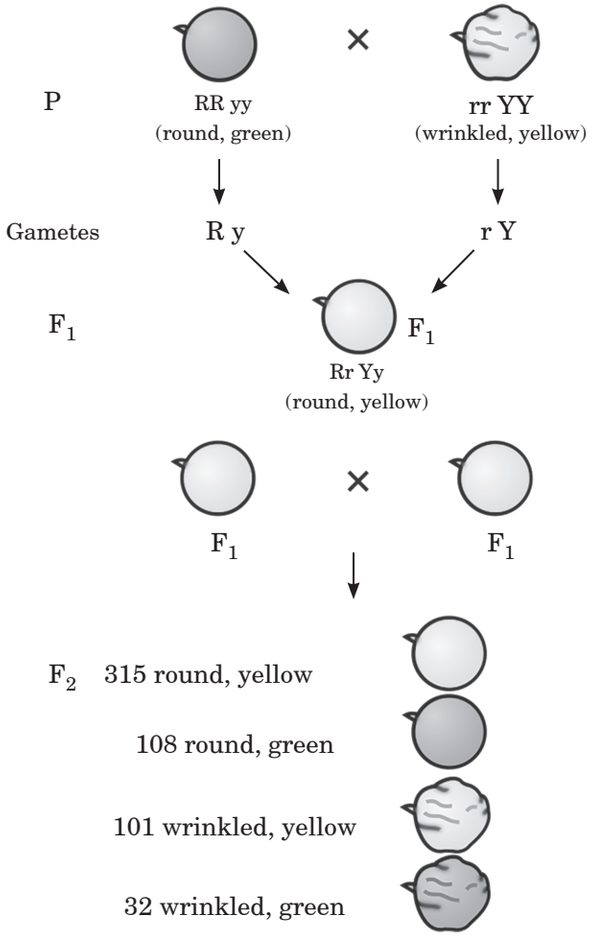

| | P | Q | R | S |
|---|---|---|---|---|
| (a) | XX | XY | XY | XX |
| (b) | XY | XX | XX | XY |
| (c) | XXX | XY | XYY | XXX |
| (d) | XO | XX | XX | XO |

**14.** Refer to the given figure and select the correct statement(s) regarding it.




(i) It is a monohybrid cross.
(ii) Red flower colour trait is dominant over white flower colour trait.
(iii) Both the traits red flower colour and white flower colour were inherited in F1 plants, but only red flower trait was expressed.
(a) (ii) and (iii) (b) Only (i)
(c) Only (ii) (d) (i), (ii) and (iii)

**15.** Mendel performed a cross between two garden pea plants; one with round and green seed and the other with yellow and wrinkled seed as shown below.




Select the correct match(es) regarding it.

| | Cross | | | Progeny |
|---|---|---|---|---|
| (i) | RRYY (Round, yellow) | RRYY (Round, yellow) | – | Round, yellow only |
| (ii) | RrYy (Round, yellow) | RrYy (Round, yellow) | – | Round, yellow and Round, green only |
| (iii) | rryy (Wrinkled, green) | rryy (Wrinkled, green) | – | Wrinkled, green only |
| (iv) | RRYY (Round, yellow) | rryy (Wrinkled, green) | – | Round, green only |

(a) (i) and (iii) (b) (ii) and (iv)
(c) (ii) and (iii) (d) (i) and (iv)

**16.** The information source for making proteins in the cell is the

(a) chromosome (b) DNA
(c) enzyme (d) nucleus.

**17.** A plant bearing purple flowers (RR) was cross pollinated with a plant bearing white flowers (rr). What would be the ratio of the plants bearing white flowers and purple flowers respectively in $F_2$ generation when the $F_1$ progeny were self pollinated?

(a) 1 : 3 (b) 3 : 1
(c) 1 : 1 (d) 2 : 1

**18.** What will be the percentage of purple stemmed plants in the $F_2$ generation, when the $F_1$ generation resulted due to cross breeding of green stemmed (GG) tomato plants with purple stemmed (gg) tomato plants, are self pollinated?

(a) 10% (b) 25%
(c) 75% (d) 50%

**19.** In human beings, the statistical probability of having a male child is

(a) 25% (b) 50%
(c) 75% (d) 60%.

**20.** Segregation of alleles takes place during

(a) meiosis (b) cleavage
(c) fertilisation (d) crossing over.

**21.** The genotypic ratio in $F_2$ generation of monohybrid cross will be

(a) 1 : 2 : 1 (b) 3 : 1
(c) 1 : 1 (d) 1 : 2.

**22.** Mendel studied seven contrasting characters for his breeding experiment with *Pisum sativum*. Which of the following characters did he not use?

(a) Pod colour (b) Pod shape
(c) Leaf shape (d) Plant height

**23.** Mutation is a

(a) change that causes evolution when inherited
(b) change which affects the parents only but never inherited
(c) change which affects the offspring of $F_2$ generation only
(d) factor responsible for plant growth.

**24.** Allele that cannot express itself in presence of another is

(a) codominant (b) dominant
(c) recessive (d) complementary.

**25.** XX-XO type of sex determination and XX-XY type of sex determination are the examples of

(a) male heterogamety
(b) female heterogamety
(c) male homogamety
(d) both (b) and (c).

**26.** Select the incorrect statement.

(a) In male grasshoppers, 50% of sperms have no sex chromosome.
(b) Female fruitfly is heterogametic.
(c) Human male produces two types of sperms 50% having X chromosome and 50% having Y chromosomes.
(d) In turtle, sex determination is regulated by environmental factors.

**27.** Some of the dominant traits studied by Mendel were

(a) round seed shape, green seed colour and axial flower position
(b) terminal flower position, green pod colour and inflated pod shape
(c) violet flower colour, green pod colour and round seed shape
(d) wrinkled seed shape, yellow pod colour and axial flower position.

**28.** In plant, tall phenotype is dominant over dwarf phenotype, and the alleles are designated as T and t, respectively. Upon crossing one tall and one dwarf plant, total 250 plants were obtained, out of which 124 displayed tall phenotype and rest were dwarf. Thus, the genotype of the parent plants were

(a) TT × TT (b) TT × tt
(c) Tt × Tt (d) Tt × tt.

