THE VILLAGE
INTERNATIONAL SCHOOL
"We Nurture Dreams"

AIM HIGH, TOGETHER WE FLY

Grade 12 Biology

Chapter 5: Principles of inheritance and variation

Question bank part 2

Q. 26. Study the figures given below and answer the question.

Identify in which of the crosses is the strength of linkage between the genes higher. Give reasons in support of your answer.

Ans. In Cross A because the genes are closely placed. Lesser the distance between genes greater is the strength of linkage as lesser is the chance of crossing over between them.

Q. 27. Write the scientific name of the fruitfly. Why did Morgan prefer to work with fruitflies for his experiments? State any three reasons.

Ans. Drosophila melanogaster is the scientific name of fruitfly. Morgan preferred work with fruitflies because: Reason for selecting Drosophila melanogaster (fruit fly):

(i) They could be grown on simple synthetic medium in the laboratory.

(ii) They complete their life cycle in two weeks.

(iii) A single mating could produce a large number of progeny.

(iv) There was clear differentiation of the sexes, i.e., male and female flies are easily distinguishable.

(v) It has many types of hereditary variations that can be seen with low power microscopes.

Q. 28. In a dihybrid cross white eyed, yellow bodied female Drosophila crossed with red eyed, brown bodied male Drosophila produced in F2 generation, 1.3 per cent recombinants and 98.7 per cent progeny with parental type combinations. This observation of Morgan deviated from Mendelian F2 phenotypic dihybrid ratio. Explain, giving reasons, Morgan's observations.

Ans. Morgan saw that when the two genes in a dihybrid cross were situated on the same chromosome, the proportion of parental gene combinations were much higher than the non-parental type. Morgan attributed this due to physical association or linkage of two genes and coined the term linkage to describe this physical association of genes on a chromosome and the term recombination to describe the generation of non-parental gene combinations. %of recombinants depends on distance between genes. More is the distance more is % of recombinants and vice versa.

Q. 29. Linkage and crossing-over of genes are alternatives of each other. Justify with the help of an example.

Ans. In Drosophila a yellow bodied white eyed female was crossed with brown bodied red eyed male. The F1 progeny produced, when intercrossed, it was observed that the F2 phenotypic ratio of Drosophila deviated

significantly from Mendel's 9 : 3 : 3 : 1. The genes for eye colour and body colour are closely located on the 'X' chromosome, showing linkage and therefore, these are inherited together. Recombinants were formed due to crossing over but at low percentage.

Q. 30. How does the gene 'I' control ABO blood groups in humans? Write the effect the gene has on the structure of red blood cells.

Ans. Gene 'I' has three different alleles IA, IB, i

(a) IA produces A type of sugar polymer on surface of RBC which results in A group

(b) IB produces B type of sugar polymer on surface of RBC which results in B group

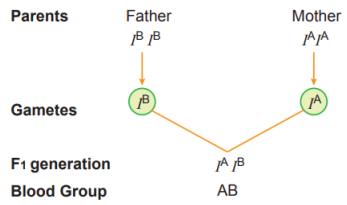
(c) i produces no sugar which result in O blood group

The sugar polymers protrude from the surface of plasma membrane of RBCs which are characteristics of each blood group.

Q. 31. (a) Why is human ABO blood group gene considered a good example of multiple alleles?

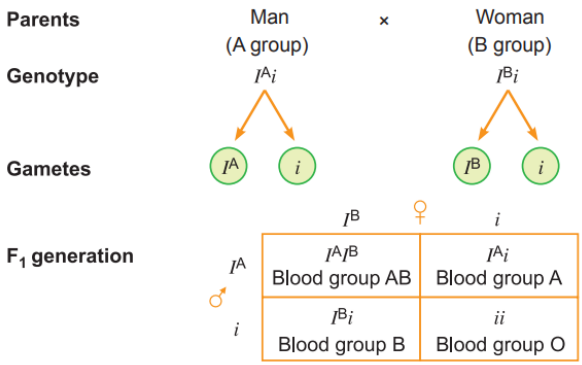
(b) Work out a cross up to F1 generation only, between a mother with blood group A (Homozygous) and the father with blood group B (Homozygous). Explain the pattern of inheritance exhibited.

Ans. (a) This is because more than two alleles govern the human ABO blood group gene.



The cross exhibits co-dominance. When the two alleles I A and I B are present together, both the alleles express each other equally forming the blood group AB.

Q. 32. A man with blood group A married a woman with B group. They have a son with AB blood group and a daughter with blood group O. Work out the cross and show the possibility of such inheritance.



