BYJU'S Study Planner for Board Term I (CBSE Grade 12)

Date: 15/11/2021

Subject: Biology

Topic : Principles of Inheritance and Variation

Class: Standard XII

---

1. How many pairs of contrasting traits were studied by Mendel in pea plant ?

   ✗ **A.** 6

   ✓ **B.** 7

   ✗ **C.** 8

   ✗ **D.** 10

Mendel selected seven pairs of contrasting characters like seed shape, seed color, pod shape, pod color, flower color, flower position, and plant height.
Each of them has one pair of contrasting traits which Mendel used for his experiments and to analyse the results.

Seed		Flower	Pod		Stem	
Form	Cotyledon	Color	Form	Color	Place	Size
						
Round	Yellow	White	Full	Green	Axial pods	Tall
						
Wrinkled	Green	Violet	Constricted	Yellow	Terminal pods	Short
1	2	3	4	5	6	7

BYJU'S Study Planner for Board Term I (CBSE Grade 12)

2. Mendel observed visible contrasting forms of a character. Each variant of a character is called _____.

- ✗ **A.** inheritance
- ✓ **B.** trait
- ✗ **C.** genome
- ✗ **D.** DNA

Each variant of an inheritable character is called a trait for that character. The genetic material in most organisms is DNA - deoxyribonucleic acid, the segments of the DNA are known as genes. The limitations of technology in the Mendelian era could not elaborate the structure of the DNA and genes. Mendel called the inheritable units as factors.

The advancement of technology and microscopy eventually paved way for the explanation that the characters expressed in the offspring are inherited from the parents. The difference in the expression of these genes can lead to different traits.

Inheritance refers to the pattern in which the genes are transferred from one generation to another.

Sum total of an organisms DNA is referred to as the genome of the organism. It includes genes that code for proteins, regulatory molecules as well as mitochondrial DNA and chloroplast DNA (in the case of plants).

BYJU'S Study Planner for Board Term I (CBSE Grade 12)

3. If linkage was known at the time of Mendel then which of the following laws, he would not have been able to explain?

A. Law of segregation

B. Law of purity of gametes

C. Law of dominance

D. Law of independent assortment

The law of independent assortment states that when two or more characteristics are inherited, individual hereditary factors assort independently during gamete production, giving different traits an equal opportunity of occurring together. On the other hand, linkage refers to the presence of two different genes on the same chromosome. Two genes that occur on the same chromosome are said to be linked, and those that occur very close together are tightly linked. So, this would have been contradictory as Mendel would have not been able to explain the inheritance of two genes without one affecting the other.
Law of segregation or law of purity of gametes and law of dominance work for a single gene.

So, the correct answer is the law of independent assortment.

BYJU'S Study Planner for Board Term I (CBSE Grade 12)

4. A monohybrid cross is conducted in which a pea plant that produces yellow coloured seeds was crossed with a pea plant that produces green coloured seeds.
The plants with yellow coloured seeds are produced in:

✗ **A.** F_1 generation only

✗ **B.** F_2 generation only

✓ **C.** F_1 and F_2 generation

✗ **D.** Difficult to predict

Mendel conducted hybridisation experiments on pea plants. He selected pure lines as parents. Pure lines are always homozygous. Crossing of parents results in F_1 generation.
The F_1 generation hybrids are heterozygous and exhibit the dominant phenotype only.

Selfing of F_1 hybrids results in F_2generation in which individuals with both the dominant and recessive phenotypes are produced.

Yellow colour of seeds is dominant over green colour of seeds in pea plant.
Hence, plants with yellow seed colour are produced in both F_1 and F_2generations.

Plants with green coloured seeds are produced in F_2 generation only as it is a recessive trait.

BYJU'S Study Planner for Board Term I (CBSE Grade 12)

5. If hereditary units relate to the term genes carrying genetic information from one generation to next, then what will be related to the term coloured bodies found inside the nucleus?

- **A.** Chromosomes
- **B.** Factors
- **C.** Lysosomes
- **D.** Genes

The chromosomes are coloured bodies when stained, and are found inside the nucleus. They are clearly visible under the microscope.

Factors are hereditary units. This term was used by Mendel which nowadays are called genes.

Genes are located on the chromosomes.

Lysosomes are cell organelles found in the cytoplasm outside the nucleus. Lysosomes contain powerful hydrolytic enzymes capable of digesting the macromolecules.

