CHAPTER 5

Principles of Inheritance and Variation

5.1 Mendel's Laws of Inheritance

1. How many true breeding pea plant varieties did Mendel select as pairs, which were similar except in one character with contrasting traits?
(a) 4 (b) 2
(c) 14 (d) 8 *(NEET 2020)*

2. Among the following characters, which one was not considered by Mendel in his experiments on pea?
(a) Trichomes-Glandular or non-glandular
(b) Seed-Green or yellow
(c) Pod-Inflated or constricted
(d) Stem-Tall or dwarf *(NEET 2017)*

3. Which one from those given below is the period for Mendel's hybridisation experiments?
(a) 1840-1850 (b) 1857-1869
(c) 1870-1877 (d) 1856-1863
(NEET 2017)

4. In his classic experiments on pea plants, Mendel did not use
(a) seed shape (b) flower position
(c) seed colour (d) pod length. *(2015)*

5. How many pairs of contrasting characters in pea plants were studied by Mendel in his experiments?
(a) Eight (b) Seven
(c) Five (d) Six *(2015 Cancelled)*

6. Which one of the following traits of garden pea studied by Mendel was a recessive feature?
(a) Axial flower position
(b) Green seed colour
(c) Green pod colour
(d) Round seed shape *(2003)*

7. The genes controlling the seven pea characters studied by Mendel are now known to be located on how many different chromosomes?
(a) Seven (b) Six
(c) Five (d) Four *(2003)*

8. According to Mendelism, which character shows dominance?
(a) Terminal position of flower
(b) Green colour in seed coat
(c) Wrinkled seeds
(d) Green pod colour *(2000)*

9. First geneticist/father of genetics was
(a) De Vries (b) Mendel
(c) Darwin (d) Morgan. *(1991)*

10. Which contribute to the success of Mendel?
(a) Qualitative analysis of data
(b) Observation of distinct inherited traits
(c) His knowledge of biology
(d) Consideration of one character at one time
(1988)

5.2 Inheritance of One Gene

11. Identify the wrong statement with reference to the gene '*I*' that controls ABO blood groups.
(a) The gene (*I*) has three alleles.
(b) A person will have only two of the three alleles.
(c) When I^A and I^B are present together, they express same type of sugar.
(d) Allele *i* does not produce any sugar.
(NEET 2020)

12. In *Antirrhinum* (Snapdragon), a red flower was crossed with a white flower and in F_1 generation all pink flowers were obtained. When pink flowers were selfed, the F_2 generation showed white, red and pink flowers. Choose the incorrect statements from the following.
(a) Law of segregation does not apply in this experiment.
(b) This experiment does not follow the Principle of Dominance.
(c) Pink colour in F_1 is due to incomplete dominance.
(d) Ratio of F_2 is $\frac{1}{4}$(red) : $\frac{2}{4}$(pink) : $\frac{1}{4}$(white).
(NEET 2019)

13. The genotypes of a husband and wife are I^AI^B and I^Ai. Among the blood types of their children, how many different genotypes and phenotypes are possible?
(a) 3 genotypes; 4 phenotypes
(b) 4 genotypes; 3 phenotypes
(c) 4 genotypes; 4 phenotypes
(d) 3 genotypes; 3 phenotypes *(NEET 2017)*

14. A tall true breeding garden pea plant is crossed with a dwarf true breeding garden pea plant. When the F_1 plants were selfed the resulting genotypes were in the ratio of
(a) 3 : 1 : : Tall : Dwarf
(b) 3 : 1 : : Dwarf : Tall
(c) 1 : 2 : 1 : : Tall homozygous : Tall heterozygous : Dwarf
(d) 1 : 2 : 1 : : Tall heterozygous : Tall homozygous : Dwarf. *(NEET-I 2016)*

15. A gene showing co-dominance has
(a) alleles that are recessive to each other
(b) both alleles independently expressed in the heterozygote
(c) one allele dominant on the other
(d) alleles tightly linked on the same chromosome. *(2015)*

16. Alleles are
(a) different molecular forms of a gene
(b) heterozygotes
(c) different phenotype
(d) true breeding homozygotes. *(2015 Cancelled)*

17. Multiple alleles are present
(a) at the same locus of the chromosome
(b) on non-sister chromatids
(c) on different chromosomes
(d) at different loci on the same chromosome. *(2015 Cancelled)*

18. A man with blood group 'A' marries a woman with blood group 'B'. What are all the possible blood groups of their offspring?
(a) A, B, AB and O (b) O only
(c) A and B only (d) A, B and AB only *(2015 Cancelled)*

19. If two persons with 'AB' blood group marry and have sufficiently large number of children, these children could be classified as 'A' blood group: 'AB' blood group : 'B' blood group in 1 : 2 : 1 ratio. Modern technique of protein electrophoresis reveals presence of both 'A' and 'B' type proteins in 'AB' blood group individuals. This in an example of
(a) partial dominance
(b) complete dominance
(c) codominance
(d) incomplete dominance. *(NEET 2013)*

20. Which idea is depicted by a cross in which the F_1 generation resembles both the parents?
(a) Inheritance of one gene
(b) Co-dominance
(c) Incomplete dominance
(d) Complete dominance *(NEET 2013)*

21. F_2 generation in a Mendelian cross showed that both genotypic and phenotypic ratios are same as 1 : 2 : 1. It represents a case of
(a) co-dominance
(b) dihybrid cross
(c) monohybrid cross with complete dominance
(d) monohybrid cross with incomplete dominance. *(2012)*

22. A test cross is carried out to
(a) determine the genotype of a plant at F_2
(b) predict whether two traits are linked
(c) assess the number of alleles of a gene
(d) determine whether two species or varieties will breed successfully. *(Mains 2012)*

23. Test cross in plants or in *Drosophila* involves crossing
(a) between two genotypes with recessive trait
(b) between two F_1 hybrids
(c) the F_1 hybrid with a double recessive genotype
(d) between two genotypes with dominant trait. *(Mains 2011)*

24. ABO blood groups in humans are controlled by the gene *I*. It has three alleles - I^A, I^B and *i*. Since there are three different alleles, six different genotypes are possible. How many phenotypes can occur?
(a) Three (b) One
(c) Four (d) Two *(2010)*

25. The genotype of a plant showing the dominant phenotype can be determined by
(a) test cross (b) dihybrid cross
(c) pedigree analysis (d) back cross. *(2010)*

26. Which one of the following cannot be explained on the basis of Mendel's law of dominance?
(a) The discrete unit controlling a particular character is called a factor.
(b) Out of one pair of factors one is dominant, and the other recessive.
(c) Alleles do not show any blending and both the characters recover as such in F_2 generation.
(d) Factors occur in pairs. *(2010)*

27. ABO blood grouping is controlled by gene *I* which has three alleles and show co-dominance. There are six genotypes. How many phenotypes in all are possible?
(a) Six (b) Three
(c) Four (d) Five *(Mains 2010)*

28. A cross in which an organism showing a dominant phenotype is crossed with the recessive parent in order to know its genotype is called
(a) monohybrid cross (b) back cross
(c) test cross (d) dihybrid cross.
(Mains 2010)

29. In *Antirrhinum* two plants with pink flowers were hybridized. The F_1 plants produced red, pink and white flowers in the proportion of 1 red, 2 pink and 1 white. What could be the genotype of the two plants used for hybridisation? Red flower colour is determined by RR and white by rr genes.
(a) rrrr (b) RR
(c) Rr (d) rr *(Mains 2010)*

30. In pea plants, yellow seeds are dominant to green. If a heterozygous yellow seeded plant is crossed with a green seeded plant, what ratio of yellow and green seeded plants would you expect in F_1 generation?
(a) 9 : 1 (b) 1 : 3
(c) 3 : 1 (d) 50 : 50 *(2007)*

31. A common test to find the genotype of a hybrid is by
(a) crossing of one F_2 progeny with female parent
(b) studying the sexual behaviour of F_1 progenies
(c) crossing of one F_1 progeny with male parent
(d) crossing of one F_2 progeny with male parent.
(2007)

32. Test cross involves
(a) crossing between two genotypes with dominant trait
(b) crossing between two genotypes with recessive trait
(c) crossing between two F_1 hybrids
(d) crossing the F_1 hybrid with a double recessive genotype. *(2006)*

33. Phenotype of an organism is the result of
(a) genotype and environment interactions
(b) mutations and linkages
(c) cytoplasmic effects and nutrition
(d) environmental changes and sexual dimorphism.
(2006)

34. A gene is said to be dominant if
(a) it expresses its effect only in homozygous state
(b) it expresses its effect only in heterozygous condition
(c) it expresses its effect both in homozygous and heterozygous condition
(d) it never expresses its effect in any condition.
(2002)

35. When dominant and recessive alleles express itself together it is called
(a) co-dominance (b) dominance
(c) amphidominance (d) pseudodominance.
(2001)

36. In hybridisation, Tt × tt gives rise to the progeny of ratio
(a) 2 : 1 (b) 1 : 2 : 1
(c) 1 : 1 (d) 1 : 2. *(1999)*

37. A child's blood group is 'O'. The parent's blood groups cannot be
(a) A and B (b) A and A
(c) AB and O (d) B and O. *(1994)*

38. A child of O-group has B-group father. The genotype of father will be
(a) I^OI^O (b) I^BI^B
(c) I^AI^B (d) I^BI^O. *(1992)*

39. An allele is dominant if it is expressed in
(a) both homozygous and heterozygous states
(b) second generation
(c) heterozygous combination
(d) homozygous combination. *(1992)*

40. An organism with two identical alleles is
(a) dominant (b) hybrid
(c) heterozygous (d) homozygous. *(1992)*

41. A man of A-blood group marries a woman of AB blood group. Which type of progeny would indicate that man is heterozygous A?
(a) AB (b) A
(c) O (d) B *(1991)*

42. Multiple alleles control inheritance of
(a) phenylketonuria (b) colour blindness
(c) sickle cell anaemia (d) blood groups. *(1991)*

43. The contrasting pairs of factors in Mendelian crosses are called
(a) multiple alleles (b) allelomorphs
(c) alloloci (d) paramorphs. *(1991)*

44. Mendel's last law is
(a) segregation
(b) dominance
(c) independent assortment
(d) polygenic inheritance. *(1991)*

45. Blue eye colour is recessive to brown eye colour. A brown eyed man whose mother was blue eyed marries a blue-eyed woman. The children will be
(a) both blue eyed and brown eyed 1 : 1
(b) all brown eyed
(c) all blue eyed
(d) blue eyed and brown eyed 3 : 1. *(1991)*

46. RR (Red) *Antirrhinum* is crossed with white (WW) one. Offspring RW are pink. This is an example of
(a) dominant-recessive
(b) incomplete dominance
(c) hybrid
(d) supplementary genes. *(1991)*

47. ABO blood group system is due to
(a) multifactor inheritance
(b) incomplete dominance
(c) multiple allelism
(d) epistasis. *(1990)*

48. tt mates with Tt. What will be characteristic of offspring?
(a) 75% recessive (b) 50% recessive
(c) 25% recessive (d) All dominant *(1990)*

49. Haploids are able to express both recessive and dominant alleles/mutations because there are
(a) many alleles for each gene
(b) two alleles for each gene
(c) only one allele for each gene in the individual
(d) only one allele in a gene. *(1988)*

5.3 Inheritance of Two Genes

50. Experimental verification of the chromosomal theory of inheritance was done by
(a) Mendel (b) Sutton
(c) Boveri (d) Morgan. *(NEET 2020)*

51. What map unit (centimorgan) is adopted in the construction of genetic maps?
(a) A unit of distance between genes on chromosomes, representing 50% cross over.
(b) A unit of distance between two expressed genes, representing 10% cross over.
(c) A unit of distance between two expressed genes, representing 100% cross over.
(d) A unit of distance between genes on chromosomes, representing 1% cross over.
(NEET 2019)

52. The frequency of recombination between gene present on the same chromosome as a measure of the distance between genes was explained by
(a) Sutton Boveri (b) T.H. Morgan
(c) Gregor J.Mendel (d) Alfred Sturtevant.
(NEET 2019)

53. The mechanism that causes a gene to move from one linkage group to another is called
(a) inversion (b) duplication
(c) translocation (d) crossing-over.
(NEET-II 2016)

54. In a test cross involving F_1 dihybrid flies, more parental-type offspring were produced than the recombinant-type offspring. This indicates
(a) the two genes are linked and present on the same chromosome
(b) both of the characters are controlled by more than one gene
(c) the two genes are located on two different chromosomes
(d) chromosomes failed to separate during meiosis.
(NEET-I 2016)

55. The term "linkage" was coined by
(a) G. Mendel (b) W. Sutton
(c) T.H. Morgan (d) T. Boveri. *(2015)*

56. The movement of a gene from one linkage group to another is called
(a) translocation (b) crossing over
(c) inversion (d) duplication.
(2015 Cancelled)

57. Fruit colour in squash is an example of
(a) recessive epistasis
(b) dominant epistasis
(c) complementary genes
(d) inhibitory genes. *(2014)*

58. Which of the following statements is not true of two genes that show 50% recombination frequency?
(a) The gene show independent assortment.
(b) If the genes are present on the same chromosome, they undergo more than one cross-overs in every meiosis.
(c) The genes may be on different chromosomes.
(d) The genes are tightly linked. *(NEET 2013)*

59. When two unrelated individuals or lines are crossed, the performance of F_1 hybrid is often superior to both its parents. This phenomenon is called
(a) heterosis (b) transformation
(c) splicing (d) metamorphosis.
(2011)

60. Select the correct statement from the ones given below with respect to dihybrid cross.
(a) Tightly linked genes on the same chromosomes show higher recombinations.
(b) Genes far apart on the same chromosome show very few recombinations.
(c) Genes loosely linked on the same chromosome show similar recombinations.
(d) Tightly linked genes on the same chromosome show very few recombinations. *(2010)*