**29.** The percentage of yr gamete produced by YyRr parent will be

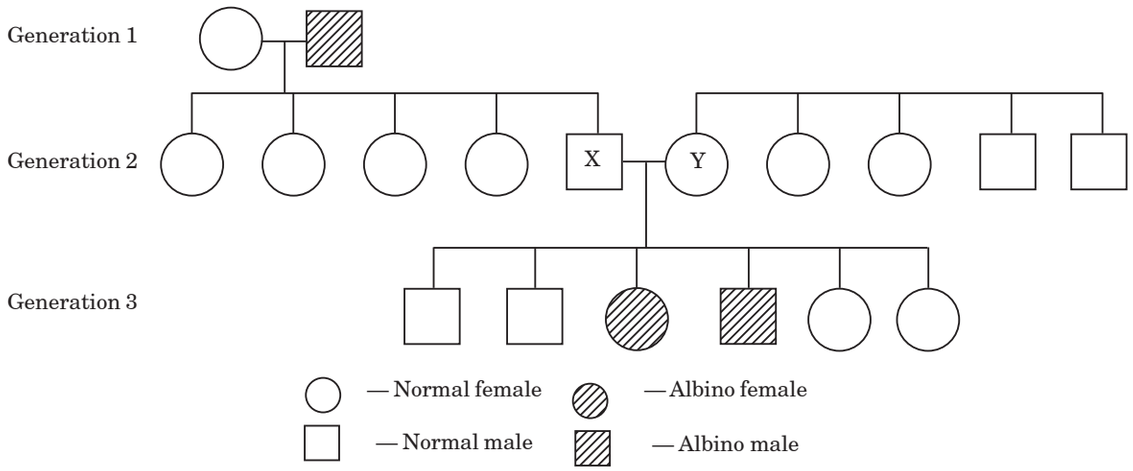
(a) 25% (b) 50%
(c) 75% (d) 12.5%.

**30.** If a genotype consists of different types of alleles, it is called

(a) homozygous (b) heterozygous
(c) monoallelic (d) uniallelic.

## Case Based MCQs

**Case 1 :** Read the following and answer the following questions from 31 to 35.
Refer to the schematic representation of the albinism that is an inherited condition caused by recessive allele (a). 'A' is the dominant allele for the normal condition. The inheritance of certain genetic traits for two or more generations is represented in a pedigree or family tree. Study the given pedigree chart and answer the following questions.




**31.** Which of the following could be the genotypes of X and Y?

| | **X** | **Y** |
|---|---|---|
| (a) | AA | AA |
| (b) | AA | Aa |
| (c) | Aa | Aa |
| (d) | aa | aa |

**32.** Which of the following could be the genotype of generation - 1 male and female?

| | **Male** | **Female** |
|---|---|---|
| (a) | AA | aa |
| (b) | aa | AA |
| (c) | Aa | aa |
| (d) | AA | AA |

**33.** If X married an albino female, then what is the probability that their children would be albino?
(a) 0 (b) 0.125
(c) 0.25 (d) 0.5

**34.** If Y married a normal homozygous male, then what is the probability that their children would be albino?
(a) 0 (b) 0.125
(c) 0.25 (d) 0.5

**35.** Which of the following could be the genotype of offsprings produced by cross of X and Y?
(a) AA, Aa, aa (b) aa, aa
(c) Aa, Aa (d) AA, AA

**Case II :** Read the following and answer the following questions from 36 to 40.
Refer to the given table regarding results of $F_2$ generation of Mendelian cross.

| | |
|---|---|
| Plants with round and yellow coloured seeds (P) | 315 |
| Plants with round and green coloured seeds (Q) | 108 |
| Plants with wrinkled and yellow coloured seeds (R) | 101 |
| Plants with wrinkled and green coloured seeds (S) | 32 |

**36.** Which of the following would be the phenotype of $F_1$ generation regarding given data of $F_2$ generation?
(a) Plants with round and yellow coloured seeds.
(b) Plants with round and green coloured seeds.
(c) Plants with wrinkled and yellow coloured seeds.
(d) Plants with wrinkled and green coloured seeds.

**37.** Which of the following would be the genotype of parental generation regarding given result of $F_2$ generation?
(a) YYRR and yyrr (b) YYRR and YYRR
(c) YYRR and YyRr (d) YyRr and YyRr

**38.** If plant with wrinkled and green coloured seeds (S) is crossed with plant having wrinkled and yellow coloured seeds (R), what will be the probable phenotype of offsprings?

(a) All plants with wrinkled and yellow coloured seeds.
(b) 50% plants with wrinkled and yellow coloured seeds and 50% plants with wrinkled and green coloured seeds.
(c) All plants with wrinkled and green coloured seeds.
(d) Both (a) and (b)

**39.** Which of the following will result when plant YyRr is self-pollinated?

(a) 9 : 3 : 3 : 1 ratio of phenotypes only
(b) 9 : 3 : 3 : 1 ratio of genotypes only
(c) 1 : 1 : 1 : 1 ratio of phenotypes only
(d) 1 : 1 : 1 : 1 ratio of phenotypes and genotypes

**40.** The percentage of yR gamete produced by YyRR parent will be

(a) 25% (b) 50%
(c) 75% (d) 12.5%

## Assertion & Reasoning Based MCQs

**For question numbers 41-50,** a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

*(a) Both assertion and reason are true, and reason is correct explanation of the assertion.*
*(b) Both assertion and reason are true, but reason is not the correct explanation of the assertion.*
*(c) Assertion is true, but reason is false.*
*(d) Assertion is false, but reason is true.*

**41. Assertion :** Mendel successfully postulated laws of heredity.
**Reason :** He recorded and analysed results of breeding experiments quantitatively.

**42. Assertion :** The principle of segregation given by Mendel is the principle of purity of gametes.
**Reason :** Gametes are pure for a character and do not mix up.