BYJU'S Study Planner for Board Term I (CBSE Grade 12)

6. Which of the following is correct regarding monohybrid cross?

- ✗ **A.** It involves crossing between parents which differ in a single character
- ✗ **B.** The genotypic ratio of the offspring in F_2 generation is 1 : 2 : 1
- ✗ **C.** The phenotypic ratio of the offspring in F_2 generation is 3 : 1
- ✓ **D.** All of the above

BYJU'S Study Planner for Board Term I (CBSE Grade 12)

A monohybrid cross is defined as a cross between two parents which are similar in all characters except for one character.

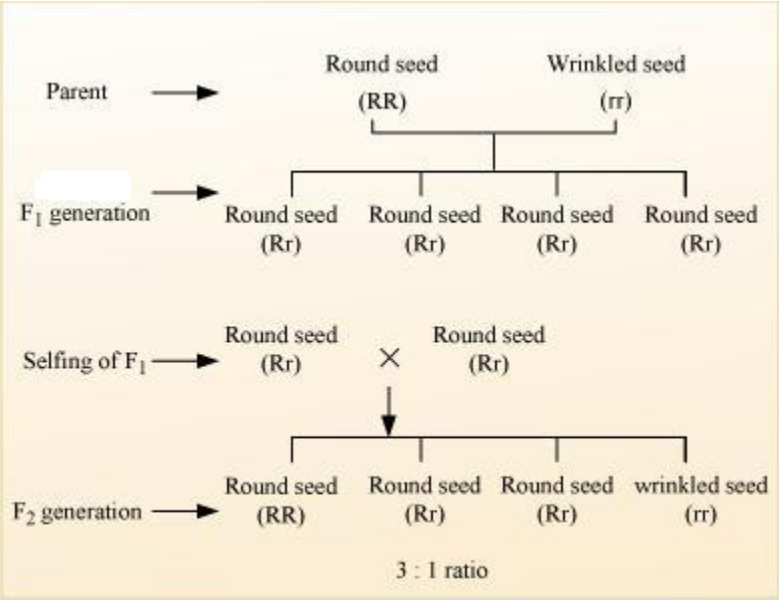
They have contrasting traits for one of the characters.

Example- a cross between two pea plants, one of which yields round seeds and one of which yields wrinkled seeds, is known as a monohybrid cross.

Some more examples of monohybrid cross conducted by Mendel.

Character	Trait in parent 1 (in monohybrid cross)	Trait in parent 2 (in monohybrid cross)
Height	Tall	Dwarf
Seed colour	Yellow	Green
Pod shape	Inflated	Constricted
Pod colour	Green	Yellow
Flower colour	Violet	White
Flower position	Axial	Terminal

Let us understand monohybrid cross considering seed shape.



A monohybrid cross between round and wrinkled pea seeds

Genotypic ratio in F_2 generation:
RR : Rr : rr = 1 : 2 : 1

Phenotypic ratio in F_2 generation:
Round seeds producing plants: Wrinkled seeds producing plants = 3 : 1

7. In a dihybrid cross AABB × aabb, F2 progeny of AABB, AABb, AaBB and AaBb occurs in ratio of_____.

- ✗ **A.** 1: 1: 1: 1
- ✗ **B.** 9: 3: 3: 1
- ✗ **C.** 1: 2: 2: 1
- ✓ **D.** 1: 2: 2: 4

♂ ♀

Parental generation: AABB X aabb

⇩ ⇩

Gametes: AB ab

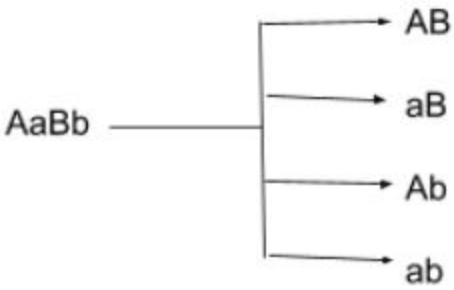
⇩

F1 generation: AaBb

F1 Selfing: AaBb x AaBb

The punnett square chart for F2

Gametes formation from AaBb for selfing



F2 generation:

generation is as follows:

Gametes	AB	aB	Ab	ab
AB	AABB	AaBB	AABb	AaBb
aB	AaBB	aaBB	AaBb	aaBb
Ab	AABb	AaBb	AAbb	Aabb
ab	AaBb	aaBb	Aabb	aabb

Thus, the ratio of AABB, AABb, AaBB and AaBb is 1 : 2 : 2 : 4.