61. A human male produces sperms with the genotypes AB, Ab, aB and ab pertaining to two diallelic characters in equal proportions. What is the corresponding genotype of this person?
(a) AaBB (b) AABb
(c) AABB (d) AaBb *(2007)*

62. In Mendel's experiments with garden pea, round seed shape (RR) was dominant over wrinkled seeds (rr), yellow cotyledon (YY) was dominant over green cotyledon (yy). What are the expected phenotypes in the F_2 generation of the cross RRYY × rryy?
(a) Round seeds with yellow cotyledons, and wrinkled seeds with yellow cotyledons
(b) Only round seeds with green cotyledons
(c) Only wrinkled seeds with yellow cotyledons
(d) Only wrinkled seeds with green cotyledons
(2006)

63. In order to find out the different types of gametes produced by a pea plant having the genotype AaBb it should be crossed to a plant with the genotype
(a) AABB (b) AaBb
(c) aabb (d) aaBB. *(2005)*

64. In a plant, red fruit (R) is dominant over yellow fruit (r) and tallness (T) is dominant over shortness (t). If a plant with RRTt genotype is crossed with a plant that is rrtt,
(a) 25% will be tall with red fruit
(b) 50% will be tall with red fruit
(c) 75% will be tall with red fruit
(d) all the offspring will be tall with red fruit.
(2004)

65. Lack of independent assortment of two genes A and B in fruit fly *Drosophila* is due to
(a) repulsion (b) recombination
(c) linkage (d) crossing over. *(2004)*

66. Two crosses between the same pair of genotypes or phenotypes in which the sources of the gametes are reversed in one cross, is known as
(a) test cross (b) reciprocal cross
(c) dihybrid cross (d) reverse cross. *(2003)*

67. There are three genes *a, b, c*. Percentage of crossing over between *a* and *b* is 20%, *b* and *c* is 28% and *a* and *c* is 8%. What is the sequence of genes on chromosome?
(a) *b, a, c* (b) *a, b, c*
(c) *a, c, b* (d) None of these *(2002)*

68. Two non-allelic genes produces the new phenotype when present together but fail to do so independently then it is called
(a) epistasis
(b) polygene
(c) non complementary gene
(d) complementary gene. *(2001)*

69. A and B genes are linked. What shall be genotype of progeny in a cross between AB/ab and ab/ab?
(a) AAbb and aabb (b) AaBb and aabb
(c) AABB and aabb (d) None of these
(2001)

70. Ratio of complementary genes is
(a) 9 : 3 : 4 (b) 12 : 3 : 1
(c) 9 : 3 : 3 : 4 (d) 9 : 7. *(2001)*

71. Independent assortment of genes does not take place when
(a) genes are located on homologous chromosomes
(b) genes are linked and located on same chromosome
(c) genes are located on non-homogenous chromosome
(d) all of these. *(2001)*

72. Due to the cross between TTRr × ttrr the resultant progenies show what percent of tall, red flowered plants?
(a) 50% (b) 75%
(c) 25% (d) 100% *(2000)*

73. A gene pair hides the effect of another gene. The phenomenon is called
(a) dominance (b) segregation
(c) epistasis (d) mutation. *(1999)*

74. If Mendel had studied the seven traits using a plant with 12 chromosomes instead of 14, in what way would his interpretation have been different?
(a) He would not have discovered the law of independent assortment.
(b) He would have discovered sex linkage.
(c) He could have mapped the chromosome.
(d) He would have discovered blending or incomplete dominance. *(1998)*

75. Crossing over in diploid organism is responsible for
(a) segregation of alleles
(b) recombination of linked alleles
(c) dominance of genes
(d) linkage between genes. *(1998)*

76. A fruit fly is heterozygous for sex-linked genes, when mated with normal female fruit fly, the males specific chromosome will enter egg cell in the proportion
(a) 3 : 1 (b) 7 : 1
(c) 1 : 1 (d) 2 : 1. *(1997)*

77. When two dominant independently assorting genes react with each other, they are called
(a) collaborative genes (b) complementary genes
(c) duplicate genes (d) supplementary genes. *(1996)*

78. When two genetic loci produce identical phenotypes in *cis* and *trans* position, they are considered to be
(a) multiple alleles (b) the parts of same gene
(c) pseudoalleles (d) different genes. *(1995)*

79. The phenomenon, in which an allele of one gene suppresses the activity of an allele of another gene, is known as
(a) epistasis (b) dominance
(c) suppression (d) inactivation. *(1995)*

80. Which of the following is suitable for experiment on linkage?
(a) aaBB × aaBB (b) AABB × aabb
(c) AaBb × AaBb (d) AAbb × AaBB *(1993)*

81. Two dominant nonallelic genes are 50 map units apart. The linkage is
(a) *cis* type (b) *trans* type
(c) complete (d) absent/incomplete. *(1993)*

82. Mendel studied inheritance of seven pairs of traits in pea which can have 21 possible combinations. If you are told that in one of these combinations, independent assortment is not observed in later studies, your reaction will be
(a) independent assortment principle may be wrong
(b) Mendel might not have studied all the combinations
(c) it is impossible
(d) later studies may be wrong. *(1993)*

83. In a cross between AABB × aabb, the ratio of F_2 genotypes between AABB, AaBB, Aabb and aabb would be
(a) 9 : 3 : 3 : 1 (b) 2 : 1 : 1 : 2
(c) 1 : 2 : 2 : 1 (d) 7 : 5 : 3 : 1. *(1992)*

84. Segregation of Mendelian factors (no linkage, no crossing over) occurs during
(a) anaphase I (b) anaphase II
(c) diplotene (d) metaphase I. *(1992)*

85. The allele which is unable to express its effect in the presence of another is called
(a) codominant (b) supplementary
(c) complementary (d) recessive. *(1991)*

86. Cross between AaBB and aaBB will form
(a) 1AaBB : 1aaBB (b) all AaBB
(c) 3AaBB : 1aaBB (d) 1AaBB : 3aaBB. *(1990)*

87. In a genetic cross having recessive epistasis, F_2 phenotypic ratio would be
(a) 9 : 6 : 1 (b) 15 : 1
(c) 9 : 3 : 4 (d) 12 : 3 : 1. *(1990)*

88. Bateson used the terms coupling and repulsion for linkage and crossing over. Name the correct parental of coupling type alongwith its cross over or repulsion.
(a) Coupling AABB, aabb; Repulsion AABB, aabb
(b) Coupling AAbb, aaBB; Repulsion AaBb, aabb
(c) Coupling aaBB, aabb; Repulsion AABB, aabb
(d) Coupling AABB, aabb; Repulsion AAbb, aaBB *(1990)*

89. Segregation of Mendelian factor (Aa) occurs during
(a) diplotene (b) anaphase I
(c) zygotene/pachytene (d) anaphase II. *(1990)*

90. Two linked genes a and b show 20% recombination. the individuals of a dihybrid cross between ++/++ × ab/ab shall show gametes
(a) ++ : 80 : : ab : 20
(b) ++ : 50 : : ab : 50
(c) ++ : 40 : : ab : 40 : : + a : 10 : : + b : 10
(d) ++ : 30 : : ab : 30 : : + a : 20 : : + b : 20. *(1989)*

5.4 Polygenic Inheritance

91. Which of the following characteristics represent 'inheritance of blood groups' in humans?
(i) Dominance
(ii) Co-dominance
(iii) Multiple allele
(iv) Incomplete dominance
(v) Polygenic inheritance
(a) (ii), (iii) and (v) (b) (i), (ii) and (iii)
(c) (ii), (iv) and (v) (d) (i), (iii) and (v) *(NEET 2018)*

92. Inheritance of skin colour in humans is an example of
(a) point mutation
(b) polygenic inheritance
(c) codominance
(d) chromosomal aberration. *(2007)*

93. How many different kinds of gametes will be produced by a plant having the genotype AABbCC?
(a) Two (b) Three
(c) Four (d) Nine *(2006)*

94. Which one of the following is an example of polygenic inheritance?
(a) Skin colour in humans
(b) Flower colour in *Mirabilis jalapa*
(c) Production of male honeybee
(d) Pod shape in garden pea *(2006)*

95. On selfing a plant of F_1-generation with genotype "AABbCC", the genotypic ratio in F_2-generation will be
(a) 3 : 1
(b) 1 : 1
(c) 9 : 3 : 3 : 1
(d) 27 : 9 : 9 : 9 : 3 : 3 : 3 : 1. *(2002)*

96. In human beings, multiple genes are involved in the inheritance of
(a) sickle-cell anaemia (b) skin colour
(c) colour blindness (d) phenylketonuria.
(1999)

97. How many different types of genetically different gametes will be produced by a heterozygous plant having the genotype AABbCc?
(a) Six (b) Nine
(c) Two (d) Four *(1998)*

98. The polygenic genes show
(a) different karyotypes (b) different genotypes
(c) different phenotypes (d) none of these. *(1996)*

99. A polygenic inheritance in human beings is
(a) skin colour (b) phenylketonuria
(c) colour blindness (d) sickle cell anaemia.
(1993)

5.5 Pleiotropy

100. Match the terms in column I with their description in column II and choose the correct option.

	Column I		Column II
A.	Dominance	(i)	Many genes govern a single character
B.	Co-dominance	(ii)	In a heterozygous organism only one allele expresses itself
C.	Pleiotropy	(iii)	In a heterozygous organism both alleles express themselves fully
D.	Polygenic	(iv)	A single gene inheritance influences many characters

	A	B	C	D
(a)	(iv)	(i)	(ii)	(iii)
(b)	(iv)	(iii)	(i)	(ii)
(c)	(ii)	(i)	(iv)	(iii)
(d)	(ii)	(iii)	(iv)	(i)

(NEET-I 2016)

101. A pleiotropic gene
(a) controls a trait only in combination with another gene
(b) controls multiple traits in an individual
(c) is expressed only in primitive plants
(d) is a gene evolved during Pliocene. *(2015)*

102. Which of the following is an example of pleiotropy?
(a) Haemophilia (b) Thalassemia
(c) Sickle cell anaemia (d) Colour blindness
(2002)

103. When a single gene influences more than one trait it is called
(a) pseudodominance (b) pleiotropy
(c) epistasis (d) none of these. *(1998)*

5.6 Sex Determination

104. Select the incorrect statement.
(a) Human males have one of their sex-chromosome much shorter than other.
(b) Male fruit fly is heterogametic.
(c) In male grasshoppers, 50% of sperms have no sex-chromosome.
(d) In domesticated fowls, sex of progeny depends on the type of sperm rather than egg.
(NEET 2019)

105. Which of the following pairs is wrongly matched?
(a) Starch synthesis in pea : Multiple alleles
(b) ABO blood grouping : Co-dominance
(c) XO type sex determination: Grasshopper
(d) T.H. Morgan : Linkage *(NEET 2018)*

106. Which one of the following conditions of the zygotic cell would lead to the birth of a normal human female child?
(a) Two X chromosomes
(b) Only one Y chromosome
(c) Only one X chromosome
(d) One X and one Y chromosome *(Mains 2011)*

107. In *Drosophila*, the sex is determined by
(a) the ratio of number of X-chromosome to the sets of autosomes
(b) X and Y chromosomes
(c) the ratio of pairs of X-chromosomes to the pairs of autosomes
(d) whether the egg is fertilized or develops parthenogenetically. *(2003)*

108. Number of Barr bodies in XXXX female is
(a) 1 (b) 2
(c) 3 (d) 4. *(2001)*

109. Male XX and female XY sometime occur due to
(a) deletion
(b) transfer of segments in X and Y chromosome
(c) aneuploidy
(d) hormonal imbalance. *(2001)*

110. Probability of four sons to a couple is
(a) 1/4 (b) 1/8
(c) 1/16 (d) 1/32. *(2001)*

111. Genetic identity of a human male is determined by
(a) sex-chromosome (b) cell organelles
(c) autosome (d) nucleolus. *(1997)*

112. When an animal has both the characters of male and female, it is called
(a) super female (b) super male
(c) intersex (d) gynandromorph. *(1996)*

113. Mr. Kapoor has Bb autosomal gene pair and d allele sex-linked. What shall be proportion of Bd in sperms?
(a) Zero (b) 1/2
(c) 1/4 (d) 1/8 *(1993)*

114. Sex is determined in human beings
(a) by ovum
(b) at time of fertilisation
(c) 40 days after fertilisation
(d) seventh to eight week when genitals differentiate in fetus. *(1993)*

115. A normal green male maize is crossed with albino female. The progeny is albino because
(a) trait for a albinism is dominant
(b) the albinos have biochemical to destroy plastids derived from green male
(c) plastids are inherited from female parent
(d) green plastids of male must have mutated. *(1989)*

116. A family of five daughter only is expecting sixth issue. The chance of its being a son is
(a) zero (b) 25%
(c) 50% (d) 100%. *(1988)*

5.7 Mutation

117. One of the parents of a cross has a mutation in its mitochondria. In that cross, that parent is taken as a male. During segregation of F_2 progenies that mutation is found in
(a) one-third of the progenies
(b) none of the progenies
(c) all the progenies
(d) fifty percent of the progenies. *(2004)*

118. The most striking example of point mutation is found in a disease called
(a) Down's syndrome (b) sickle cell anaemia
(c) thalassaemia (d) night blindness. *(1995)*

5.8 Genetic Disorders

119. Select the correct match.
(a) Haemophilia – Y linked
(b) Phenylketonuria – Autosomal dominant trait
(c) Sickle cell anaemia – Autosomal recessive trait,chromosome -11
(d) Thalassemia – X linked *(NEET 2020)*

120. What is the genetic disorder in which an individual has an overall masculine development, gynaecomastia and is sterile?
(a) Down's syndrome
(b) Turner's syndrome
(c) Klinefelter's syndrome
(d) Edward syndrome *(NEET 2019)*

121. A woman has an X-linked condition on one of her X chromosomes. This chromosome can be inherited by
(a) only daughters
(b) only sons
(c) only grandchildren
(d) both sons and daughters. *(NEET 2018)*