**43. Assertion :** Test cross is a back cross.
**Reason :** In test cross, individual is crossed with recessive parent.

**44. Assertion :** Pure lines are called true breeds.
**Reason :** True breeds are used for cross breeding.

**45. Assertion :** In a monohybrid cross, offspring of $F_1$ generation express dominant character.
**Reason :** Dominance occurs only in heterozygous state.

**46. Assertion :** The traits that are obtained from parents are inherited traits.
**Reason :** These traits were developed in the parents during their lifetime.

**47. Assertion :** If blood group of both mother and father is 'O' then the blood group of children will also be O.
**Reason :** Blood group in humans is determined by many alleles of a gene *viz.* $I^A$, $I^B$, $I^O$.

**48. Assertion :** In grasshoppers, females are heterogametic and males are homogametic.
**Reason :** In grasshoppers, male has only one sex chromosome (XO) whereas the female has sex chromosomes (XX).

**49. Assertion :** If mother is homozygous for black hair and father has red hair then their child can inherit black hair.
**Reason :** Gene for black hair is recessive to gene for red hair in humans.

**50. Assertion :** A child which has inherited X chromosome from father will develop into a girl child.
**Reason :** Girl child inherits X chromosome from father and Y chromosome from mother.

# SUBJECTIVE TYPE QUESTIONS

## Very Short Answer Type Questions (VSA)

1. Name two human traits that show variations.
2. What is a gene?
3. Give an example where sex determination is regulated by environmental factors.
4. How do genes control traits?

**5.** Name one trait which is inherited and one trait which is acquired.

**6.** All the variations in a species do not have equal chances of survival. Why?

**7.** Sex chromosomes of human males are dissimilar. Justify.

**8.** Why is the progeny always tall when a tall pea plant is crossed with a short pea plant?

**9.** How many pairs of allelic characters did Mendel study in pea plant?

**10.** What do you mean by a true breeding plant?

## Short Answer Type Questions (SA-I)

**11.** Differentiate between inherited and acquired traits.

**12.** Why do all the gametes formed in human females have an X chromosome?

**13.** An individual inherits different traits from his parents. On what basis classification of traits as dominant and recessive is done?

**14.** Which type of organisms will have more variations – sexually or asexually reproducing organisms? Justify.

**15.** "The chromosome number of the sexually reproducing parents and their offspring is the same." Justify this statement.

**16.** Crossing of a pea plant with purple flower and pea plant with white flowers, produces 50 plants with only purple flowers. On selfing, the plants produced 470 plants with purple flowers and 160 with white flowers. Explain the genetic mechanism accounting for the above results.

**17.** In which generation does the segregation of allelic phenotype takes place?

**18.** The gene for red hair is recessive to the gene for black hair. What will be the hair colour of a child if he inherits a gene for red colour from his mother and a gene for black hair from his father? Express with the help of flow chart.

**19.** Differentiate between genotype and phenotype.

**20.** Explain the law of purity of gametes.

## Short Answer Type Questions (SA-II)

**21.** "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.

**22.** The genotype of green stemmed tomato plants is denoted as GG and that of purple stemmed tomato plants as gg. When these two are crossed :

(i) What colour of stem would you expect in their $F_1$ progeny ?

(ii) Give the percentage of purple-stemmed plants if $F_1$ plants are self pollinated.

(iii) In what ratio would you find the genotypes GG and Gg in the $F_2$ progeny?

**23.** How do germ cells make a single set of genes from two normal copies of genes?

**24.** "Different species use very different strategies for determining the sex of their new born." Justify this statement.

**25.** How do proteins control the expression of characters? Explain it by taking an example of tallness in plants as a characteristic.

**26.** Give reasons for the appearance of new combinations of characters in the $F_2$ progeny.

**27.** In the following crosses write the characteristics of the progeny.

| Cross | | Progeny |
|---|---|---|
| (a) | RRYY x RRYY<br>Round, Round,<br>yellow yellow | ..... |
| (b) | RrYy x RrYy<br>Round, Round,<br>yellow yellow | ..... |

**28.** 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.

**29.** A man having blood group O marries a woman having blood group B and they have a daughter. What will be the blood group of the daughter?

**30.** Explain with an example, how genes control the characteristics (or traits).

**31.** (a) State one advantage of variation to a species.

(b) What are sex chromosomes? How many sex chromosomes are there in humans? Name them.

**32.** Explain in brief how Mendel interpreted his results to show that the traits may be dominant or recessive.

## Long Answer Type Questions (LA)

**33.** Explain determination of sex among human beings, with the help of a diagram.

**34.** A blue colour flower plant denoted by BB is cross-bred with that of white colour flower plant denoted by bb.

(i) State the colour of flower you would expect in their $F_1$ generation plants.

(ii) What must be the percentage of white flower plants in $F_2$ generation if flowers of $F_1$ plants are self-pollinated?

(iii) State the expected ratio of the genotypes BB and Bb in the $F_2$ progeny.

**35.** Write the basic features of mechanism of inheritance. How do Mendel's experiment show that traits are inherited independently?

**36.** Plant with full green pod is said to be homozygous dominant. Plant with constricted yellow pod is said to be homozygous recessive. Crossing of these two plants can also give rise to plants with full yellow pod. Plants with constricted green pod are also produced.

(i) What conclusion could Mendel draw from this observation?

(ii) Work out a cross upto $F_2$ generation for such type.

## ANSWERS

### OBJECTIVE TYPE QUESTIONS

**1. (b) :** Mendel conducted his famous breeding experiments by working on garden pea, *Pisum sativum.*

**2. (d) :** Before Mendel, several scientists performed breeding experiments to study inheritance, but they could not succeed. Reasons for Mendel's success were all the mentioned factors. Besides these, most important reason for Mendel's success was that he kept definite numerical records which helped him to deduce ratios of different progenies.

**3. (b) :** Dogs are unisexual. A female can produce progeny only after fertilisation by a male. It will always result in new combination of genes and purity of individuals will not be maintained which is essential for inheritance studies. While in pea plant self fertilisation occurs mostly and it has shorter life cycle as compared to dogs.