BYJU'S Study Planner for Board Term I (CBSE Grade 12)

8. Identify the incorrect statements:
i) Multiple alleles are produced due to repeated mutation of the same gene but in different directions.
ii) In co-dominance, both the alleles of the gene are dominant and express independently in the heterozygous condition.
iii) Incomplete dominance results in two different phenotypes in the hybrid.

✗ **A.** Statements i and ii

✓ **B.** Statement iii only

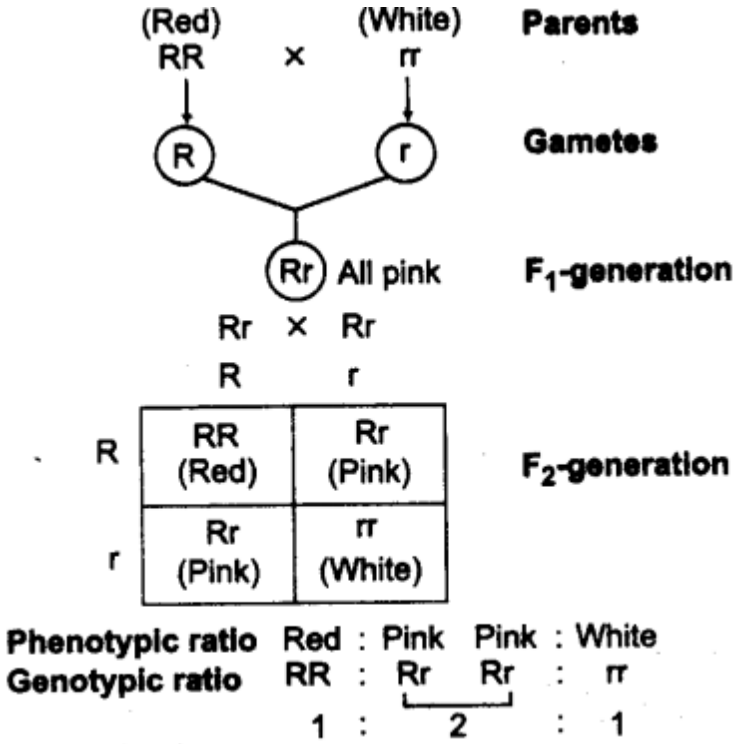
✗ **C.** Statements ii and iii

✗ **D.** Statement i only

BYJU'S Study Planner for Board Term I (CBSE Grade 12)

Incomplete dominance does not result in two different phenotypes, rather an intermediate phenotype is seen in the hybrid.

For example, in dog flower (*Antirrhinum*), the cross between red and white-flowered plants produces pink-flowered plants.



Multiple alleles exist in a population when there are many variations of a single gene. These are produced due to repeated mutations of the same gene in different directions in the population. Example - 3 alleles for ABO blood groups in humans, 4 alleles for coat colour in rabbits etc.

In co-dominance, both the alleles of the gene are dominant and are expressed independently in the heterozygous condition. For example, the cross between shorthorn cattle of red and white coat colour produces roan coat (patches of red and white) cattle.

BYJU'S Study Planner for Board Term I (CBSE Grade 12)

9. If you cross a roan cow with a roan bull, what percentage of the progeny would you expect to be roan?

- **A.** 10%
- **B.** 25%
- **C.** 50%
- **D.** 75%

Roan coat colour in shorthorn cattle is a co-dominant trait in which the roan cattle are heterozygous for the coat colour gene (WR).
When roan cattle are crossed,

	W	R
W	WW (White coat)	WR (Roan coat)
R	WR (Roan coat)	RR (Red coat)

50% of the progeny would be of roan coat colour (WR)

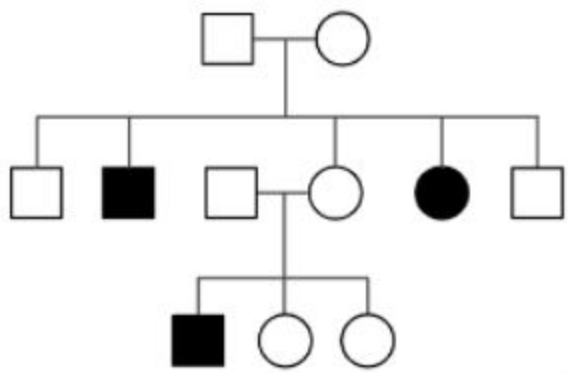
10. What can be the blood group of offspring when both parents have an AB blood group?