122. Thalassemia and sickle cell anaemia are caused due to a problem in globin molecule synthesis. Select the correct statement.
(a) Both are due to a quantitative defect in globin chain synthesis.
(b) Thalassemia is due to less synthesis of globin molecules.
(c) Sickle cell anaemia is due to a quantitative problem of globin molecules.
(d) Both are due to a qualitative defect in globin chain synthesis. *(NEET 2017)*

123. A disease caused by an autosomal primary non-disjunction is
(a) Klinefelter's syndrome
(b) Turner's syndrome
(c) Sickle cell anaemia
(d) Down's syndrome. *(NEET 2017)*

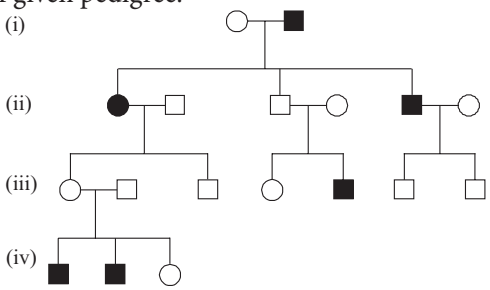
124. If a colour-blind man marries a woman who is homozygous for normal colour vision, the probability of their son being colour-blind is
(a) 0 (b) 0.5
(c) 0.75 (d) 1. *(NEET-II 2016)*

125. Pick out the correct statements.
(1) Haemophilia is a sex-linked recessive disease.
(2) Down's syndrome is due to aneuploidy.
(3) Phenylketonuria is an autosomal recessive gene disorder.
(4) Sickle cell anaemia is an X-linked recessive gene disorder.
(a) (1), (3) and (4) are correct.
(b) (1), (2) and (3) are correct.
(c) (1) and (4) are correct.
(d) (2) and (4) are correct. *(NEET-I 2016)*

126. Which of the following most appropriately describes haemophilia?
(a) Chromosomal disorder
(b) Dominant gene disorder
(c) Recessive gene disorder
(d) X-linked recessive gene disorder
(NEET-I 2016)

127. A colour blind man marries a woman with normal sight who has no history of colour blindness in her family. What is the probability of their grandson being colour blind ?
(a) Nil (b) 0.25
(c) 0.5 (d) 1 *(2015)*

128. In the following human pedigree, the filled symbols represent the affected individuals. Identify the type of given pedigree.



(a) Autosomal recessive
(b) X-linked dominant
(c) Autosomal dominant
(d) X-linked recessive *(2015)*

129. An abnormal human baby with 'XXX' sex chromosomes was born due to
(a) fusion of two ova and one sperm
(b) fusion of two sperms and one ovum
(c) formation of abnormal sperms in the father
(d) formation of abnormal ova in the mother.
(2015 Cancelled)

130. A man whose father was colour blind marries a woman who had a colour blind mother and normal father. What percentage of male children of this couple will be colour blind?
(a) 25% (b) 0%
(c) 50% (d) 75% *(2014)*

131. A human female with Turner's syndrome
(a) has 45 chromosomes with XO
(b) has one additional X chromosome
(c) exhibits male characters
(d) is able to produce children with normal husband. *(2014)*

132. Select the incorrect statement with regard to haemophilia.
(a) It is a dominant disease.
(b) A single protein involved in the clotting of blood is affected.
(c) It is a sex-linked disease.
(d) It is a recessive disease. *(NEET 2013)*

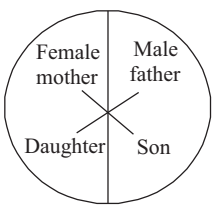
133. If both parents are carriers for thalassaemia, which is an autosomal recessive disorder, what are the chances of pregnancy resulting in an affected child?
(a) 25% (b) 100%
(c) No chance (d) 50% *(NEET 2013)*

134. Which one is the incorrect statement with regard to the importance of pedigree analysis?
(a) It confirms that DNA is the carrier of genetic information.
(b) It helps to understand whether the trait in question is dominant or recessive.
(c) It confirms that the trait is linked to one of the autosome.
(d) It helps to trace the inheritance of a specific trait. *(Karnataka NEET 2013)*

135. Down's syndrome in humans is due to
(a) three 'X' chromosomes
(b) three copies of chromosome 21
(c) monosomy
(d) two 'Y' chromosomes. *(Karnataka NEET 2013)*

136. A normal-visioned man whose father was colour-blind, marries a woman whose father was also colour-blind. They have their first child as a daughter. What are the chances that this child would be colour-blind?
(a) 100% (b) Zero percent
(c) 25% (d) 50% *(2012)*

137. Represented here is the inheritance pattern of a certain type of trait in humans. Which one of the following conditions could be an example of this pattern?



(a) Phenylketonuria (b) Sickle cell anaemia
(c) Haemophilia (d) Thalassemia
(Mains 2012)

138. Which one of the following conditions correctly describes the manner of determining the sex?
(a) Homozygous sex chromosomes (ZZ) determine female sex in birds.
(b) XO type of sex chromosomes determine male sex in grasshopper.
(c) XO condition in humans as found in Turner's syndrome, determines female sex.
(d) Homozygous sex chromosomes (XX) produce male in *Drosophila*. *(2011)*

139. Which one of the following symbols and its representation, used in human pedigree analysis is correct?

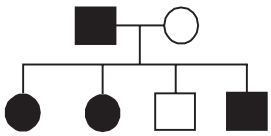
(a)  = Mating between relatives

(b) ○ = Unaffected male

(c) □ = Unaffected female

(d) ◆ = Male affected *(2010)*

140. Study the pedigree chart of a certain family given below and select the correct conclusion which can be drawn for the character.



(a) The female parent is heterozygous.

(b) The parents could not have had a normal daughter for this character.

(c) The trait under study could not be colour blindness.

(d) The male parent is homozygous dominant. *(Mains 2010)*

141. Select the incorrect statement from the following.

(a) Galactosemia is an inborn error of metabolism.

(b) Small population size results in random genetic drift in a population.

(c) Baldness is a sex-limited trait.

(d) Linkage is an exception to the principle of independent assortment in heredity. *(2009)*

142. Sickle-cell anaemia is

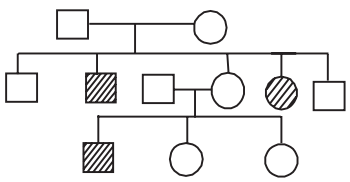
(a) caused by substitution of valine by glutamic acid in the beta globin chain of haemoglobin

(b) caused by a change in a single base pair of DNA

(c) characterized by elongated sickle like RBCs with a nucleus

(d) an autosomal linked dominant trait. *(2009)*

143. Study the pedigree chart given below. What does it show?



(a) Inheritance of a condition like phenylketonuria as an autosomal recessive trait.

(b) The pedigree chart is wrong as this is not possible.

(c) Inheritance of a recessive sex-linked disease like haemophilia.

(d) Inheritance of a sex-linked inborn error of metabolism like phenylketonuria. *(2009)*

144. Which one of the following conditions in humans is correctly matched with its chromosomal abnormality/linkage?

(a) Erythroblastosis fetalis - X-linked

(b) Down's syndrome - 44 autosomes + XO

(c) Klinefelter's syndrome - 44 autosomes + XXY

(d) Colour blindness - Y-linked *(2008)*

145. Both sickle cell anaemia and Huntington's chorea are

(a) virus-related diseases

(b) bacteria-related diseases

(c) congenital disorders

(d) pollutant-induced disorders. *(2006)*

146. If a colour blind woman marries a normal visioned man, their sons will be

(a) all colour blind

(b) all normal visioned

(c) one-half colour blind and one-half normal

(d) three-fourths colour blind and one-fourth normal. *(2006)*

147. Cri-du-chat syndrome in humans is caused by the

(a) trisomy of 21st chromosome

(b) fertilisation of an XX egg by a normal Y-bearing sperm

(c) loss of half of the short arm of chromosome 5

(d) loss of half of the long arm of chromosome 5. *(2006)*

148. Sickle cell anaemia has not been eliminated from the African population because

(a) it is controlled by dominant genes

(b) it is controlled by recessive genes

(c) it is not a fatal disease

(d) it provides immunity against malaria. *(2006)*

149. A man and a woman, who do not show any apparent signs of a certain inherited disease, have seven children (2 daughters and 5 sons). Three of the sons suffer from the given disease but none of the daughters affected. Which of the following mode of inheritance do you suggest for this disease?

(a) Sex-linked dominant

(b) Sex-linked recessive

(c) Sex-limited recessive

(d) Autosomal dominant *(2005)*

150. A woman with 47 chromosomes due to three copies of chromosome 21 is characterised by

(a) superfemaleness (b) triploidy

(c) Turner's syndrome (d) Down's syndrome. *(2005)*

151. Haemophilia is more commonly seen in human males than in human females because
(a) a greater proportion of girls die in infancy
(b) this disease is due to a Y-linked recessive mutation
(c) this disease is due to an X-linked recessive mutation
(d) this disease is due to an X-linked dominant mutation. *(2005)*

152. Which of the following is not a hereditary disease?
(a) Cystic fibrosis (b) Thalassaemia
(c) Haemophilia (d) Cretinism *(2005)*

153. A woman with normal vision, but whose father was colour blind, marries a colour blind man. Suppose that the fourth child of this couple was a boy. This boy
(a) may be colour blind or may be of normal vision
(b) must be colour blind
(c) must have normal colour vision
(d) will be partially colour blind since he is heterozygous for the colour blind mutant allele. *(2005)*

154. A male human is heterozygous for autosomal genes A and B and is also hemizygous for haemophilic gene *h*. What proportion of his sperms will be abh?
(a) 1/8 (b) 1/32
(c) 1/16 (d) 1/4 *(2004)*

155. A normal woman, whose father was colour-blind is married to a normal man. The sons would be
(a) 75% colour-blind (b) 50% colour-blind
(c) all normal (d) all colour-blind. *(2004)*

156. The recessive genes located on X-chromosome humans are always
(a) lethal (b) sub-lethal
(c) expressed in males (d) expressed in females. *(2004)*

157. Pattern baldness, moustaches and beard in human males are examples of
(a) sex linked traits
(b) sex limited traits
(c) sex influenced traits
(d) sex determining traits. *(2003)*

158. Which one of the following conditions though harmful in itself, is also potential saviour from a mosquito borne infectious disease?
(a) Thalassaemia
(b) Sickle cell anaemia
(c) Pernicious anaemia
(d) Leukaemia *(2003)*

159. Down's syndrome is caused by an extra copy of chromosome number 21. What percentage of offspring produced by an affected mother and a normal father would be affected by this disorder?
(a) 100 % (b) 75 %
(c) 50 % (d) 25 % *(2003)*

160. Christmas disease is another name for
(a) haemophilia B (b) hepatitis B
(c) Down's syndrome (d) sleeping sickness. *(2003)*

161. A diseased man marries a normal woman. They get three daughters and five sons. All the daughters were diseased and sons were normal. The gene of this disease is
(a) sex linked dominant (b) sex linked recessive
(c) sex limited character (d) autosomal dominant. *(2002)*

162. Which of the following is a correct match?
(a) Down's syndrome - 21st chromosome
(b) Sickle cell anaemia - X-chromosome
(c) Haemophilia - Y-chromosome
(d) Parkinson's disease - X and Y chromosome *(2002)*

163. Sickle cell anaemia induce to
(a) change of amino acid in α-chain of haemoglobin
(b) change of amino acid in β-chain of haemoglobin
(c) change of amino acid in both α and β chains of haemoglobin
(d) change of amino acid either α or β chains of haemoglobin. *(2001)*

164. Mongolian Idiocy due to trisomy in 21st chromsome is called
(a) Down's syndrome
(b) Turner's syndrome
(c) Klinefelter's syndrome
(d) Triple X syndrome. *(2000)*

165. In *Drosophila*, the XXY condition leads to femaleness whereas in human beings the same condition leads to Klinefelter's syndrome in male. It proves
(a) in human beings Y chromosome is active in sex determination
(b) Y chromosome is active in sex determination in both human beings and *Drosophila*
(c) in *Drosophila* Y chromosome decides femaleness
(d) Y chromosome of man have genes for syndrome. *(2000)*

166. A marriage between normal visioned man and colour blind woman will produce offspring
(a) colour blind sons and 50% carrier daughter
(b) 50% colourblind sons and 50% carrier daughter
(c) normal males and carrier daughters
(d) colour blind sons and carrier daughters. *(1999)*

167. Haemophilic man marries a normal woman. Their offspring will be
(a) all haemophilic
(b) all boys haemophilic
(c) all girls haemophilic
(d) all normal. *(1999)*

168. A woman with two genes for haemophilia and one gene for colour blindness on one of the 'X' chromosomes marries a normal man. How will the progeny be?
(a) 50% haemophilic colour-blind sons and 50% normal sons.
(b) 50% haemophilic daughters (carrier) and 50% colour blind daughters (carrier).
(c) All sons and daughters haemophilic and colour-blind.
(d) Haemophilic and colour-blind daughters. *(1998)*

169. Mental retardation in man, associated with sex chromosomal abnormality is usually due to
(a) moderate increase in Y complement
(b) large increase in Y complement
(c) reduction in X complement
(d) increase in X complement. *(1998)*

170. Albinism is known to be due to an autosomal recessive mutation. The first child of a couple with normal skin pigmentation was an albino. What is the probability that their second child will also be an albino?
(a) 50% (b) 75%
(c) 100% (d) 25% *(1998)*

171. A person with the sex chromosomes XXY suffers from
(a) gynandromorphism
(b) Klinefelter's syndrome
(c) Down's syndrome
(d) Turner's syndrome. *(1997)*

172. In which of the following diseases, the man has an extra X-chromosome?
(a) Turner's syndrome (b) Klinefelter's syndrome
(c) Down's syndrome (d) Haemophilia *(1996)*

173. A person whose father is colour blind marries a lady whose mother is daughter of a colour blind man. Their children will be
(a) all sons colour blind
(b) some sons normal and some colour blind
(c) all colour blind
(d) all daughters normal. *(1996)*