**4. (a) :** An allele is said to be dominant if it is expressed in both homozygous and heterozygous conditions. It is generally represented by capital alphabets.

**5. (b) :** In Mendel's dihybrid cross, with yellow round and green wrinkled seeds, 9 : 3 : 3 : 1 ratio was obtained showing four phenotypes. Yellow colour was originally present with round seeds but in $F_2$ generation, it was assorted independently of round seed character and expressed with wrinkled seeds. Same is the case with green colour. Thus, it shows independent assortment of characters.

**6. (d) :** A condition in which a single gene influences more than one trait is known as pleiotropy and such a gene is called pleiotropic gene.

**7. (d) :** A segment of DNA providing information for a protein is called gene. Gene stores information in the form of nucleotide sequence and acts as unit of inheritance.

**8. (d) :** Recessive mutations can express only in homozygous condition as in heterozygous condition presence of dominant normal gene will mask their expression.

**9. (a) :** Some recessive mutations which are harmful do not get eliminated from gene pool as they are carried by heterozygous individuals and they do not express in heterozygotes. The individuals with such harmful genotype

cannot be affected by natural selection (because of its phenotype) and will survive successfully and act as carriers of these mutations to future generations.

**10. (a) :** It is a monohybrid cross. Monohybrid cross produces progeny of $F_2$ generation in ratio 3 : 1, where 1 is the ratio of recessive progeny. Herein, the number of recessive white eyed individuals can be found by:

Total number according to ratio = 3 + 1 = 4

Total number of individuals produced actually = 12

Number of white eyed individuals

$$= \frac{1}{4} \times 12 = 3$$

**11. (d) :** When a true breed tall and smooth seeded pea plant crossed with a true breed dwarf and wrinkled seeded plant, all plants were tall and smooth seeded in $F_1$. It demonstrates that tallness and seed smoothness was dominant over dwarfness and wrinkled seed. $F_1$ plants were genotypically hybrids but phenotypically dominant character was expressed.

**12. (b) :** The lowest part of the ear, called the earlobe, is closely attached to the side of the head in some of us, and not in others. Free and attached earlobes are two variants found in human populations. It is a type of inherited character.

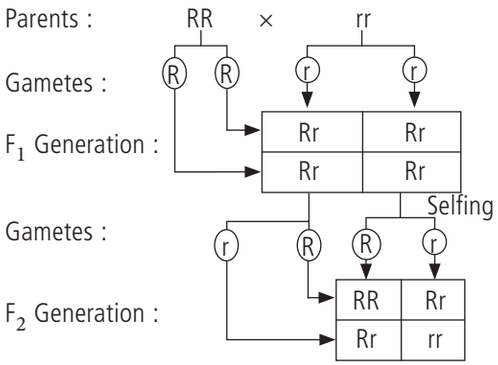
**13. (b)**

**14. (d)**

**15. (a) :** In the cross between RRYY (round, yellow) and RRYY (round, yellow), the offsprings would be RRYY (round, yellow) and in the cross between rryy (wrinkled, green) and rryy (wrinkled, green) the offsprings would be rryy (wrinkled, green).

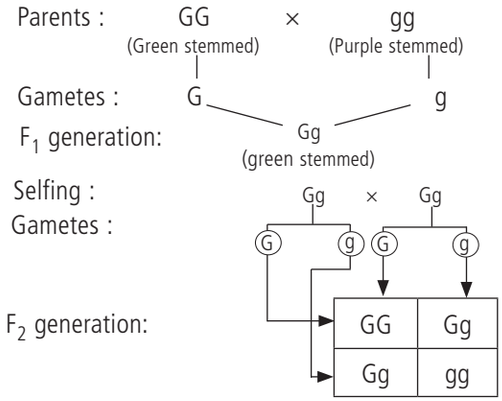
**16. (b) :** DNA is the information source for making proteins in the cell.

**17. (a) :** A cross between plant with purple colour flower and plant with white flower produces three purple flower plants and one white flower plant in $F_2$ generation as shown below:



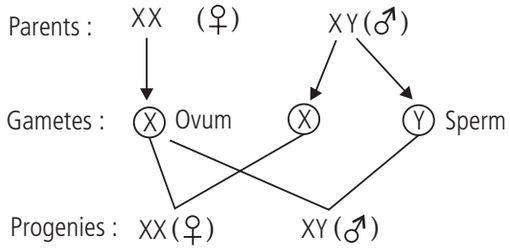

Thus, the ratio of white flower plants to purple flower plants is 1:3.

**18. (b) :** When $F_1$ generation of a cross between green stemmed tomato plants and purple stemmed tomato plants were self-pollinated then the $F_2$ progeny can be obtained as follows:




Thus, the percentage of purple stemmed plants in the $F_2$ generation is 25%.

**19. (b) :** 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 is produced, otherwise a male child is produced.




**20. (a) :** Segregation of alleles takes place during meiosis. Meiosis is a reductional division in which a chromosome number is reduced to half, so the alleles present on homologous chromosome segregate.

**21. (a) :** The genotypic ratio in $F_2$ generation of monohybrid cross will be 1(pure, dominant) : 2(hybrid, dominant) : 1 (pure, recessive).

**22. (c) :** Mendel did not use leaf shape character. He used seven characters which were pod colour, pod shape, seed shape, seed colour, flower colour, flower position and stem height.

**23. (a) :** Mutations are sudden inheritable changes in DNA of the cell. They occur naturally and are usually recessive.

They can also be induced. Mutations create inheritable variations which cause evolution.

**24. (c) :** According to Mendel's observations, in a hybrid only one of the alleles is expressed. The allele that cannot express itself in presence of the other allele (dominant allele) is called recessive allele.

**25. (a) :** In XX-XO type and XX-XY type of sex determining mechanisms, males produce two different types of gametes, either with or without X-chromosome (XO type), or some gametes with X-chromosome and some with Y-chromosome (XY type). Such type of sex determination mechanism is designated to be the example of male heterogamety. In both, females are homogametic and produce X type of gametes in both the cases and have XX genotype.