- **A.** AB only
- **B.** A, B and AB
- **C.** A, B, AB and O
- **D.** A and B only

When both parents have blood group $AB(I^AI^B)$ then offsprings can have blood groups $A(I^AI^A)$, $B(I^BI^B)$, or $AB(I^AI^B)$ but not O as allele *i* is not present in any of the parent.

BYJU'S Study Planner for Board Term I (CBSE Grade 12)

11. The pedigree chart represents



A. autosomal dominant trait

B. autosomal recessive trait

C. X linked recessive trait

D. Y linked trait

The given pedigree chart represents autosomal recessive trait. Autosomal recessive trait is the type of trait which is present on autosomes (chromosomes other than the sex chromosomes) and are only expressed when both the alleles of the trait are present.

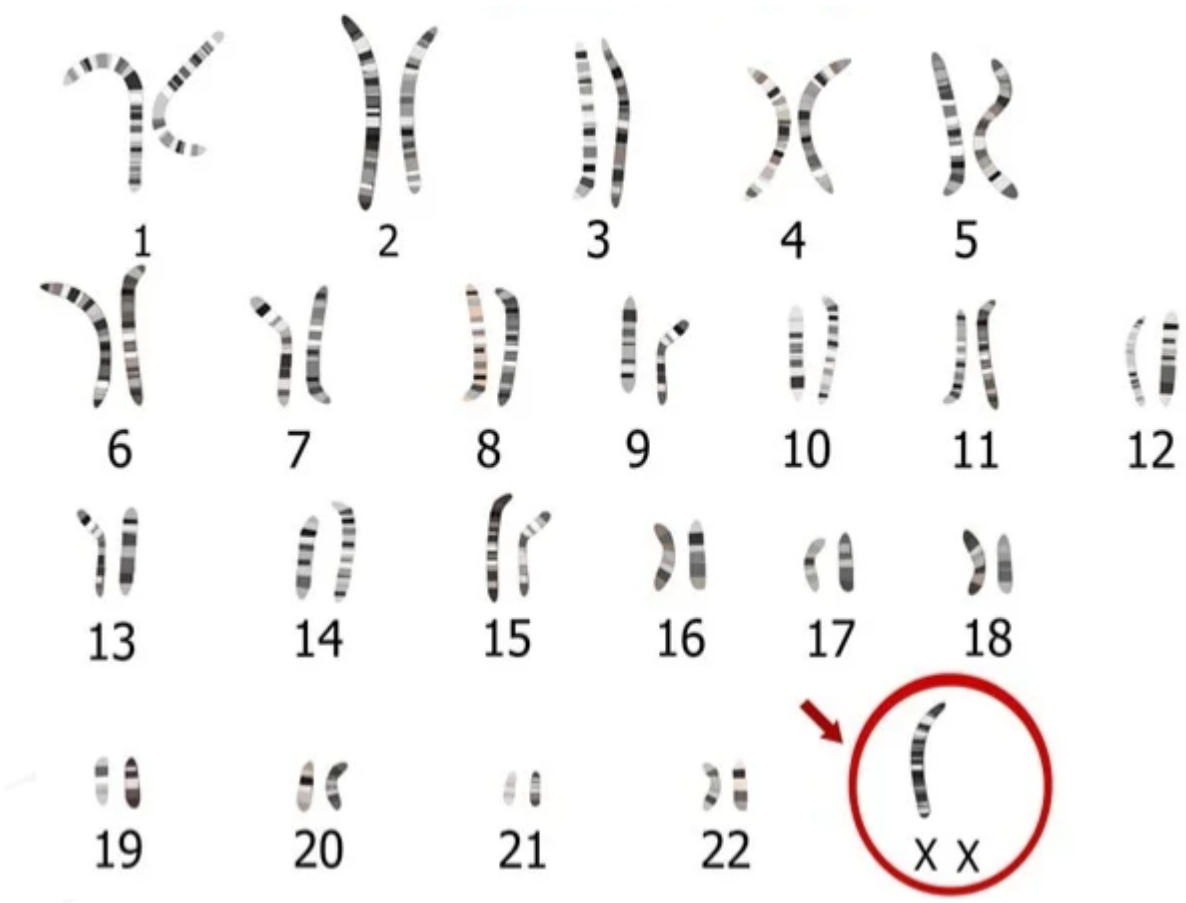
The I generation male and female are heterozygous or carriers and hence, unaffected. But the recessive alleles were transmitted to their offspring. If the trait is autosomal dominant, the parents (individuals) in heterozygous conditions will be affected which has not happened in this case. So, the pedigree chart represents an autosomal recessive trait.