174. A genetically diseased father (male) marries with a normal female and gives birth to 3 carrier girls and 5 normal sons. It may be which type of genetic disease?
(a) Sex-influenced disease
(b) Blood group inheritance disease
(c) Sex-linked disease
(d) Sex-recessive disease *(1996)*

175. An abnormal human male phenotype involving an extra X-chromosome (XXY) is a case of
(a) Edward's syndrome
(b) Klinefelter's syndrome
(c) intersex
(d) Down's syndrome. *(1995)*

176. The genes, which remain confined to differential region of Y-chromosome, are
(a) autosomal genes (b) holandric genes
(c) completely sex-linked genes
(d) mutant genes. *(1994)*

177. Albinism is a congenital disorder resulting from the lack of which enzyme?
(a) Tyrosinase (b) Xanthine oxidase
(c) Catalase (d) Fructokinase *(1994)*

178. The colour blindness is more likely to occur in males than in females because
(a) the Y-chromosome of males have the genes for distinguishing colours
(b) genes for characters are located on the sex-chromosomes
(c) the trait is dominant in males and recessive in females
(d) none of these. *(1994)*

179. Of both normal parents, the chances of a male child becoming colour blind are
(a) none
(b) possible only when all the four grand parents had normal vision
(c) possible only when father's mother was colour blind
(d) possible only when mother's father was colour blind. *(1993)*

180. Of a normal couple, half the sons are haemophiliac while half the daughters are carriers. The gene is located on
(a) X-chromosome of father
(b) Y-chromosome of father
(c) one X-chromosome of mother
(d) both the X-chromosomes of mother. *(1993)*

181. A colour blind mother and normal father would have
(a) colour blind sons and normal/carrier daughters
(b) colour blind sons and daughters
(c) all colour blind
(d) all normal. *(1992)*

182. Down's syndrome is due to
(a) crossing over
(b) linkage
(c) sex-linked inheritance
(d) non-disjunction of chromosomes. *(1992)*

183. In human beings 45 chromosomes/single X/XO abnormality causes
(a) Down's syndrome
(b) Kinefelter's syndrome
(c) Turner's syndrome
(d) Edward's syndrome. *(1992)*

184. A colour blind girl is rare because she will be born only when
(a) her mother and maternal grand father were colour blind
(b) her father and maternal grand father were colour blind
(c) her mother is colour blind and father has normal vision
(d) parents have normal vision but grand parents were colour blind. *(1991)*

185. In Down's syndrome of a male child, the sex complement is
(a) XO (b) XY
(c) XX (d) XXY. *(1990)*

186. Haemophilia is more common in males because it is a
(a) recessive character carried by Y-chromosome
(b) dominant character carried by Y-chromosome
(c) dominant trait carried by X-chromosome
(d) recessive trait carried by X-chromosome. *(1990)*

187. Which one is a hereditary disease?
(a) Cataract (b) Leprosy
(c) Blindness (d) Phenylketonuria *(1990)*

188. Both husband and wife have normal vision though their fathers were colour blind. The probability of their daughter becoming colour blind is
(a) 0% (b) 25%
(c) 50% (d) 75%. *(1990)*

ANSWER KEY

1.	(c)	**2.**	(a)	**3.**	(d)	**4.**	(d)	**5.**	(b)	**6.**	(b)	**7.**	(d)	**8.**	(d)	**9.**	(b)	**10.**	(d)
11.	(c)	**12.**	(a)	**13.**	(b)	**14.**	(c)	**15.**	(b)	**16.**	(a)	**17.**	(a)	**18.**	(a)	**19.**	(c)	**20.**	(b)
21.	(d)	**22.**	(a)	**23.**	(c)	**24.**	(c)	**25.**	(a)	**26.**	(c)	**27.**	(c)	**28.**	(c)	**29.**	(c)	**30.**	(d)
31.	(c)	**32.**	(d)	**33.**	(a)	**34.**	(c)	**35.**	(a)	**36.**	(c)	**37.**	(c)	**38.**	(d)	**39.**	(a)	**40.**	(d)
41.	(d)	**42.**	(d)	**43.**	(b)	**44.**	(c)	**45.**	(a)	**46.**	(b)	**47.**	(c)	**48.**	(b)	**49.**	(c)	**50.**	(d)
51.	(d)	**52.**	(d)	**53.**	(c)	**54.**	(a)	**55.**	(c)	**56.**	(a)	**57.**	(b)	**58.**	(d)	**59.**	(a)	**60.**	(d)
61.	(d)	**62.**	(a)	**63.**	(c)	**64.**	(b)	**65.**	(c)	**66.**	(b)	**67.**	(a)	**68.**	(a)	**69.**	(b)	**70.**	(d)
71.	(b)	**72.**	(a)	**73.**	(c)	**74.**	(a)	**75.**	(b)	**76.**	(c)	**77.**	(b)	**78.**	(c)	**79.**	(a)	**80.**	(b)
81.	(d)	**82.**	(b)	**83.**	(c)	**84.**	(a)	**85.**	(d)	**86.**	(a)	**87.**	(c)	**88.**	(d)	**89.**	(b)	**90.**	(c)
91.	(b)	**92.**	(b)	**93.**	(a)	**94.**	(a)	**95.**	(a)	**96.**	(b)	**97.**	(d)	**98.**	(c)	**99.**	(a)	**100.**	(d)
101.	(b)	**102.**	(c)	**103.**	(b)	**104.**	(d)	**105.**	(a)	**106.**	(a)	**107.**	(c)	**108.**	(c)	**109.**	(b)	**110.**	(c)
111.	(a)	**112.**	(d)	**113.**	(c)	**114.**	(b)	**115.**	(c)	**116.**	(c)	**117.**	(b)	**118.**	(b)	**119.**	(c)	**120.**	(c)
121.	(d)	**122.**	(b)	**123.**	(d)	**124.**	(a)	**125.**	(b)	**126.**	(d)	**127.**	(b)	**128.**	(a)	**129.**	(d)	**130.**	(c)
131.	(a)	**132.**	(a)	**133.**	(a)	**134.**	(a)	**135.**	(b)	**136.**	(b)	**137.**	(c)	**138.**	(b)	**139.**	(a)	**140.**	(a)
141.	(c)	**142.**	(b)	**143.**	(a)	**144.**	(c)	**145.**	(c)	**146.**	(a)	**147.**	(c)	**148.**	(d)	**149.**	(b)	**150.**	(d)
151.	(c)	**152.**	(d)	**153.**	(a)	**154.**	(a)	**155.**	(b)	**156.**	(c)	**157.**	(c)	**158.**	(b)	**159.**	(c)	**160.**	(a)
161.	(a)	**162.**	(a)	**163.**	(b)	**164.**	(a)	**165.**	(a)	**166.**	(d)	**167.**	(d)	**168.**	(b)	**169.**	(d)	**170.**	(d)
171.	(b)	**172.**	(b)	**173.**	(d)	**174.**	(c)	**175.**	(b)	**176.**	(b)	**177.**	(a)	**178.**	(b)	**179.**	(d)	**180.**	(c)
181.	(a)	**182.**	(d)	**183.**	(c)	**184.**	(b)	**185.**	(b)	**186.**	(d)	**187.**	(d)	**188.**	(a)				

Hints & Explanations

1. (c) : Mendel conducted artificial pollination or cross pollination experiments using several true-breeding pea lines. He selected 14 true-breeding pea plant varieties, as pairs which were similar except for one character with contrasting traits. Some of the contrasting traits selected were smooth or wrinkled seeds, yellow or green seeds, inflated (full) or constricted green or yellow pods and tall or dwarf plants.

2. (a) : Mendel considered the following characters of pea in his experiments:

	Character	Dominant	Recessive
(i)	Seed shape	Round (R)	Wrinkled (r)
(ii)	Seed cotyledon colour	Yellow (Y)	Green (y)
(iii)	Flower colour	Violet (V)	White (v)
(iv)	Pod shape	Inflated (I)	Constricted (i)
(v)	Pod colour	Green (G)	Yellow (g)
(vi)	Flower position	Axial (A)	Terminal (a)
(vii)	Stem height	Tall (T)	Dwarf (t)

3. (d) : Mendel carried out hybridisation experiments on garden pea for 7 years from 1856-1863.

4. (d) : *Refer to answer 2.*

5. (b)

6. (b) : *Refer to answer 2.*

7. (d) : Mendel worked on seven characters. These characters showed complete independent assortment despite the seven characters chosen by him were present on four chromosomes –1, 4, 5 and 7.

8. (d) : *Refer to answer 2.*

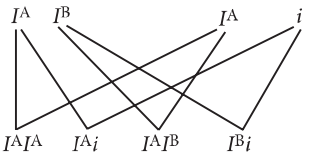
9. (b) : An Austrian monk, Gregor Mendel, developed his theory of inheritance. He formulated the Law of Heredity. Therefore, he is called the 'father of genetics'.

10. (d) : Consideration of one character at one time contribute to the success of Mendel. Mendel's contribution was unique because of his methodological approach to a definite problem, use of clear cut variables and application of mathematics (statistics) to the problem. Using pea plants and statistical methods, Mendel was able to demonstrate that traits were passed from each parent inheritance of genes.

11. (c) : ABO blood groups are controlled by the gene *I*. The gene (*I*) has three alleles I^A, I^B and *i*. The alleles I^A and I^B produce a slightly different form of the sugar while allele *i* does not produce any sugar. Because humans are diploid organisms, each person possesses any two of the three *I* gene alleles. When I^A and I^B are present together they both express their own types of sugars,because of co-dominance.

12. (a) : Law of segregation applies in this case as when pink flowers obtained in F_1 are selfed then red and white flowers are obtained in F_2 which indicates that there is no mixing of gametes.

13. (b) : If the genotypes of husband and wife are I^AI^B and I^Ai respectively, then the probabilities of genotypes and phenotypes among their children can be worked out as:

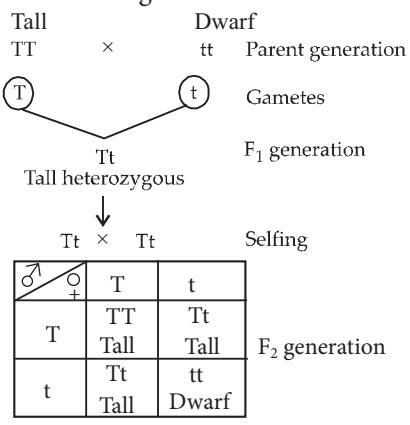


Genotype:	$I^A I^A$	I^Ai	I^AI^B	I^Bi
Phenotype:	A	A	AB	B

Thus, there are four possible genotypes, *viz.*, I^AI^A, I^Ai, I^AI^B and I^Bi and three possible phenotypes, *viz.*, A, AB and B among the children.

14. (c) : When a tall true breeding garden pea plant is crossed with a dwarf true breeding garden pea plant and the F_1 plants were selfed the resulting genotypes were in the ratio of 1 : 2 : 1, *i.e.,* Tall homozygous : Tall heterozygous : Dwarf

It can be illustrated as given below:



Phenotypic ratio : 3 : 1 : : Tall : Dwarf

Genotypic ratio - 1 : 2 : 1 : : TT : Tt : tt

15. (b) : The phenomenon of expression of both the alleles in a heterozygote is called co-dominance. The alleles which do not show dominance-recessive relationship and are able to express themselves independently when present together are called co-dominant alleles. As a result the heterozygous condition has a phenotype different from either of homozygous genotypes, *e.g.*, alleles for blood group A (I^A) and for blood group B (I^B)

are codominant so that when they come together in an individual, they produce blood group AB.

16. (a) : Genes are the units of inheritance and contain the information that is required to express a particular trait in an organism. Alternating forms of a single gene which code for a pair of contrasting traits are known as alleles. For example, two alleles determine the height of pea plant (tall and dwarf).

17. (a)

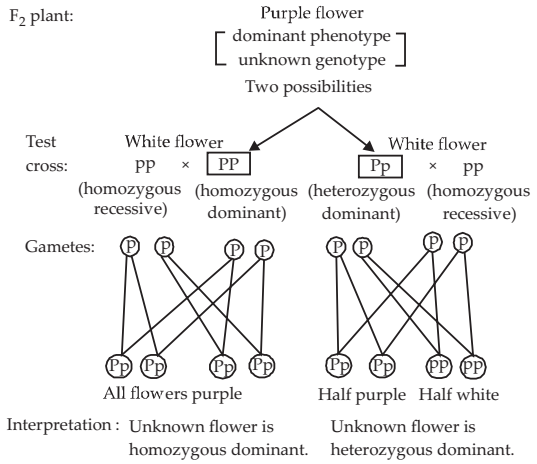
18. (a) : The man has blood group A, thus its genotype can either be I^AI^A or I^AI^O. Similarly, woman can either have I^BI^B, or I^BI^O genotype. Thus, their offspring can have any of the blood groups A (I^AI^A or I^AI^O), B (I^BI^B or I^BI^O), AB (I^AI^B) or O (I^OI^O).

19. (c) : *Refer to answer 15.*

20. (b) : In co-dominance, both the alleles are able to express themselves independently when present together resulting in a phenotype that is intermediate between both the parental homozygous phenotypes, thereby resembling both of them. *E.g.*, roan coat colour in cattle is a result of co-dominance of alleles for white and red coat colour.

21. (d) : The inheritance of flower colour in the dog flower (snapdragon or *Antirrhinum* sp.) is a an example of incomplete dominance. In a cross between true-breeding red-flowered (RR) and true-breeding white-flowered plants (rr), the F_1 (Rr) was pink. When the F_1 was self-pollinated the F_2 resulted in the following ratio, 1 (RR) Red : 2 (Rr) Pink : 1 (rr) White. Here, the genotype ratios were 1 : 2 : 1 as in any Mendelian monohybrid cross, but the phenotype ratios had changed from the 3 : 1 dominant : recessive ratio to 1 : 2 : 1.