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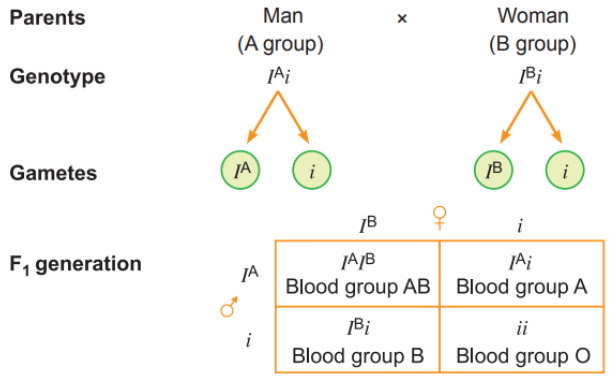
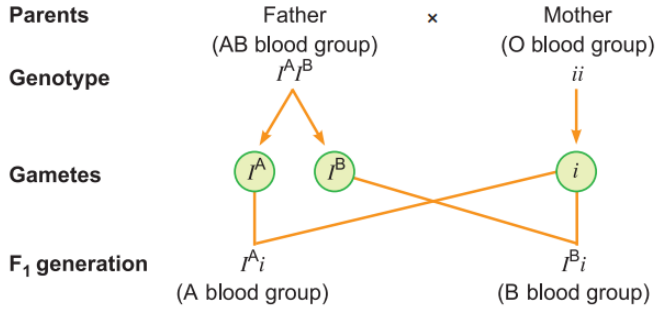


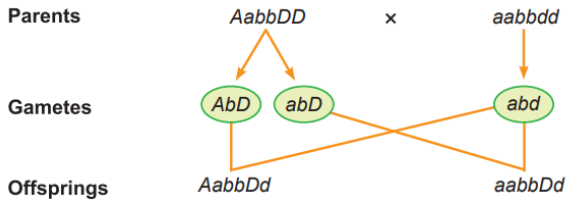
Thus, the F1 progeny can have all the four possible blood groups, i.e., A, B, AB and O.

Q. 33. A woman with blood group O married a man with AB group. Show the possible blood groups of the progeny. List the alleles involved in this inheritance.



The alleles involved in this inheritance are: I A, I B and i.

Q. 34. A, B and D are three independently assorting genes with their recessive alleles a, b and d, respectively. A cross was made between individuals of AabbDD genotype and aabbdd. Explain the type of genotypes of the offspring produced.



Q. 35. Explain mechanism of sex determination in birds.

Ans. In birds, females are heterogemetic and males are homogametic. Females have one Z sex chromosome and one W sex chromosome. Males have a pair of Z sex chromosome. If Z sperm fertilises Z ovum, a male offspring is produced, and if Z sperm fertilises W ovum a female offspring is produced.

Q. 36. Explain the mechanism of sex determination in insects like Drosophila and grasshopper.

Ans. In grasshopper, the mechanism of sex determination is of the XO type. In females, the eggs bear a pair of X chromosomes along with the autosomes. Males contain only 1 X chromosome with autosomes. On the other hand, there are two types of sperms formed in males–one having a X chromosome and other without X chromosome. Hence, grasshopper shows male heterogamety.

Q. 37. Differentiate between “ZZ” and “XY” type of sex-determination mechanisms.

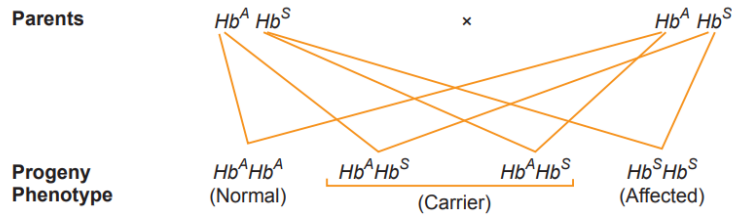
Ans. ZZ type is seen in birds. The males are homogametic (ZZ) and females are heterogametic (ZY). Sex is determined by the type of egg getting fertilised. XY type is seen in human beings The males are heterogametic (XY) and females homogametic (XX). Sex is determined by the type of sperm fertilising the ovum.

Q. 38. Why is pedigree analysis done in the study of human genetics? State the conclusions that can be drawn from it.

Ans. Pedigree analysis is done because control crosses are not possible in case of humans beings. This can be useful for analysis of traits, in several generations of a family, to trace pattern of inheritance to check whether the trait is dominant or recessive or sex-linked or not.

