38 Heredity and Variation

• **Genetics :**

- The term genetics was first coined by William Bateson in 1906.
- The word genetics is derived from the Greek term gen which means 'to become'.
- "Genetics is the branch of Biology which deals with heredity and variation among related Organisms."

• **Heredity :**

- "Transmission of the characters from parents to offsprings."

• **Variation :**

- "The occurrence of differences among the individuals of same species is known as variation."

• **<u>Historical Background of Heredity :</u>**

• **Babylon and Assyria :** Selective breeding of horses, donkeys and date palm was also done during the ancient civilization of Babylone and Assyria nearly 6000 years ago.

• **Ancient Chinese Writing :** Ancient chinese writing mentions creating better varieties of paddy nearly 5000 years ago.

• **Hippocrates (400 B.C.) :** Hippocrates believed that characteristic are inherited from parents because reproductive material is handed over from all parts of the body of an individual.

• **Gregor Johann Medel :** The science of heredity and Variation, the scientific principle of the science of genetics originated in 1900 with re-discovery of a scientific article published in 1866 by Gregor Johann Medel.

* **Johansen :** Mendel's 'factors', the carriers of heredity information are known as 'genes' a term coined by Johansen in 1909.

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(1) The term genetics was first coined by ..... .

(A) Bateson (B) Mendel

(C) Morgan (D) Correns

(2) In which civilization selective breeding of horses, donkeys and date palm was done?

(A) Babylon (B) Assyria

(C) Harappa (D) A and B Both

(3) Who believed that characteristic are inherited from parents because reproductive material is handed over from all parts of the body of an individual ?

(A) Mendel (B) Bateson

(C) Hippocrates (D) Johansen

(4) Who believed that 'factors' responsible for hereditary information ?

(A) Mendel (B) Johansen

(C) Bateson and Punnet (D) Morgan

(5) Mendel's factors the carriers of heredity information are known as 'genes' a term coined by ..... .

(A) Bateson (B) Johansen

(C) Morgan (D) Tschermak

(6) Mendelism is related with ……

(A) Heredity is living beings. (B) Meiosis during sexual reproduction

(C) Mutation in living organisms (D) Crossing over and Linkage

(7) The first great "geneticist" was ..... .

(A) Engler (B) Mendel (C) Bateson (D) Boveri

(8) Nearly 5000 years ago ancient Chinese writing mentions for creating better varieties of ..... .

(A) Horses (B) Donkeys (C) Paddy (D) Date Palm

Answers : (1-A), (2-D), (3-C), (4-A), (5-B), (6-A), (7-B), (8-C)

- **Gregor Mendel – The Father of Genetics :**

The contribution of Mendel to Genetics is called Mendelism. Mendel is called the father of Genetics.

Christien Johann Mendel was born in 1822. He came to the monastery at Brunn and was appointed as priest in 1848. In 1856, he began to collect and observe the numerous varieties of the garden pea. These varieties differed in seed, pod, flower and a number of other characteristics. He grew each variety in different plots, so that any variation from the listed characteristics could be easily spotted. He carried out experiments for seven years (1856 – 1863) in the monastery gardens. He presented the result of his study of hybridizations together with the generalizations at the Natural History Society of Brunn in 1865. No one at that time read Mendel's research papers. They lay neglected until 1900 when they were discovered almost simultaneously and independently by Karl currens, Hugo de varies and Von Tschermak. He died in 1884. When Mendel's work was recognized and appreciated, he was no more.

Gregor Johann Mendel
(1822 - 1884)

(9) Mendel Presented the results of his study of hybridization together with generalizations at ..... .

(A) British Government in 1865 (B) American Government in 1865

(C) Natural History Society of Brunn in 1865 (D) De. Varies, Correns and Tschermak in 1865

(10) Which scientist had rediscovered Mendel's work ?

(A) De Varies (B) Tschermak (C) Correns (D) All above

(11) Mendel was the native of ..... .

(A) France (B) Austria (C) Sweden (D) Italy

Answers : (9-C), (10-D), (11-B)

- **Mendel's work :**
- Mendel did his work on Garden pea (*Pisum satium L.*)
- It is very easy to cultivate the pea plant in open ground.
- The flowers of pea plants are normally self- fertilized.
- The pea plant shows a number of contrasting characters.
- The hybrid of garden pea are perfectly fertile.

- Cross pollination is not very difficult in pea plant.
- Artificial fertilization was almost Successful.
- It produced large number of OFFSpring.

Speciality of Mendels work :

- Many scientists earlier to the period of Mendel (1856) had attempted Inheritance experiments. How ever, most of them failed to arrive at any specific conclusion or principles to explain the pattern of inheritance.
- During Mendels investigations into inheritance patterns it was for the first time that a statistical analysis and mathematical logic were applied.
- He studied the inheritance of only one character at a time in most of the experiments.
- He maintained statistical records of his results. It helped Mendel to drive numerical ratios of significances.

(12) Mendel did his work on…..

(A) *Pisum sativum* (B) *Drosophila moelanogaster*

(C) *Mirabilis jalapa* (D) *Lathyrus odoratus*

(13) The hybrid of garden Pea are…

(A) Intraspecific sterile (B) Perfectly fertile

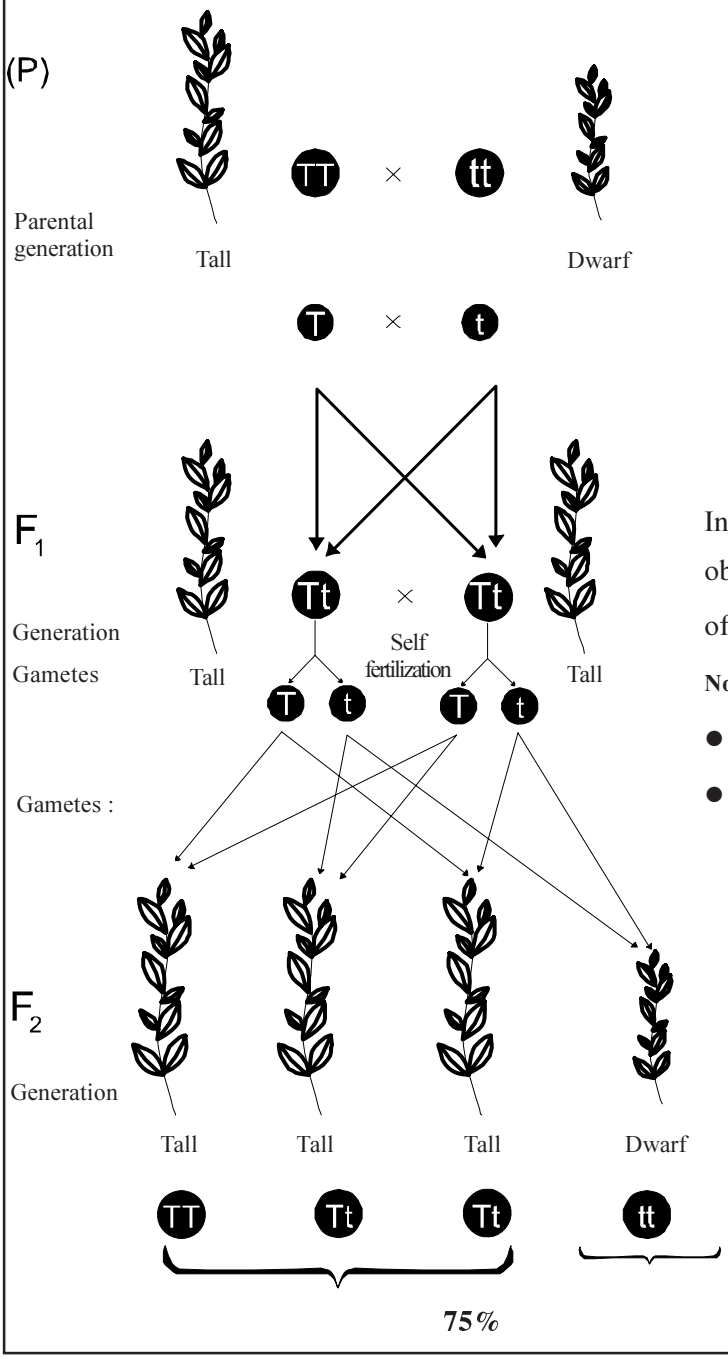
(C) Interspecific sterile (D) Dwarf

Answers : (12-A), (13-B)

- **Monohybrid Cross Experiments or Single Gene Inheritance**
- The experiments Considering the inheritance of any one character are called Monohybridization experiment.
- Mendel selected two pea plants one with a tall plant and other with a dwarf or short plant.
- These plants were considered as parental Plants (P) and were pure breeding.
- Pure means it maintain some characters generation to generation out of two plants any one can be taken either as a male or female.
- This was done by first removing the anther of an immature flower of all plants. This flower was than covered with a small plastic bag when this flower matured, the pistil was dusted with pollen received from the dwarf plant. Seeds were collected from this plant.
- These seeds were sown and a group of plants were raised. These plants represents F_1 generation.
- In Mendel's above referred experiment, all plants in F_1 generation were tall.
- They were as tall as their parents in P generation.
- The F_1 plants were inbreed. The seeds were collected and the next generation F_2 was raised.
- In the F_2 generation two type of plants were found.
- They were tall and dwarf.

- Mendel counted the number of tall and dwarf plants of the 1064 plants of F_2 generation, 787 plants were tall and 277 plants were dwarf, this ratio is approximately 3:1.
- Mendel carried out similar experiments, involving seven different characters. Each time he obtained similar results.
- Mendel's differentiating characters have been variously called 'factors' or 'genes'.
- Bateson Proposed the name 'Alleomorph' or 'Allele' for them.

Experimetns with garden pea for single pair of contrasting characters.



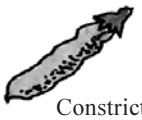
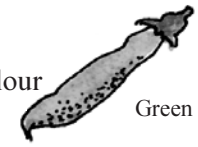
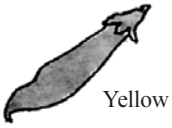
In F_2 generation 3/4 of the total OFFsprings obtained exhibit dominant expression and 1/4 of them exhibit recessive expression.

Note :

- Monohybride experiment phenotypic ratio = 3:1
- Monohybride experiment segnotypic ratio = 1:2:1

• Phenotypic ratio : 3:1 • Genotypic ratio : 1:2:1

Seven Pairs of contrasting traits in pea plant studied by Mendel

	Character	Dominant Trait	Recessive Trait
(1)	Seed Shape	 Round	 Wrinkled
(2)	Seed Colour	 Yellow	 Green
(3)	Flower Colour	 Violet	 White
(4)	Pod Shape	 Full	 Constricted
(5)	Pod Colour	 Green	 Yellow

	Character	Dominant	Recessive
(6)	Flower position	 Axial	 Terminal
(7)	Stem Height	 Tall	 Dwarf

(14) In Mendel's monohybrid experiment how many different characters selected to carry out similar experiments?

(A) 2 (B) 4 (C) 7 (D) 1

(15) Which of the parental plants Mendel has selected for his experiments ?

(A) Heterozygous and pure (B) Homozygous and mixed

(C) Homozygous and pure (D) Heterozygous and mixed

(16) In a Monohybrid cross of Mendel's the different phenotypes available in F_1 generation are …… .

(A) pure, tall (B) mixed, dwarf

(C) heterozygous, tall (D) heterozygous, dwarf

(17) How many different types of plants are formed in F_2 progeny obtained from self-pollination of a F_1 ?

(A) 1 (B) 2 (C) 4 (D) 16

(18) How many different type of plants counted by Mendel in the F_2 generation ?

(A) 1199 tall and 787 dwarf (B) 1064 tall and 787 dwarf

(C) 1064 tall and 277 dwarf (D) 787 tall and 277 dwarf

(19) What is the Phenotype ratio of Mendel's monohybrid cross ?

(A) 2:2 (B) 3:1 (C) 1:1 (D) 1:2:1

(20) What is the Genotype ratio of Mendel's monohybrid cross ?

(A) 1:2:1 (B) 3:1 (C) 1:1 (D) 2:2

(21) The term 'Alleomorph' was coined by ..... .

(A) Morgan (B) Johansen (C) Bateson (D) Tschermak

(22) In a monohybrid cross between two heterozygous individuals, the number of pure homozygous individuals obtained in F_1 generation is ..... .

(A) 2 (B) 4 (C) 6 (D) 8

(23) Two pea plants were subjected cross pollination of the 183 plants produced in the next generation, 94 plants were found to be tall and 89 plants were found to be dwarf. The genotypes of the two parental plants are likely to be ..... .

(A) TT and tt (B) Tt and Tt (C) Tt and tt (D) TT and TT

(24) What will be the genotypes of parental generation ? If all progeny obtained in F_1 were recesive and Dwarf.…

(A) TT and tt (B) tt and tt (C) tt and Tt (D) Tt and Tt

Answers : (14-D), (15-C), (16-C), (17-B), (18-D), (19-B), (20-A), (21-C), (22-A), (23-C), (24-B)

Laws of Inheritance :

– Based on his observation on monohybrid crosses, Mendel proposed two general rules to consolidate his understanding of inheritance in monohybrid crosses. Today these rules are called the principles or laws of inheritance.

– The first law or law of dominance and the second law or law of segregation.

Law of Dominance :

– When two different alleles for a character occur in an organism, only one of the two alleles expresses itself. The other allele remains unexpressed. The allele which is expressed is called dominant gene and the allele which is not expressed is called recessive gene.

– Let us now examine results obtained from self-fertilization among F_1 individuals. AllF_1 plants are tall and have Tt genotype.

– As a male parent, they will produced two types of gamets (T and t gamets).

– As a female parent also they will produce two types of gamets (T and t).

– Two types of gamets can fertilize another two types of gametes in four possible ways (TT, Tt, Tt, tt). Of these, three kinds will be tall (TT, Tt, Tt) and one kind will be dwarf (tt).

– Thus in F_2 generation $\frac{3}{4}$ of the total offsprings obtained exhibit dominant expression and $\frac{1}{4}$ of them exhibit recessive expression. Thus, the ratio of 3:1 is obtained.

Law of Segregation :

– When a pair of contrasting traits are brought together in a hybrid, the two factors (alleles) remain together without mixing.

– When the gametes are formed from each other, only one enters each gamete. Thus any gamete contains only one gene for an expression of a character, this is also called Law of purity of gametes.

– An organism can be homozygous or heterozygous for a character, but its gametes will always be pure for a particular expression of that character.

(25) What is dominat gene ?

(A) Both the genes expresses their expression together.

(B) The allele which is expressed their character.

(C) The allele which is remains unexpressed.

(D) Multiple effect of a single gene.

(26) The allele which is not expressed is called ..... .

(A) Recessive gene (B) Dominant gene

(C) Homozygous gene (D) Co-dominant gene

(27) Both the genes of a character are identical is…..

(A) Homozygous (B) Heterozygous

(C) Dominant (D) Co-dominant

(28) Both the genes of character are unlike is…

(A) Homozygous (B) Incomplete dominant

(C) Heterozygous (D) Co-dominant

(29) The gametes will always be…… for a particular expression of that character.

(A) n, mixed (B) 2n, pure (C) n, pure (D) none of this

(30) The results obtained from self- fertilization amongst F_1 individuals in Mendel's Monohybrid cross is ..... .

(A) $\frac{3}{4}$ Dominant and $\frac{1}{4}$ Recessive (B) $\frac{1}{4}$ Dominant and $\frac{3}{4}$ Recessive

(C) $\frac{1}{4}$ Dominant and $\frac{2}{4}$ Recessive (D) $\frac{9}{16}$ Dominant and $\frac{4}{16}$ Recessive

Answers : (25-B), (26-A), (27-A), (28-C), (29-C), (30-A)

Characters	Explanation	Eample
Characters	Mental and moral qualities distinctive to an individual	Plant height
Expression	Phenomena of representing character	Tall or Dwarf height
Gene	Unit of heredity	T or t
Phenotype	It is the expression of a character	Tall or Dwarf plant
Genotype	Genotype is the gene complement of an organism	TT or Tt or tt
Homozygous	An individual with two indentical alleles	TT or tt
Heterozygous	An individual with two dissimilar alleles	Tt
Dominant factor	It express itself even in the presence of recessive allele.	T
Recessive factor	Recessive allele fails to express it effect in presence of dominant allele	t

* **Test Cross :**

– A cross arranged for deciding whether an organism is homozygous or Heterozygous is called test cross.

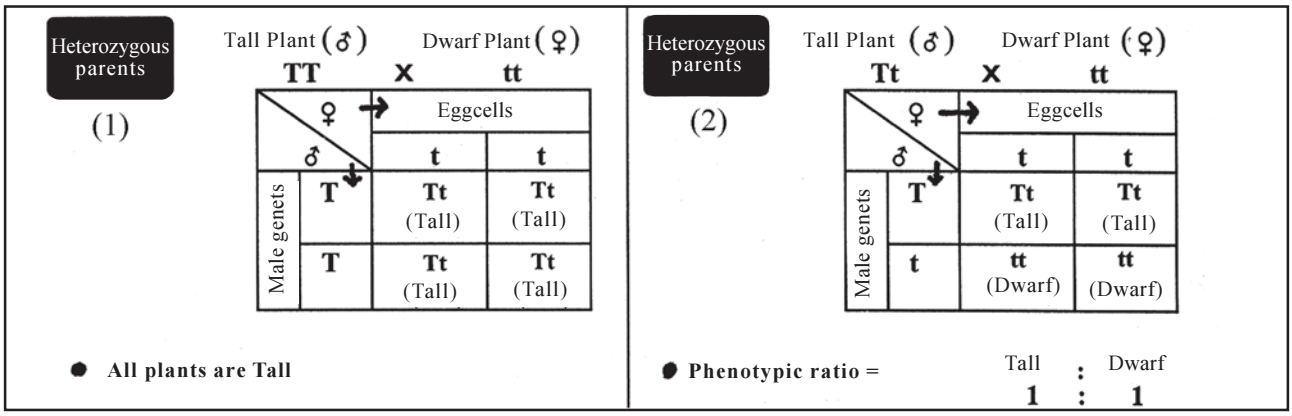
– Selected cross breed of pea may be homozygous tall (TT) or heterozygous tall (Tt). The genotype of both (TT and Tt) are different but phenotype are same.

– If we cross a tall plant with a dwarf plant, two outcomes are possible. This will depend on the genotype of tall plant.

– If homozygous tall (TT) is cross with dwarf plant (tt) all offspring will be tall.

– If it is heterozygous tall (Tt) 50% will be tall and 50% will be dwarf)

– Thus, through such a cross, genotype of the plant can be determined. Hence, it is called test cross. The ratio obtained is 1: 1.



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(31) Which option is true for test – cross?

(A) Tt ×Tt (B) TT × TT (C) Tt × tt (D) tt × tt

(32) A cross, arranged for deciding whether an organism is homozygous or Heterozygous is ..... .

(A) Epistasis (B) Test-cross (C) Back cross (D) Monohybrid-cross

(33) The phenotype and Genotypes of test-cross is ..... .

(A) 3:1 and 1:1 (B) 1:1 and 3:1 (C) 1:1 and 1:1 (D) 9:3 and 3:1

(34) If Homozygous recessive parent cross with homozygous dominant parent. Then what will be the result ?

(A) 100% heterozygous dominant progeny

(B) 50% dominant and 50% recessive progeny

(C) 70% dominant and 25% recessive progeny

(D) 70% dominant and 30% recessive progeny

(35) Heterozygote tall plant (Tt) is crossed with homozygous dwarf (tt) plant. Then what will be the result ?