22. (a) : Test cross is performed to determine the genotype of F_2 plant. In a typical test cross, an organism showing dominant phenotype and whose genotype is to be determined is crossed with one that is homozygous recessive for the allele being investigated, instead of self-crossing. The progenies of such a cross can easily be analysed to predict the genotype of the test organism. Given below is an illustration of test cross:



23. (c)

24. (c) : The three alleles I^A, I^B and i of gene I in ABO blood group system can produce six different genotypes and four different phenotypes as shown below :

Genotypes	Phenotypes
I^AI^A, I^Ai	Blood group A
I^BI^B, I^Bi	Blood group B
I^AI^B	Blood group AB
ii	Blood group O

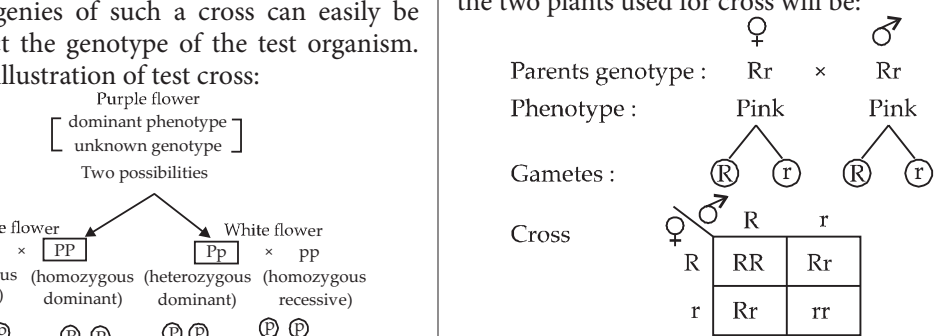
25. (a) : *Refer to answer 22.*

26. (c) : According to Mendel's law of dominance, in heterozygous individuals a character is represented by two contrasting factors called alleles or allelomorphs which occur in pairs. Out of the two contrasting alleles, only one is able to express its effect in the individual. It is called dominant factor or dominant allele. The other allele which does not show its effect in the heterozygous individual is called recessive factor or recessive allele. The option (c) in the given question cannot be explained on the basis of law of dominance. It can only be explained on the basis of Mendel's law of independent assortment, according to which in a dihybrid cross, the two alleles of each character assort independently (do not show any blending) of the alleles of other character and separate at the time of gamete formation. Both the characters are recovered as such in F_2 generation producing both parental and new combinations of traits.

27. (c) : *Refer to answer 24.*

28. (c) : *Refer to answer 22.*

29. (c) : The given situation is an example of incomplete dominance where phenotype found in F_1 generation do not resemble either of the two parents. The genotype of the two plants used for cross will be:



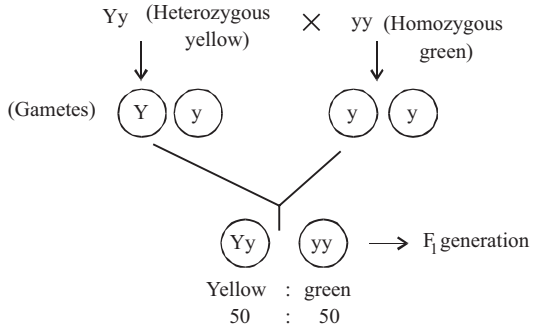
Genotypic ratio : RR : Rr : rr
1 : 2 : 1

Phenotype : Red : Pink : White

The incomplete dominance of dominant allele (here 'R') over recessive allele (here 'r') could be due to mutations (insertion, deletion, substitution or inversion

of nucleotides). The mutant allele generally produces a faulty or no product. This modification in the product may lead to incomplete dominance of the (unmodified) wild type dominant allele.

30. (d) : Yellow (Y) seeds are dominant to green (y). So, a heterozygous yellow seeded plant will have the genotype of (Yy) and a green seeded plant will have genotype of (yy). When these two plants are crossed, the F_1 generation will have the ratio of yellow : green as 50 : 50. It is shown as:



31. (c) : A common test to find the genotypes of a hybrid is by crossing of one F_1 progeny with male parent.

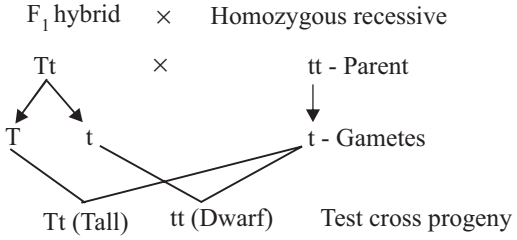
32. (d) : *Refer to answer 22.*

33. (a) : The external manifestation, morphological or physiological expression of an individual with regard to one or more characters is called phenotype. For recessive genes, phenotype and genotype are similar. For dominant genes, the phenotype is same for both homozygous states. Phenotype is influenced by environment as well as age. A child definitely differs from adolescent, the latter from adult and an adult from aged one. Many phenotypes are determined by multiple genes. Thus, the identity of phenotype is determined by genotype and environment.

34. (c) : Dominant factor is an allele or Mendelian factor which expressess itself in the hybrid (heterozygous) as well as in homozygous state. It is denoted by capital letter.

35. (a) : *Refer to answer 20.*

36. (c) : Crossing of individuals having dominant phenotype with its homozygous recessive is a test cross, which can be represented as:



Thus, ratio of progeny is = 1 : 1

37. (c) : O blood group of a child cannot be obtained from the parents having blood group O × AB. The parents blood groups may be A × O, A × B, B × O, B × A, O × A and O × B.

38. (d) : The genotype of the child would be I^OI^O (recessive). Hence, the genotype of the father can only be I^BI^O.

39. (a)

40. (d) : An organism with two identical alleles is homozygous. Homozygous have identical genes at the same locus on each member of a pair of homologous/ chromosomes.

41. (d) : $I^AI^O \times I^AI^B$ gives us the following genotypes I^AI^A, I^OI^B, I^AI^B. Hence, when a man of blood group A marries a woman of AB blood group, B progeny would indicate that man is heterozygous A.

42. (d) : ABO blood group system is due to multiple allelism. A gene can have more than two alleles or allelomorphs, which can be expressed by mutation in wild form in more than one ways. These alleles or allelomorphs make a series of multiple alleles. The mode of inheritance in case of multiple alleles is called multiple allelism. A well known and simplest example of multiple allelism is the inheritance of ABO blood groups in human beings. In human population, 3 different alleles for this character are found - I^A I^B and I^O. A person is having only two of these three alleles and blood type can be determined.

43. (b) : The contrasting pairs of factors in Mendelian crosses are called allelomorphs. Alleles or allelomorphs are the different forms of a gene, having the same locus on homologous chromosomes and are subject to Mendelian (alternative) inheritance.

44. (c) : Mendel's last law is independent assortment. The principle of independent assortment states that when two individuals differ from each other in two or more pairs of factors, the inheritance of one pair is quite independent of the inheritance of other.

45. (a) : The brown eyed man will have the genotype Bb and his wife bb. Hence, Bb × bb = Bb : bb. Therefore, the children shall be both blue eyed and brown eyed the ratio is 1 : 1.

46. (b) : The inheritance of flower colour in the dog flower (snapdragon or *Antirrhinum* sp.) is a an example of incomplete dominance. In a cross between true-breeding red-flowered (RR) and true-breeding white-flowered plants (rr), the F_1 (Rr) was pink. When the F_1 was self-pollinated the F_2 resulted in the following ratio, 1 (RR) Red : 2 (Rr) Pink : 1 (rr) White. Here, the genotype ratios were 1 : 2 : 1 as in any Mendelian monohybrid cross, but the phenotype ratios had changed from the 3 : 1 dominant : recessive ratio to 1 : 2 : 1.

47. (c) : *Refer to answer 42.*

48. (b) : *Refer to answer 36.*

49. (c) : Haploids are able to express both recessive and dominant alleles/ mutations because there are only one allele for each gene in the individual. Diploid is an organism containing two different alleles or individual containing both dominant and recessive genes of an allelic pairs.

50. (d) : Sutton and Boveri proposed the chromosomal theory of inheritance but its experimental verification was done by Thomas Hunt Morgan.

51. (d) : Genetic map is a linear graphic representation of the sequence and relative distance of various genes present in a chromosome. 1% crossing over between two linked genes is known as 1 map unit or centiMorgan (cM).

52. (d) : T.H. Morgan coined the term linkage to describe the physical association of genes on chromosome and term recombination to describe the generation of non-parental gene combinations. Alfred Sturtevant used the frequency of recombination between gene pairs on the same chromosome as a measure of the distance between genes.

53. (c) : Translocation is a chromosomal abnormality caused by rearrangement of parts between non-homologous chromosomes. It may cause a gene to move from one linkage group to another.

54. (a) : If in a dihybrid test cross more parental combinations appear as compared to the recombinants in F_2 generation, then it is indicative of involvement of linkage. Linkage is the tendency of two different genes on the same chromosome to remain together during the separation of homologous chromosomes at meiosis. During complete linkage no recombinants are formed whereas in incomplete linkage few recombinants are produced along with parental combinations.

55. (c) : Linkage is the phenomenon of certain genes staying together during inheritance through generations without any change or separation due to their being present on the same chromosome. Linkage was first suggested by Sutton and Boveri (1902-1903) when they propounded the famous "chromosomal theory of inheritance." Bateson and Punnett (1906) while working on sweet pea found that the factors for certain characters do not show independent assortment. However, it was Morgan (1910) who clearly proved and defined linkage on the basis of his breeding experiments in fruit fly (*Drosophila melanogaster*).

56. (a) : *Refer to answer 53.*

57. (b) : A dominant epistatic allele suppresses the expression of a non-allelic gene whether the latter is dominant or recessive. The gene which suppresses the expression of a non-allelic gene is known as epistatic gene. The gene or locus which is suppressed by the presence of non-allelic gene is termed as hypostatic gene. In summer squash or *Cucurbita pepo*, there are three types of fruit colour— yellow, green and white. White colour is dominant over other colours while yellow is dominant over green. Yellow colour is formed only when the dominant epistatic gene is represented by its recessive allele (w). When the hypostatic gene is also recessive (y), the colour of the fruit is green, *i.e.*,

W_ Yy, W_ yy → White
wwY_ → Yellow
wwyy → Green

58. (d)

59. (a) : The increased vigour displayed by the offspring from a cross between genetically different parents is called heterosis. Hybrids from crosses between different crop varieties (F_1 hybrids) are often stronger and produce better yields than the original varieties.

60. (d) : Linkage is the phenomenon of certain genes staying together during inheritance through generations without any change or separation due to their being present on the same chromosome. Linked genes occur in the same chromosome. Strength of the linkage between two genes is inversely proportional to the distance between the two, *i.e.*, two linked genes show higher frequency of crossing over (recombination) if the distance between them is higher and lower frequency if the distance is small.

61. (d) : As sperms produced are with genotypes AB, Ab, aB, ab (two diallelic character) the person must be heterozygous for both genes. So, his genotype will be AaBb.

62. (a) : Since round seed shape is dominant over wrinkled seed shape and yellow cotyledon is dominant over green cotyledon so RRYY individuals is round yellow and rryy is wrinkled green.

Round yellow seeds × Wrinkled green seeds
RRYY rryy
↓
F_1 generation RrYy

F_2 generation is obtained by selfing F_1.

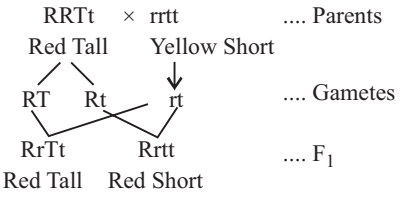
♀ / ♂	RY	Ry	rY	ry
RY	RRYY	RRYy	RrYY	RrYy
Ry	RRYy	RRyy	RrYy	Rryy
rY	RrYY	RrYy	rrYY	rrYy
ry	RrYy	Rryy	rrYy	rryy

Expected phenotypes in F_2 generation

Round yellow seed	Wrinkled yellow seed
9	3
Round green seed	Wrinkled green seed
3	1

63. (c) : A test cross involving the crossing of F_1 individual with the homozygous recessive parent. It is done to find out homozygous and heterozygous individuals. So, AaBb should be crossed with aabb.

64. (b) : Since red fruit colour is dominant over yellow fruit colour and tallness is dominant over shortness.



These are produced in 1 : 1 ratio.

65. (c) : Mendel's law of independent assortment states that when the parent differs from each other in two or more pairs of contrasting characters, the inheritance of one pair of factor is independent of the other. For the character to assort independently they should be located on separate non-homologous chromosomes. Genes present on the same chromosome show linkage. It means that these characters remain together and thus low numbers of combinations are formed. This phenomenon is called linkage and such genes are called linked genes. So, A and B are linked genes.

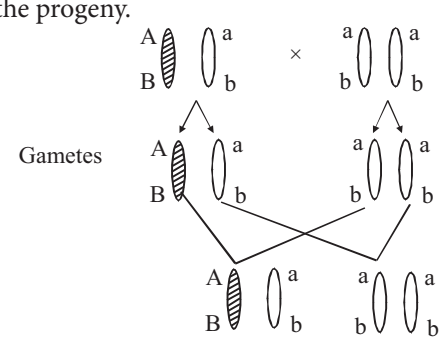
66. (b) : A reciprocal cross means that the same two parent are used in two experiments in such a way that if in one experiment A is used as the female parent and B is used as the male parent then in the other experiment A will be used as the male parent and B as the female parent. Thus the sources of gametes are reversed. When the F_1 individuals obtained in a cross is crossed with the recessive parent, it is called a test cross. When inheritance of two pairs of contrasting character is studied simultaneously it is called dihybrid cross.