**26. (b) :** Male fruitfly is heterogametic whereas female fruitfly is homogametic.

**27. (c) :** Characters studied by Mendel are as follows:

| | Trait studied | Dominant | Recessive |
|---|---|---|---|
| 1. | Plant height | Tall (T) | Dwarf (t) |
| 2. | Flower position | Axial (A) | Terminal (a) |
| 3. | Flower colour | Violet (V) or (W) | White (v) or (w) |
| 4. | Pod shape | Full or Inflated (I) or (C) | Constricted (i) or (c) |
| 5. | Pod colour | Green (G) or (Y) | Yellow (g) or (y) |
| 6. | Seed shape | Round (R) or (W) | Wrinkled (r) or (w) |
| 7. | Seed colour | Yellow (Y) or (G) | Green (y) or (g) |

**28. (d)**

**29. (a) :** Gametes produced by YyRr parent would be 25% YR, 25% yR, 25% Yr and 25% yr.

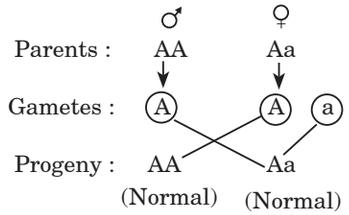
**30. (b) :** Factors representing the alternate or same form of a character are called alleles. In heterozygous individuals or hybrids, a character is represented by two contrasting alleles. Out of the two contrasting alleles, only one is able to express its effect in the individual. It is called dominant allele. The other allele which does not show its effect in the heterozygous individual is called recessive allele, *e.g.*, in case of hybrid tall pea plants (Tt). 'T' is dominant allele whereas 't' is recessive allele.

**31. (c) :** X and Y parents must have 'a' allele (recessive) that is respective for albinism, the genotype of both X and Y individuals would be Aa and Aa as they are normal and 3$^{rd}$ generation, normal and albino male and female is formed in 3 : 1 ratio.

**32. (b) :** Albinism is caused by the recessive allele. The children of generation-1, male and female all are normal (Aa). So, in generation-1, the genotype of female must be AA as she is normal and genotype of male is aa as he is albino male.

**33. (d) :** Albinism is caused by the recessive allele and father of X is albino male so, the genotype of X is Aa and genotype of albino female is aa. So, the probability that their children would be albino is 50%.

**34. (a) :** If Y married a normal homozygous male then there will be zero probability for this children to be albino. This can be explained as follows.




**35. (a)**

**36. (a)**

**37. (a) :** The parental generation for the given $F_2$ generation will be homozygous round and yellow (YYRR) and homozygous wrinkled and green (yyrr).

**38. (d) :** Plant with wrinkled and green coloured seeds (S) (genotype rryy) is crossed with plant with wrinkled and yellow coloured seeds (R) (genotype rrYY or rrYr). If plant with wrinkled and green coloured seeds (rryy) is crossed with plant having wrinkled and yellow coloured seeds of genotype rrYY then all plants produced with wrinkled and yellow coloured seeds whereas if plant with wrinkled and green coloured seeds (rryy) is crossed with plant having wrinkled and yellow coloured seeds that has genotype rrYy then 50% plants with wrinkled and yellow coloured seeds and 50% plants with wrinkled and green coloured seeds are produced.

**39. (a) :** When plant YyRr is self pollinated, 9 : 3 : 3 : 1 ratio of phenotypes will be observed. This can be explained as follows:

Parents : YyRr × YyRr

Progenies :

| ♀ / ♂ | YR | Yr | yR | yr |
|---|---|---|---|---|
| YR | YYRR Yellow round | YYRr Yellow round | YyRR Yellow round | YyRr Yellow round |
| Yr | YYRr Yellow round | YYrr Yellow Wrinkled | YyRr Yellow round | Yyrr Yellow Wrinkled |
| yR | YyRR Yellow round | YyRr Yellow round | yyRR Green round | yyRr Green round |
| yr | YyRr Yellow round | Yyrr Yellow Wrinkled | yyRr Green round | yyrr Green Wrinkled |

Phenotypic ratio = 9 yellow and round : 3 yellow and wrinkled : 3 green and round : 1 green and wrinkled.

**40. (b) :** Gametes produced by YyRR parent would be 50% YR and 50% yR.

**41. (a) :** Earlier workers did same crosses but lack of numerical records resulted in their failures.

**42. (a) :** According to principle of segregation (first law of Mendel), the two factors of a character which remain together in an individual do not get mixed up but keep their identity distinct and separate at the time of gametogenesis. Gametes carry a single factor or allele for a trait. The two Mendelian factors present in the $F_1$ plants segregate during gamete formation. The principle of segregation is called the principle of purity of gametes because segregation of the two Mendelian factors of a trait results in gametes receiving only one factor out of a pair. As a result gametes are always pure for a character.

**43. (b) :** Back cross is a cross which is performed between hybrid and one of its parents. In test cross, the individual is crossed with recessive parent. It is called a test cross, because it is used to test whether an individual is homozygous or heterozygous (hybrid). Refer the given crosses.

| | | |
|---|---|---|
| Parental generation TT × tt<br>↓<br>$F_1$ Tt<br>(i) | $F_1$ hybrid Tt × Dominant parent TT<br>↓<br>TT, Tt<br>(ii) | $F_1$ hybrid Tt × Recessive parent tt<br>↓<br>Tt, tt<br>(iii) |

Here, (i) is monohybrid cross. (ii) and (iii) are back cross but (iii) is also a test cross.

**44. (b) :** Pure line is a strain of genetically true breeding individuals. Members of pure line are homozygous for one or more characters. In homozygous form both the factors express the same effect. They are used for cross breeding in order to get the desired improvement in crops.

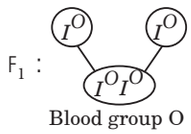
**45. (c) :** Monohybrid cross is a cross between two organisms of a species considering a single pair of alleles or factors of a character. Dominant character express itself whether present in homozygous or heterozygous state. In $F_1$ generation, progenies are heterozygous dominant.