Pedigree chart cannot be X linked disorder because the parents of the affected females in the II generation are unaffected. For X linked recessive trait, the father should be affected and the mother should be a carrier or be affected for the trait to pass to their offspring.

Pedigree chart cannot be Y linked disorder as the Y linked disorder transmits in only males which is not happening in this case.

BYJU'S Study Planner for Board Term I (CBSE Grade 12)

12. Study the human karyotype given below and identify the disorder:



A. Down's syndrome

B. Turner's syndrome

C. Klinefelter's syndrome

D. The karyotype is of a normal individual

A technique that produces an image of an individual's chromosomes is called karyotype.

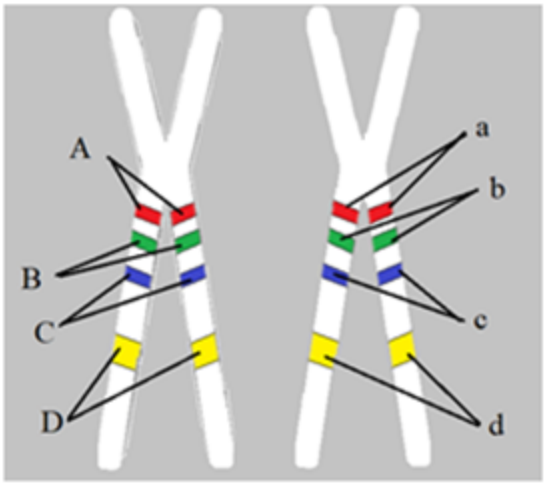
A normal diploid cell has 46 chromosomes, out of which 44 are autosomes and 2 are sex chromosomes which are XX and XY for females and males respectively.

The karyotype of a normal person will have a total of 23 pairs of chromosomes.

Females affected with Turner's syndrome have the chromosomal complement, 44+XO, i.e, they lack an X chromosome. The given karyotype represents the similar condition. Hence, this reflects Turner's syndrome.

Down's syndrome is characterized by the presence of three copies of the 21^{st} chromosome while males with Klinefelter's syndrome have 44+XXY, i.e. presence of an extra X chromosome.

13. Given figure shows a pair of homologous chromosomes during meiosis.
Maximum crossing over will take place between genes



A. A and a, D and d

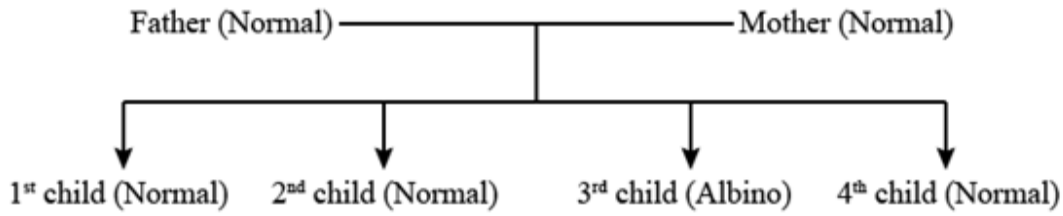
B. C and d, c and D

C. B and c, b and C

D. A and d, a and D

Increase in distance between genes increases the chances of crossing over. As A and d & a and D are located farther away, chances of crossing over are maximum.