67. (a) : Linkage/ Cross over/ Chromosome map is a graphic representation of relative positions/ order and relative distances of genes in a chromosome in the form of line like a linear road map depicting different places and their relative distances without giving exact mileage. It is based on Morgan's hypothesis (1911) that frequency of crossing over/recombination between two linked genes is directly proportional to the physical distance between the two. 1 map unit or centrimorgan is equivalent to 1% recombination between two genes. Percentage of crossing over between *a* and *b* is 20% so they are 20 map distance apart and *b* and *c* are 28 map distance apart. So, that correct sequence of genes on chromosomes will be as

$$b \xrightarrow{20} a \xrightarrow{8} c$$

68. (a) : Epistasis is the phenomenon of suppression of phenotypic expression of gene by a non-allelic gene which shows its own effect. The gene which masks the effect of another is called epistatic gene while the one which is suppressed is termed hypostatic gene. Epistasis is of three types - dominant, recessive and dominant-recessive.

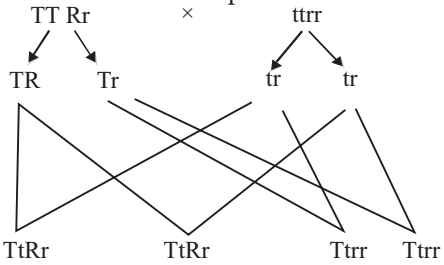
69. (b) : The tendency of potential combinations to remain together, which is expressed in terms of low frequency of recombinations (new combinations) is called linkage. Genes present on same chromosomes show linkage. These genes are called linked genes. Since A and B genes are linked they will be passed on together in the progeny.



70. (d) : If two genes present on different loci produce the same effect when present alone but interact to form a new trait when present together, they are called complementary genes. The F_2 ratio is modified to 9 : 7 instead of 9 : 3 : 3 : 1.

71. (b) : According to law of independent assortment, the two factors of each trait assort at random and independent of the factors of other traits at the time of meiosis and get randomly as well as independently rearranged in the offspring. Principle of law of independent assortment is applicable to only those factors or genes which are present on different chromosomes.

72. (a) : The cross can be represented as :



Tall Red TtRr - 50%

Tall White Ttrr - 50%

73. (c) : *Refer to answer 68.*

74. (a) : According to principle of independent assortment, the two factors of each trait assort at random and independent of the factors of other traits at the time of meiosis and get randomly as well as independently rearranged in the offspring. Principle of independent assortment is applicable to only those factors or genes which are present on different chromosomes.

Chromosome have hundreds of genes which show linked inheritance or linkage. Linkage is the phenomenon of certain genes (present on the same chromosome) to remain together and get inherited through generations. The seven characters that Mendel chose were present on 14 chromosomes and so they did not show linkage but if present on 12 chromosomes they would have shown linkage and the principle of independent assortment would not have been discovered.

75. (b) : Crossing over is the reciprocal exchange of segments between non-sister chromatids of a pair of homologous chromosomes. It results in recombination of genes.

76. (c) : The female *Drosophila* possesses two homomorphic sex chromosomes (XX) and the male *Drosophila* contains two heteromorphic sex chromosomes (XY). The differential or non-homologous region of Y-chromosome is mostly heterochromatic. The female parent produces only one type of eggs (22 + X). The male parent produces two types of gametes (22 + Y) and (22 + X). They are produced in equal proportions. As the two types of sperms are produced in equal proportions, there are equal chances of getting a male or female fly in a particular mating.

77. (b) : Complementary genes are those non-allelic genes which independently show a similar effect but produce a new trait when present together in the dominant form. Supplementary genes are a pair of non-allelic genes, one of which produces its effect independently in the dominant state while the dominant allele of the second gene is without any independent effect but is able to modify the effect of the former to produce a new trait. Duplicate genes are independent genes producing the same or similar effect.

78. (c) : E.B. Lewis in 1951 reported from a cross of apricot eyed and white eyed flies in *Drosophila*, he obtained F_1 having intermediate eye colour. In F_2, he had expected segregation only for apricot and white, but he recovered very low frequency of wild type. Since those alleles behaved as non-alleles, Lewis preferred to call them pseudoalleles and the phenomenon as pseudoallelism. In pseudoallelism, in *cis* position both the mutant alleles are on one chromosome. So, the other chromosome will be normal and will be able to produce the end result. But in *trans* position the sequence of steps involved in synthesis will be interrupted due to mutations on either of the two homologous chromosomes thus leading to a mutant phenotype.

79. (a) : *Refer to answer 68.*

80. (b) : AABB × aabb is suitable for experiment on linkage. Linkage is the tendency for certain genes tend to be inherited together, because they are on the same chromosome. Thus, parental combinations of characters are found more frequently in offspring than non-parental.

81. (d) : Two dominant non-allelic genes are 50 map units apart. The linkage is absent/incomplete. Chromosome mapping is based on the fact that genes are linearly arranged in the chromosome and frequency of crossing over is directly proportional to the distance between two genes. Dominant genes show *cis* arrangement. At 50 map units *cis* is changed to *trans* and *vice-versa* hence no fixed linkage is present.

82. (b)

83. (c) : In a cross between AABB × aabb, the ratio of F_2 genotypes between AABB, AaBB, Aabb and aabb would be 1 : 2 : 2 : 1.

84. (a) : Segregation of Mendelian factors (no linkage, no crossing over) occurs during anaphase I. At anaphase I, actual segregation occurs, but two similar alleles occurs in the dyad chromosome which separate at anaphase II.

85. (d) : The allele which is unable to express its effect in the presence of another is called recessive. A member of a pair of alleles that does not show its effect in the phenotype in the presence of any other allele. It is denoted by small letter.

86. (a) : Cross between AaBB and aaBB will form 1AaBB : 1 aaBB. On crossing, AaBB × aaBB gives 50% individuals having genotype AaBB and 50% individuals having genotype aaBB.

87. (c) : In a genetic cross having recessive epistasis, F_2 phenotypic ratio would be 9 : 3 : 4. The recessive epistasis is illustrated by coat colour in mouse, the coat colour is determined by A/a pair, recessive allele b is epistatic over A/a. Thus, in the presence of bb, both A and aa give the same phenotype (albino). The F_2 ratio is generally 9 : 3 : 4.

88. (d) : Bateson and Punnet explained that when two dominants enter from the same parent-they try to remain together, called coupling. When two dominants enter from different parents they try to remain separate called repulsion. Bateson and Punnett (1906) used the term coupling and repulsion in sweet pea (*Lathyrus odoratus*) for linkage and crossing over. The correct parental of coupling type along with its cross over or repulsion is coupling AABB, aabb : Repulsion AAbb; aaBB.

89. (b) : Segregation of Mendelian factor (Aa) occurs during anaphase I. The paired homologous chromosomes separate in meiosis I so that each gamete receives one chromosomes of each homologous pair. During anaphase I chromosome divides at the point of centromere or kinetochore and thus two sister chromatids are formed, which are called as chromosomes.

90. (c) : Two linked genes a and b show 20% recombination. The individuals of a dihybrid cross between ++/++ × ab/ab shall show gametes + + : 40 : : ab : 40 : : + a : 10 : : + b : 10.

91. (b) : ABO blood group system in human beings is an example of dominance, co-dominance and multiple allelism.

I^A I^O, I^B I^O or *i* - Alleles shows dominant-recessive relationship.

I^A I^B - Co-dominance is a phenomenon in which alleles of a gene do not show dominant recessive relationship and express themselves independently when present together.

I^A, I^B I^O or *i* - More than two alternate forms of a gene present on the same locus are called as multiple alleles and the mode of inheritance in the alleles is called multiple allelism.

92. (b) : Polygenic (or Quantitative) inheritance is that type of inheritance in which the complete expression of a trait is controlled by two or more genes in which a dominant allele of each gene contributes only a unit fraction of the trait and total phenotypic expression is the sum total of a additive or cumulative effect of all the dominant alleles of genes/polygenes. Human skin colour is an example of such polygenic inheritance which is controlled by three pairs of polygenes A, B and C. Negro/ black colour is due to presence of all the six dominant contributing alleles AABBCC. Very light colour or white colour is due to presence of all six recessive non-contributing alleles aabbcc.

93. (a) : The plant having genotype AABbCC is heterozygous for only one character B. Number of gametes = 2^n, where *n* is the heterozygosity.
Since *n* = 1 so 2 gametes will be formed. Those are ABC and AbC.

94. (a) : *Refer to answer 92.*

95. (a) : Selfing is the process of fertilisation with polar or male gametes of the same individual. AABbCC will produce two type of gametes ABC and AbC. Thus, in F_2 generation three genotypes will be obtained. These are AABBCC, AABbCC and AAbbCC in the ratio of 1 : 2 : 1. Phenotypically AABBCC and AABbCC are same. So, the phenotypic ratio in F_2 generation will be 3 : 1.

96. (b) : *Refer to answer 92.*

97. (d) : Number of gametes = $2^n = 2^2 = 4$.
where *n* is the number of gene in heterozygous form.
The four gametes formed will be →ABc, AbC, Abc and ABC.

98. (c)

99. (a) : *Refer to answer 92.*

100. (d)

101. (b) : The ability of a gene to have multiple phenotypic effects because it influences a number of characters simultaneously is known as pleiotropy. The gene having a multiple phenotypic effect because of its ability to control expression of two or more characters is called pleiotropic gene. In human beings pleiotropy is exhibited by syndromes called sickle cell anaemia and phenylketonuria.

102. (c) : Pleiotropic gene is such a gene which has a wider effect on phenotype, *i.e.*, it controls several phenotypic traits. Sickle cell anaemia is considered to be caused by one such pleiotropic gene. It is caused due to mutation in β-globin gene of haemoglobin.

103. (b) : The ability of a gene to have multiple phenotypic effect because it influences a number of characters simultaneously is known as pleiotropy.

104. (d) : In birds, *e.g.*, fowls, males have homomorphic sex chromosomes (AA + ZZ) and females have heteromorphic sex chromosomes (AA + ZW). So, males produce only one type of sperms containing (A + Z) whereas females produce two types of eggs (A + Z and A + W). Therefore, the sex of the progeny depends on the type of the egg which is fertilised by the sperm.

105. (a) : The gene for starch synthesis in pea seeds can produce more than one effect which implies it is a pleiotropic gene.

106. (a) : In humans, the female has a pair of X chromosome (homogametic composition) and the male has XY chromosomes (heterogametic composition). Therefore, two normal X chromosomes in zygotic cell lead to the birth of a normal human female child.

107. (c) : According to genic balance theory of sex determination the ratio between the number of X-chromosomes and number of complete sets of autosomes will determine the sex. The X-chromosome is believed to carry female tendency genes, while autosomes carry male tendency genes. Both these sets of genes start functioning and there has to be a balance between them for an individual to become male or female. If the ratio between X and A is 1.0 it will be a female individual and when it is 0.5, it would be male.

108. (c) : Barr body is a mass of condensed sex chromatin in the nuclei of normal female somatic cells due to inactive X chromosome. Whenever the number of X-chromosomes is two or more than two, the number of Barr bodies is one less than the number of X-chromosomes. Therefore, the number of Barr bodies in XXXX female is three.

109. (b) : Male XX and female XY sometimes occur due to transfer of segments in X and Y chromosomes.

Deletion is the loss of an intercalary segment of a chromosome which is produced by a double break in the chromosomes followed by the union of remaining parts. Aneuploidy is a condition of having fewer or extra chromosomes than the normal genome number of the species.

110. (c)

111. (a) : Sex chromosomes are those chromosomes whose presence, absence or particular form determines the sex of the individual in unisexual or dioecious organisms, *e.g.*, XX denotes female and XY denotes male.

112. (d) : Gynandromorph (hermaphrodite) is an animal that possesses both male and female characteristics. For example, earthworm.

113. (c)

114. (b) : Sex is determined in human beings at the time of fertilisation. Sex of the baby depends upon the sperm which fertilises the ovum.

115. (c) : A normal green male maize is crossed with albino female. The progeny is albino because, plastids are inherited from female parents.

116. (c) : A family of five daughter only is expecting sixth issue. The chance of its beings a son is 50%. Human have 22 pairs chromosomes which are XX in females and XY in males. So if we cross the parents there is 1 : 1 chance for boy and girl.

117. (b) : Mutation is a sudden alteration of the chemical structure of a gene or the alteration of its position on the chromosome by breaking and rejoining of the chromosome. It has occurred in male parent. But organelles like mitochondria, chloroplast etc., are a part of cytoplasmic inheritance.

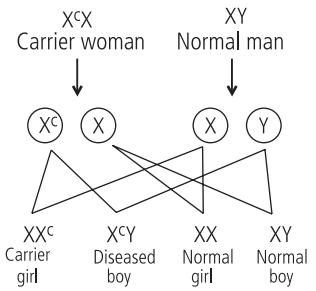
Cytoplasmic inheritance is the passage of traits from parents to offspring through structures present inside the cytoplasm of contributing gametes. Plasma genes occur in plastids, mitochondria, plasmids and some special particles like kappa particles, sigma particles, etc. In higher organisms cytoplasmic inheritance is called maternal inheritance because the zygote receives most of its cytoplasm from the ovum. Therefore, cytoplasmic inheritance is usually uniparental. So, none of the progeny will show mutation.

118. (b) : Point mutation involves only the replacement of one nucleotide with another. One type of point mutation is missense mutation. These are base changes that alter the codon for an amino acid resulting in its substitution with a different amino acid. For example, mutation of the codon CTT to ATT would result in the replacement of the hydrophobic amino acid leucine with isoleucine, another hydrophobic amino acid. Many other missense mutations have been described which do affect the encoded protein and result in genetic diseases. These include an A to T mutation in the gene for β-globin, one of the polypeptides of haemoglobin. This mutation changes codon six of the gene from GAG which encodes glutamic acid to GTG which encodes valine. The mutation results in a condition called sickle cell anaemia.

119. (c)

120. (c) : Klinefelter's syndrome occurs by the union of an abnormal XX egg and a normal Y sperm or a normal X egg and abnormal XY sperm. The individual has 47 chromosomes (44 + XXY). Such persons are sterile males with undeveloped testes, mental retardation, sparse body hair, long limbs and with some female characteristics such as enlarged breast, *i.e.*, gynaecomastia.