**46. (c) :** Acquired traits are non-genetic changes and are not transferred to future generations while inherited traits are controlled by specific genes and are passed on from one generation to another. Any alteration in the DNA (genes) will be passed on, through germ cells, to the progeny resulting in variations in them.

**47. (b) :** The blood group system in humans is determined by a gene which has 3 different alleles *viz.* $I^A$, $I^B$ and $I^O$. $I^A$ and $I^B$ are dominant to $I^O$ but codominant to each other. Blood group A is indicated by genotype $I^AI^A$ or $I^AI^O$, Blood group B $\rightarrow$ $I^BI^B$ or $I^BI^O$, Blood group AB $\rightarrow$ $I^AI^B$ and blood group O $\rightarrow$ $I^OI^O$

When ♀ $I^OI^O$ × $I^O$ $I^O$ ♂

The gametes :



Blood group O

**48. (d) :** In grasshoppers, the male has only one sex chromosome (XO) whereas the female has two sex chromosomes (XX) *i.e.*, homogametic. This type of sex determination mechanism is called XX–XO mechanism.

**49. (c) :** Gene for black hair colour is dominant to gene for red hair colour in humans. Mother has black hair and can be represented by (BB) whereas father can be represented by (bb).

(i) Parents : ♀ BB × bb ♂

Gametes : B, b

Progeny : Bb

Heterozygous black

So, the child will be heterozygous for black hair colour.

**50. (c) :** Father produces two types of sperms, one with X and one with Y chromosome whereas mother produces all egg with X chromosome. Zygote that inherits X chromosome from father has XX chromosomes and develops into baby girl whereas zygote which inherits Y chromosome from father has XY chromosomes and develops into baby boy.

## SUBJECTIVE TYPE QUESTIONS

**1.** Colour of eyes and shape of external ears.

**2.** Gene is the unit of inheritance. It is a segment of the chromosome which controls hereditary characteristics.

**3.** In garden lizards, sex of the organism is determined by environmental factor such as temperature.

**4.** Genes carry information for the the production of proteins which, on the other hand, control the various body characteristics.

**5.** Inherited trait – Eye colour in humans
Acquired traits – Reduction in body weight of an animals due to starvation.

**6.** 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.

**7.** Human males have XY sex chromosomes, where X chromosome is morphologically distinct from Y chromosome. Y chromosome is smaller than X chromosome. Hence, they are dissimilar or heteromorphic.

**8.** When a tall pea plant is crossed with a short pea plant, the resultant progeny is always tall because tallness is a

dominant trait while shortness is a recessive trait. Hence, dominant trait expresses itself in the progeny.

**9.** Mendel studied seven pairs of allelic characters in pea plant.

**10.** A true breeding plant is the one that when self-fertilised, produces offspring with the same traits. They will be either homozygous dominant or homozygous recessive.

**11.** Differences between inherited and acquired traits are as follows :

| S. No. | Inherited traits | Acquired traits |
|---|---|---|
| (i) | These are obtained from the parents. | These are developed during the life of an individual. |
| (ii) | These are genetic variations. | These are somatic variations. |
| (iii) | These develop due to crossing over phenomenon and mutations. | These develop due to use and disuse of organs and direct effect of environment. |
| (iv) | These are passed on from one generation to the other. | These are lost with the death of the individual. |

**12.** Genotype of human female is 44 + XX. Human female is homogametic. During meiosis, at the time of gamete formation, only one X chromosome enters in each gamete. Hence, all female gametes have genotype (22 + X).

**13.** A trait which is able to express itself both in homozygous as well as heterozygous conditions is called a dominant trait, *e.g.*, tallness is a dominant trait in pea plant. A trait which expresses itself only in homozygous condition, but remains suppressed in heterozygous condition is called recessive trait, *e.g.*, dwarfness is the recessive trait in a pea plant.

**14.** Sexually reproducing organisms will show more variations as genetic material is exchanged between homologous pair of chromosomes during crossing over. However, during asexual reproduction, mutations are the only means of variations during DNA replication which are not very common and thus may lead to very little variation.

**15.** Gametes formation involves meiosis or reduction division. The gamete mother cell is diploid (2n), *i.e.*, it has two sets of chromosomes. This single diploid cell divides by meiosis to form 4 haploid (n) daughter cells. Each daughter cell becomes a gamete, either male or female. Each gamete possesses single set of chromosomes. Fusion of these gametes results in the formation of a zygote having a double set of chromosomes *i.e.*, diploid (2n) (one set of paternal and the other set maternal). Thus the number of chromosomes in parents and offsprings of a particular species remains constant.

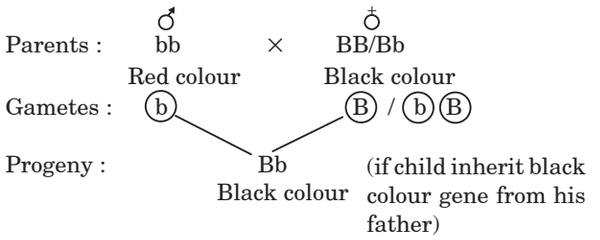
**16.** In this breeding experiment, ratio of purple to white flowers is approximately 3 : 1 in $F_2$ generation. So the ratio is according to Mendelian monohybrid cross. The cross further explains the following facts:

(i) $F_1$ is represented only by dominant trait, *i.e.*, purple flowered plants.

(ii) Both the traits, *i.e.*, purple and white flower colour show segregation and thus appear in $F_2$ generation.

**17.** In $F_1$ generation both alleles come together in hybrid but only dominant character is expressed. In $F_2$ generation, on selfing of $F_1$ hybrids, these alleles segregate. As a result, dominant (pure and hybrid) and recessive (pure) phenotypes are segregated.