(A) All progeny will be (Tt) tall

(B) 50% TT and 50% tt progeny

(C) 70% TT and 30% tt progeny

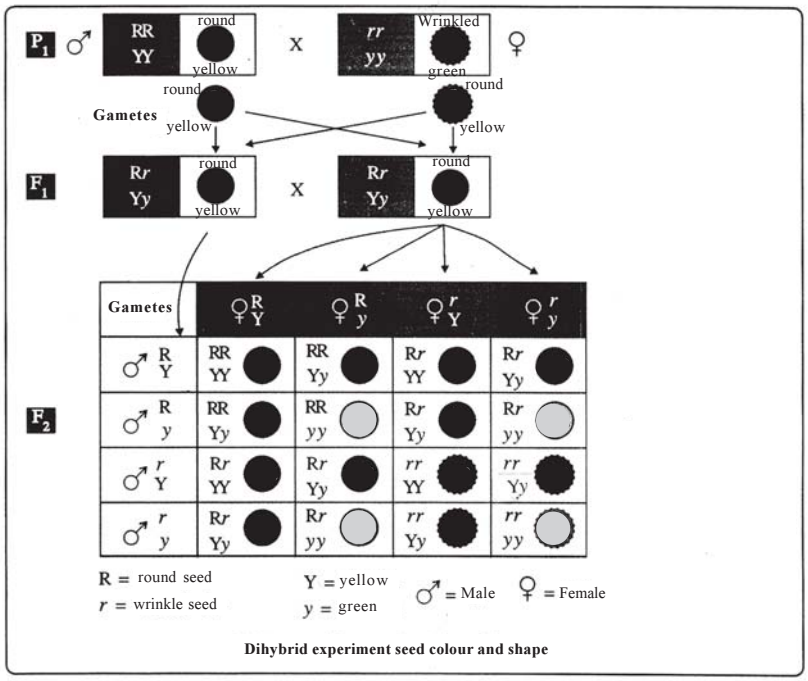
(D) 75% Tt and 25% tt progeny

Answers : (31-C), (32-B), (33-C), (34-A), (35-B)

Inheritance of two Genes/Dihybrid Experiment :

- The crossing of two plants differing in two characters is called dihybrid experiment.
- Mendel arranged experiments to follow simulataneous inheritance of two characters in pea plant e.g. shape of seed and colour of seed.
- Mendel selected pure- breeding yellow, round seed producing plant and another pure breeding green, wrinkle seed producing plant.
- These two plants were treated as parents and were crossed.
- Here, the gene for round shape of seeds 'R' is dominant over the gene for wrinkled shape of seed 'r'.
- Gene for yellow colour of seed 'Y is dominant over the gene for green colour seed 'y'.
- In his experiment, the F_1 generation plants produced only yellow round seed.
- Results in F_2 offsprings are as follow.

Round yellow seeded plant	Wrinkled yellow seeded plant	Round green seeded plant	Wrinkle green seeded plant
9/16	3/16	3/16	1/16



Dihybrid experiment seed colour and shape

R = smooth seed Y= Yellow colour

R = Rough seed y = Green colour

Note : Phenotypic ratio of Dihybrid Experiment } 9:3 : 3:1

Genotypic ratio of Dihybrid Experiment } 1:2:2:4:4:1:2:1:2:1

Law of Independent Assortment : (x × y = xy)

- The segregation of genes controlling one character is independent of the segregation of genes controlling another character. This law is based on dihybrid experiment.
- During gametes formation of a dihybrid cross, the factors (genes) for yellow colour assort out independently of the factors for round shape.

- The gene Y may combine with the dominant gene R or the recessive gene r of the other character and enter a gamete.
- In the same way the gene y may combine with the dominant gene R or the recessive gene r and enter a gamete.

So, the F_1 dihybrid plants produce four type of gametes and they are YR, Yr, yR and yr.

Hence, [x × y = xy]

Shape	Round	:	Wrinkled				
(X)	3	:	1				
							
Colour	Yellow	:	Green				
(Y)	3	:	1				
	9	:	3	:	3	:	1
	Round and yellow seeded plant		Wrinkled yellow seeded plant		Round green seeded plant		Wrinkled green seeded plant

This law also has only limited expression. It is true only in those case where the two pairs of genes, independently controlling two different characters are located on two different pairs of hamologous chromosomes. Gene on the same pairs of chromosomes are not assorted.

(36) How many different kind of phenotypic form will be obtain if we arrange Mendel's dihybrid experiment result in Punnett 16 square boxes ?
(A) 8 (B) 4 (C) 2 (D) 16

(37) What was different genotypic form of four different kinds of phenotypic plants obtained in F_2 generation of Mendel's dihybrid experiment?
(A) 16 (B) 4 (C) 8 (D) 9

(38) How many Genotypes of RrYy in F_2 generation of dihybrid experiment ?
(A) 3 (B) 2 (C) 4 (D) 9

(39) How many Genotypes of rryy in F_2 generation of dihybrid experiment ?
(A) 1 (B) 4 (C) 2 (D) 3

(40) What type of gametes will form by genotype RrYy ?
(A) RY, Ry, rY, ry (B) RY, Ry, ry, ry (C) Ry, Ry, ry, ry (D) Rr, RR, Yy, YY

(41) How many different kinds of gametes will be produced by a plant having the Genotype AABbCC ?
(A) 9 (B) 2 (C) 3 (D) 4

(42) How many different (Re combinant) progeny obtained at the end of dihybrid experiment ?
(A) 4 (B) 2 (C) 9 (D) 16

(43) In dihybrid cross, the factors for yellow colour assort out independently of the factors for ..... .
(A) Green colour (B) Round shape (C) Wrinkle shape (D) Long shape

(44) What is the mathematical formula for independent Assortment ?
(A) x + y = w + z (B) $(a + b)^2$ (C) x × y = xy (D) $(a + b + c)^2$

Answers : (36-B), (37-D), (38-C), (39-A), (40-A), (41-B), (42-B), (43-B), (44-C))

Evaluation of Mendel's work :

– All conclusions and deductions by Mendel have not been found true in all cases.

– His belief that of two alleles of a gene, one is dominant and the other is recessive is not true in all cases.

– Many exceptions are found where both genes express their effects jointly.

– It is also not true that there are only two alleles of a gene.

– It is also not true that one character is controlled by one pair of genes.

(45) What was Mendel's belief for two alleles of a gene ?

(A) dominant, dominant (B) dominant, co- dominant

(C) dominant, incomplete Dominant (D) dominant, recessive

(46) According to Mendel's belief, How many gene require for controlling one character ?

(A) 2 pairs (B) 4 pairs (C) 1 pair (D) One

(47) One character is controlled by one pair of genes. This statement is incorrect for ..... .

(A) Co-dominance (B) Polygenic Inheritance

(C) Sex linked inheritance (D) Incomplete dominance

Answers : (45-D), (46-C), (47-B)

Incomplete Dominance : [1 : 2 : 1]

– Incomplete Dominance can be studied though experiments on Mirabilis Jalapa plant. Three colours occur in the flowers of this plant: red, white and pink.

– When homozygous red flowered and homozygous white flowered plants are crossed, all offsprings in F_1 generation are pink flowered.

– When these F_1 generation are self- fertilized in F_2 generation. Three kinds of plants are obtained. 25% plants are red flowered, 25% are white flowered and 50% are pink flowered plants.

– If we represent gene for red colour by 'R' and gene for white colour by 'W' the details of experiment results can be displayed as under :

– Homozygous red flowred plants have both genes of 'R' type. Their genotype is RR.

– All gametes which they produce will contain gene 'R'.

– Homozygous white flowered plants have both genes of 'W' type. Their genotype is WW. All gametes produced by them will contain gene 'W'.

– F_1 plants formed through their cross will contain one 'R' gene and one 'W' gene. Their genotype is RW. All plants will produce pink coloured flowers.

– If 'R' gene were dominant over 'W' gene, the plants should have been red flowered.

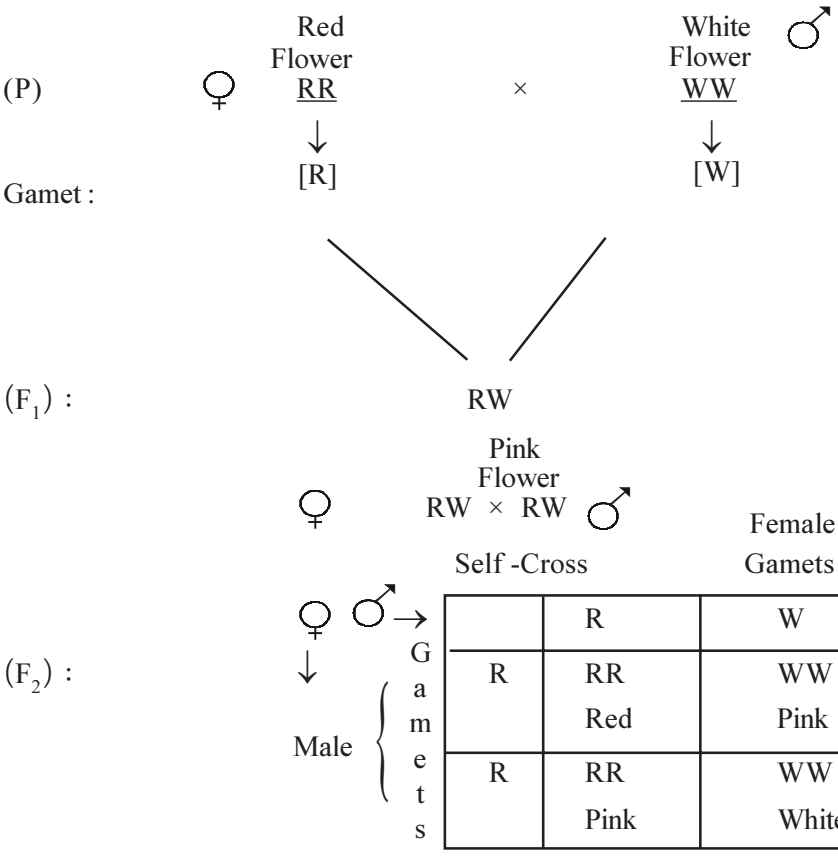
– If 'W' gene were dominant over 'R' gene the plants should have been white flowered. However, all plants are obtained pink flowered.

– This indicates that a mixed effect of both genes is observed. No allele is dominant over the other.

– F_2 plants produced by self cross of F_1 plants yields 1 red flowered : 2 pink flowered : 1 white flowered ratio. It means RR produces red colour flowers, WW produces white flowers and RW produces pink flowers.

– Incomplete dominance (1:2:1).

– The phenotypic and Genotypic ratio of incomplete Dominance is 1:2:1.



The phonotypic and Genotypic ratio of Incomplete Dominance is 1:2:1.

(48) Incomplete dominance can be studied through experiments on ..... .

(A) Sweet pea (B) Mirabilis (C) Drosophilla (D) E.Coli

(49) What was Phenotypic and genotypic ratio of incomplete dominance in F_2?

(A) 3:1 and 1:2:1 (B) 1:2:1 and 1:2:1

(C) 3:1 and 3:1 (D) 1:2:2 and 1:1

(50) When homozygous red flowered and homozygous white flowered are crossed all offsprings in F_1 generation are ..... .

(A) Pink (B) White (C) Red (D) All of above

(51) In Mirabilis a plant with RW crossed with RW then the expected percentage value of Red, Pink and White is ..... .

(A) 25%, 50%, 25% (B) 25%, 25%, 50%

(C) 10%, 20%, 70% (D) 50%, 25%, 25%

(52) In Mirabilis a hybrid for pink (RW) flower is crossed with white flower (WW) the expected phenotypic and genotypic ratio is ..... .

(A) Phenotype : Red, White, Genotype : RR, WW

(B) Phenotype : Pink, Pink, Genotype : RW, RW

(C) Phenotype : Pink, White, Genotype : RW, WW

(D) Phenotype : White, White, Genotype : WW, WW

Answers : (48-B), (49-B), (50-A), (51-A), (52-C)

Co-dominance :

– In co-dominance both dominant and recessive alleles lack their dominant and recessive relationships and both the genes expresses their expression independently.

– In these cases the dominant character is not mixed with recessive character.

– In short horn cattle, there are two pure varieties, both red and white for coat colour. A cross between the two varieties (Red RR × white rr) leads to the formation of a new variety (Rr) with reddish grey colour coat. Such contains both red hair and white hair.

(P) Red White

♂ RR × r r ♀

↓ ↓

R r

$[F_1]$: Rr

Reddish grey

♂ Rr × Rr ♀

Self- cross

$[F_2]$

♂ → / ↓ ♀	R	r
R	RR Red coat	kr Reddish grey coat
r	Rr Reddish coat grey	rr white coat

$[F_2]$ RR (Red coat) = $\frac{1}{4}$ [25%]

Rr(Reddish grey coat) = $\frac{1}{2}$ [50%]

rr(White coat) = $\frac{1}{4}$ [25%]

The phenotype and Genotype of co-dominance is 1:2:1.

(53) In which case dominant and recessive alleles lack their dominant and recessive relationships ?

(A) Incomplete dominance (B) Polygenic inheritance

(C) Co-dominance (D) Dominance

(54) When Reddish grey (Rr) short horn cattle crossed with white (rr) short horn cattle then what will be result?

(A) Reddish grey : white (1 : 1) (B) Reddish grey : white (3 : 1)

(C) Reddish grey : Red (1 : 1) (D) White : Red (3 : 1)

(55) What is genotypic ratio of co-dominance ?

(A) 3 : 1 (B) 1 : 2 : 2 (C) 1 : 2 : 1 (D) 1 : 1

(56) Short horn cattle variety (Rr) having …….. colour coat.

(A) Red (B) Black (C) Red, White (D) White, Red, Black

(57) What is genotype of Reddish grey variety ?

(A) RR (B) rr (C) Br (D) Rr

Answers : 53 (C), 54 (A), 55 (C), 56 (C), 57 (D)

Polygenic Inheritance :

- Two or more independent pairs of factors or genes which affect the same characteristic but in an additive manner are known as multiple genes or cumulative genes.
- These affect the degree of development of a character quantitatively.
- Here the effect is dependent upon the number of doses of genes present in the individual.
- According to Dervenport, skin colour in man is determined by multiple genes.
- Human skin colour is generally controlled by three separate genes.
- Each gene contributes to a unit of darkness due to incomplete dominance.
- These three genes can be designated as A, B and C, and thus the skin shade has to vary from a very dark in a AABBCC individual to very light in aabbcc individual.

---

(58) Which gene effect is depend upon the number of doses of genes present in the individual?

(A) Cumulative gene (B) Co-dominance gene

(C) Incomplete dominance gene (D) Multiple alleles gene

(59) Human skin colour gene contributes to a unit of darkness due to ..... .

(A) Complete dominance (B) Incomplete dominance

(C) Co-dominance (D) Multiple allele

(60) How many different skin colours available in human?

(A) 16 (B) 4 (C) 30 (D) 64

(61) That is a genotype of very dark skin : ..... .

(A) AA BB CC (B) aa bb cc (C) AA bb cc (D) aa BB cc

(62) That is a genotype of very light skin ..... .

(A) AA bb CC (B) AA BB cc (C) AA Bb cc (D) aa bb cc

Answers : (58-A), (59-B), (60-D), (61-A), (62-D)

Multiple alleles :

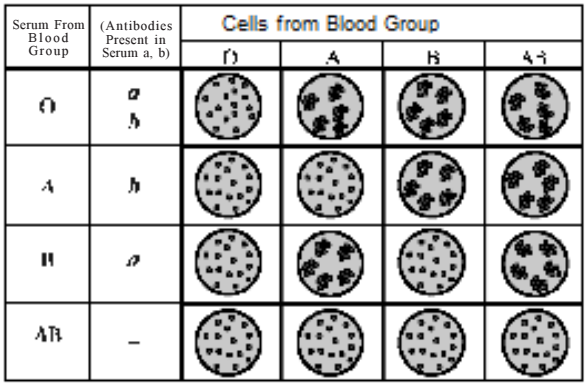
– As per Mendel, every character is controlled by one pair of alleles. There are only two optional forms, one of which is dominant and the other one is recessive.

– Cases are observed where there are more than two optional forms of a gene for one character. Thus when three or more alleles are responsible for a single characteristic, they known as multiple alleles.

- All these alleles occupy the same specific locus on the chromosomes.
- In a diploid cell, only two alleles can be present at a time on the homologous chromosomes.
- A wellknown example is the ABO blood type in humans. Here the inheritance is based on three alleles i.e. I^A , I^B, i
- I^A and I^B are dominant and i is recessive.
- The gene for producing antigen is I and its allele for non-producing antigen is i.
- I^A is responsible for producing antigen - A.
- I^B is responsible for producing antigen - B.
- These two alleles are codominant which means that both can express themselves in presence of each other.
- Thus three alternatives are possible.
- Various persons in different blood groups can have following genotypes.

Blood group	Possible Genotype
A	I^AI^A or I^Ai^o
B	I^AI^B or I^Bi^o
AB	I^AI^B
O	i *i*

- If blood group of parents are known, probable blood groups in their children can be known. Conversely, if blood group of a child is known, the blood group of its parents can be known.
- Landsteiner describe human blood groups. Four blood groups occur. These are A, B, AB and O.
- Two aspects are to be considered in deciding these blood groups- which kind of antigen occurs on RBCs, and which kind of antibody occurs in blood plasma in a person.
- **A blood group :** Person belonging to A blood group has A antigen on RBCs and b antibody in blood plasma.
- **B blood group :** Person belonging to B blood group has B antigen on RBCs and a antibody in blood plasma.
- **AB blood group :** Person belonging to AB blood group has A antigen and B antigen in other RBCs where as blood plasma does not have a or b antibodies.
- **O blood group :** Person belonging to O blood group does not have any antigen in RBCs. Its blood plasma contain 'a' as well as 'b' antibodies.
- An antigen is indicated by capital letter and the antibody effective against it is indicated by the same letter in small script.
- Antibody reacts against the antigen and causes agglutination of RBCs which possess that antigen. Thus clotting takes place.
- **Serum test :** Compability of blood groups is checked for blood transfusion. Serum test is carried out to determine the blood group of a person.



Human Blood Groups - Serum Test

- Following table shows which person can accept blood from whom and can donate blood to whom.

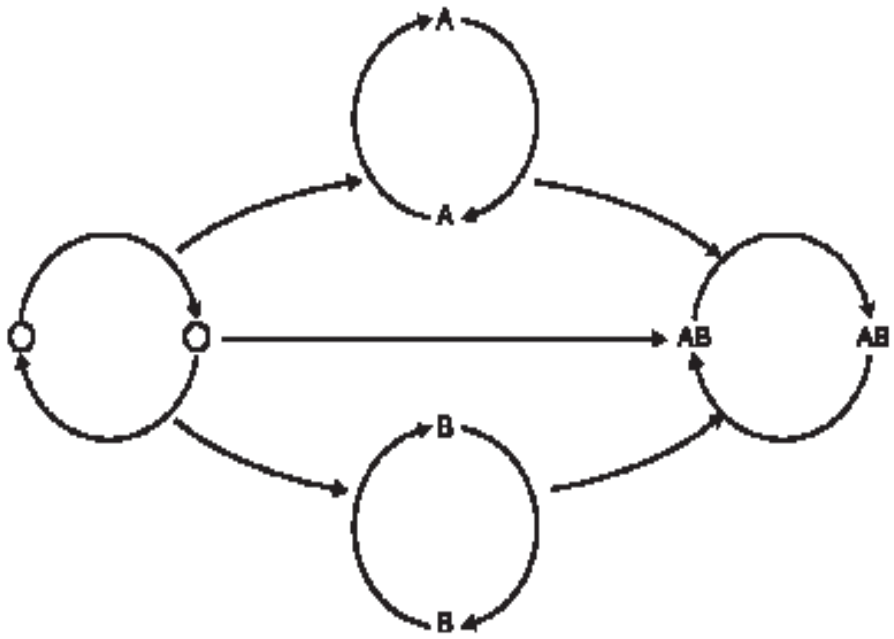
Blood Group	Antigen on RBC	Antibody in plasma	To whom can he/she Donate	From whom he/she receive
A	A	b	A, AB	A,O
B	B	a	B, AB	B ,O
AB	A , B	--	AB	A, B, O , AB (universal recipient)
O	--	a, b	A ,B,AB,O (universal donor)	O

- The following table indicates the effects that would be produced during transfusing blood between antigen and antibody of different types of donor and recipient.

Blood group based on corpuscles of Donor	Blood Group of Receipient			
	A	B	AB	O
A	-	+	-	+
B	+	-	-	+
AB	+	+	-	+
O	-	-	-	-

+ Agglutination takes place.

- Agglutination does not take place.



Simple explanation

Exclusion of paternity based on ABO Blood Groups.

Child blood group	Mother blood group	Father must be of blood group	Father can not be of blood group
A	O	A or AB	O or B
A	A	A ,B, AB, or O	-
A	B	A or AB	O or B
B	B	A , B, AB, or O	-
B	A	B or AB	O or A
B	O	B or AB	O or A
AB	A	B or AB	O or A
AB	B	A or AB	O or B
AB	AB	A, B or AB	O
O	O	O, A or B	AB
O	A	O, A or B	AB
O	B	O, A or B	AB

* **Blood groups of parents and probable blood groups of child :**

No	Blood group of parents	Probable blood group of child
1	O × O	O
2	O × A	O, A
3	O × B	O, B
4	O × AB	A, B
5	A × A	A, O
6	A × B	A ,B, AB ,O
7	A × AB	A, B, AB
8	B × B	B ,O
9	B × AB	A ,B ,AB
10	AB × AB	A, B, AB

(63) Inheritance of blood type in humans is ..... .

(A) multiple Alleles (B) co-dominance

(C) polygenic inheritance (D) incomplete dominance

(64) Which gene produce antigen for blood group ?

(A) I (B) i

(C) A (D) B

(65) Which genes are co-dominance for producing antigen?

(A) I^AI^A or I^Ai (B) I^BI^B or I^Bi (C) I^AI^B (D) i i

(66) Who describe human blood groups?

(A) Morgan (B) Landsteiner (C) Dervenport (D) Mendel

(67) Which condition decided blood group in human beings?