14. Refer to the figure and give answer



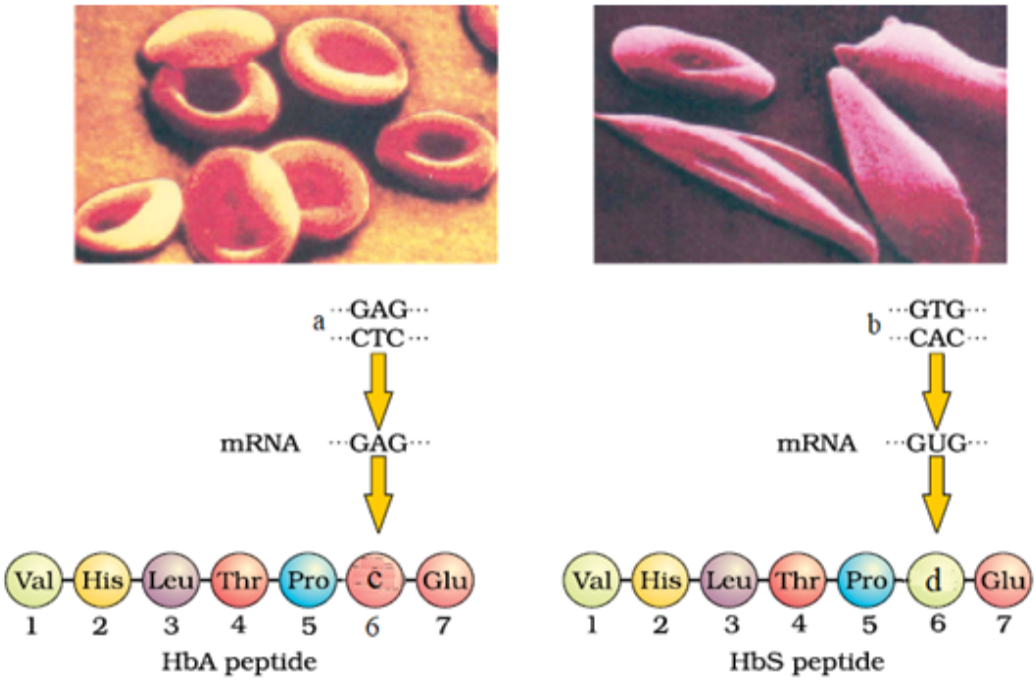
If A = Normal allele and a = Albino allele then genotypes of father and mother are respectively

- **A.** Aa and Aa
- **B.** AA and Aa
- **C.** Aa and AA
- **D.** Aa and aa

Albinism is an autosomal recessive disease. Reproduction between Aa and Aa will result in 1 Homozygous normal (AA), 2 Heterozygous normal (Aa) and 1 Albino child (aa).

Male ↓ /Female →	A	a
A	AA; Homozygous Normal	Aa; Heterozygous Normal
a	Aa; Heterozygous Normal	Aa; Albino

15. Recognise the figure and find out the correct matching.



A. $c-\text{Glu},\ d-\text{Val},\ a-\text{normal-Hb-(A)-gene},\ b-\text{sickle-cell-Hb-(S)-gene}$

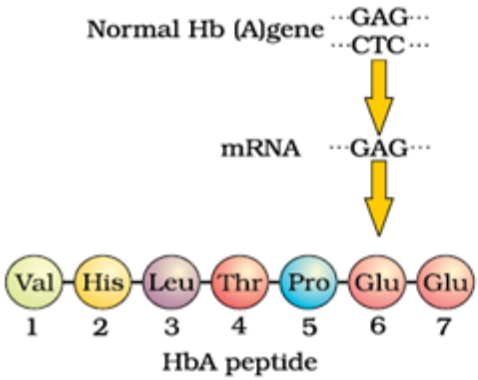
B. $c-\text{Glu},\ d-\text{Val},\ b-\text{normal-Hb-(A)-gene},\ a-\text{sickle-cell-Hb-(S)-gene}$

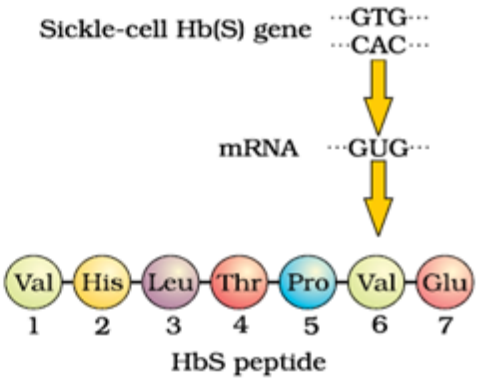
C. $d-\text{Glu},\ c-\text{Val},\ a-\text{normal-Hb-(A)-gene},\ b-\text{sickle-cell-Hb-(S)-gene}$

D. $c-\text{Glu},\ d-\text{Val},\ b-\text{normal-Hb-(A)-gene},\ a-\text{sickle-cell-Hb-(S)-gene}$

BYJU'S Study Planner for Board Term I (CBSE Grade 12)

Sickle cell anemia is an autosomal linked recessive trait that can be transmitted from parents to the offspring when both the parents are carrier for the gene (or heterozygous). The disease is controlled by a single pair of allele, Hb^A and Hb^S. Out of the three possible genotypes only homozygous individuals for Hb^S (Hb^sHb^s) show the diseased phenotype. Heterozygous (Hb^AHb^S) individuals appear apparently unaffected but they are carrier of the disease as there is 50 per cent probability of transmission of the mutant gene to the progeny, thus exhibiting sickle-cell trait. The defect is caused by the substitution of glutamic acid (Glu) by valine (Val) at the sixth position of the beta globin chain of the haemoglobin molecule. The substitution of amino acid in the globin protein results due to the single base substitution at the sixth codon of the beta globin gene from GAG to GUG. The mutant haemoglobin molecule undergoes polymerisation under low oxygen tension causing the change in the shape of the RBC from biconcave disc to elongated sickle like structure.