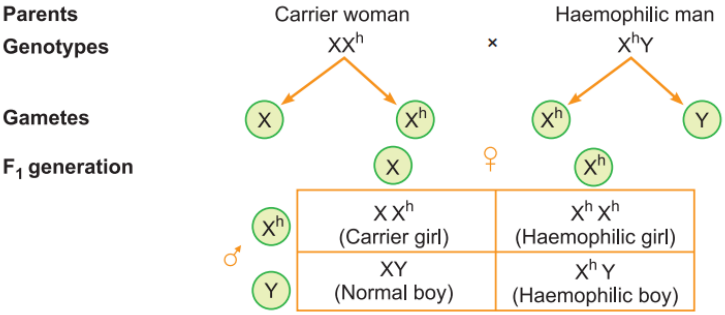
Q. 39. Give an example of an autosomal recessive trait in humans. Explain its pattern of inheritance with the help of a cross.

Ans. Sickle cell anaemia is an autosomal recessive trait in humans. The disease is controlled by a single pair of alleles HbA and HbS. Only the homozygous individuals HbS HbS show the diseased phenotype. The heterozygous individuals (HbAHbS) are carriers.



Q. 40. Recently a baby girl has been reported to suffer from haemophilia. How is it possible? Explain with the help of a cross.

Ans. It is possible to have a haemophilic girl if a carrier woman married a haemophilic man as shown here:

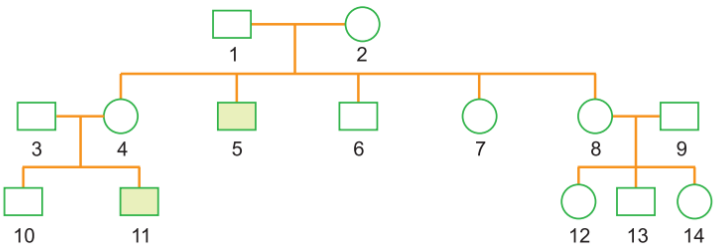


Q. 41. Why are human females rarely haemophilic? Explain. How do haemophilic patients suffer?

Ans. Haemophilia is a sex-linked recessive disorder. The females haves XX chromosomes and the males have XY chromosomes. If one of the two X chromosomes is normal, she remains a carrier and not diseased. Female will be haemophilic only when both the X chromosomes carry the haemophilia gene and this is possible only when the mother is a carrier and father is haemophilic. Haemophillic patients suffer from non-stop bleeding and no clotting in case of injury.

Q. 42. Haemophilia is a sex-linked inheritance condition in humans where a simple cut causes non-stop bleeding. Study the pedigree chart showing the inheritance of haemophilia in a family.

Answer the questions that follow:



Give reasons which explain that haemophilia is

(i) sex-linked, and

(ii) caused by 'X'-linked gene.

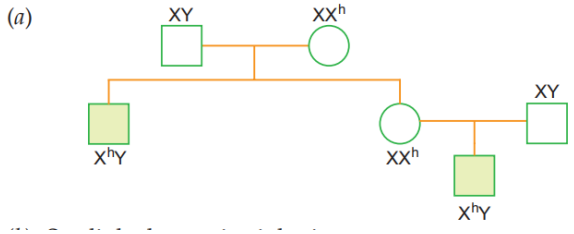
Ans. (i) Haemophilia is sex-linked because it shows transmission from unaffected carrier female to some of the male progeny.

(ii) Haemophilia is caused by 'X'-linked gene because the heterozygous female for haemophilia may transmit the disease to sons. It appears more in males because of only one X chromosome.

Q. 43. Marriage between a normal couple resulted in a son who was haemophilic and a normal daughter. In course of time, when the daughter was married to a normal man, to their surprise, the grandson was also haemophilic.

(a) Represent this cross in the form of a pedigree chart. Give the genotypes of the daughter and her husband.

(b) Write the conclusion you draw from the inheritance pattern of this disease.



(b) Sex-linked recessive inheritance pattern.

Q. 44. (a) Sickle celled anaemia in humans is a result of point mutation. Explain.

(b) Write the genotypes of both the parents who have produced a sickle celled anaemic offspring.

Ans. (a) In sickle cell anaemia, due to point mutation there is a substitution of a single nitrogen base at the sixth codon of the β-globin chain of haemoglobin that leads to substitution of valine in place of glutamic acid.

$$\underset{\text{Glutamic acid}}{\text{GAG}} \xrightarrow{\text{Mutation}} \underset{\text{Valine}}{\text{GUG}}$$

(b) The genotypes of both the parents would be HbAHbS and HbAHbS .

Q. 45. Name a disorder, give the karyotype and write the symptoms, a human suffers from as a result of monosomy of the sex chromosome.