121. (d) : Woman acts as a carrier when she has the X-linked condition on one of her X-chromosomes. Both son and daughter inherit X-chromosome from mother. Hence, one of the two daughters will be carrier and one of the two sons will be diseased. It can be explained by the given cross :



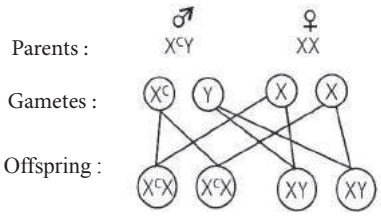
where X^C is the X-chromosome carrying the gene for the condition.

122. (b) : Sickle cell anaemia is caused due to point mutation in which at the 6^{th} position of beta globin chain, glutamic acid is replaced by valine. Thus, it is a qualitative defect in functioning of globin molecules.

Thalassemia is caused due to either mutation or deletion which ultimately results in reduced rate of synthesis of one of the globin chains that make up haemoglobin. Hence, it is a quantitative defect in functioning of globin molecules.

123. (d) : Down's syndrome is an autosomal aneuploidy, caused by the presence of an extra-chromosome number 21. Both the chromosomes of the pair 21 pass into a single egg due to non disjunction during oogenesis.

124. (a) : Genotype of colour blind man – X^c Y
Genotype of woman homozygous – XX
for normal woman

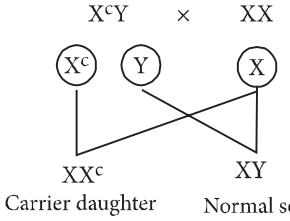


Hence, there is zero (0) probability of their son to be colour-blind.

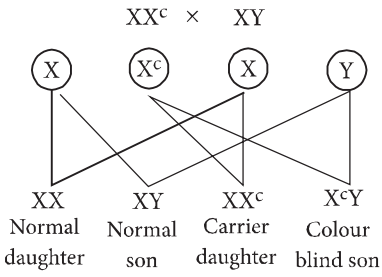
125. (b) : Sickle-cell anaemia is an autosomal recessive genetic disorder. It can be transmitted from parents to the offspring when both the partners are carriers of the gene (or heterozygous).

126. (d) : Haemophilia is a sex-linked disease. It occurs due to the presence of a recessive sex linked gene *h*, which is carried by X-chromosome.

127. (b) : When a colour blind man (X^cY) marries a normal woman (XX), all of their daughters are carriers and all of their sons are normal, as shown in following figure:

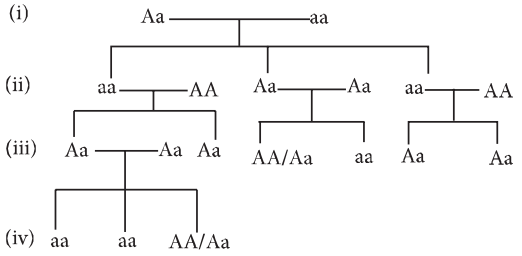


When the carrier daughter (XX^c) is married to a normal man, the probability of their son being colour blind is 0.25, as shown in following figure:



From above crosses, it is clear that the probability of occurrence of colour blindness in the grandson of a colour blind man and a normal woman is 0.25.

128. (a) : Autosomal recessive traits are the traits which are caused by recessive autosomal genes when present in homozygous condition. The given pedigree can be explained as:

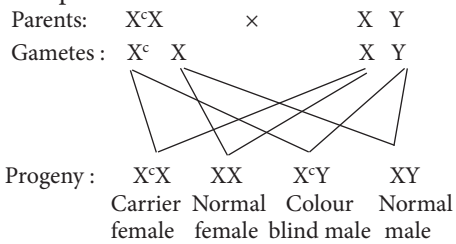


As the trait appears only in homozygous recessive individuals (aa), therefore it is an autosomal recessive trait.

129. (d) : The abnormal baby has an extra X chromosome, thus it must have been produced by fusion of abnormal XX ovum with a normal X sperm. Abnormal XX sperm is not possible because, males have XY genotype, and if produce abnormal sperms, then XY sperms and O sperms will be produced. If fusion of multiple gametes have occurred (either two ova with one sperm or two sperms with one ovum), then the human baby will have triploid genotype not the trisomy of sex chromosomes.

130. (c) : It is given that the man had colour blind father, *i.e.*, man's genotype would be XY.

Now, the woman had a colourblind mother and normal father, thus her genotype would be X^cX. A cross between them can be represented as below.



Therefore, 50% of male children of this couple will be colour blind.

131. (a) : A human female with Turner's syndrome has single sex chromosome *i.e.*, 44 + X0 (45). Such females are called sterile females with rudimentary ovaries. Other associated phenotypes of this condition are short stature, webbed-neck, broad chest, lack of secondary sexual characteristics and sterility. Thus, any imbalance in the copies of the sex chromosomes may disrupt the genetic information necessary for normal sexual development.

132. (a) : Haemophilia is sex-linked disease which is also known as bleeder's disease as the patient will continue to bleed even from a minor cut since he or she does not possess the natural phenomenon of blood clotting due to absence of antihaemophiliac globulin or factor VIII (haemophilia – A) and plasma thromboplastin factor IX (haemophilia–B, Christmas disease) essential for it. As a result of continuous bleeding, the patient may die of blood loss. It is genetically due to the presence of a recessive sex linked gene *h*, carried by X-chromosome. A female becomes haemophiliac only when both of her X-chromosomes carry the gene (X^hX^h). However, such females generally die before birth because the combination of these two recessive alleles is lethal. A female having only one allele for haemophilia (XX^h) appears normal because the allele for normal blood clotting present on the other X-chromosome is dominant. Such females are

known as carriers. In case of males, a single gene for the defect is able to express itself as the Y-chromosome is devoid of any corresponding allele (X^hY).

133. (a) : Thalassaemia is an autosomal recessive blood disorder. In the given case, both the partners are unaffected carriers for the gene, *i.e.*, have heterozygous genotype Tt. Persons homozygous for the autosomal recessive gene of β-thalassaemia suffer from severe haemolytic anaemia. Heterozygous persons are also not normal, but show the defect in a less severe form (thalassaemia minor).

Parents genotype: Tt × Tt

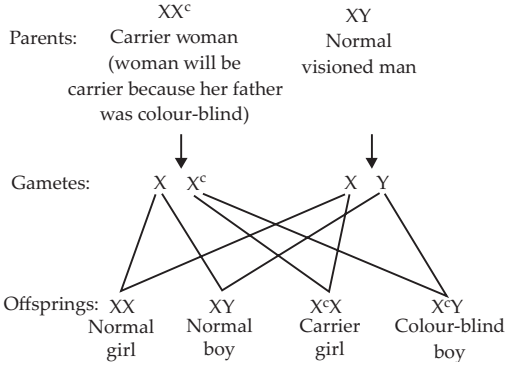
↓

Offspring genotype:	TT	:	Tt	:	tt
	1	:	2	:	1
	Normal		Carriers		Affected
	25%		50%		25%

134. (a) : Pedigree analysis is a system of analysis by following the movement and distribution of certain genetic traits in many generations of a family. Pedigree analysis cannot confirm that DNA is the carrier of genetic information because it is an analysis system. For DNA based experiments, molecular biology techniques are used.

135. (b) : Down's syndrome is the trisomy of 21st chromosome in man. Down's syndrome is characterised by short stature, warty skin, protruding tongue, slanting eyes, with folded eyelids. The affected person's face presents a typical mongoloid look. Hence, it is also called as mongoloid idiocy. It occurs due to the phenomenon of non-disjunction. Non-disjunction occurs when a pair of homologous chromosomes do not separate in meiosis but migrate to the same pole of the cell resulting in an uneven number of chromosomes in the daughter cells (45 in one and 47 in other). This numerical abnormality results in trisomy (2n + 1) and monosomy (2n – 1). Non-disjunction is more common in sex chromosomes.

136. (b) : In the given condition the chances of child to be colour-blind is zero percent. It can be understood by the given cross :



137. (c)

138. (b) : XO type of sex chromosomes determine male sex in grasshoppers. This type of sex-determination comes under XX-XO type. Its common examples are cockroaches, grasshoppers and bugs. The female has two homomorphic sex chromosomes XX and is homogametic. It produces similar eggs, each with X-chromosome. The male has one chromosome only and is heterogametic. It produces 2 types of sperms : gynosperms with X and androsperms without X. Fertilisation of an egg by X-bearing sperm yields female offspring and by no X bearing sperm yields male offspring.

Parents	Phenotypes	Male	Female
	Genotypes	AA + XO	AA + XX
Gametes		A + X, A + O	A + X, A + X

F_1 Generation

♂ \ ♀	A + X	A + X	
A + X	AA + XX	AA + XX	Females
A + O	AA + XO	AA + XO	Males
	Genotypes		Phenotypes

139. (a) : A record of inheritance of certain genetic traits for two or more generations presented in the form of a diagram or family tree is called pedigree. In a pedigree, a square represents the male, a circle the female, solid (blackened) symbol shows the trait under study or affected individual; unaffected or normal individual by an open or clear symbol and a cross or shade (of any type) in the symbol signifies the carrier of a recessive allele. Words can also be used in place of symbols. Parents are shown by horizontal line while their offspring are connected to it by a vertical line. The offspring are then shown in the form of a horizontal line below the parents and numbered with arabic numerals.

140. (a)

141. (c) : Baldness is a sex influenced trait. The dominance of alleles may differ in heterozygotes of the two sexes. This phenomenon is called "sex influenced dominance". Gene products of heterozygotes in the two sexes may be influenced differentially by sex hormones.

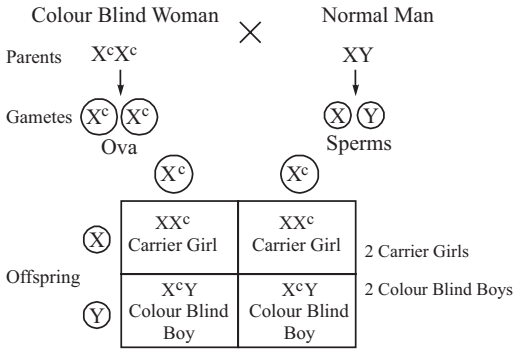
142. (b) : Sickle-cell anaemia is an autosomal hereditary disorder in which erythrocytes become sickle shaped. It is caused by the formation of abnormal haemoglobin called haemoglobin-S. Haemoglobin-S is formed when 6th amino acid of β-chain, *i.e.*, glutamic acid is replaced by valine due to substitution. It occurs due to a single nucleotide change (A → T) in the β-globin gene of coding strand. In the normal β-globin gene the DNA sequence is CCTGAGGAG, while in sickle-cell anaemia, the sequence is CCTGTGGAG.

143. (a) : This chart shows inheritance of an autosomal recessive trait like phenylketonuria. An autosomal recessive trait may skip a generation. It appears in case of marriage between two heterozygous individuals (Aa × Aa = 3 Aa + 1 aa), a recessive individual with hybrid (Aa × aa = 2 Aa + 2 aa) and two recessive (aa × aa = all aa). Phenylketonuria is an inborn, autosomal, recessive metabolic disorder in which homozygous recessive individual lacks the enzyme phenylalanine hydroxylase. The heterozygous individuals are normal but carriers.

144. (c) : Klinefelter's syndrome is a genetic disorder in which there are three sex chromosomes, XXY, rather than the normal XX or XY. The number of autosomes are normal, *i.e.*, 44. Affected individuals are apparently male but are tall and thin, with small testes, failure of normal sperm production (azoospermia), enlargement of the breasts (gynaecomastia) and absence of facial and body hairs.

145. (c) : A congenital disorder is a medical condition that is present at birth. Congenital disorders can be a result of genetic abnormalities, the intrauterine environment, or unknown factors. Sickle cell disease (a group of genetic disorders caused by sickle haemoglobin (HbS). HbS molecules tend to clump together, making red blood cells sticky, stiff and more fragile and causing them to form into a curved, sickle shape) and Huntington's chorea (an inherited disorder characterised by degenerative changes in the basal ganglia structures, which ultimately result in a severely shrunken brain and enlarged ventricles, abnormal body movements called chorea and loss of memory) are congenital disorders.

146. (a) : Colour blindness is a recessive sex-linked trait.



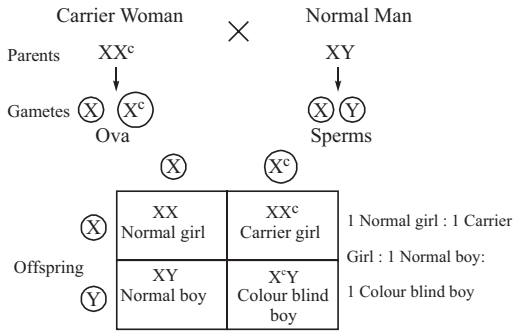
All sons will be colour blind and all daughters will be carriers.

147. (c) : Cri-du-chat syndrome, also called deletion 5p syndrome, (or 5p minus), is a rare genetic disorder. Cri-du-chat syndrome is due to a partial deletion of the short arm of chromosome number 5. The name of this syndrome is French for "cry of the cat," referring to the distinctive cry of children with this disorder. The cry is caused by abnormal larynx development, which becomes normal within a few weeks of birth. Infants with cri-du-chat have low birth weight and may have respiratory problems. Some people with this disorder have a shortened lifespan, but most have a normal life expectancy.

148. (d) : Sickle cell anaemia is an autosomal hereditary disorder in which the erythrocytes become sickle shaped. The disorder or disease is caused by the formation of an abnormal haemoglobin called haemoglobin-S. Carriers of the sickle cell anaemia gene are protected against malaria because of their particular haemoglobin mutation; this explains why sickle cell anaemia is particularly common among people of African origin. The malarial parasite has a complex life cycle and spends part of it in red blood cells and feeds on haemoglobin. Both sickle-cell anaemia and thalassemia are more common in malaria areas, because these mutations convey some protection against the parasite. In a carrier, the presence of the malaria parasite causes the red blood cell to rupture, making the *Plasmodium* unable to reproduce. Further, the polymerisation of Hb affects the ability of the parasite to digest Hb in the first place. Therefore, in areas where malaria is a problem, people's chances of survival actually increase if they carry sickle cell anaemia. Thus, sickle-cell anaemia is a potential saviour from malaria.