(A) Antigen types on RBCs (B) Antibody in blood plasma

(C) Antigen types in blood plasma (D) A and B both

(68) Which blood group having antibody 'a' as well as antibody 'b'?

(A) A (B) AB (C) B (D) O

(69) If mother and father both having 'O' blood group, then what will be probable blood group of child?

(A) O (B) O, A (C) O, B (D) A, B

(70) If mother having O blood group and father having A blood group then what will be probable blood group of child ?

(A) A, B, AB (B) O, A (C) B, O (D) AB, O

(71) If mother having O blood group and father having B blood group then what will be probable blood group of child ?

(A) A, B, O (B) A, O (C) O, B (D) AB, AB

(72) What will be a probable blood group of parents having child has sequencely A and O blood group?

(A) A, A (B) A, B (C) B, AB (D) A, AB

(73) What will be a probable blood group of parents having children has sequencely A, B, AB and O blood groups ?

(A) A,B (B) A,AB (C) B ,B (D) AB, AB

(74) What will be a propable blood group of couple having three children blood group sequencely are A, B and AB ?

(A) A, B (B) B ,B (C) A ,AB (D) AB, O

(75) A couple having two sons out of one son having B blood group and another having O blood group, then what is probable blood group of couple?

(A) AB, O (B) B ,B (C) AB, AB (D) A, B

(76) A woman with blood group O has a child with blood group O. She claims that a man with blood group 'A' is the father of her child. What would be the genotype of the father, if her claim is right?

(A) I^oI^o (B) I^AI^B (C) I^Ai (D) I^AI^A

(77) For a child having blood group B, if father has blood group A, what may be the blood group of the mother?

(A) B or AB (B) O or A (C) A or B (D) AB or A

(78) A person with unknown blood group under ABO system, has suffered much blood loss in an accident and needs immediate blood transfusion. His one friend who has a valid certificate of his own blood type, offers for blood donation without delay. What would have been the type of blood group of the donor friend?

(A) Type A (B) Type B (C) Type AB (D) Type O

Answers : (63-A), (64-A), (65-C), (66-B), (67-D), (68-D), (69-A), (70-B), (71-C), (72-A), (73-A), (74-C), (75- B), (76-C), (77-A), (78-D)

Pleiotropism :

– It is the effect of a single gene upon two or more characters which are not related.

– Let us see some of their examples in Drosophila, the recessive gene for Vestigial wings produces

vestigial wings in homozygous condition. In addition to wing length it is also responsible for the production of ..... .

(i) the tiny wing like balancer behind the wing

(ii) certain bristles

(iii) the structure of the spermatheca and

(iv) low number of eggs

– This phenomenon of multiple effect of a single gene is called pleiotropism.

– Genes which have multiple effects are called pleiotropic genes.

– The ability of a gene to have many effects is known as pleotropism.

– Its important example is sickle cell anemia.

(79) The effect of a single gene upon two or more characters is ..... .

(A) pleiotropism (B) multiple alleles

(C) polygenic inheritance (D) incomplete dominance

(80) In Drosophila, the recessive gene for vestigial wings produces vestigial wings in homozygous condition. In addition to wing length it is also responsible for ..... .

(A) low number of eggs (B) certain bristles

(C) the structure of spermatheca (D) all of above

(81) Pleiotropic genes mean ..... .

(A) gene which is most dominant (B) gene which have multiple effects

(C) gene responsible for polygenic inheritance (D) gene which have incomplete dominance

(82) The example of pleiotropism is ..... .

(A) red eyes of drosophila (B) sickle cell-anemia

(C) klinefelter's syndrome (D) phenyl ketonuria (PKU)

Answers : (79-A), (80-D), (81-B), (82-B)

Chromosomal basis of inheritance :

– Mendel published his work on inheritance of characters in 1866 but for following reasons, it remained unrecognized till 1900.

– Communication was not easy.

– His thoughts on factors that controlled the expression of traits were not accepted by his contemporaries.

– Mendel's approach of using statistical analysis is to explain biological phenomena was totally new in those days.

– He could not provide any physical proof for the location of these factors (now genes) in the cell was unknown to him.

– In those days neither the role of nucleus in reproduction nor the existence of chromosomes in the nucleus was known.

– **De varies, Correns and Van Tschermak :**

In 1900, De varies, Correns and Van Tschermak independently rediscovered Mendel's results on the inheritance of characters. Thus Mendel's work was rediscovered. Also, by this time, due to advancements of microscopy that were taking place, scientists were able to carefully observe meiotic cell division.

– **Sutton and Boveri :**

In 1902 by Sutton and Boveri they put forward the theory that chromosomes from the physical basis of

factors or genes which determine the heredity of living organisms. This is known as the "chromosome theory of heredity".

– It was also established that chromosomes were separated during formation of Gametes. So haploid gametes are formed through meiosis. When ovum(n) fuses with a sperm (n) during fertilization the diploid status is reestablished in the zygote (2n).

– **Sutton :**

– Sutton demonstrated similarities in the behaviour of chromosomes located with the nucleus and the behaviours of Mendel's hypothetical 'factors'. For example genes (= Factors) occur in pairs. Chromosomes also occur in pairs.

– Each gamete possesses any one gene from a pair each gamete possesses any one chromosome from a pair of homologous chromosomes.

– Mendel's law of independent assortment can also be explained on chromosomal basis.

– Organisms of each species have a fixed number of chromosomes. But Mendel's hypothetical units are not chromosomes. They are genes.

– Genes are located on chromosomes in various numbers of each chromosome.

– Chromosomes as well as genes occur in pairs.

– The two alleles of a gene pair are located at homologous sites on homologous chromosomes.

– Sutton united the knowledge of chromosomal segregation with Mendelian principles and called it the chromosomal theory of inheritance.

– **Thomas Hunt Morgan :**

– He worked on fruit fly, *Drosophila melanogaster*. He suggested that genes are arranged in a linear fashion on chromosomes.

– All such aspects establish that there is a chromosomal basis for laws of inheritance proposed by Mendel.

---

(83) Which is correct reason for unrecognized Mendel work on inheritance of characters?

(A) Communication was not easy.

(B) No physical proof for the existence of the factors.

(C) Mendel's approach of using statistical analysis to explain biological phenomena was totally new in those days.

(D) All of above.

(84) The scientists who rediscovered Mendel's results on the inheritance of characters are ..... .

(A) Varies, Correns, Tschermak (B) Bateson and Punnet

(C) Sutton and Boveri (D) Thomas Hunt Morgan and Sutton

(85) Which scientist has proposed the theory of "chromosome theory of heredity"?

(A) Boveri, Tschermak (B) Bateson, Punnet

(C) Sutton, Boveri (D) Thomas Hunt Morgan

(86) Who demonstrated similarities in the behaviour of chromosomes located with the nucleus and the behaviour of Mendel's hypothetical 'factors'?

(A) Boveri (B) Sutton (C) Tschermak (D) Morgan

(87) Mendel's laws of inheritance was based on ..... .

(A) Gene (B) DNA (C) RNA (D) Chromosomes

(88) Which statement given by Thomas Hunt Morgan?

(A) Similarities in the behaviour of chromosomes located with the nucleus and the behaviour of Mendel's hypothetical factors.

(B) Genes are arranged in a linear fashion.

(C) The free assortment behaviours of chromosomes depend on linkage and crossing over.

(D) Gamete contains only one gene for an expression of a character.

Answers : (83-D), (84-A), (85-C), (86-B), (87-D), (88-B)

* **Linkage and Recombination :**

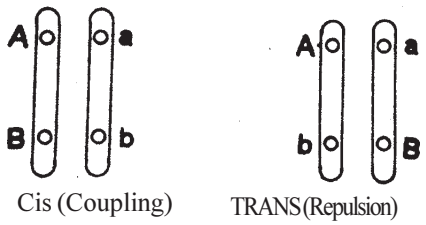
- However in 1903, Sutton and later T.H. Morgan in 1911 found that genes do not assort freely as envisaged by Mendel.
- Basteson and Punnet in their study in the same pea plant found that when they crossed red flowers and spherical pollen plant with a plant having purple flower and cylindrical pollen the test cross yielded a ratio of 7 : 1 : 1 : 7 instead of the expected 1 : 1 :1 :1 ratio.
- Thus we have noted that Mendel's law of independent assortment is not true in all cases.
- If the two pairs of genes controlling two different characters are located in the same pair of homologous chromosomes they can not be segregated separately. Such gene are called linked genes and their inheritance is called linkage.

* **Linkage in Sweet pea plant :**

- Experiments indicative of linkage were first performed by Bateson and Punnet on sweet pea plant (*Lathyrus odoratus L.*).
- In those plants purple flower colour is dominant over red flower colour. The respective genes are R and r.
- Long shape of pollen grains is dominant over round shape of pollen. The respective genes are L and *l*. They used the same method as Mendel followed.
- In F_1 generation, all plants had purple flowers and long pollen. This result was as per expectation. But the expected F_2 result, if assortment of these characters was independent, was as under :

Result	**Purple flower Long pollen**	**Purple flower round pollen**	**Red flower Long pollen**	**red flower round pollen**
Expected	9 :	3 :	3 :	1
Actual	11 :	1 :	1 :	3

Cis and Trans arrangement of genes :



- **Cis arrangement :**

Linkage has coupling phase and repulsion phase. In coupling phase both the linked genes have their dominant alleles in one chromosome and recessive alleles in other chromosomes. The heterozygotes with such constitution is called cis heterozygote. Cis arrangement is an original arrangement which form two types of gametes as (AB) and (ab)

- **Trans arrangement :**

In repulsion phase the normal alleles as well as mutant alleles lie in opposite chromosomes of the homologous pair, such heterozygote is called trans heterozygote. It is not original arrangement, caused due to crossing over, which form two type of gametes (Ab) and (aB).

---

(89) When AaBb parent and aabb parent are crossed. What will be the genotypes of offsprings?

(A) AaBb, Aabb, aaBb, aabb (B) AbBb, Aabb, aaAB, ABab

(C) AABB, BBaa, AbAB, ABaa (D) AABB, BBaa, abAB, aabb

(90) When red flowers and spherical pollen plant crossed with a plant having purple flower and cylindrical pollen, the test cross yielded a ratio of ..... .

(A) 1:1:1:1 (B) 9:3:3:1 (C) 7:1:1:7 (D) 11:1:1:3

(91) If the two pairs of genes controlling two different characters are located in the same pair of homologous chromosomes, they can not be segregated separately, such gene are called ..... .

(A) Homologous genes (B) Dominant genes

(C) Recessive genes (D) Linked genes

(92) When ppL*l* plant crossed with ppL*l* Bateson found the ratio of progeny as ..... .

(A) 1:7:7:1 (B) 1:1:1:1 (C) 9:3:3:1 (D) 11:1:1:3

(93) The percentage of recombination progeny obtained in F_2 generation compairision to expected progeny because of linkage is ..... .

(A) 12.5 % (B) 30 % (C) 87.5 % (D) 70 %

(94) The Actual results of purple flower long pollen in F_2 generation is ..... .

(A) 3 (B) 11 (C) 9 (D) 1

(95) This is true for *Lathyrus odoratus L*.

(A) Complementry genes (B) Mutant genes

(C) Recombination genes (D) Linked genes

(96) Coupling and repulsion associated with ..... .

(A) crossing over node (B) linkage

(C) assortment (D) mutation

(97) Couple gene is separated by which event ? ..... .

(A) pleiotropism (B) epistasis

(C) mutation (D) crossing over

(98) Linkage reduces possibility of ..... .

(A) recombinant progeny (B) dominant gene

(C) recessive gene (D) B and C both

(99) The condition in which both linked genes have their dominant alleles in one chromosome and recessive alleles in other chromosomes is ..... .

(A) TRANS (B) PERI CENTRIC (C) CIS (D) PARA CENTRIC

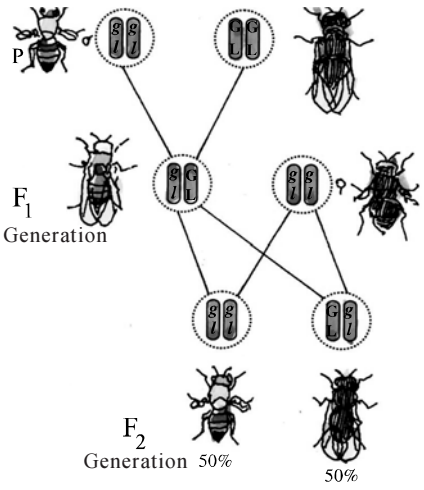
Answers : (89-A), (90-C), (91-D), (92-D), (93-A), (94-B), (95-D), (96-B), (97-D), (98-A), (99-C)

* **Morgan use Drosophila as the experimental material :**

- Drosophila can be easily grown in laboratory.
- Its lifespan is also of about fifteen days.
- It produces a large number of offsprings.
- More over, male and female flies are separate.
- Thus, chances of self-fertilization are not there.

* Linkage in Drosophila :

- Morgan had collected data regarding various characters through monohybrid experiments.
- Body colour grey is dominant over black body colour.
- Long wing is dominant over vestigial wing.
- G represents gene for grey body colour. Its allele g is recessive for black colour.
- Similarly, gene L is for long wing and its allele l for vestigial wings is recessive.
- He took flies with grey body colour and long wings as one parent and flies with black body colour and vestigial wings as another parent.
- All F_1 generation flies were grey and long winged. This was expected result.
- Now, Morgan test – crossed F_1 flies with a parent which is recessive for both the characters of the flies he had obtained, 50% were grey and long winged and 50% were black and vestigial winged.
- No flies were obtained with new combinations of characters. Such results represent complete linkage.
- This is because no crossing over occurs in male drosophila.



Drosophila : Complete linkage

Crossing over :

- In the second experiment like the one above, when he used F_1 female flies to cross with double recessive male flies, he obtained the following results :

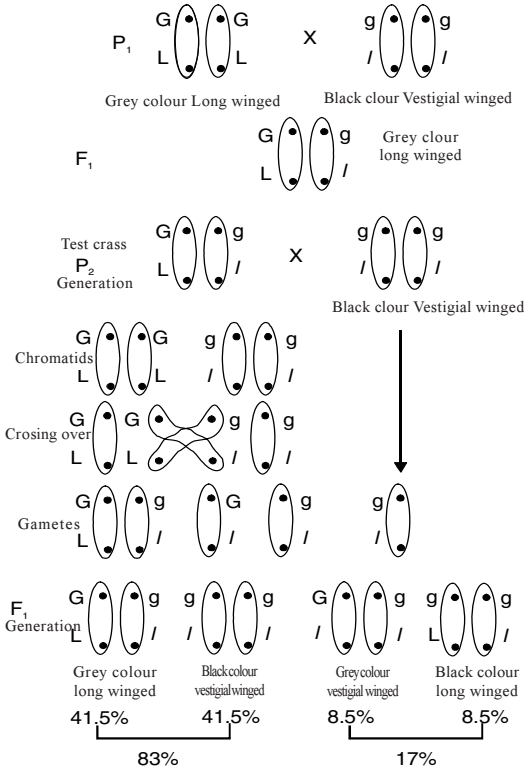
Parental combinations 83% → Grey long winged = 41.5 %

Parental combinations 83% → Black vestigial winged = 41.5 %

Recombinations 17% → Grey vestigialwinged = 8.5%

Recombinations 17% → Black long winged = 8.5 %

- Morgan explained that this unusual ratio is because of the presence of the genes for black and vestigial on the same chromosomes.
- Here the genes are linked together. The two pairs of gene Gg and Ll are not assorted independently.
- Morgan explained crossing over as given in the following diagram :
- Morgan attributed this due to the physical association of genes on a chromosome. The term recombinations is used to describe the generation of non-parental gene combination.



(100) The result of test-crossed between GgLl (F_1 male flies) with a parent which is recessive for both the characters (ggll) are ..... .
(A) Grey colour long winged (B) Black colour vestigial winged
(C) Gery colour vestigial winged (D) A and B both

(101) Odd flies for crossing over is ..... .
(A) male Drosophila (B) female Drosophila
(C) drone bees (D) worker bees

(102) Recombination means ..... .
(A) as like parents (B) progeny without evolution
(C) progeny unlike parents (D) progeny like dominant parent

(103) In second experiment when morgan used F_1 female flies to cross with double recessive male flies, he obtained…….result.
(A) Parental combination = 83%, Recombinations = 17%
(B) Parental combination = 17%, Recombinations = 83%
(C) Parental combination = 75%, Recombinations = 25%
(D) Parental combination = 50%, Recombinations = 50%

(104) The four daughter cells derived from a single meiosis differ from each other due to ..... .
(A) difference in chromosome number
(B) crossing over only
(C) independent assortment of chromosomes only
(D) crossing over as well as independent assortment of chromosomes

(105) Crossing over takes place at a stage of ..... .
(A) Leptotene (B) Pachytene (C) Zygotene (D) Diakinesis

(106) Mendel observed that some characters did not assort independently. Later researchers found it to be due to ..... .
(A) Crossing-over (B) Linkage (C) Dominance (D) Amitosis

(107) Unit of crossing over is ..... .

(A) Cistrone (B) Centimorgan (C) Recon (D) Mutone

Answers : (100-D), (101-A), (102-C), (103-A), (104-D), (105-B), (106-B), (107-C)

* **Chomosomal Theory of Sex Determination :**

* **Henking :**

- Henking observed that in insects, two kinds of sperms are produced.
- The difference was in the presence or absence of one chromosome.
- He had described this chromosome as X-body. He was unable to indentify it as chromosome.

* **Mc Lung :**

- He had indentified X-body as a chromosome.
- Mc Lung also noted that in insects like grasshopper, male has an odd number of chromosomes.

* **Miss. Stevens (1905) and Bridges (1922) :**

- The choromosomal theory of sex determination was proposed by miss Stevens and Bridges.

* **Gold Schmidt (1938) :**

- Gold Schmidt supported chromosomal theory.
- According to this there are two types of chromosomes in an organisms.
- They are the autosomes and allosomes (sex chromosomes).
- The autosomes contain genes which determine the somatic characters of the organisms.
- The sex chromosomes determine the sex of an organism.
- There are two types of sex chromosomes : They are x chromosomes and y chromosomes.
- These two chromosomes differ not only in appearance but also in genetic composition.
- The X chromosome is larger than Y. X is straight while y has a bend at one end.
- In normal animal, there are two sex chromosomes. The two sex chromosomes may be XX or XY.
- In man, insect etc. Female has two X chromosomes.
- But in birds the male has two ZZ chromosomes and the female has one Z chromosome and one W chromosomes.

(108) Which scientist had identified X chromosome as a X body?

(A) Henking (B) Mc Lung (C) Bridges (D) Morgan

(109) Which scientist had identified X body as a chromosome?

(A) Mc Lung (B) Mendel (C) Bridges (D) Dervenport

(110) Which theory is supported by Gold Schmidt ?

(A) Sex Determination (B) Heredity

(C) Chromosomal theory of sex determination (D) Mutation theory

(111) According to which theory there are two types of sex chromosomes in an organism?

(A) Inheritance theory (B) Natural selection

(C) Mutation (D) Chromosomal theory of sex determination

(112) The sex chromosomes determine ..... .