16. Assertion: Though the chromosome content of the daughter cells is halved by the end of meiosis I, meiosis II is essential for generation of haploid cells.

Reason: During meiosis II, the duplicated sister chromatids separate from each other and are distributed into the haploid daughter cells.

- ✔ **A.** Both the assertion and reason are true and the reason is the correct explanation of the assertion
- ✘ **B.** Both the assertion and reason are true but the reason is not the correct explanation for the assertion
- ✘ **C.** The assertion is true but the reason is false
- ✘ **D.** Both assertion and the reason are false

Meiosis involves 2 cycles of division, meiosis I and meiosis II.

Meiosis I: During meiosis I, the homologous chromosomes of the cell separate and the parent cell divides into two daughter cells. Each of the two daughter cells receives only half the number of chromosomes and hence the chromosome content is reduced to half in the daughter cells. Hence, meiosis I is known as reduction division.

Meiosis II: The haploid daughter cells formed after meiosis I undergo another round of division called meiosis II. During meiosis II, the sister chromatids of each chromosome separate and four haploid daughter cells are formed by the end of meiosis II.

Thus, even though the diploid parent cell undergoes reduction division during meiosis I itself, meiosis II is important to separate the sister chromatids of each chromosome to generate four haploid daughter cells.

Therefore, the assertion and the reason are true and the reason is the correct explanation of the assertion.

17. Assertion : When yellow bodied, white eyed Drosophila females were hybridised with brown-bodied, red eyed males; and F_1 progeny were intercrossed, F_2 ratio deviated from 9:3:3:1.
Reason : When two genes in a dihybrid are on the same chromosome, the proportion of parental gene combinations in the offsprings are much higher than the non-parental type.

✓ **A.** Both assertion and reason are true and reason is the correct explanation of the assertion

✗ **B.** Both assertion and reason are true but reason is not the correct explanation of the assertion

✗ **C.** Assertion is true but the reason is false

✗ **D.** Assertion and reason both are false

In Morgan's dihybrid cross in *Drosophila*, the genes for eye colour and body colour were found to be located on the same X chromosome.
When yellow bodied (y), white eyed (w) Drosophila females were hybridised with brown-bodied (y+), red eyed (w+) males; and F_1 progeny was intercrossed, the F_2 ratio deviated from 9:3:3:1. This is because the genes were situated on the same chromosome (X), on closer loci. The alleles did not get assorted independently. Hence, the proportion of offsprings with parental gene combinations was much higher than the non-parental types.

BYJU'S Study Planner for Board Term I (CBSE Grade 12)

18. Given below is a list of features observed in an individual with L type of syndrome. This chromosomal disorder is caused due to trisomy of the K chromosome.
i. Clenched fists with overlapping fingers
ii. Dysplastic or malformed ears
iii. Back part of the skull is prominent
Identify L and K.

- ✔ **A.** L-Edwards syndrome; K-18^{th} chromosome
- ✘ **B.** L-Down's syndrome; K-21^{st} chromosome
- ✘ **C.** L-Klinefelter's syndrome; K-Sex chromosome
- ✘ **D.** L-Turner's syndrome; K-Sex chromosome

BYJU'S Study Planner for Board Term I (CBSE Grade 12)

The list of features mentioned in the question are seen in individuals affected with Edwards syndrome.

It is a chromosomal disorder which is caused due to the trisomy of the 18^{th} chromosome.

Hence, L is Edwards syndrome; K is 18^{th}chromosome.

Trisomy is characterised by the presence of three copies of a particular chromosome in an individual instead of two. This disorder arises due to an error during cell division.

Gametes are formed through meiosis (reduction division).
During meiosis, the homologous chromosomes and sister chromatids separate and move to opposite poles during meiosis I and meiosis II respectively. This process is called disjunction. As a result of this, the gametes produced will have a single copy of each chromosome.

But failure of separation of particular homologous chromosomes or sister chromatids (nondisjunction) results in gametes with either both copies of a particular chromosome or with no copies of that particular chromosome.

If one of the gametes fusing to form the zygote has two copies of the 18^{th} chromosome (due to nondisjunction) instead of one, then the resulting zygote will have three copies of the 18^{th} chromosome. This is called trisomy of the 18^{th} chromosome and it results in Edwards syndrome.