149. (b) : Traits governed by sex-linked recessive genes : (a) produce disorders in males more often than in females, (b) express themselves in males even when represented by a single allele because Y-chromosome does not carry any corresponding alleles, (c) seldom appear in both father and son, (d) fail to appear in females unless their father also possesses the same and the mother is a carrier, (e) female heterozygous for the trait function as carrier and (f) female homozygous for the recessive trait transfer the trait to all the sons.

Take the example of colour blindness which is a recessive sex-linked trait. In the question, as man and woman do not show any signs of disease, so man must be normal and woman must be carrier.



150. (d) : Down's syndrome is caused by the presence of an extra chromosome number 21. Both the chromosomes of the pair 21 pass into a single egg. Thus, the egg possesses 24 chromosomes instead of 23 and offspring has 47 chromosomes (45 + XY in males, 45 + XX in males) instead of 46. Turner's syndrome is formed by the union of an abnormal 0 egg and a normal X sperm or a normal egg and an abnormal 0 sperm. The individual has 45 chromosomes (44 + X) instead of 46. Female with more than two X chromosomes is called superfemale.

Triploidy is a condition in which an organism has three times (3n) the haploid number (n) of chromosomes.

151. (c) : *Refer to answer 132.*

152. (d) : Cretinism occurs due to hyposecretion of thyroid hormones. Haemophilia is a sex linked recessive trait. Cystic fibrosis is also a recessive autosomal disorder resulting in mucus clogging in lungs. Thalassemia involves a gene mutation in the polypeptide chains of haemoglobin.

153. (a) : Colour blindness is a recessive sex-linked trait. Since the woman's father was colour blind, she should be carrier of the colour blind gene (X^CX). When she marries to colour blind man their progeny could be

Parent: X^CX (Carrier woman) × X^CY (Colourblind man)

Progeny: X^CX^C (Colour blind girl), X^CX (Carrier girl), X^CY (Colour blind son), XY (Normal son)

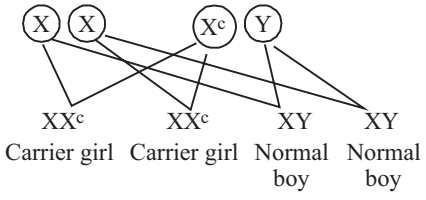
154. (a) : The male human is heterozygous for autosomal gene A and B and also hemizygous for haemophilic gene *h,* then his genotype will be $AaBbX^hY$ because haemophilia is a sex linked trait that is present on X-chromosome. So, the total number of gametes will be abX^h, abY, ABX^h, ABY, AbX^h, AbY, aBX^h, aBY. So the proportion of abX^h sperm will be 1/8.

155. (b) : In question, where the genotype of the other parent is not mentioned then that should be considered normal. Colour blindness is a recessive sex-linked trait

(i) To find out the genotype of a woman.

Her father is colour-blind so his genotype is X^cY and her mother is normal so her genotype is XX.

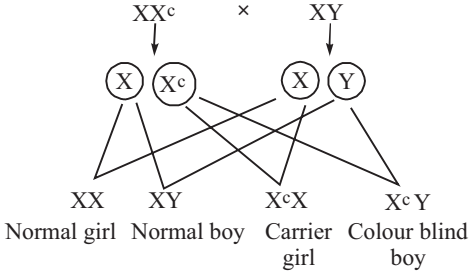
∴ $XX \times X^cY$



So, woman is carrier.

(ii) When this woman marries normal man

∴ 50% of the sons would be colour blind.



156. (c) : The recessive genes located on X-chromosome of humans are always expressed in males, *e.g.*, colour blindness is a recessive sex-linked trait in which the eye fails to distinguish red and green colours. The gene for the normal vision is dominant. The normal gene and its recessive allele are carried by X-chromosomes. In females colour blindness appears only when both the sex chromosomes carry the recessive gene (X^cX^c). The females have normal vision but function as carrier if a single recessive gene for colour blindness is present (XX^c). However, in human males the defect appears in the presence of a single recessive gene (X^cY) because Y-chromosome of male does not carry any gene for colour vision.

157. (c) : *Refer to answer 141.*

158. (b) : *Refer to answer 148.*

159. (c) : Down's syndrome is the example of autosomal aneuploidy. Here, an extra copy of chromosome 21 occurs. As it is an autosomal disease, the offspring produced from affected mother and normal father should be 50 %.

160. (a) : Haemophilia B, a type of haemophilia is also known as christmas disease. It is due to deficiency of a blood coagulation factor, the christmas factor (factor IX). Christmas was the person (20^{th} century) in whom the factor was first identified. Haemophilia B is a defect of the blood which prevents its clotting.

161. (a) : In the inheritance pattern of sex chromosomes, X-chromosome of father always passes to daughter and X-chromosome of mother passes to son. As the father is diseased and all the girls inherit it, it is obvious the disease is sex-linked. The mother is not a carrier (as evident from the fact that no son is diseased). Thus, the gene is dominant and expresses even in heterozygous condition.

162. (a) : Down's syndrome (Mongolian Idiocy, Mongolism) is caused by the presence of an extra chromosome number 21. Sickle cell anaemia is not a sex linked (*i.e.*, X linked) disease but an autosomally inherited recessive trait.

Haemophilia is X-linked but not holandric/Y-linked.

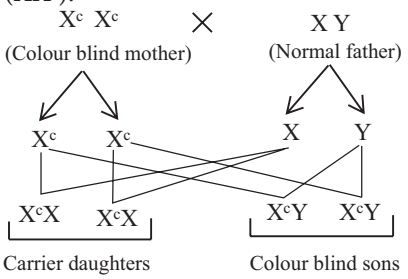
Parkinson's disease is a degenerative disease. It is not at all hereditary.

163. (b) : *Refer to answer 142.*

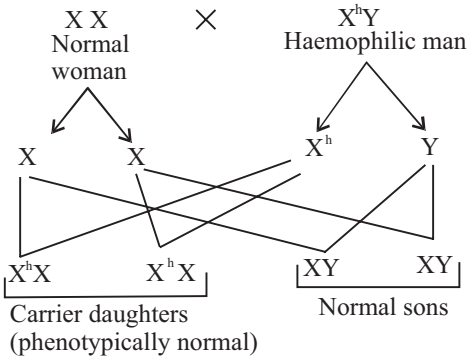
164. (a) : *Refer to answer 162.*

165. (a) : Y-chromosome does not play any role in determination of sex in *Drosophila*. In human being, XXY is phenotypically male with underdeveloped testes, gynecomastia and often mental retardation. It is caused by the union of a non-disjunct XX egg and sperm and a normal X egg and abnormal XY sperm. This indicates that in human being Y chromosome is active in sex determination.

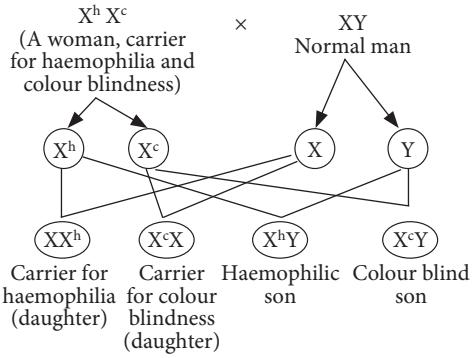
166. (d) : Colour blindness is produced by a recessive gene which lies on X chromosome. A marriage between normal visioned man (XY) and colour blind woman (X^cX^c), results in colour blind sons (X^cY^c) and carrier daughters (XX^c).



167. (d) : Haemophilia is caused by a recessive gene located in the X-chromosome. When a haemophilic man (X^hY) marries a normal woman (XX), produces carrier girls (XX^h) and normal boys (XY), *i.e.* all their offspring will be normal.



168. (b) : Both diseases are produced by a recessive gene which lies on the X-chromosomes. A woman having both gene for haemophilia on one X-chromosome and gene for colour blindness on another X-chromosome will have genotype X^hX^c.



Thus, progeny includes 50% haemophilic daughters (carrier) and 50% colour blind daughters (carrier).

169. (d) : In humans, sex chromosomal abnormality is due to gene carried on X-chromosome. Increase in X-complement leads to Klinefelter's syndrome. The individiuals of Klinefelter's syndrome has 47 chromosomes (44 + XXY), this condition caused by a chromosome aneuploidy. Affected males have an extra X sex chromosome. It is formed by the union of an XX egg and normal Y sperm or normal X egg and abnormal XY sperm. Affected males are almost always effectively sterile, although advanced reproductive assistance is sometimes possible and some degree of language learning impairment and mental retardation may be present. In adults, possible characteristics vary widely and include little to no signs of affectedness, a lanky, youthful build and facial appearance, or a rounded body type with some degree of gynecomastia (increased breast tissue).

170. (d) : Albinism is caused by the absence of the enzyme tyrosinase which is essential for the synthesis of the pigment from dihydroxy-phenyl-alanine. The gene for albinism (a) does not produce the enzyme tyrosinase but its normal allele (A) does. Thus, only homozygous individual (aa) is affected by this disease. Albinos (individuals with albinism) lack dark pigment melanin in the skin, hair and iris. Although albinos have poor vision yet they lead normal life. On the basis of principles of simple recessive inheritance, the probability of albinic child from a normally pigmented parents, will be 1/4 or 25%.

171. (b) **172. (b)**

173. (d) : In question where the genotype of the other parent is not mentioned then that should be considered as normal.

(i) To find out the genotype of person.
His father is colour blind.
∴ genotype = X^cY ... (i)
His mother is normal XX ... (ii)
$X^cY \times XX$
Offspring X^cX, X^cX, XY, XY
As all sons will be normal therefore the genotype of the person will be XY. ...(iii)

(ii) To find out the genotype of lady
Father's genotype - XY ... (iv)
Her mother is a daughter of colourblind father and normal mother.
$X^cY \times XX$
X^cX, X^cX, XY, XY
So the mother of lady would be carrier having genotype X^cX ...(v)
Performing cross between (iv) and (v) to find out lady's genotype.
$XY \times X^cX$
X^cX, XX, X^cY, XY
As 50% daughter are carrier and 50% daughter are normal. So the lady can be normal or carrier having genotype XX, X^cX respectively. ... (vi)
Now considering both the genotype of the lady and the genotype of the person, the result would be as follows.

$XY \times X^cX$ $XY \times XX$
X^cX, XY, XX, X^cY XX, XX, XY, XY

About cases show that if mother (lady) is carrier then options (a) and (c) are not true. Option (b) is true and option (d) all daughters normal (though phenotypically) is also true. If mother is normal then options (a), (b) and (c) are not true and option (d) is true so from the cases, it is concluded that option (d) is true.

174. (c) **175. (b)**

176. (b) : Despite differences in morphology, the XY chromosomes are homologous and synapse during zygotene. It is because they have two parts, homologous and differential. Homologous regions of the two help in pairing. They carry same genes which may have different alleles. The differential region of Y-chromosome carries only Y-linked or holandric genes, *e.g.*, testis determining factor (TDF). It is perhaps the smallest gene occupying only 14 base pairs. Other holandric genes are hypertrichosis (excessive hairiness) on pinna, porcupine skin, keratoderma dissipatum (thickened skin of hands and feet) and webbed toes. Holandric genes are directly inherited by a son from his father. Chromosomes which control most of the morpho-physiological characters other than sex, are called autosomes. Sex linked genes are those which are found on the sex chromosomes. Mutant genes are formed by a change in the nucleotide type and sequence of a DNA segment representing a gene or a cistron.

177. (a) : *Refer to answer 170.*

178. (b)

179. (d) : The chance of a male child becoming colour blind are possible only when mother's father was colour blind. It is an example of criss cross inheritance. If a cross is made between two sexes differing in certain characters, in such a way that character of one sex remains hidden in the opposite sex of F_1 generation, but it is passed on to the same sex in the F_2 generation, it is said to exhibit criss cross inheritance.

180. (c) : The gene is located on one X-chromosomes of mother. Cross between a haemophilic carrier female X^hX and normal male would yield 50% of the sons being haemophilic and 50% of the daughter are carriers.

181. (a) **182. (d)**

183. (c) : In human beings, 45 chromosomes/single X/XO abnormality causes Turner's syndrome. Individuals having a single X chromosome 2A + XO (45) have female sexual differentiation but ovaries are rudimentary. Other associated phenotypes of this condition are short stature, webbed neck, broad chest, lack of secondary sexual characteristics and sterility. Thus, any unbalance in the copies of the sex chromosomes may disrupt the genetic information necessary for normal sexual development.

184. (b) : A colour blind girl is rare because she will be born only when her father and maternal grand-father were colour blind. The genotype of the mother was to be either X^CX^C or X^CX and that of father X^CY so that the daughter becomes colour blind.

185. (b) : In Down's syndrome of a male child, the sex complement is XY. Down syndrome is an autosomal birth defect caused by the presence of an extra chromosome number 21 (three instead of two number 21 chromosomes or trisomy 21).

186. (d) : Haemophilia is more common in males because it is a recessive trait carried by X-chromosome. Haemophilia A is the most common X-linked genetic disease that prevents normal blood clotting when blood vessels are ruptured.

187. (d) : Phenylketonuria is a hereditary disease. Phenylketonuria is an inherited error of metabolism caused by a deficiency in the enzyme phenylalanine hydroxylase. It results in mental retardation and is inherited as an autosomal recessive trait. It is a hereditary human condition resulting from the inability to convert phenylalanine into tyrosine. This change can be traced to a tiny mutation in a single gene on chromosome 12.

188. (a) : Both husband and wife have normal vision through their fathers were colour blind, the probability of their daughter becoming colour blind is 0%. The chances of daughter becoming colour blind arises only when the father is also colour blind.

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