(A) Sex characters (B) Somatic characters

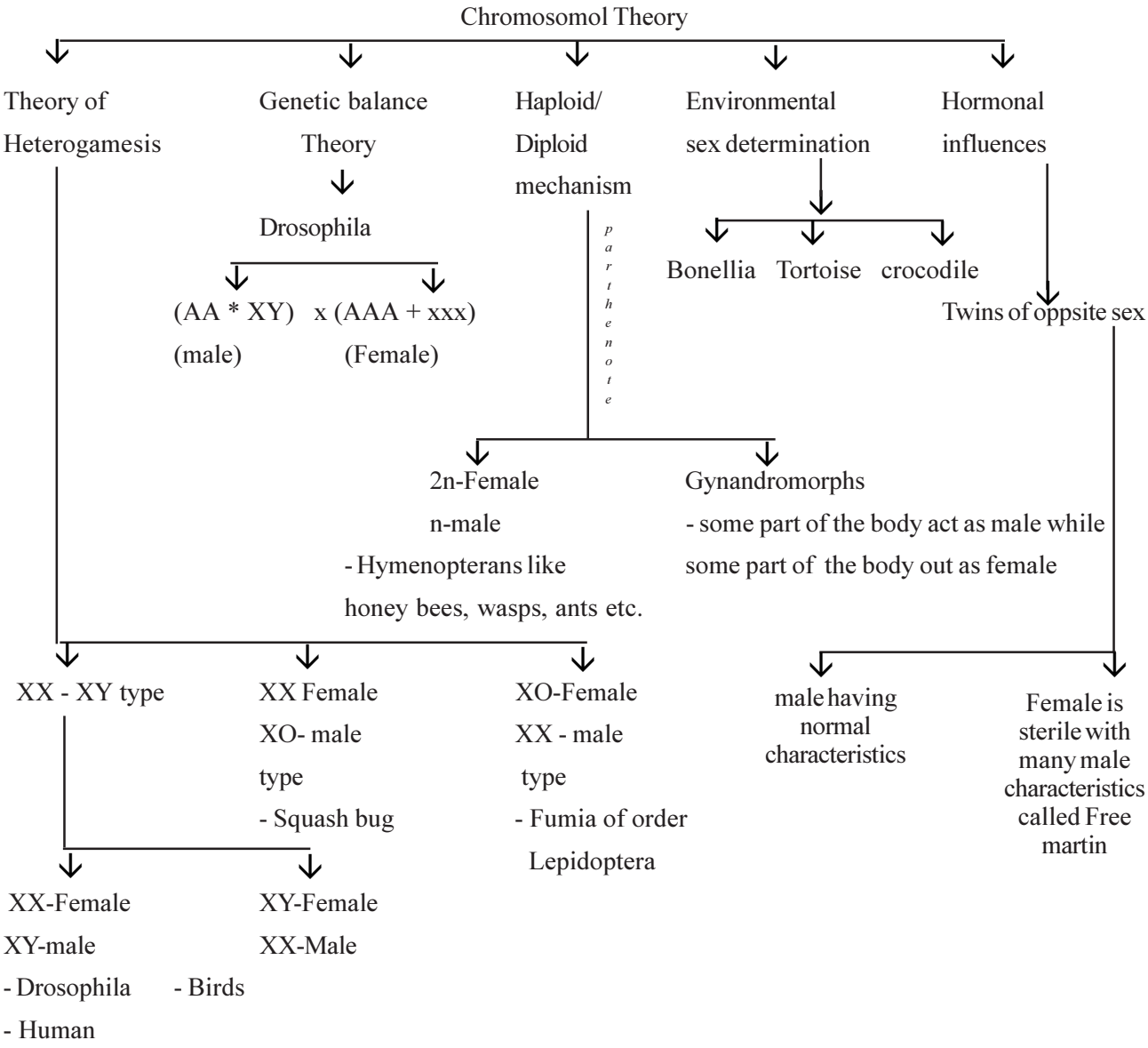
(C) Shape, growth (D) Volume, length

Answers : (108-A), (109-A), (110-C), (111-D), (112-A)

Sub division of chromosomal theory :

(1) Theory of heterogamesis (2) Genetic balance theory (3) Haploid and Diploid mechanism

(4) Environmental effect on determination of sex (5) Hormonal influences



(1) **Theory of Heterogamesis :**

– This theory was proposed by correns in 1906. according to this theory, one sex produce two type of gamete and each type of gamete determine a different sex on fertilization.

– It can be (A) XX - XY type or (B) XX- XO type

(A) XX - XY type :

– There are two different patterns of sex determination (a) through XX - female, XY - male and (b) through XY - female, XX - male type.

(a) **XX - female, XY - male type :**

It was studied in Drosophila and man.

* **Sex determination in Drosophila :**

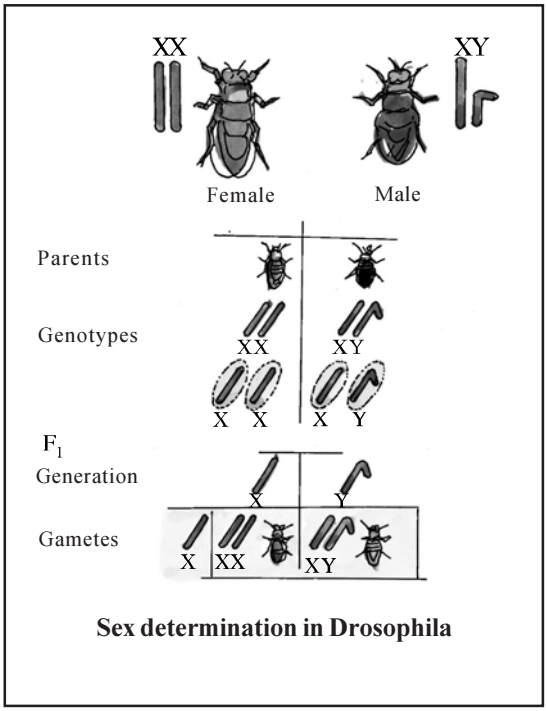
– Morgan had discovered sex chromosomes in

– Drosophila, Morgan studied chromosomal constitution in male and female.

– Drosophila has four pairs of chromosomes, out of it there are three pairs of autosomes (3AA) and one pair of sex chromosome.

– In female this is represented by 3AA + XX and in male 3AA + XY.

– The female produces only one type of Ova which carry 3A + X. But the male produces two types of sperms and they are 3A + X and 3A + Y type of chromosomes.



Sex determination in Drosophila

– Sex is determined by the type of sperm fertilizing an egg.

– If an egg is fertilized by the X type sperm, the resulting individual is a female and by Y type sperm, resulting individual is male.

– This method of sex determination is also called XY male method.

Sex determination in Human :

– In Humans, 23 pairs of chromosomes occur. Of these, twenty – two pairs are of autosomes. They are similar in man and woman.

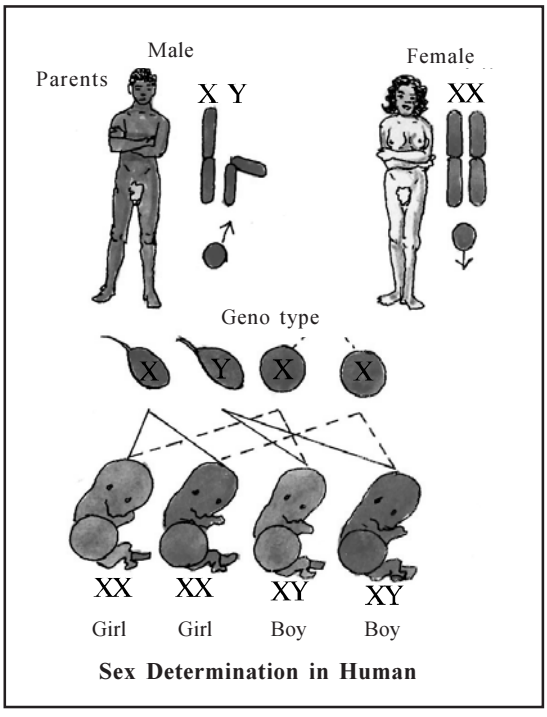
– In woman, twenty third pair consist of two similar X sex chromosomes.

– In man, one chromosome in twenty third pair is X – chromosome, and its homologous chromosome is smaller in size and is called Y chromosome.

– All egg of woman are similar. Each egg contains 22 autosomes and one X sex chromosome.

– In man sperms are of two type.

– Half the number of sperms have 22 autosomes and X sex chromosome, while the other half contains 22 autosomes and one Y sex chromosome.



Sex Determination in Human

– Whether the child will be a boy or a girl depends on the kind of sperm that fertilizes the egg.

(b) **XY – female, XX – male type :**

– In this type of sex determination, the female is sexually heterozygous having X and Y chromosomes.

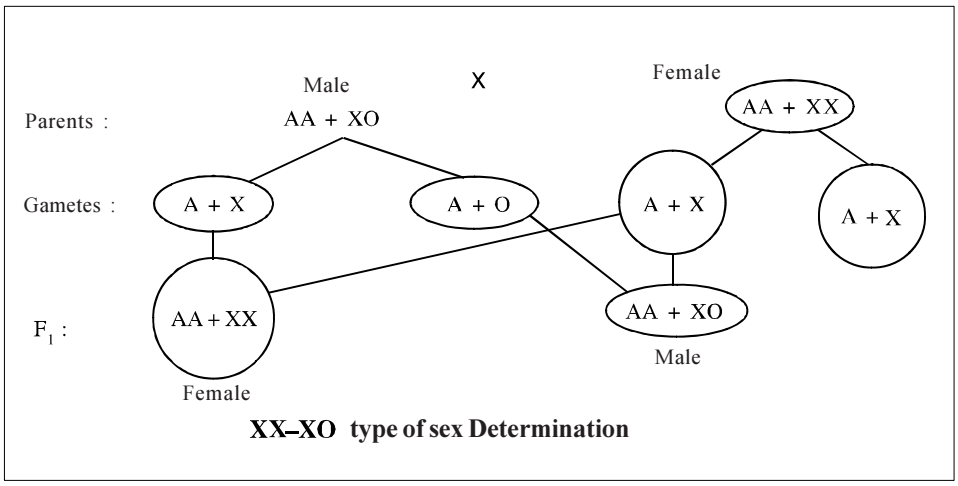
– The male is sexually homozygous having two x chromosomes.

– Males produce only one type of sperms while the females produce two types of eggs.

– In birds the X and Y chromosomes are designated as Z and W chromosomes so the chromosomal structure of the female is AA + ZW and the male is AA + ZZ.

(B) XX –XO type :

- This type of sex determination was first studied in squash bug (protenor).
- Here the sex of the animal is determined by the number of X chromosomes present in the cell.
- In one sex, XX chromosomes are present and in the other sex only one X chromosome is present e.g. bugs and grasshopper.



XX–XO type of sex Determination

* **Female XO and Male XX :**

In some insects like Fumia of order Lepidoptera, the female has one X – chromosome and the male has two X chromosomes.

(113) In which organisms female is sexually heterozygous and male is sexually homozygous?
(A) Drosophila (B) Human (C) Birds (D) All of above

(114) According to which theory, one sex produces two types of gametes and each type of gamete determine a different sex on fertilization?
(A) Genetic balance theory (B) Inheritance theory
(C) Mutation (D) Theory of heterogamesis

(115) The type of sex determination in Drosophila is ..... .
(A) XX – male, XY – female (B) XX – female, XY – male
(C) XX – male, XO – female (D) XO – male, XX – female

(116) The theory of heterogamesis proposed by ..... .
(A) Derven Port (B) Mc Lung (C) Morgan (D) Correns

(117) 3A + X and 3A + Y means ..... .
(A) Types of sperms in male drosophila (B) Types of sperms in birds
(C) Types of sperms in Humans (D) Types of female eggs in drosophila

(118) Which is responsible for sex-determination in drosophila ?
(A) Type of egg cells (B) Type of sperm cells
(C) Type of somatic cells (D) Type of dominant genes

(119) It is a type of sperm cells in man.
(A) 22A +X, 22A + Y (B) 23A +X, 23A + Y
(C) 44A +X, 44A + Y (D) 46A +X, 46A + Y

(120) XX-XO sex determination mean ..... .

(A) Sex- determined by number of x chromosomes present in the cell.

(B) Sex- determined by autosome present in the cell.

(C) Sex-determined by number of sex chromosomes present in the cell.

(D) Sex – determined by XX female.

(121) They follow XX- XO sex-determination ..... .

(A) drosophila, human (B) bug, grasshopper

(C) birds, fumia (D) honey bees, drosophila

(122) What is the order of Fumia?

(A) Hymenoptera (B) Coleoptera (C) Lepidoptera (D) Orthoptera

(123) It is true for XO- Female and XX - male ..... .

(A) bug (B) fumia (C) grasshopper (D) beetles

Answers : (113-C), (114-D), (115-B), (116-D), (117-A), (118-B), (119-A), (120-A), (122-B), (123-C)

* **Genetic Balance Theory :**

- This theory was formulated by bridges student of Morgan.
- According to this theory, sex is determined by the relative number of X – chromosomes and autosomes.
- It is actually the ratio between the X chromosomes and autosomes that determines the sex.
- Drosophila flies having XO- chromosomes were male. However they were sterile.
- They had only one X- sex chromosome it means, Y – sex chromosome is not essential for maleness.
- Bridges during his experiments found triploid female flies.
- These were fertile, they had three sets of autosomes and three X-sex chromosomes.
- He arranged cross breeding amongst such triploid female flies and normal diploid male flies.
- The probabilities are indicated in the table given below :

Female (AAA + XXX)

Kinds of eggs

Kinds of sperms	A + X	AA + XX	A + XX	AA + X
	AA+XX	AAA+XXX	AA+XXX	AAA+XX
	Normal female	Normal female	Super sterile female	Inter sex Sterile
A+X	$\frac{XX}{AA}=\frac{2}{2}=1$	$\frac{XXX}{AAA}=\frac{3}{3}=1$	$\frac{XXX}{AA}=\frac{3}{2}=1.5$	$\frac{XX}{AAA}=\frac{2}{3}=0.67$
	AA+XY	AAA+XXY	AA+XXY	AAA+XY
A+Y	Normal male	Inter sex sterile	Normal female	super male sterile
	$\frac{X}{AA}=\frac{1}{2}=0.5$	$\frac{XX}{AAA}=\frac{2}{3}=0.67$	$\frac{XX}{AA}=\frac{2}{2}=1$	$\frac{X}{AAA}=\frac{1}{3}=0.33$

- Bridges noted that the offsprings contained normal males, normal females, sterile males, sterile females and sterile intersex flies.
- It seems that the ratio of X-sex chromosomes to autosomal chromosomes (X/A) is responsible for these results.

  If $\frac{X}{A}$ = 0.5 than flies will be Normal male.

  If $\frac{X}{A}$ = 1 than flies will be Normal female.

  If $\frac{X}{A}$ = 1.5 than flies will be Super sterile female.

  If $\frac{X}{A}$ = 0.33 than flies will be Super male sterile.

  If $\frac{X}{A}$ = between 0.5 to 1.0 than flies will be Intersex sterile.
- Bridges suggested on the basis of results that in Drosophila, the genes for maleness are distributed over autosomes and those for femaleness are located on X-sex chromosomes. Sex depends on their balance.

---

(124) On the basis of Genetic balance theory sex-determination conducted by ..... .

(A) X- sex chromosome

(B) Balance of autosomal chromosomes and X-sex chromosomes.

(C) Number of X and Y chromosomes

(D) Autosomes and hormones balance.

(125) Drosophila flies having XO chromosome were ..... .

(A) Sterile male (B) Fertile male (C) Fertile female (D) Sterile female

(126) According to the genetic balance theory the ratio of the $\frac{X}{A}$ chromosomes obtained 1, than what will be the nature of flies?

(A) Normal female (B) Inter sex sterile (C) Sterile female (D) Supermale

(127) The ratio of $\frac{X}{A}$ chromosomes obtained 0.5, than what will be the nature of flies develop?

(A) Inter sex sterile (B) Super male(C) Normal female (D) Normal male

(128) The ratio of $\frac{X}{A}$ chromosomes is 1.5. It means ..... .

(A) Normal female (B) Super male(C) Normal male (D) Super female

(129) The ratio of $\frac{X}{A}$ chromosome is 0.33. It means ..... .

(A) Intersex sterile (B) Super female (C) Super male(D) Normal female

(130) According to the genetic balance theory the ratio of the $\frac{X}{A}$ chromosomes obtained between 0.5 to 1, it means ..... .

(A) Super female (B) Inter sex sterile (C) Normal female (D) Super male

(131) It is a conclusion of genetic balance theory…

(A) In drosophila the genes for maleness are distributed over autosomes and those for femaleness are located on X- sex chromosomes.

(B) In drosophila the genes for maleness are distributed over Y chromosomes and those for femaleness are located on X- chromosomes.

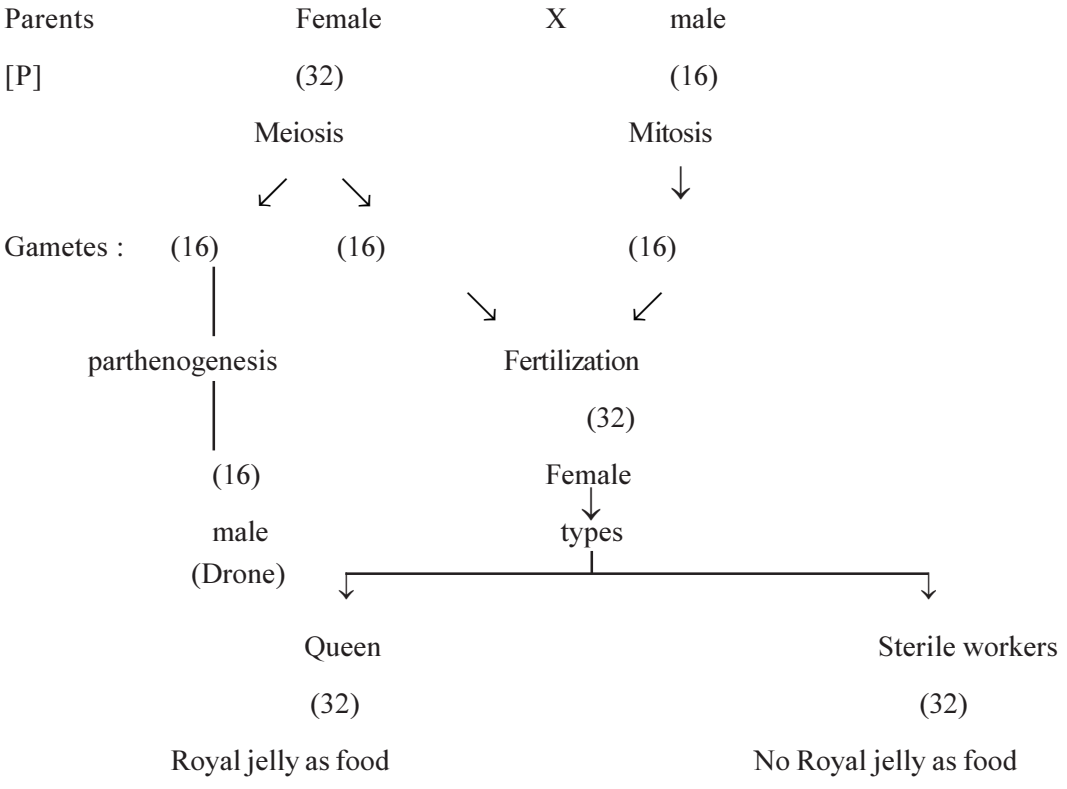
(C) In drosophila Y- chromosome responsible for length of wings.

(D) In Drosophila autosomes are responsible for sex-determination.

Answers : 124 (B), 125 (A), 126 (A), 127 (D), 128 (D), 129 (C), 130 (B), 131 (A)

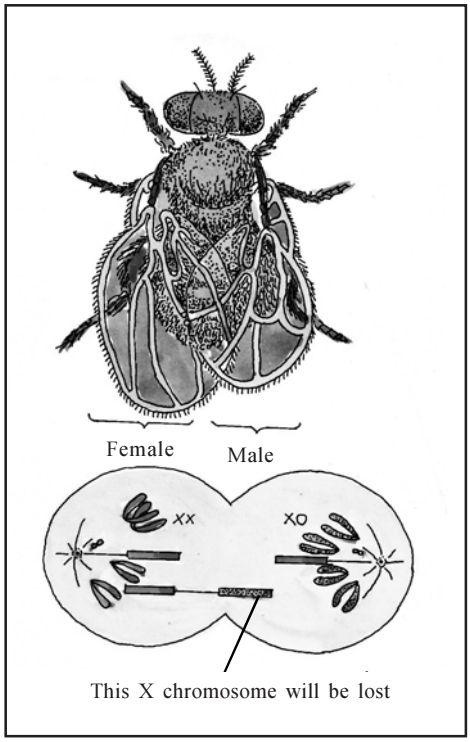
* **Haploidy and diploidy Mechanism :**

- Development of an ovum into a young one without fertilization is known as parthenogenesis.
- An individual produced parthenogenetically is called parthenote.
- In some hymenopterans like honey bees, wasps and ants, the females are diploid and the males are haploid.
- The female lays the normal egg which carries the haploid sets of chromosomes.
- The unfertilized haploid eggs develop parthenagenetically into functional males or drones.
- If the eggs are fertilized; the zygote develops into a diploid female.
- In these two types of females are produced from the fertilized eggs and they are (1) fertile normal diploid queen and (2) Sterile non-functional diploid female workers.
- The diploid larva which gets the Royal jelly as the food material develops into Queen and the other develop into workers.



* **Gynandromorphs :**

- Gynandromorphs are individuals who show male characters on some part of the body and female characters on other parts of the body. They are sterile.
- It happens in rare cases.
- They occur in Drosophila, butterflies beetles, wasps, bees, silkworm etc.
- It happens due to loss of X- chromosomes or due to binucleated eggs.
- The loss of an X- chromosome during mitosis in a 2A+XX cell leads to the derivation of two daughter cells one having 2A+XX and the other having 2A+X.



* **Barr-body Test :**

- The mammalian cells of certain sexes contain a darkly stained body in the nucleus. It is called sex-chromatin or barr-body.
- It was discovered by Barr and Bertram in 1949.
- It helps to identify the sex of the animal.
- The number of Barr bodies is always one less than the number of X chromosomes (X-1).