Clenched fists with overlapping fingers, dysplastic or malformed ears and back part of the skull is prominent in individuals affected with this disorder.

If one of the gametes fusing to form the zygote has two copies of the 21^{st} chromosome (due to nondisjunction) instead of one, then the resulting zygote will have three copies of the 21^{st} chromosome. This is called trisomy of the 21^{st} chromosome and it results in Down's syndrome.

The affected individuals have a short stature with rounded head, furrowed tongue, wide palm with distinct palm crease and retarded physical, mental and psychomotor development.

If the female gamete (egg) without X chromosome (sex chromosome) fuses with the sperm carrying X chromosome, it results in Turner's syndrome. The affected females are sterile with rudimentary ovaries. The absence of one chromosome is called monosomy. In this case it is one of the X chromosomes which is absent.

Klinefelter's syndrome is a chromosomal disorder characterised by the presence of an extra X chromosome in the human males giving rise to XXY condition. The affected individuals display overall masculine development; however, the feminine characters are also displayed.

BYJU'S Study Planner for Board Term I (CBSE Grade 12)

19. A pure line tall pea plant was grown in nutrient deficient soil which resulted in its stunted growth. After crossing it with a dwarf pea plant, _____.

A. all the offspring were dwarf

B. all the offspring were tall

C. 50% offspring were tall and 50% offspring were dwarf

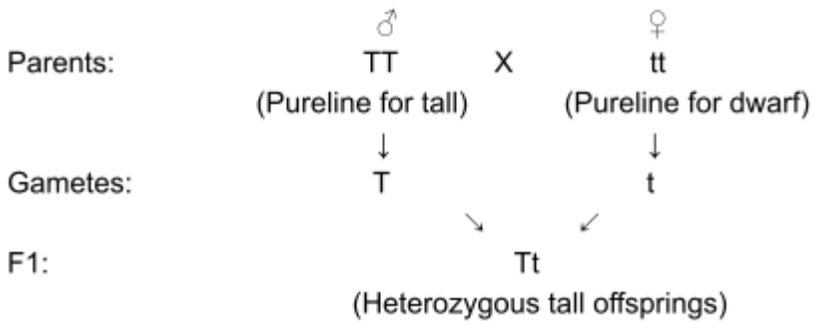
D. 75% offspring were tall and 25% offspring were dwarf

A pure line shows the stable trait inheritance due to continuous self-pollination.

The pea plant which was grown in nutrient deficient soil was pure line for the trait of being tall. Hence, the genotype of the plant was TT (homozygous dominant).

Nutrient deficiency in the soil resulted in the stunted growth of the plant, however, it did not interfere with the genotype of that plant.

When this plant was crossed with a dwarf plant, all the offspring were tall.



20. A woman heterozygous for haemophilia marries a haemophilic man. What will be the ratios of carrier daughters, haemophilic daughters, normal sons and haemophilic sons in F_1 generation?

- **A.** 1: 2: 2:1
- **B.** 2: 1: 1: 2
- **C.** 1: 1: 1: 1
- **D.** 1: 2: 1: 2

As haemophilia is a sex-linked recessive disorder, it gets expressed when genes are altered on both the X chromosomes, allosomes (XX) in females. If out of the two X chromosomes, any one is altered and the other X chromosome is normal, then the females will not have haemophilia, but they could be the carriers and pass the disease to their offsprings.
While in males, as they have only one X chromosome in their allosomes (XY), alteration in that one X chromosome can cause the disease to get expressed.

Thus, the genotype of allosomes of a haemophilic man will be X^hY.
The genotype of allosomes of normal man will be XY.
The genotype of allosomes of a normal woman will be XX.
The genotype of allosomes of a carrier woman will be X^hX.
The genotype of allosomes of a haemophilic woman will be X^hX^h.

According to the question, a woman heterozygous for haemophilia will be a carrier with genotype X^hX. She marries a haemophilic man whose genotype will be X^hY.

Let's find out their F_1 progenies genotypes by Punnett square method.

X^hX X X^hY

Gametes	X^h	Y
X^h	X^hX^h(affected female)	X^hY(affected male)
X	X^hX(carrier female)	XY (normal male)

	Genotype	
Carrier daughter	X^hX	1
Haemophilic daughter	X^hX^h	1
Normal son	XY	1
Haemophilic son	X^hY	1

Hence, the ratio is 1:1:1:1.