**18.** The hair colour of child will be black. This can be illustrated as follows:




**19.** Differences between genotype and phenotype are as follows :

| | Characters | Genotype | Phenotype |
|---|---|---|---|
| 1. | Definition | Genotype is the gene complement of an organism, *i.e.* TT or Tt for a tall plant. | It is the expression of a character, e.g. tall plant. |
| 2. | Change | Genotype remain unchanged. | Phenotype may change under the effect of environment. |
| 3. | Observation | It cannot be studied directly. It can be ascertained from ancestry or by studying progeny obtained by mating. | Phenotype can be observed directly. |
| 4. | Similarity | Organisms with different genotypes may have similar phenotypes, *e.g.* tallness with TT or Tt genotypes. | Organisms with different phenotypes are usually with different genotypes. |

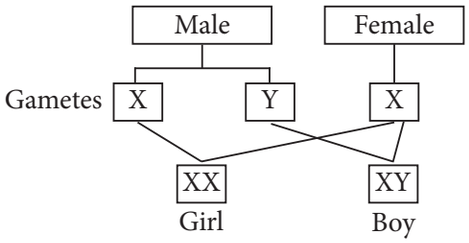
**20.** Principle of purity of gametes is also known as principle or law of segregation. According to this law, the two unit factors of a character which remains together in an individual do not get mixed up and keep their distinct identity. They separate during gamete formation so that each gamete receives only one factor or gene for each character and is always pure.

**21.** Sex is determined at the time of fertilisation when male and female gametes fuse to form zygote. Male produces two types of gametes, *i.e.*, having X or Y chromosome and female produces one type of gametes all containing X chromosomes.

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 is 50% chance of a male child and 50% chance of a female child.




**22.** (i) In $F_1$ progeny all tomato plants will be green stemmed with genotype Gg.

(ii) 25% of plants will be purple stemmed in $F_2$ generation which are produced due to self pollination of $F_1$ plants.

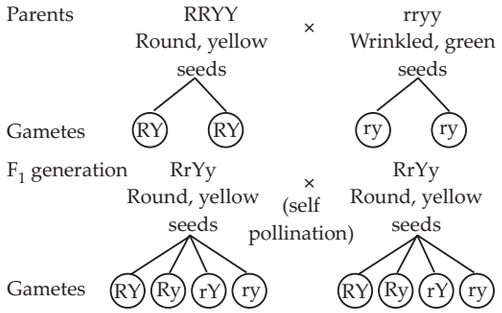
(iii) In $F_2$ progeny ratio of GG to Gg will be 1 : 2 and will be green stemmed.

**23.** There is a pair of genes for a particular trait. The genes controlling a particular trait separate from each other during gamete formation. Germs cells make a single set of genes from two normal copies by a process called meiosis or reduction division. Hence gamete is always pure as far as contrasting characters are considered and will possess only one gene set. When male and female gametes fuse during fertilisation, paired condition is restored.

**24.** In some animals, environmental factors such as association with families, egg size and incubation temperature determine the sex of the individuals. For example, in lizards the temperature at which fertilised eggs are kept, determines whether the developing animal in fertilised egg is male or female. In some animals, like snail, individual can change sex. However, in some animals, sex of individuals determined genetically by specific chromosomes. For example in humans, if a child inherits X-chromosome from the father, will be a girl and one who inherits a Y-chromosome from the father will be a boy.

**25.** Plants have hormones that can trigger growth. Plant height can depend on the amount of a particular plant hormone. The amount of the plant hormone produced will depend on the efficiency of the process for making it. An enzyme (chemically protein molecules) that is important for this process, if works efficiently, a lot of hormone will be produced, and the plant will be tall. If the gene for that enzyme has an alteration that makes the enzyme less efficient, the amount of hormone will be less, and the plant will be short. Thus, enzymes which are protein in nature control the expression of characters.

**26.** A breeding experiment dealing with two characters at the same time is called a dihybrid cross. In such a cross only one parental combination appears in $F_1$ generation. However, in $F_2$ generation raised by self pollination, four combinations of traits appear. These include two parental types and two new combinations. A typical dihybrid cross in pea plant is depicted as follows :

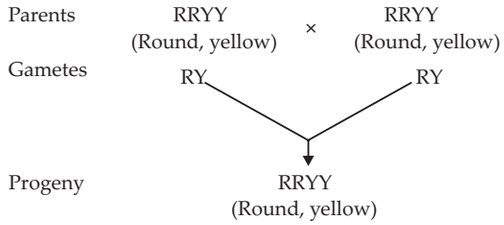



$F_2$ generation :

| Plant with round and yellow seeds | : | Plant with round and green seeds | : | Plant with wrinkled and yellow seeds | : | Plant with wrinkled and green seeds |
|---|---|---|---|---|---|---|
| 9 | : | 3 | : | 3 | : | 1 |

New combination of characters appear in $F_2$ generation because the inheritance of factors controlling a particular trait in an organism are independent of each other. This is called law of independent assortment. At the time of reproduction, two pairs of factors of each of the two traits in a dihybrid cross segregate independently during gamete formation and randomly form combinations in $F_2$ generation.

**27.** (a) When two plants with round yellow seeds are crossed, the progeny produced will also possess round yellow seeds.




(b) When plants heterozygous for round seed shape and yellow seed colour are crossed following progenies will be produced :

**Parents** **RrYy** (Round, yellow) **RrYy** (Round, yellow)

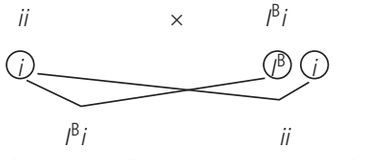
**$F_1$ generation**

| Gametes | 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 |

The progeny produced will posses round yellow, round green, wrinkled yellow, and wrinkled green seeds in the ratio of 9 : 3 : 3 : 1.

**28.** In Mendel's dihybrid cross, with yellow round and green wrinkled seeds 9 : 3 : 3 : 1 ratio was obtained showing four phenotypes. Yellow colour was originally present with round seeds but in $F_2$ generation it was assorted independently of round seed character and expressed with wrinkled seeds. Same is the case with green colour. Thus, it shows independent assortment of characters.

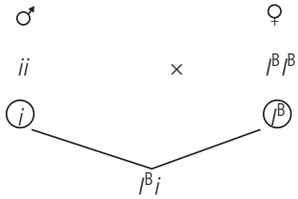
**29.** (i) ♂ ♀




Blood group B Blood group O

or

(ii) ♂ ♀




Blood group B

The blood group of the daughter be either B or O depending upon the blood group of mother.