Chromosomes	No. of Barr bodies	Sex
22AA+ XY	No Barr body	Male
22AA+ XX	One Barr body	Female
22AA+ X	No Barr body	(Turner's syndrome) Female
22AA+ XXY	One Barr body	Male (Kline felter's syndrome)

(132) Pathenote mean ..... .
(A) development of an ovum in to young one without fertilization.
(B) best hybrid species
(C) inter sex sterile species
(D) super male and super female

(133) The order of honey bees, wasps and ants is ….
(A) Lepidoptera (B) Coleoptera (C) Hymenoptera (D) Orthoptera

(134) Which members are having 2n female and n male?
(A) Ant, beetles, honey bees, drosophila (B) Ant, grasshopper, wasps, drosophila
(C) Ant, beetles, honey bees (D) Drosophila, bonellia, honey bees

(135) How many chromosomes are there in drone ?
(A) 32 (B) 16 (C) 6 (D) 8

(136) The diploid larva which gets the Royal jelly as the food material develops into ..... .
(A) Drone (B) Sterile workers (C) Queen (D) Super female

(137) If diploid larva does not get Royal jelly as food material it will develop in to ..... .
(A) Drone (B) Sterile workers (C) Queen (D) Super female

(138) Gynandromorphs mean ..... .
(A) individuals who show male and female characters.
(B) Parthenote
(C) fertile female
(D) Sterile species having only male characters.

(139) The loss of X- chromosome in beetles during mitosis it leads to form ..... .
(A) 2A + XX, 2A +Y (B) 2A + X, 2A +X
(C) 2A + XX, 2A +X (D) 2A + X, 2A +Y

(140) The Darkly stained body in the nucleus of mammalian cells is ..... .
(A) Nucleolus (B) Barr – body (C) Ribosomes (D) DNA

(141) Who discovered sex chromatin ?
(A) Barr and Bertram (B) Derven port and Barr
(C) Bateson and Punnet (D) Bertram and Morgan

(142) It is true for Barr-body.
(A) (2x-1) (B) (x-1) (C) (xy-2) (D) (xxx-1)

(143) How many barr-body in person having Turner's syndrome?
(A) 0 (B) 2 (C) 1 (D) 3

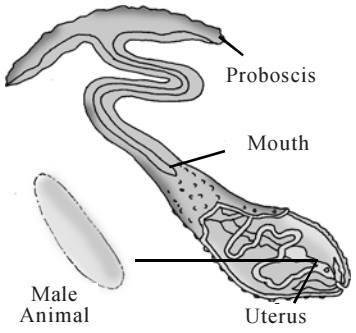
(144) How many barr-body in male having XXY chromosomes?
(A) 2 (B) 0 (C) 3 (D) 1

(145) How many barr –body in female having super female syndrome?
(A) 0 (B) 2 (C) 1 (D) 3

Answers : (132-A), (133-C), (134-C), (135-B), (136-C), (137-B), (138-A), (139-C), (140-B), (141-A), (142-B), (143-A), (144-D), (145-D)

* **Environmental effect on Determination of sex :**

- Baltzar (1935) stated that in Bonellia, sex is determined by environmental factor.
- In Bonellia (marine animal) all zygote are genetically identical-whether the embryo will develop into a male or a female depends on where it develops.
- If it develop near proboscis of a female it enters the body of the female and develops into a male animal.
- If it develops away from female, it develops into a female animal.
- Bonellia exhibits sexual dimorphism.
- It is believed that the proboscis secret a hormone like substance which prevents the development of femaleness.



Sea Determination in Bonellia

* **Sex determination in Tortoise :**

- In tortoise if the water temperature where it lives is higher than 30^0C zygote develops as a female, at a lower temperature, male development occur.

* **Sex determination in Crocodile :**

- In Crocodile the reverse is observed. A higher temperature induces male development and a lower temperature induces female development.

(146) Who stated that in Bonellia sex is determined by environmental factor?
(A) Baltzar (B) Barr (C) Bertram (D) Morgan

(147) In Bonellia all zygotes are genetically ..... .
(A) Dominant (B) Heterozygous (C) Recessive (D) Identical

(148) In Bonellia embryo will develop into a male or a female depends on ..... .
(A) temperature (B) position of zygotes in body
(C) light (D) royal jelly

(149) When male development occur in tortoise?
(A) Water temperature 25°C (B) Water temperature 40°C
(C) Water temperature 50°C (D) Water temperature 35°C

(150) Sex-determination in crocodile is ..... .
(A) higher temperature male lower temperature female
(B) higher temperature female lower temperature male
(C) higher temperature super female, lower temperature male
(D) higher temperature super male, lower temperature female

Answers : (146-A), (147-D), (148-B), (149-A), (150-A)

* **Hormonal Theory of Sex Determination :**

- Generally in higher animals secondary sexual characters are under the influence of their related sex hormones.
- But Lillie found that when twins of opposite sex (one female and other male) are born, the male is normal but the female is sterile with many male characteristics.
- Such sterile females are called free martin.
- In cattle, twins occurs frequently.
- During development both the twins are connected by a common umbilical cord.
- The gonads of the male develop earlier than those of the female at that time, the male hormones reach the female embryo and influence the development of male sex in the female embryo.

(151) Who found that when twins of opposite sex are born, the male is normal but the female is sterile with many male characteristics ?
(A) Baltzar (B) Bridges (C) Dervenport (D) Lillie

(152) In hormonal theory of sex determination sterile female are called as ..... .
(A) free martin (B) super female (C) parthenote (D) twins baby

(153) Which type of gonads development in twins of opposite sex?
(A) Male and female gonads develop at similar rate.
(B) The gonads of the male develop earlier than those of the female.
(C) The gonads of the female develop earlier than those of the male.
(D) The gonads of the male develop poor than those of the female.

Answers : (151-D), (152-A), (153-B)

* **Sex-determination in plants :**

- The mechanism of sex determination has been studied in a large number of plants.
- In most of the plants the sex is controlled by the Y chromosomes as in the case of man.

- If Y - chromosomes are absent, the plant will be female.

* **Liver worts :**

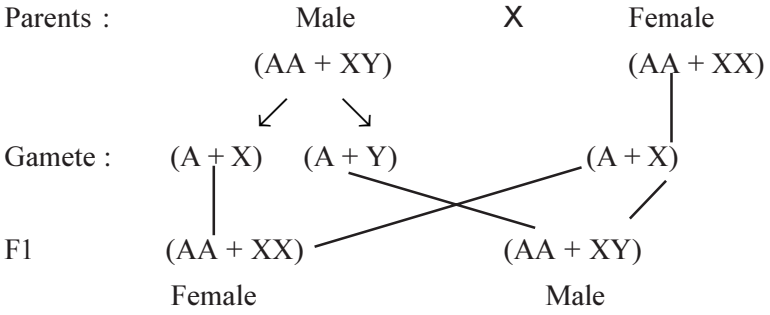
- In plants chromosomes were first studied by Allen in Liver worts.
- In Liver worts the sex organ are located on haploid gametophyte.

* **Sphaerocarpes :**

- In sphaerocarpes the male gametophyte has seven autosomes and one Y chromosomes (7A +Y), the female has (7A +X).

* **Angiosperm :**

- In Angiosperm female is homogametic and male heterogametic type.



* **Flagellaria :**

- In Flagellaria plant, female is heterogametic and male homogametic.

* **Dioscoria sinulate :**

- In Discoria sinulate female is homogametic (AA + XX) and male is heterogametic (AA+XO)

* **Humulus japanic :**

- In Humulus japanic, the female has two X chromosomes, but the male has one X chromosome and two Y chromosomes.

* **Sex-differentiation in Monoecious plants :**

* **Maize :**

- Maize is monoecious, having both staminate flowers and pistilate flower on the same plant.
- The female flowers normally develop along the sides of the stalk, and the male flower at the top of the plant.
- But in some cases the grains of corn may actually be produced at the tip of the plant because of some mutation. There is a mutant gene called ta.
- In homozygous condition (ta ta) it converts the male flowers into female flowers.
- There is another mutant gene (bs); it suppresses the development of the female flowers.

* **Spinach :**

- In spinach sex is controlled by single gene ‘m’ which is located in the X-chromosome.

---

(154) In most of the plants the sex is controlled by the ..... .

(A) X-chromosome (B) Y-chromosome

(C) Somatic A chromosome (D) By ratio of autosomal and sex chromosomes.

(155) In plant chromosomes were first studied by Allen.

(A) Sphaerocarpes (B) Liver worts (C) Flagellaria (D) Dioscoria sinulate

(156) It is true for Sphaerocarpes …..

(A) (7A +Y) male gametophyte and (7A + X) female gameto phyte.

(B) Female is homogametic (AA +XX) and male is heterogametic (AA+XO).

(C) Male (8A+X) and female (8A+Y).

(D) Male has one X chromosome and female has three X chromosomes.

(157) In which plant female heterogametic and male homogametic ?

(A) Liver worts (B) Flagellaria (C) Dioscoria sinulate (D) Humulus japanic

(158) In which plant female has XX and male has XYY chromosomes?

(A) Liver Worts (B) Dioscoria sinulate (C) Flagellaria (D) Humulus japanic

(159) It is a mutant gene in maize.

(A) ta (B) bs (C) m (D) A and B both

(160) What is a role of ta gene in Maize ?

(A) It converts the male flowers into female flowers.

(B) It converts the female flowers into male flowers.

(C) It suppresses the development of the female flowers.

(D) All of above.

(161) What is function of 'bs' mutant gene in Maize?

(A) It converts the male flowers into female flowers.

(B) It converts the female flowers into male flowers.

(C) It suppresses the development of the female flowers.

(D) It suppresses the development of maize.

(162) In spinach sex is controlled by a ..... .

(A) Single gene m (B) Mutant gene ta

(C) Mutant gene bs (D) XX and XY chromosomes.

Answers : (154-B), (155-B), (156-A), (157-B), (158-D), (159-D), (160-A), (161-C), (162-A)

* **Mutation :**

- The term 'Mutation' was first utilized by De vries.
- Mutation is a phenomenon which result in alteration of DNA sequence and consequently results in changes in the genotype and the phenotype of an organism.
- Mutation is a sudden change of a gene or chromosome from one form to another.
- It produces an alteration in the character under its control.
- Dobzhansky stated that mutation is a mistake or misprint in cell division.

* **Types of mutations** :

No	Type	Explanation
1	Somatic mutation	Occurring in the somatic cells. It is not inherited.
2	Germinal mutation	Occurring in the germ cells. It is a inherited.
3	Gametic mutation	Takes place in gametes.
4	Zygotic mutation	It occurs in zygote.
5	Dominant mutation	Mutation produces a dominant gene.
6	Recessive mutation	Mutation produces recessive gene, it does not express immediately
7	Back mutation	This is the reversal of mutation rarely does it happen.
8	Lethal mutation	As a result the mutant dies.

9	Spontaneous mutation	It occurs in the absence of any obvious cause. Most of the mutations occurring in nature are of this type.
10	Induced mutation	Mutations caused by external factors. The factors are called mutagens. E.g. ionizing radiation, mustard gas, peroxides, colchicines, formaldehyde, dimethyl sulphate, nitrous acid etc….
11	Biochemical mutation	Mutation causing change in the metabolites or their end products. Mostly it happens in enzymes. These are metabolic errors.

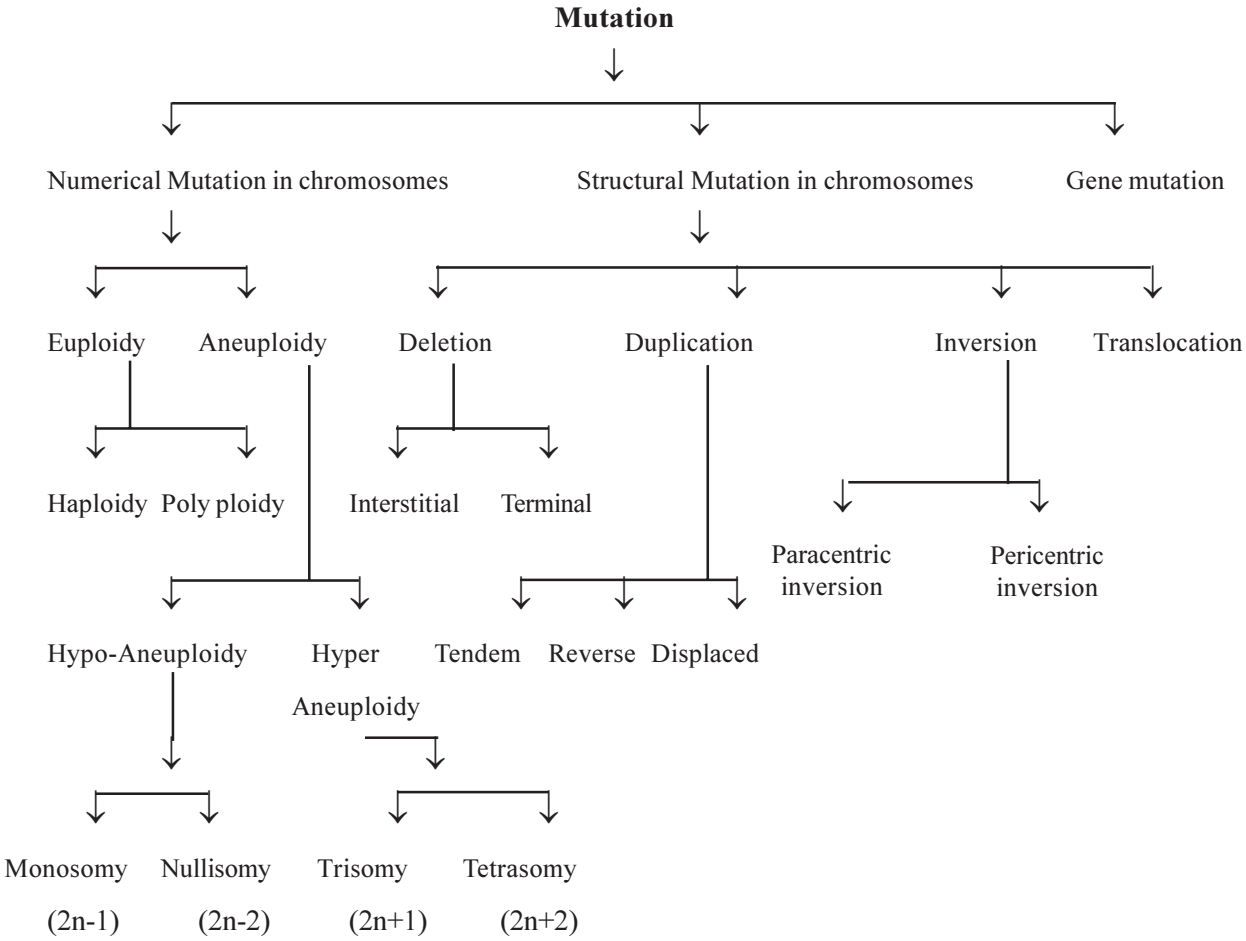
* **Types of mutation :**

• **Mainly three types of mutation :**

(1)Numerical mutation in chromosomes

(2) Structural mutation in chromosomes

(3) Gene mutations



(1) Numerical mutation in chromosomes ploidy :

- We know that the number of chromosomes is fixed for every species.
- Change in the number of chromosomes can be either in the number of sets of chromosomes or in the number of chromosomes in one set.
- This changes cause loss of one chromosome from one set or an addition of chromosomes.
- Chromosomal abberration are broadly classified into two namely euploidy and aneuploidy.

(A) Euploidy

It refers to the change in the number of chromosomes sets. It is further classified into two namely (i) Haploidy (ii) Polyploidy

(i) Haploidy or monoploidy :

Sometimes a set of chromosomes is lost and leads to haploidy.

(ii) Polyploidy :

- If there is an increase in the number of chromosomes which is in a multiple of the basic number n, the change is called polyploidy.
- The number can be 3n, 4n, 5n etc…
- Many of our cultivated crops are developed in this way.
- In plants, generally polyploidy produces larger leaves and flowers and heavier fruits and seeds.

(B) Aneuploidy :

- Aneuploidy refers to the loss or gain of one or more chromosomes in a set.
- Normally here are two members in a homologous pair of chromosomes.
- Instead there may be only one or nil member or three or four members.

* Monosomy (2n-1) :

If there is only one member instead of two in a pair, the condition is called monosomy.

* Nullisomy (2n-2) :

If a homologous pair of chromosomes is totally missing, the condition is called nullisomy. Normally it is lethal.

* Trisomy (2n+1) :

If there are three members instead of two in a given pair of chromosomes, the condition is called trisomy.

* Tetrasomy(2n+2) :

If there are four members in a pair of chromosomes instead of two, the condition is called tetrasomy.

Depending on the kind of chromosomes involved, aneuploidy can be of two kinds:

(1) Autosomal aneuploidy : It involves autosomal pairs of chromosomes.

(2) Sex chromosomal aneuploidy : It involves sex chromosomes.

---

(163) Mutation means ..... .

(A) Change in genes present on DNA (B) Change in structure of chromosomes

(C) Increase in number of cells. (D) None of this.

(164) Which mutation is not inherited?

(A) Somatic (B) Genetic (C) Gametic (D) Zygotic

(165) Which is rarely happen?

(A) Spontaneous (B) Induced (C) Back (D) Biochemical

(166) Which option is true for mutagens?

(A) Mustard gas, padiaton, CO_2, nitrous oxide (B) Colchicine, mustard gas, formaldehyde

(C) Mustard gas, benzene, toluene, formaldehyde (D) Ethanol, methanol, nitrous oxide

(167) Which mutation causing changes in the metabolites ?

(A) Induced (B) Genetic (C) Biochemical (D) Back

(168) Haploidy mean ..... .

(A) 2n-1-1 (B) 2n-2

(C) Deletion of set of chromosome (D) 2n+1

(169) Polyploidy mean ..... .

(A) Increase in the number of chromosomes which is in a multiple of the basic number n.

(B) Decrease in the number of chromosomes

(C) 2n+1

(D) 2n+2

(170) Which mutation responsible for production of larger leaves, flowers and heavier fruits?
(A) Haploidy (B) Aneuploidy (C) Polyploidy (D) Back mutation

(171) It is true for polyploidy ..... .
(A) 3n (B) 4n (C) 5n (D) All above

(172) The loss or gain of one or more chromosomes in a set is ..... .
(A) Aneuploidy (B) Haploidy (C) Polyploidy (D) All above

(173) Nullisomy mean ..... .
(A) 2n-2 (B) 2n-1 (C) 2n+1 (D) 2n+2

(174) It is true for double monosomy.
(A) 2n-2 (B) 2n-1-1 (C) 2n-2 (D) 2n-2-2

(175) Tetrasomy mean..
(A) 2n-2 (B) 2n-1-1 (C) 2n+2 (D) 2n-4

(176) Which mutation is normally lethal?
(A) Monosomoy (B) Nullisomy (C) Trisomy (D) Tetrasomy

Answers : (163-A), (164-A), (165-C), (166-B), (167-C), (168-C), (169-A), (170-C), (171-D), (172-A), (173-A), (174-B), (175-C), (176-B)

* **Structural abnormalities in chromosomes :**

- Each species is characterized by the presence of a specific number of chromosomes and each chromosome is arranged at definite location and in a definite sequence.
- Sometimes, changes occur in the number and arrangement of genes and in the number of chromosomes. These changes are called chromosomal aberrations or chromosomal nutation.
- Four kinds of chromosomal aberrations can occur. These are deletion, duplication, inversion and translocation.

* **Deletion :**

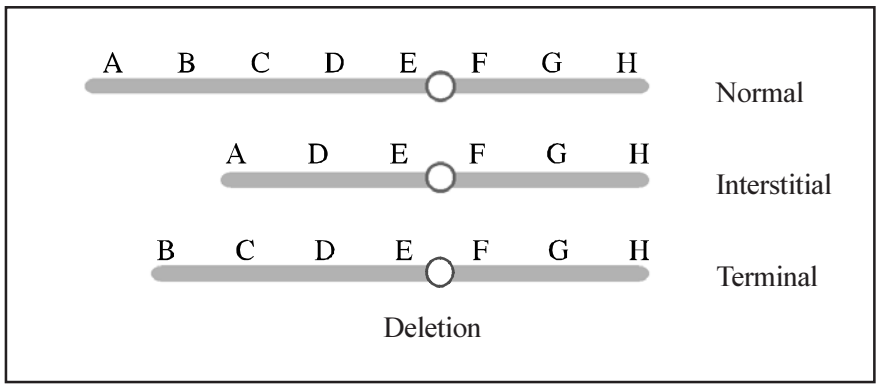
- Deletion is the loss of one or more genes from a chromosome and it is due to the loss of a chromosome segment.
- During deletion some genes are lost, so the organism shows some defects.
- Such a loss can be from the end region or from the inner region of a chromosome i.e. deletion may be 'terminal' or 'intercalary'.

* **Cri-du-chat :**

- In human a disease called cri-du-chat result due to deletion from the short arm of chromosome number five.