Ans. Turner's syndrome is a disorder caused by the absence of one of the X-chromosomes. Its karyotype will be 45 + XO. Symptoms are:

(i) Sterile females

(ii) Rudimentary ovaries

(iii) Lack of secondary sexual characters.

Q. 46. Name a disorder, give the karyotype and write the symptoms where a human male suffers as a result of an additional X-chromosome.

Ans. Klinefelter's syndrome. The karyotype is 44 + XXY. Symptoms are:

(i) Sex of the individual is masculine but possesses feminine characters.

(ii) Gynaecomastia, i.e., development of breasts.

(iii) Poor beard growth and often sterile.

(iv) Feminine pitched voice.

Q. 47. Name the phenomenon that leads to situations like 'XO' abnormality in humans. How do humans with 'XO' abnormality suffer? Explain.

Ans. Absence of one X chromosome due to non segregation of chromatids during cell division leads to XO abnormality. These are sterile female with rudimentary ovaries. They have shield-shaped thorax, webbed neck, poor development of breasts, short stature, small uterus and puffy fingers.

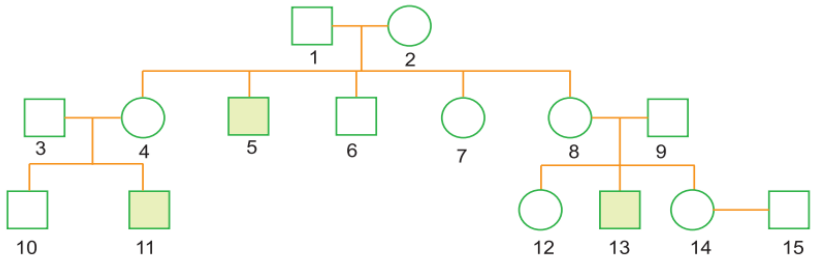
Q. 48. Which chromosome carries the mutated gene causing β-thalassemia? What are the problems caused by the mutation?

Ans. Chromosome number 11 carries the mutant gene causing β-thalassemia. It causes formation of abnormal haemoglobin molecules, resulting into anaemia.

Q. 49. Both haemophilia and thalassemia are blood related disorders in humans. Write their causes and the difference between the two. Name the category of genetic disorder they both come under.

S.No.		Haemophilia	Thalassemia
(*i*)	Cause	Single protein is involved in the clotting of blood is affected.	Defects in the synthesis of globin leading to formation of abnormal haemoglobin.
(*ii*)	Genetic disorder	Sex-linked recessive disorder.	Autosomal recessive disorder.
(*iii*)	Difference	Blood does not clot due to lack of clotting factors.	Results in anaemia (abnormal or lack of haemoglobin).

Q. 50. Haemophilia is a sex-linked recessive disorder of humans. The pedigree chart given below shows the inheritance of haemophilia in one family. Study the pattern of inheritance and answer the questions given.



(a) Give all the possible genotypes of the members 4, 5 and 6 in the pedigree chart.

(b) A blood test shows that the individual 14 is a carrier of haemophilia. The member numbered 15 has recently married the member numbered 14. What is the probability that their first child will be a haemophilic male?

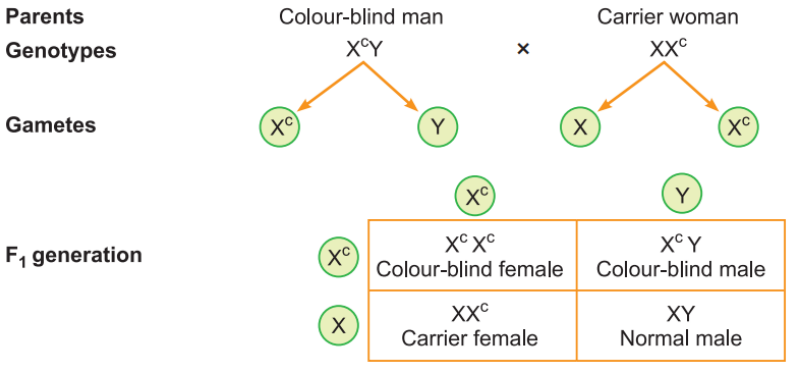
Ans. (a) Genotypes of member 4—XX or XX^h

Genotype of member 5—X^hY and Genotype of member 6—XY

(b) The probability of first child to be a haemophilic male is 25%.

Q. 51. A colour-blind man marries a woman with normal vision whose father was colour-blind. Work out a cross to show the genotype of the couple and their respective sons.

Ans. The father of normal woman is colour-blind, so the woman will be carrier, i.e., XX^C.



50% sons will be colour-blind and rest 50% will be normal. 50% daughters will be colour-blind and rest 50% will be carriers.