**30.** The genes control the characteristics by making a specific protein. Genes are the segment of DNA that contains information to form RNA which ultimately forms protein. Each gene contains two alleles and this instruct the cell to make protein for expression of traits. For example, if the plant has genes for violet flower, then it will make protein which will give violet colour to flowers.

**31.** (a) Variation increases the chance of the species survival in a changing environment.

(b) A sex chromosome is a type of chromosome that participates in sex determination. Humans have two sex chromosomes, X and Y.

**32.** When Mendel crossed two pea plants with a pair of contrasting characters only one character appeared in all the members of $F_1$ progeny, the other was not expressed.

On selfing $F_1$, the hidden characters reappeared in just 25% of the offsprings and the other 75% shared the characters expressed in $F_1$.

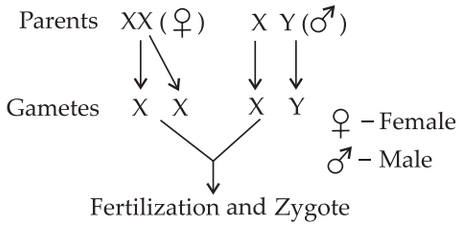
Mendel concluded that the character which expresses itself in $F_1$ and in 75% of the individuals of $F_2$ is dominating while the other is recessive.

**33.** Diploid organisms like human beings have separate sexes. In organisms, where sex is determined genetically, a pair of chromosomes called sex chromosomes determines the sex of the individual. All other chromosomes are termed autosomes. In human beings, there are 46 chromosomes. Of these, one pair is of sex chromosomes which are of two types – X chromosome and Y chromosome.

(i) A male individual contains one X chromosome and one Y chromosome *i.e.*, XY.

(ii) A female contains two X chromosomes *i.e.*, XX.

The sex of the child is determined at the time of fertilisation when male and female gametes fuse to form zygote. It can be shown as follows:



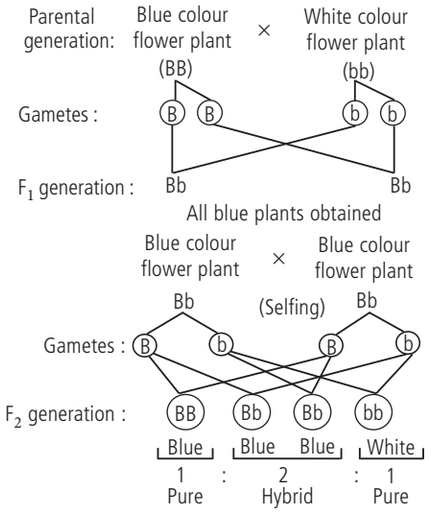

| ♀ \ ♂ | X | Y |
|---|---|---|
| X | XX(♀) | XY(♂) |
| X | XX(♀) | XY(♂) |

**34.** (i) : The colour of the flower in $F_1$ generation will be blue with Bb genotype.

(ii) If the flowers of $F_1$ generations are self pollinated, then the percentage of white flowers in $F_2$ generation must be 25%.

(iii) The expected ratio of the genotypes BB and Bb in the $F_2$ progeny is 1 : 2.

The above results could be depicted by the given cross:




**35.** The basic features of mechanism of inheritance are as follows:

(i) Characters are controlled by genes and each gene controls one character.

(ii) Chromosomes are gene carrier and genes are basic unit of heredity.

(iii) One form of gene may be dominant on other, *i.e.*, genes are allelic in nature.

(iv) The two forms of alleles separate at the time of gamete formation, *i.e.*, they do not mix with each other.

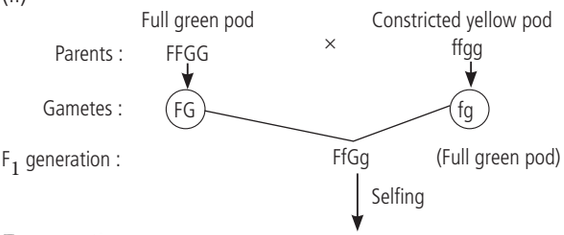
(v) Two allelic forms of a gene are brought together in zygote.

Traits are inherited independently can be explained by dihybrid cross. A cross is made between a pure round yellow seeded pea plant (RRYY) with wrinkled green seeded pea plant (rryy). Yellow colour is dominant over green and rounded seed shape over wrinkled seed shape. F1 plants are all round and yellow seeded. F1 plants are self breed and produce F2 generation. F2 generation has four types of plants: rounded yellow, rounded green, wrinkled yellow and wrinkled green in the ratio of 9:3:3:1 respectively.

Each of the characters if considered separately shows a ratio of 3:1 as found in monohybrid cross. The $F_2$ ratio of 9:3:3:1 shows two types of recombinants, wrinkled yellow and rounded green. They can be produced only if the alleles of the two different characters are free to recombine, *i.e.*, separate and combine independent to each other.

**36.** (i) The plants obtained on crossing the given plants can have different combination as gametic fusion can take place in any manner (both parental combination and recombination) are possible, which proved that both the traits of the two characters are assorted independently, and hence, plants with different kind of pods are produced.

(ii)




$F_2$ generation

| ♀ \ ♂ | FG | Fg | fG | fg |
|---|---|---|---|---|
| FG | FFGG Full green pod | FFGg Full green pod | FfGG Full green pod | FfGg Full green pod |
| Fg | FFGg Full green pod | FFgg Full yellow pod | FfGg Full green pod | Ffgg Full yellow pod |
| fG | FfGG Full green pod | FfGg Full green pod | ffGG Constricted green pod | ffGg Constricted green pod |
| fg | FfGg Full green pod | Ffgg Full yellow pod | ffGg Constricted green pod | ffgg Constricted yellow pod |

Phenotypic ratio : Full green pod : Full yellow pod : Constricted green pod : Constricted yellow pod

9 : 3 : 3 : 1