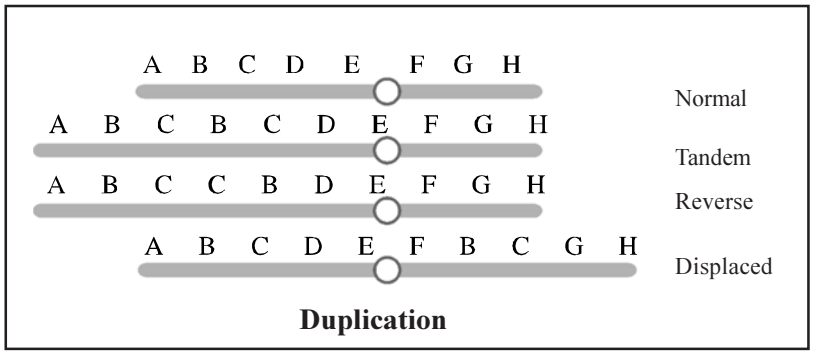
* **Philadelphia syndrome :**

• Similarly a deletion from the long arm of chromosome number twenty two is responsible for the disease Philadelphia syndrome.



* **Duplication :**

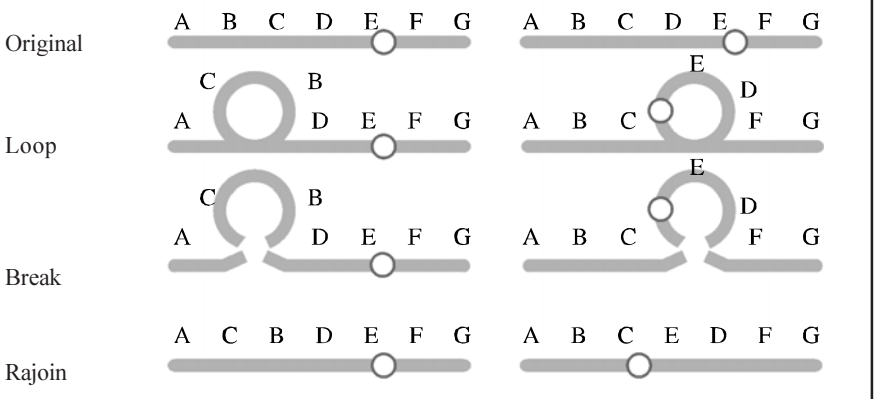
- In such an abnormality a part of a chromosome occure twice
- This can occur during replication of DNA.
- In such cases, the sequence of genes is either maintained or inverted.
- For example, say the sequence of gene is A B C D E F G H and genes BC are duplicated. The new sequences can either ABCBCDEFGH (Tendem) or A B C C B D E F G H (reverse) or ABCDEFBCGH(displaced).
- Abnormally in size of eyes in Drosophila appears to be due to this reason.
- Duplication play a role in evolution.



Duplication

* **Inversion :**

- In inversion, there is no loss or gain of genes.
- But a particular segment of a chromosome is broken and is attached to the same chromosome in an inverted position. So there is rearrangement of original genes.
- For example : chromosome ABCDEFG is cut between A and B and between C and D the separated piece B C undergoes inversion and then rejoins the original chromosome. The new chromosome will have a sequence A B C D E F G. The sequence of gene is changed. Due to this, sometimes phenotypic effects may changed.
- Two types of inversion : (i) paracentric inversion and (ii) pericentric inversion.



Inversion

Translocation :

- Sometimes a part of a chromosome become separated.
- This separated piece joins with another chromosome which is not its homologus chromosome this is called translocation.
- It plays a significant role in evolution.
- Chromosomal aberrations are commonly observed in cancer cells.

(177) The name of disease cause by due to deletion of from the short arm of chromosome number five is ..... .
(A) Philadelphia syndrome (B) sickle cell anemia
(C) cri-du-chat (D) thalassaemia

(178) The name of disease cause by due to deletion of long arm of chromosome number twenty two is ..... .
(A) philadelphia syndrome (B) cri-du-chat
(C) thalassaemia (D) PKU

(179) The name of disease in which child suffer from blood cancer is…..
(A) Philadelphia syndrome (B) Sickle cell anemia
(C) Albinism (D) Alkaptonuria

(180) In the sequence of gene A B C D E F G the C D E gene become tendem then the new sequence can be ..... .
(A) A B C D E F G C D E H (B) A B C D E C D E G F H
(C) A B C D E E D C F G H (D) A B C D E D C E F G H

(181) Abnormality in size of eye in Drosophila appears to be due to ..... .
(A) Deletion (B) Aneuploidy (C) Duplication (D)Inversion

(182) Inversion mean ..... .
(A) a particular segment of a chromosome is broken and is attached to same chromosome in an inverted position.
(B) loss of one or more gene from a chromosome and it is due to the loss of a chromosome segment.
(C) a particular segment of a chromosome is broken and it attached to homologous chromosomes.
(D) duplication of some part of chromosomes.

(183) Chromosome A B C D E F G H is cut between B and C and between E and F the separated piece undergoes inversion and then rejoins the original chromosomes. Then what will be the new sequence will have ..... .
(A) A BC BC D E E F G H (B) A B E D C F G H
(C) A B C D E C D E F G H (D) A B C E D F G H

(184) Which chromosomal aberrations play a significant role in evolution?
(A) Duplication (B) Translocation
(C) Deletion (D) A and B both

Answers : (177-C), (178-A), (179-A), (180-A), (181-C), (182-A), (183-B), (184-B)

* **Gene Mutation :**

- Any mutation induced by a change in the constitution of a gene is called gene mutation.
- DNA is the genetic material.
- A definite length of a DNA molecule acts as one gene.
- Mutation also arises due to change in a single base pair of DNA such mutation may alter the sequence of the nucleotides within a part of the DNA molecules.
- This alteration change the information on the DNA and results in differences in the proteins being produced this is known as point mutation.
- A classical example of such mutation is sickle-cell anemia, where haemoglobin defective and RBCs take a sickle shape.

* Points are note worthy regarding gene mutation :

- Generally a mutated gene is harmful to the individual.
- Any gene can undergo mutations.
- Mutations may be spontaneous or they may be induced.
- Mutation is an evolutionary agent and mutability is a property of the genetic material.
- Such genetic variations are useful in natural selection and evolution of a species.

(185) It is a best example of point mutation.

(A) Thalassaemia (B) Colour blindness

(C) Sickle-cell-anemia (D) Alkaptonuria

(186) It is true for gene mutation ..... .

(A) variation are useful in natural selection and evolution of a species.

(B) any gene can undergo mutations.

(C) mutated gene is harmful to the individual.

(D) all of above

(187) In which diseases haemoglobin becomes defective?

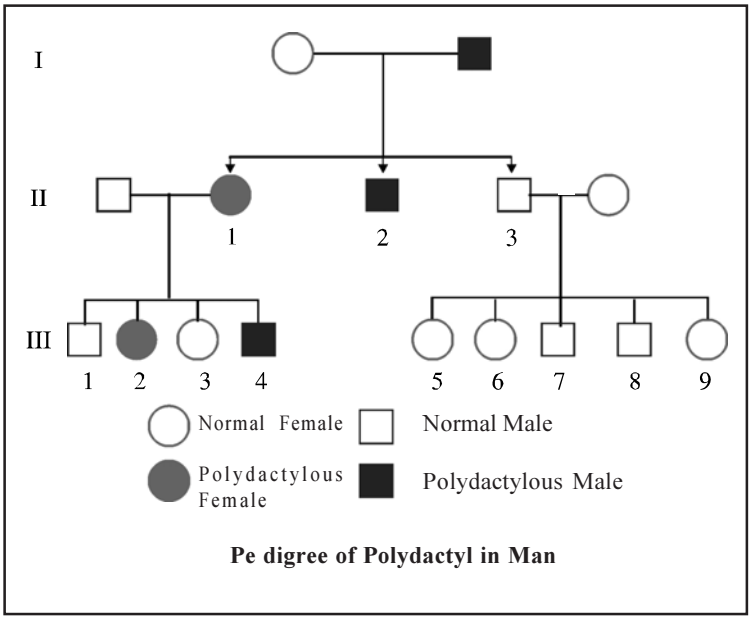
(A) Thalassaemia (B) Sickle cell anemia

(C) Philadelphia (D) Colour blindness

Answers : (185-C), (186-D), (187-B)

Pedigree Analysis :

- A record of the occurrence of trairs in several generations of a human family is known as pedigree analysis.
- For such type of analysis, information about the family history for particular traits is first collected. Then the expressions of the traits are assembled in a chart.
- The pedigree of a family is represented in the form of a chart.
- The females are represented by circles (○) and the males are represented by square (□).
- The marriage is indicated by horizontal bar connecting a circle and a square.
- The offspring are suspended from the marriage bar by vertical lines.
- In individuals in one horizontal line belong to the same generation.
- Each generation is numbered by roman numbers (I, II, III etc) and the individuals in each generation are numbered by 1, 2, 3, 4 and so on.
- Normal individuals are represented by open circle or square and affected individuals are represented by closed circle or squares.



Pe digree of Polydactyl in Man

- Heterozygous individuals are represented by closing half of the circle or squares.
- For example, in the following illustration, a pedigree analysis has been made for polydacty (the occurrence of extra fingers).
- The chart show a marriage between a poplydactylous man and a normal woman (generation I). They produce three children, a polydactylous daughter, a polydactylous son and a normal son (generation II).
- The first and the third individuals of second generation each marry normal persons, their children are shown in third generation from the results.
- We can conclude that a polydactyl offspring appears only when at least one person is polydactylous. Pedigree of polydactyl in man

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(188) A record of the occurance of traits in several generations of a human family is known as a ..... .
(A) record (B) pedigree analysis (C) family record (D) family tree

(189) The expressions of the traits are assembled in a ..... .
(A) Chart (B) Graph (C) Line (D)Table

(190) Which sign use for females and males in pedigree analysis?
(A) Line, squares (B) Squares, circle (C) Circle, squares (D) Circle, circle

(191) In pedigree analysis marriage is indicated by ..... .
(A) square (B) horizontal square
(C) horizontal bar connecting a circle and a square (D) line

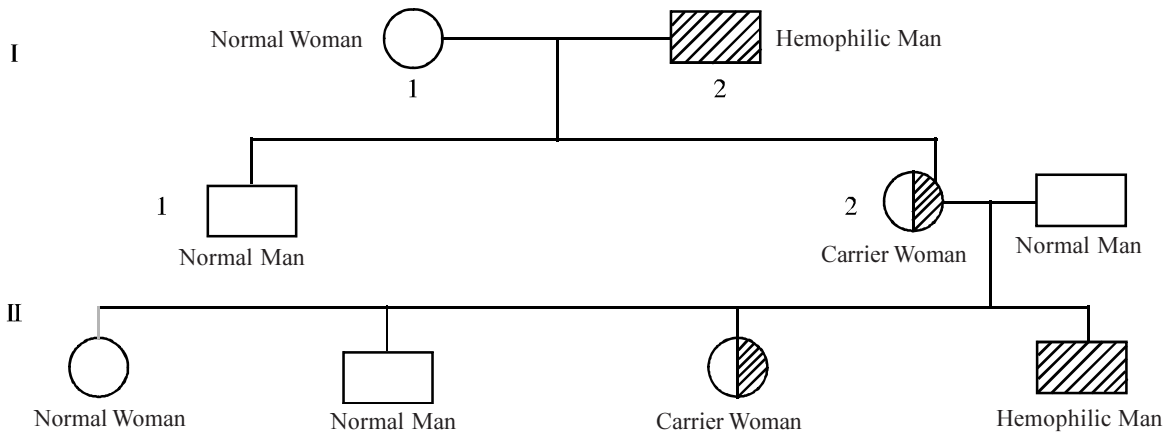
(192) In pedigree analysis normal individuals are represented by ..... .
(A) open circle or squares (B) closed circle and square
(C) closing half circle and square (D) roman numbers

(193) In pedigree analysis, heterozygous individuals are represented by…
(A) open circles and squares (B) closed circle and square
(C) closing half circle and square (D) roman numbers

Answers : (188-B), (189-A), (190-C), (191-C), (192-A), (193-C)

Haemophilia :

- It is a hereditary blood disease by delayed blood clotting.
- This is because of the absence of a factor in the blood-antihaemophilic globulin.
- Haemophilia is a sex linked recessive character and the genes are located on x-chromosome.
- It is caused by recessive genes represented by 'hh' and the normal condition is due to dominat gene H.
- The family pedigree of Queen Victoria show a number of haemophilic descendants as she was a carrier of the diseases.



(194) It is a hereditary blood disease caused by delayed blood clotting.
(A) Haemophilia (B) Sickle cell anemia (C) Thalassaemia (D) PKU

(195) Which reason is correct for haemophilia ?
(A) Absence of a factor in the blood antihaemophilic globulin.
(B) Sickle shaped RBCS.
(C) Required RBCs not generated in blood.
(D) Homogenetic acid oxidase is not produced.

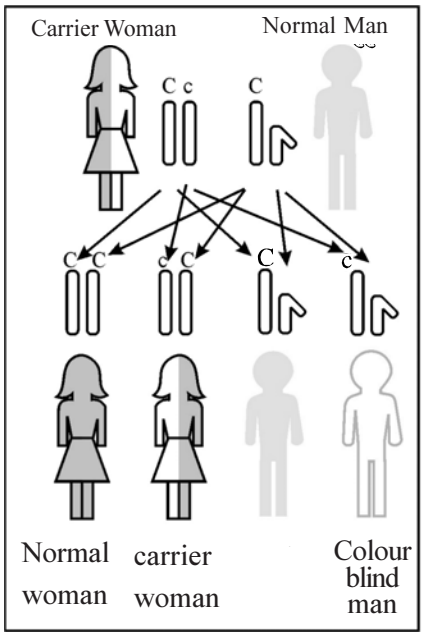
(196) Type of gene which responsible for causing haemophilia is ..... .
(A) co-dominant (B) incomplete dominant (C) recessive (D) epistatic

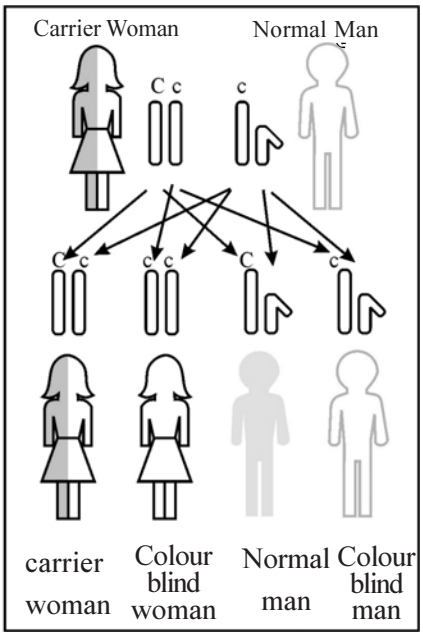
(197) Haemophilia is represented by gene ..... .
(A) HH (B) hh (C) Hh (D) Hb^s, Hb^s

Answers : (194-A), (195-A), (196-C), (197-B)

* **Colour – Blindness :**

- In it, the affected persons can not distinguish red colour and green colour.
- It is a recessive character. It is caused by recessive genes represented by 'cc'.
- The normal person contain the genes CC or Cc or C alone (in man).
- The genes for colour blindness are located on the x-chromosomes.
- Their alleles are absent from y-chromosomes.
- This character is common in man but rare in woman.
- The daughter carring one recessive gene for colour blindness is called carrier.
- The carriers are normal in their vision.





Inheritance of Colour Blindness

(198) What are all the chances of colour blind child being born in a marriage of normal female marriying a colour blind man?
(A) 0% (B) 25% (C) 75% (D) 50%

(199) What are all the chances of normal daughter being born in a marriage of normal female. Marrying a colour blind man?
(A) 0% (B) 50% (C) 100% (D) 25%

(200) What are the chances of colour blind daughter being born in a marriage of normal male marrying a carrier female?

(A) 100% (B) 50% (C) 0% (D) 75%

(201) Out of two, one son is normal and one son is colour blind of a couple, what are all the chances of colour blind daughters?

(A) 0% and 50% (B)25% and 0% (C)50% and 75% (D) 100% and 0%

(202) Why colour blindness is common in man but rare in woman?

(A) The genes for colour blindness are located on the X-chromosomes.

(B)The genes for colour blindness are located on the Y-chromosome.

(C)The dominant gene for colour-blindness are located on Y-chromosome.

(D) The genes for colour-blindness are located on X and Y-chromosomes.

Answers : (198-A), (199-C), (200-C), (201-A), (202-A)

* **Thalassaemia :**

- In this case, the required haemoglobin is not generated in the blood of a person who suffers from this disease through inheritance.
- It has different types. Out of it test of β thalassaemia is essential before arranging marriage.
- Out of male or female, one or both can be thalassaemic minor or thalassaemia major is possible.
- If out of father or mother, this effective gene is inherited from any one or the two, such offspring does not have the disease, but become a carrier for this effective gene.
- Effective gene from both parents passed to the next generation offspring can be the source of Thalassaemia.
- In such a case both parents are Thalassaemic minor. Their child is known as Thalasaemina major.
- Out of husband-wife, if one is Thalassaemic minor, they live their family life without any trouble, their children have no fear for Thalassaemia major but any one child can be a thalassaemic carrier.

---

(203) Which test of Thalassaemia is essential before arranging marriage?

(A) α (B) β (C) γ (D) δ

(204) If a Thalassamic minor man marries a thalassamic minor woman, their child will be ..... .

(A) Normal (B) Thalassamic minor

(C) Carrier of Thalassaemia (D) Thalassamic major

(205) A man and woman among two one is thalassamic minor. Then the child would be ..... .

(A) Thalassamic minor (B) Thalassamic major

(C) Normal but carrier (D) None of above

(206) The pattern of thalassaemia follows ..... .

(A) Mendelian Principles (B) Morgan Principles

(C) Bridges Principles (D) Derven Port Principles

Answers : (203-B), (204-D), (205-C), (206-A)

* **Sickle Cell Anaemia :**

- It is a hereditary disease, this disease first pointed out in 1952 by Linus Pauling.
- This disease is characterized by the presence of sickle-shaped RBCs under low oxygen pressure.
- It is due to the presence of defective haemoglobin called haemoglobin s(**Hb^S**).

- Sickle cell anaemia is a recessive character caused by the recessive genes **Hb^S, Hb^S**.
- The normal adult haemoglobin is produced by dominant genes **Hb^A, Hb^A**.
- The heterozygous **(Hb^A, Hb^S)** person are normal and are the carriers of sickle cell genes.
- The defect is caused by the substitution of Glutamic acid by Valine at the sixth position of the beta chain of the haemoglobin molecule.

Note : The genetic codes for glutamic are : GAA, GAG
The genetic codes for Valine are : GUA, GUG

---

(207) It is true for sickle cell anemia.
(A) Sickle shaped RBCs. (B) Less haemoglobin production.
(C) Poorly developed reproductive organs. (D) Absence of anti-hemophilic globulin.

(208) Which genes are responsible for sickle cell anemia ?
(A) Hb^A, Hb^A (B) Hb^A, Hb^S (C) Hb^S, Hb^S (D) All of Above

(209) It is a carrier gene for SCA
(A) Hb^A, Hb^S (B) Hb^A, Hb^C (C) Hb^H, Hb^A (D) Hb^S, Hb^H

(210) It is a main reason for causing SCA…
(A) The defect is caused at the sixth position of α-chain of a haemoglobin molecule.
(B) The defect is caused at the sixth position of β-chain of a haemoglobin molecule.
(C) Change at fifth position of β-chain of a haemoglobin.
(D) Change at forth position of α-chain of a haemoglobin molecule.

(211) Which amino acid occupied sixth position of the beta chain of haemoglobin molecule?
(A) Serine (B)Valine (C) Glutamic acid (D) Aespartic acid

(212) The SCA is caused by the substitution of Glutamic acid by…..at the sixth position of the beta chain of haemoglobin molecule.
(A) Glutamic acid (B) Valine (C) Serine (D) Aespartic acid

Answers : (207-A), (208-C), (209-A), (210-B), (211-C), (212-B)

* **Inborn Errors of Metabolism** :

(1) Phenyl Ketonuria (PKU) :

- It is an inborn error in metabolism.
- It is a recessive character caused by recessive genes represented by pp.
- When these recessive genes are present, the enzyme phenylalanine hydroxylase is not produced.
- In the absence of this enzyme, phenyl alanine can not be converted into tyrosine.
- Phenyl alanine and its derivatives accumulate in the blood and cerebrospinal fluid.
- The excess of phenyl alanine is ercreted in the urine.

(2) Alkaptonuria :

- It is an inborn error in metabolism.
- It is a recessive character caused by recessive genes represented by ‘aa’.
- When these genes are present, the enzyme homogentisic acid oxidase is not produced.

- In absence of enzyme, homogentisic acid can not be converted to acetoacetic acid as a result homogentisic acid accumulates in the blood.
- The urine of such person turns black when exposed to air.

(3) Albinism :

- It is a hereditary defect where the melanin pigment are absent from the skin, hair, eye etc..
- It is also an inborn error in metabolism caused by recessive genes. Represented by 'cc'.
- When 'cc' are present, the enzyme tyrosinase can not be produced.
- Hence tyrosine can not be converted into melanin pigments.

---

(213) Which enzyme convert phenylalanine into tyrosine ?

(A) Tyrosinase (B) Homogentisic acid oxidase

(C) Phenyl alanine hydroxylase (D) Uriase

(214) In PKU phenyl alanine and its derivatives accumulate in ..... .

(A) blood (B) cerebro spinal fluid

(C) adipose tissue (D) A and B both.

(215) Alkaptonuria caused by absence of enzyme ..... .

(A) Homogentisic acid oxidase (B) Phenyl alanine hydroxylase

(C) Tyrosinase (D) Urease

(216) In which disease the urine of person turns black when exposed to air ?

(A) PKU (B) Alkaptonuria (C) SCA (D) Albinism

(217) Albinism caused by in the absenece of ..... .

(A) Uriase (B) Maltase (C) Tyrosinase (D) Phenyl alanine hydroxylase

(218) Name of disease in which excess of homogenetisic acid accumulates in the blood?

(A) Sickle cell anemia (B) Thalassaemia

(C) Haemophilia (D) Alkapto nuria

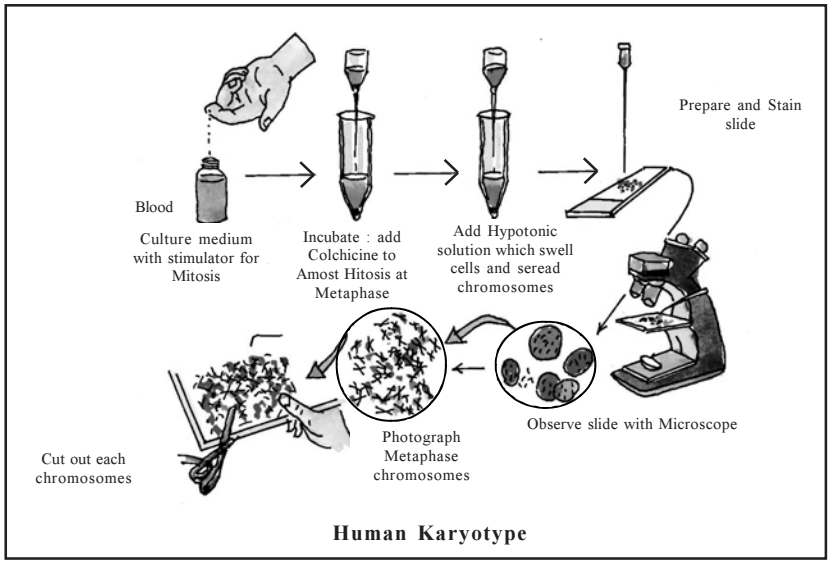
Answers : (213-C), (214-B), (215-A), (216-B), (217-C), (218-D)

* **Human karyotype : Blood culture method :**

Karyotyping of human chromosomes : Chromosomes are clearly visible only in rapidly dividing cells. Human chromosomes are studied in blood cells (WBCs), cells in bone marrow, amniotic fluid and cancerous tissues. The WBCs divide when added with phytohaemaglutinin(PHA).

The division stops when colchicine is added at metaphase stage. These dividing WBCs are then treated with hypotonic saline solution. Chromosomes are now stained with stains like orcein, Giemsa dye or recent quinacrine dye.

When viewed with special microscope in ultraviolet light the stain produces fluorescent bands on chromosomes. The chromosomes are then arranged on photographic plate for making diagram and their study. The pictorial representation of a person's chromosomes is called Karyotype.



Human Karyotype

(219) It is usefull for understanding of chromosomal disorders.
(A) Human pedigree analysis (B) Human family chart
(C) Human Karyotype (D) Inheritance

(220) In blood culture method which growth medium is use for cultivation of WBCs ?
(A) Phyto haemogglutinin (B) Agar–agar (C) Glucose (D) Lac-agar

(221) Which chemical is added at metaphase stage to arrest division of WBCs?
(A) Colchicine (B) Phytohaemogglutinin (C) Phenylalanine (D) Glucose

(222) In blood culture method harvested WBCs are treated with ..... .
(A) Isotonic solution (B) Hypertonic solution
(C) Hypotonic solution (D) None of above

(223) For preparing Human Karyotype, cells are arrested mitosis at ..... .
(A) Prophase (B) Metaphase (C) Anaphase (D) Telophase

(224) If individual chromosomes are cut out, paired as per size and shape and then arranged in a descending order of size, we can construct a ..... .
(A) Chromosomal chart (B) Pedigree analysis
(C) Karyotype of chromosomes (D) Parthenote chart

Answers : (219-C), (220-A), (221-A), (222-C), (223-B), (224-C)

* **Chomosomal Disorders :**

(1) Down's syndrome :

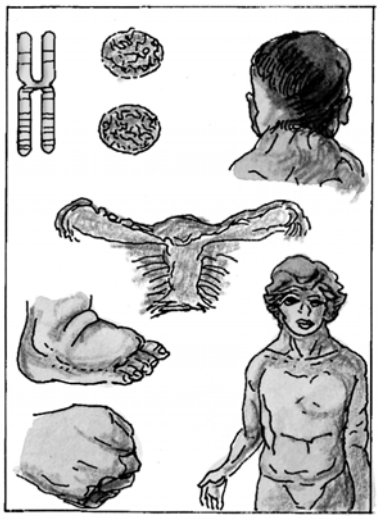
- This disorder is caused by trisomy of 21st pair of chromosomes.
- There are three members in 21st pair instead of two.
- The total number of chromosomes become 47.

Symptoms :

- Short structure, large head, short neck, flat, round face.
- Folded eyelids as are commonly observed in mongoloid race.
- Large thick and swollen tongue and drooping lips.
- Mental retardation lower sensitivity.
- Short, stubby finger, Flat palm
- Poorly developed reproductive organs.
- Sterile

(2) Turner's syndrome :

- This is a sex-linked disorder.
- When a woman has only one x-sex chromosome, instead of the normal two, this disease occurs. Thus this disorders is caused by monosomy of sex-chromosomes.



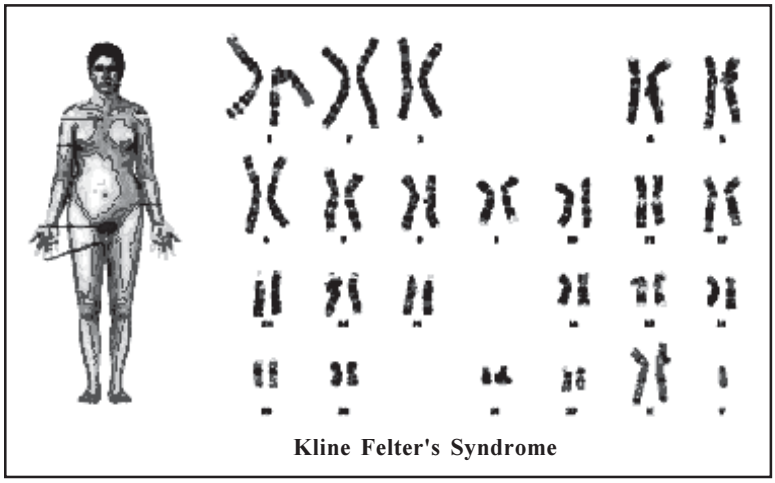
Turner's Syndrome

Symptoms :

- Short structure, short webbed neck
- Phenotypically a woman but reproductive organs are poorly developed
- Almost flat chest
- Uterus underdeveloped
- Sterile

(3) Kline felter's syndrome :

- This is a sex-linked disorder.
- When there are two or more x-sex chromosomes in a man instead of one this disorder occurs.
- Thus, this disorder is caused by trisomy of sex-chromosomes.



Kline Felter's Syndrome

Symptoms :

- Phenotypically a man, but sterile.
- Testes under developed.
- Tall in size, legs much longer, trunk shorter.
- Sparse hairs on body.
- Amount of facial hairs low.
- Breast development as in woman.
- Broad and flat pelvic girdle and shrill, feminine voice.
- Mentally retarded.

(225) Down's syndrome mean ..... .

(A) Trisomy of 21st pair of chromosomes (B) Trisomy of 22nd pair of chromosomes

(C) Monosomy of 5th pair of chromosomes (D) Monosomy of 23rd pair of chromosomes

(226) It is true for Down's syndrome ..... .

(A) flat round face, flat palm (B) folded eyelids, flat chest

(C) flat chest, poorly developed uterus (D) webbed neck, spare hairs on body.

(227) Type of female having only one X-sex chromosome is ..... .

(A) Down's syndrome (B) Super female

(C) Klinefelter's syndrome (D) Turner's syndrom

(228) Turner's syndrome ..... .

(A) Monosomy of autosomes (B) Monosomy of sex-chromosomes

(C) Trisomy of sex-chromosomes (D) Tetrasomy of autosomes

(229) Types of man having extra x-sex chromosome is ..... .

(A) Down's syndrome (B) Turner'syndrome

(C) Klinefelter's syndrome (D) Super male

(230) In which disorder folded eyelids as are commonly observed in mongoloid race?

(A) Turner's syndrome (B) Klinefelter's syndrome

(C) Down's syndrome (D) Super male

(231) It is true for Turner's syndrome.

(A) Uterus underdeveloped (B) Sterile female

(C) Almost flat chest (D) All of above

Answers : (225-A), (226-A), (227-D), (228-B), (229-C), (230-C), (231-D)

- **A = Assertion, R = Reason type questions**

Choose the correct option from the following for given questions.

(A) A and R both are correct, while R is correct explaination of A.

(B) A and R both are correct but R is not correct explaination of A.

(C) A is correct, but R is wrong.

(D) A is wrong but R is correct.

(232) Assertion A : Person suffering from haemophillia fail to produce blood clotting factor (VIII).

Reason R : Prothrombin producing platelets in such person are found in very low concentration.

(A) (B) (C) (D)

(233) Assertion A : Mustard gas act as a mutagen.

Reason R : It transfers alkyl groups to the bases in DNA.

(A) (B) (C) (D)

(234) Assertion A : The principle of segregation given by Mendel is the principle of purity of gametes.

Reason R : Gametes are pure of character.

(A) (B) (C) (D)

(235) Assertion A : Among the primates, chimpanzee is the closest relative of the present day humans.

Reason R : The banding pattern in the autosome numbers 3 and 6 of man and chimpanzee is remarkably similar.

(A) (B) (C) (D)

(236) Assertion A : Holandric genes are found on y chromosome.

Reason R : Inheritance of Holandric genes are always from father to son.

(A) (B) (C) (D)

(237) Assertion A : Haemophillia never occurs in woman.

Reason R : Gene for haemophillia is located on X-chromosome.

(A) (B) (C) (D)

(238) Assertion A : In human most sex-linked genes are present on the xchromosome.

Reason R : x-chromosome contain a large number of gene with major effect on phenotype.

(A) (B) (C) (D)

(239) Assertion A : Haploids are used to study mutation.

Reason R : Most of the mutation are recessive.

(A) (B) (C) (D)

(240) Assertion : Gene mutation is true mutation.

Reason : Genetic mutation are useful in natural selection and evolution of a species.

(A) (B) (C) (D)

(241) Assertion A : If $\frac{X}{A}$ ratio obtained 1, than flies will develop into normal female.

Reason R : In drosophila the gene for femaleness are distributed over x-chromosome and those for maleness are distributed on y-sex chromosome.

(A) (B) (C) (D)

(242) Assertion A : In twins of opposite sex sterile female called free martin.

Reason : During development both the twins are connected by separate umbilical cord.

(A) (B) (C) (D)

Answers : (232-C), (233-A), (234-A), (235-A), (236-A), (237-D), (238-A), (239-A), (240-A), (241-C), (242-C)

- **True - False (T - F) types MCQs :**

(243) Read each of the following statement if statement is true select (T) and if statement is false select (F) for them:

(i) 22AA + XY $\rightarrow$ 0 Barr Body

(ii) 22AA + XX $\rightarrow$ 1 Barr Body

(iii) 22AA + XXY $\rightarrow$ 1 Barr Body

(A) FTT (B)FFF (C)TTF (D)TTT

(244) Read each of the following statement if statement is true select (T) and if statement is false select (F) for them :

(i) During gametogenesis there is no meiosis in Drone.

(ii) In Flagellaria plant male is heterogametic.

(iii) In Humulus japanic female has XXX.

(A) TFF (B) TFT (C) FFT (D)TTF

(245) Read each of the following statement if statement is true select (T) and if statement is false select (F) for them:

(i) □ = Normal Female

(ii) ○ = Normal male

(iii) □—○ = Marriage bar

(A) TTT (B) FFT (C) FTT (D) TFT

(246) Read each of the following statement if statement is true select (T) and if statement is false select (F) for them:

(i) Aneuploidy leads to Down's syndrome.

(ii) PKU is caused by dominant genes of autosomes.

(iii) SCA is a recessive character caused by the recessive gene located on X-sex chromosome.

(A) FFT (B) FFF (C) TFF (D) TTF

(247) Read each of the following statement if statement is true select (T) and if statement is false select (F) for them:

(i) The allele which is expressed is called dominant gene and the allele which is not expressed is called recessive gene.

(ii) The genes having single effects are called pleiotropic genes.

(iii) Mirabilis jalapa is best example of pleiotropism.

(A) TFF (B) FTF (C) FFT (D) FFF

(248) Read each of the following statement if statement is true select (T) and if statement is false select (F) for them:

(i) A blood group : Genotype I^AI^A and I^Ai (ii) AB blood group : Genotype I^AI^B and I^Bi

(iii) O blood group : Genotype ii

(A) TTT (B) TFT (C) FTT (D) FFT

(249) Read each of the following statement if statement is true select (T) and if statement is false select (F) for them:

(i) For child having O blood group, mother having O blood group then the blood group of father may be O, A and B

(ii) If mother having A blood group, father having A blood group then the blood group of child will be A, B, AB or O.

(iii)If mother and father both having B blood group then the blood group of child will be B, O or AB.

(A) FFF (B) FFT (C) TFF (D) TTT

(250) Read each of the following statement if statement is true select (T) and if statement is false select (F) for them:

(i) X/A =1 means normal female (ii) X/A =0.5 means sterile female (iii)X/A = 0.66 means intersex sterile

(A) FFT (B) TFT (C) FTF (D) TTF

(251) Read each of the following statement if statement is true select (T) and if statement is false select (F) for them :

(i) Gynandromorphs are individuals who show male characters on some part of the body and female characters on other parts of body.

(ii) Examples of gynandromorphs are Drosophila, butterflies, beetles, wasps, bees etc.

(iii) The loss of Y-chromosome cause Gynandromorphs.

(A) FFT (B)TTT (C)TTF (D)TFF

(252) Read each of the following statement if statement is true select (T) and if statement is false select (F) for them :

(i) In the case of thalassaemia the required RBCs is not generated in the blood of person.

(ii) In SCA RBCs converted in shape of sickle.

(iii) The person suffering with colour blindness can not distinguish red colour and green colour.

(A) FTT (B) FFT (C) TTT (D) FFF

Answers : (243-D), (244-A), (245-B), (246-C), (247-A), (248-B), (249-C), (250-B), (251-C), (252-A)

* **Column type MCQs :**

(253) Match column-I with column-II and find the correct answer :

Column – I	**Column – II**	
(I) $\frac{X}{A}$ =1	(p)Super female	(A) (I-p) (II-q) (III-r) (IV-s)
(II) $\frac{X}{A}$ = 0.5	(q) Normal male	(B) (I-r) (II-p) (III-q) (IV-s)
(III) $\frac{X}{A}$ = 1.5	(r) Normal female	(C) (I-s) (II-r) (III-p) (IV-q)
(IV) $\frac{X}{A}$ = 0.66	(s) Intersex sterile	(D) (I-r) (II-q) (III-p) (IV-s)

(254) Match column-I with column-II and find the correct answer :

Column – I	**Column – II**	
(I) xx-xo sex determination	(p)Klinefelter's syndrome	(A) (I-s) (II-r) (III-p) (IV-q)
(II)xo- type female	(q) Birds	(B) (I-s) (II-p) (III-q) (IV-r)
(III)xxy- type male	(r) Turner's syndrome	(C) (I-q) (II-p) (III-r) (IV-s)
(IV) zz-zw sex determination	(s) Hymenopterans	(D) (I-r) (II-q) (III-p) (IV-s)

(255) Match column-I with column-II and find the correct answer :

Column – I	**Column – II**	
(I) Sickle cell anemia	(p)7^{th} chromosome	(A) (I-r) (II-s) (III-p) (IV-q)
(II)PKU	(q) 4^{th} chromosome	(B) (I-s) (II-p) (III-r) (IV-q)
(III)Cystic fibrosis	(r) 11^{th} chromosome	(C) (I-p) (II-q) (III-r) (IV-s)
(IV) Huntington	(s) 12^{th} chromosome	(D) (I-q) (II-r) (III-p) (IV-s)

(256) Match column-I with column-II and find the correct answer :

Column – I	**Column – II**	
(I) Bateson and Punnet	(p) Observed that in insects, two kinds of sperms are produced.	(A) (I-p) (II-q) (III-r) (IV-s)
(II) Henking	(q) Identified X-body as a chromosome	(B) (I-s) (II-r) (III-q) (IV-p)
(III) Mc Lung	(r) The chromosomal theory of sex-determination was proposed.	(C) (I-s) (II-p) (III-q) (IV-r)
(IV) Miss stevens	(s) Experiments indicative of Linkage were first performed on sweet pea plant.	(D) (I-q) (II-r) (III-p) (IV-s)

(257) Match column-I with column-II and find the correct answer :

Column – I	**Column – II**	
(I) Correns	(p) Genetic balance theory	(A) (I-r) (II-q) (III-p) (IV-s)
(II) Bridges	(q) Theory of heterogamesis	(B) (I-p) (II-q) (III-s) (IV-r)
(III) Barr and Bertram	(r) Environmental effect on determination of sex	(C) (I-q) (II-p) (III-r) (IV-s)
		(D) (I-q) (II-p) (III-s) (IV-r)
(IV) Baltzar	(s) Sex chromatin	

(258) Match column-I with column-II and find the correct answer :

Column – I	**Column – II**	
(I) Liver Worts	(p) The sex organs are located on a haploid gametophyte.	(A) (I-p) (II-q) (III-r) (IV-s)
		(B) (I-q) (II-p) (III-s) (IV-r)
(II) Angiosperm	(q) Male heterogametic and female homogametic	(C) (I-s) (II-r) (III-p) (IV-q)
(III) Flagellaria	(r) Female is heterogametic and male is homogametic	(D) (I-r) (II-q) (III-s) (IV-p)
(IV) Dioscoria sinulate	(s) Female (AA+XX), male (AA+XO)	

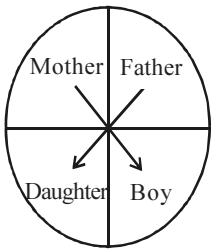
(259) Match column-I with column-II and find the correct answer :

Column – I	**Column – II**	
(I) Phenyl ketonuria	(p) Phenylalanine can not be converted into tyrosine.	(A) (A) (I-q) (II-p) (III-r) (IV-s)
(II) Alkaptonuria	(q) Homogentisic acid can not be converted into acetoacetic acid.	(B) (I-p) (II-r) (III-q) (IV-s)
(III) Albinism	(r) Tyrosine can not be converted into melanin pigment.	(C) (I-s) (II-r) (III-p) (IV-q)
(IV) Thalassaemia	(s) Required haemoglobin is not generated in the blood.	(D) (I-p) (II-q) (III-r) (IV-s)

Answers : (253-D), (254-A), (255-A), (256-C), (257-D), (258-A), (259-D)

* **Figure based MCQs :**

(260) Represented below is the inheritance pattern of a certain type of traits in humans. Which one of the following conditions could be an example of this pattern.



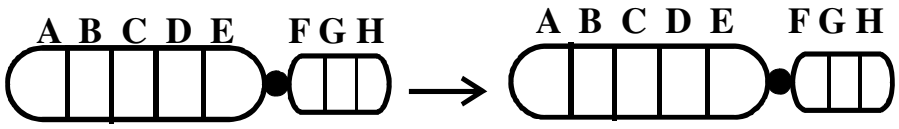
(A) Phenyl Ketonuria

(B) Sickle cell anaemia

(C) Haemophilia

(D) Thalassemia

(261) Given below is the representation of a kind of chromosomal mutation. What is the kind of mutation represented.



(A) Deletion (B) Duplication (C) Inversion (D)Reciprocal translocation

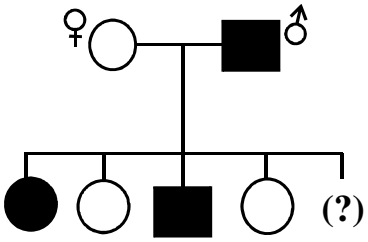
(262) In the given human hand pedigree which character is represented and what is the probability of disease occurrence in fifth child.

(A) Polydactyly (x-linked recessive disorder), 50%

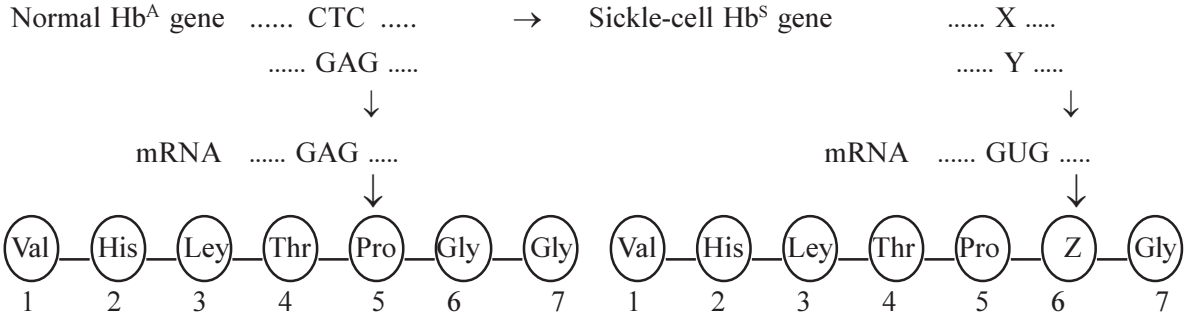
(B) Polydactyly (x-linked dominant disorder), 50%

(C) Polydactyly (autosomal recessive disorder), 50%

(D) Polydactyly (autosomal dominant disorder), 50%



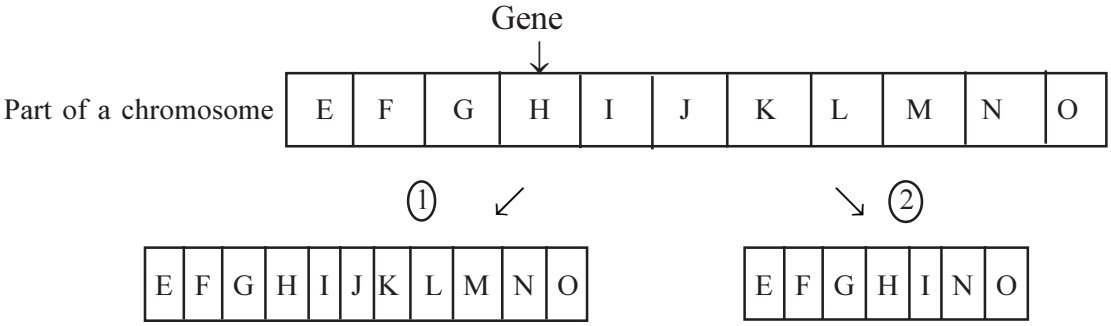
(263) Sickle cell anemia is an autosome linked recessive trait that can be transmitted from parents to the offspring when both the partners are carrier for all the gene (or heterozygous). The disease is controlled by a single pair of allele Hb^A and Hb^S. Out of the three possible genotypes only homozygous individuals for Hb^S(Hb^S, Hb^S) are lethal. Select the right option in which x, y and z are correctly identified.



(A) X - CAC, Y - GTC, Z - His (B) X - GTG, Y - CAC, Z - Val

(C) X - CAC, Y - GTG, Z - phe (D) X - CAC, Y - GTG, Z - Val

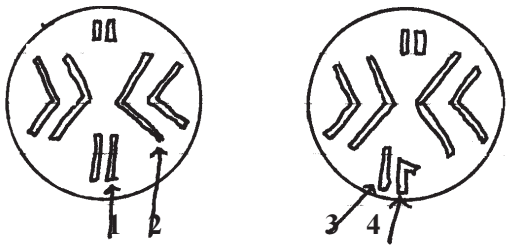
(264) The given figure shows two types of chromosome mutation. These are called ..... .



(A) 1- Inversion, 2 – substitution (B) 1- Inversion, 2 - Deletion

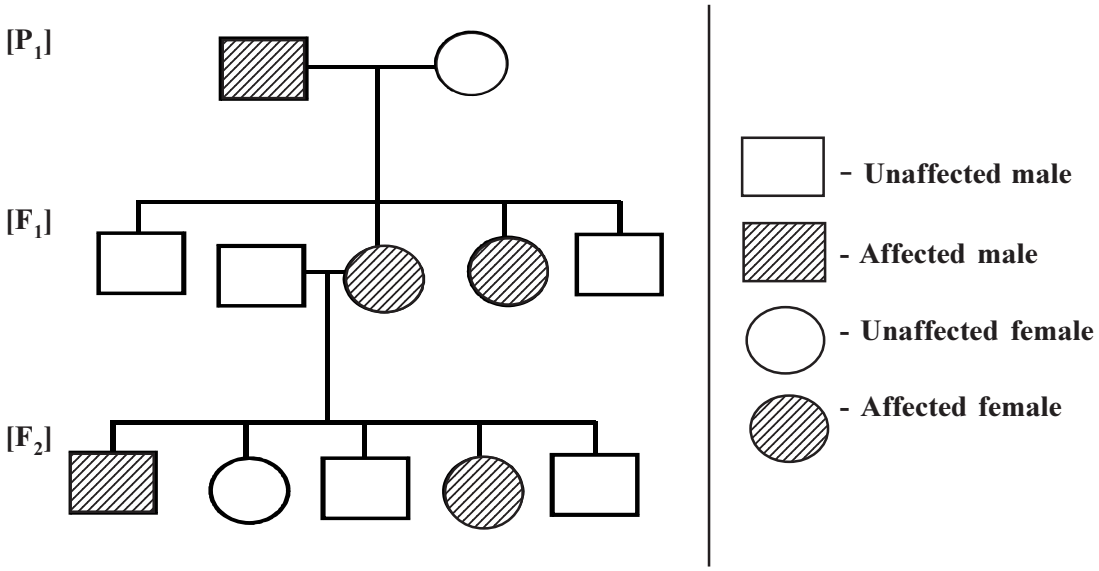
(C)1- Duplication, 2- Substitution (D) 1- Duplication, 2- Deletion

(265) The following figure refer to the chromosome complement of each sex of fruit bfly by which number is a Y chromosome labelled.



(A) 4 (B) 3 (C) 2 (D) 1

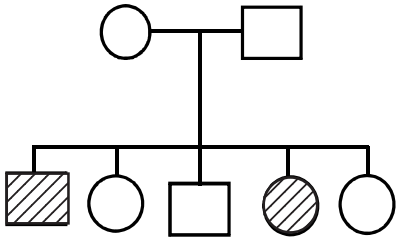
(266) Given below is a pedigree chart showing the inheritance of a certain sex-linked trait in humans. The trait traced in the given pedigree chart is ..... .



(A) X-linked dominant inheritance (B) X-linked recessive inheritance

(C) Y-linked dominant inheritance (D) Y-linked recessive inheritance

(267) The following is a pedigree chart of a family with five children. It shows the inheritance of attached ear-lobes as opposed to the free ones. The square represent the male and circle the female individuals. Which one of the following conclusions drawn is correct.



(A)The parents are homozygous dominant (B) The parents are homozygous recessive

(C) The parents are heterozygous (D) The traits is y – linked

Answers : (260-C), (261-B), (262-D), (263-D), (264-D), (265-A), (266-A), (267-D)

* **MCQs for NEET :**

(268) A man having the genotype EEFf and GgHH can produce P number of genetically different sperms, and a woman of genotype IiLLMmNn can generate Q number of genetically different egg. Determine the value of p and Q.

(A) P =4, Q =4 (B)P = 4, Q = 8 (C) P = 8, Q = 4 (D) P = 8, Q = 8

(269) Ratio of progeny when a red coloured heterozygote is crossed with a white coloured plant in which red colour is dominant in white colour.

(A) 3 : 1 (B) 1:1 (C)1:2:1 (D) 9:3:3:1

(Hint): The cross of heterozygous dominant with its recessive parent is called test cross. The test cross gives 1:1 ratio in monohybrid condition where as 1:1:1:1 in dihybrid condition.

(270) How many types of gametes may be produced by genotype D/d:E/e:F/f.

(A) 27 (B)8 (C)3 (D)6

(Hint) : Kinds of gametes may be calculated by following formula : Number of gametes = $(2)^n$ n is number of alleles

e.g. D/d: E/e : F/f have trihybrid cross

i.e. n =3 than kind of gametes = $(2)^3 = 2f2f2 = \boxed{8}$

(271) The term 'genotype' was coined by ..... .

(A) H.J. Muller (B)T.Boveri (C) W.S. Sutton (D)W.L.Johanssen

(272) When a tall plant with round seeds(TTRR) crossed with a dwarf plant with wrinkle seeds(ttrr), the F_1 generation consists of tall plants with round seeds. What would be the proportion of dwarf plant with wrinkle seeds in F_1 generation ?

(A)1/4 (B)1/16 (C)0 (D)1/2

(Hint) : (P) : Tall palnt with round seeds TTRR × Dwarf plants with wrinkled seeds tt rr

gametes : TR tr

(F_1) generation : Tt Rr Tall plant with round seeds

∴ Therefore, the proportion of dwarf plants with wrinkle seeds is zero.

(273) The dwarfness in plants of F_2 generation is ..... .

(A) recessive gene (B) dominant gene

(C) co-dominant gene (D) incomplete dominant gene

(274) 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) 50:50 (B) 9:1 (C) 1:3 (D) 3:1

(275) When yellow round heterozygous pea plants are self fertilized, the frequency of occurrence of RrYY genotype among the offspring is ..... .

(A) 9/16 (B) 3/16 (C) 2/16 (D) 1/16

(276) Test cross is used to ..... .

(A) check heterozygosity in F_1 generation (B) check heterozygosity in F_2 genration

(C) check independent assortment (D) check Dominance

(277) In Mendelism, linkage was not observed due to ..... .

(A) mutation (B) independent assortment

(C) synapsis (D) crossingover

(278) Among the seven pairs of contrasting traits in pea plants as studied by Mendel, the number of traits related to flower, pod and seed respectively were ..... .

(A) 2,2,2 (B) 2,2,1 (C) 1,2,2 (D) 1,1,2

(279) 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

(Hint): Test cross include cross of F_1 the recessive parents i.e.(Tt×tt).

(280) In a dihybrid cross where two parents differ in two pairs of contrasting traits like seed colour yellow (YY) and seed colour green (yy) with seed shape round (RR) and seed shape wrinkled (rr), the number of green coloured seeds(yy) among sixteen products of F_2 generation will be.

(A) 2 (B) 4 (C) 6 (D) 8

(Hint): Dihybrid cross

(281) In man, the blue eye colour is recessive to the brown eye colour. If the boy has brown eye and his mother is blue eyed, what would be the phenotype of his father ?

(A) Black eye (B) Brown eye (C) Green eye (D)Blue eye

(282) Pure homozygous offsprings in a dihybrid cross in the F_2 generation will be.

(A) 1/2 (B) 1/4 (C) 1/8 (D) 1/16

(283) Mendel crossed a pure white flowered recessive pea plant with a dominant pure and red-flowered plant. The first generation of hybrids from the cross should show.

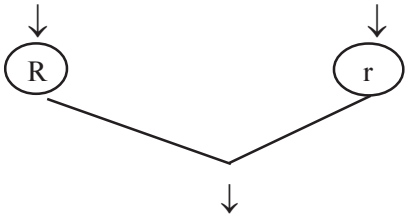
(A) 50% white flowered and 50% red flowered plants. (B) All red flowered plants.

(C) 75% red flowered and 25% white flowered plants. (D) All white flowered plants.

(Hint): All red flowered plants; according to Mendel's law of dominance.

(P) : RR x rr

Red dominant Recessive white



F_1 Rr

All Red

(284) If in a dihybrid cross Mendel had used two such characters which have, linked, he would have faced difficulty in explaining the results on the basis of his ..... .

(A) law of segeregation (B) law of multiple factor hypothesis

(C) law of independent assortment (D) law of dominance

(Hint) : In this experiment, Mendel stated that each character is governed by a single gene and there is no linkage and gene interaction. He failed to explain his law of independent assortment in the presence of linkage.

(285) From a cross AaBB × aaBB, following genotype ratio will be obtained in F_1 generaion.

(A) 1 Aa BB : 1 aa BB (B) 1 Aa BB : 3 aa BB

(C) 3 Aa BB : 1 aa BB (D) All Aa BB : No aa BB

(Hint):

AaBB × aaBB Gametes for F_1 = AB, aB and aB, aB

After crossing = AaBB, aaBB Ratio 1:1

(286) From a single ear of corn, a farmer planted 200 Kernels which produced 140 tall and 40 dwarf plants. The genotype of these offspring are most likely ..... .

(A) TT, Tt and tt (B) TT and tt only (C) TT and Tt only (D) Tt and tt only

(Hint):

TT is homozygous tall plant; (48 plants)

Tt is heterozygous tall plant (90 plants)

tt is homozygous dwarf plant (40 plants)

So, on the basis of Mendel's Monohybid cross raio will be 1 : 2 : 1.

(287) When AABB and aabb are crossed, in F_2 generation the ratio of AaBb will be

(A) 1/16 (B) 2/16 (C) 8/16 (D) 4/16

(288) If a cross is made between AA and aa, the nature of F_1 progeny will be ..... .

(A)Genotypically AA, Phenotypically a (B) Genotypically Aa, Phenotypically a

(C) Genotypically Aa, Phenotypically A (D) Genotypically aa, Phenotypically A

(Hint): AA × aa

↓ ↓

(F_1) : A a

(289) A self fertilizing trihybrid plant forms ..... .

(A)8 different gametes and 16 different zygotes.

(B) 8 different gametes and 32 different zygotes.

(C) 8 different gametes and 64 different zygotes.

(D) 4 different gametes and 16 different zygotes.

(Hint) : The offsprings show 27:9:9:9:3:3:3:1 ratio is found in trihybrid cross.

(290) When heterozygous red (Dominant) flower is crossed with white flower the progeny would be.

(A) 350 red : 350 White (B) 450 red : 250 White

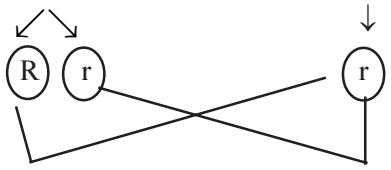
(C) 380 red : 320 White (D) None of these

(Hint) : When heterozygous red (dominant) flower (Rr) is crossed with white flower (rr), red and white flowered plants will be produced in equal ratios. The cross can be given as ..... .

(Hint): Rr × rr

Red White

Gametes



(F_1) Rr rr

generation 1 : 1

(291) In a population of 1000 individuals 360 belong to genotype AA, 480 to Aa and the remaining 160 to aa. Based on this data, the frequency of allele A in the population is ..... .

(A) 0.6 (B) 0.7 (C)0.4 (D)0.5

(Hint): According to hardy Weinberg principle

$P^2 + 2pq + q^2 = 1$;

$(p+q)^2 = 1$

(AA) p^2 = 360 out of 1000 individual or p^2 = 36 out of 100

q^2 = 160 out of 1000 or q^2 = 16 out of 100

so, $9 = \sqrt{16} = 4$

As p + q = 1

So , p is 0.6

(292) Which event responsible in Drosophila for no independent assortment of gene A and B ?

(A) Repulsion (B) Linkage (C) Crossing over (D) Recombination

(293) Which condition is responsible for PKU ?

(A) Trisomy (B) Monosomy

(C) Autosomal Dominant gene (D) Autosomal Recessive gene

(294) The loss of one member of chromosome instead of two in pair, the condition is called ..... .

(A) Monosomy (B)Nullisomy (C)Trisomy (D)Tetrasomy

(295) A diseased man marries a normal woman. They get three daughter and five sons. All the daughters were diseased and sons were normal. The gene of this disease is ..... .

(A) Autosomal Dominant (B) Sex linked dominant

(C) Sex limited character (D) Sex linked recessive

(296) Genes present in the cytoplasm of eukaryotic cells, are found in.

(A) Mitochondria and ribosomes (B) Plastids and mitochondria

(C) Plastids and lysosomes (D) Mitochondria and golgibody

(297) In Drosophila, sex is determined by ..... .

(A) whether the egg is fertilized or develops parthenogonetically

(B) X and Y chromosomes

(C) The ratio of number of X-chromosomes to the sets of autosomes

(D) The ratio of pairs of X-chromosomes to the pairs of autosomes

(298) In plants the cytoplasmic male sterility found in ..... .

(A) cytoplasmic genes (B) plastid gene complex

(C) mitochondrial gene complex (D) nuclear gene complex

(Hint) : The pollen sterility which is controlled by cytoplasmic genes is known as cytoplasmic male sterility. Usually the cytoplasm of zygote comes primarily from the egg cell and due to this progeny of such male sterile plants would always be male sterile.

In plants male sterility is of five types : (1) Genetic male sterility

(2) Cytoplasmic male sterility

(3) Cytoplasmic genetic male sterility

(4) Chemical induced male sterility and

(5) Transgenic male sterility

(299) Recessive traits studied by Mendel in pea is ..... .

(A) Round shape (B) Axial position of the flower

(C) Green colour of seed cotyledon (D) Green colour of the pod

(300) The linkage map of x-chromosome of fruit fly has 66 units with yellow body gene (y) at one end and bobbed hair (b) gene at the other end. The recombination frequency between these two genes (y and b) should be.

(A) 100% (B) 66% (C) 40% (D) 50%

(Hint) : The actual distance between two genes is said to be equivalent to the percentage of crossing over between these genes i.e. 66 %.

Crossing over chances between y and b genes suggest that these are to be placed on the chromosome at a distance of 66 untis.

(301) It is also known as Christmas disease ..... .

(A) Sickle cell anemia (B) Thalassaemia (C) Hemophilia (D) Colour blindness

(Hint) : Christmas disease also called Hemophilia B or factor IX (Christmas factor) Hemophilla, is a rare genetic disorder in which your body doesn't clot properly.

(302) Down's syndrome is caused by an extra copy of chromosome number 21. What percentage of offspring produced by an affeceted mother and normal father would be affected by this disorder ..... .

(A) 25% (B) 75% (C) 50% (D) 100%

(303) In which of the following colour blindness is inherited ?

(A) In male and female both (B) In female only

(C) In males only (D) In none of the above

(304) A male human is heterozygous for autosomal genes A and B and is also hemizygous for hemophilic gene h. what proportion of his sperms will be abh ?

(A) $\frac{1}{8}$ (B) $\frac{1}{32}$ (C) $\frac{1}{16}$ (D) $\frac{1}{4}$

(Hint) : Chance for getting A will = $\frac{1}{2}$ Chance for getting B will = $\frac{1}{2}$

Chance for getting h will = $\frac{1}{2}$ Hence, ABh = $\frac{1}{2} \times \frac{1}{2} \times \frac{1}{2} = \frac{1}{8}$

(305) A normal woman, whose father was colourblind is married to a normal man. The offsprings would be.

(A) 70% colour blind (B) 25 % colour blind

(C) Normal (D) 100% colour blind

(Hint) : Colour blind father's daughter always carrier.

(306) Kappa particles indicate ..... .

(A) nuclear inheritance (B) nucleo cytoplasmic inheritance

(C) mutation (D) cytoplasmic inheritance

(307) At a particular locus frequency of A allele is 0.6 and that of a 0.4. What would be the frequency of heterozygotes in a random mating population of equilibrium?

(A) 0.36 (B) 0.48 (C) 0.16 (D) 0.24

(Hint) : According to Hardy Weinherg

$(p+q)^2 = 1$

$P^2 + 2pq + q^2 = 1$

Heterozygotic frequency is (2pq).

$\therefore$ $2pq = 2 \times 0.6 \times 0.4 = 0.48$

Where,

p = frequency of dominent gene

q = frequency of dominent gene

pq = Heterozygous dominant

$\therefore$ p = A = 0.6

p = a = 0.4

(308) It is not a hereditary disease.

(A) Thalassaemia (B) Hemophilia (C) Cystic fibrosis (D) Cretinism

(309) Lampbrush chromosomes are visible ..... .

(A) in diplotene of meiosis (B) in prophase of meiosis

(C) in interphase (D) in metaphase of meiosis

(310) It is an example of polygenic inheritance.

(A) Production of drone (B) The shape of pod in pea

(C) Skin colour in man (D) Colour of flowers in mirabilis

(311) Why SCA is a very common in African race ?

(A) It is not a lethal disease. (B) It protect against Malaria.

(C) It controlled by dominant genes. (D) It controlled recessive genes.

(312) Character choosen by Mendel are located on how many chromosome ?

(A)4 (B) 6 (C) 5 (D) 7

(313) Which is correct for chromosomal disorders?

(A) Klinefelter's syndrome – 44 autosomes + XXY

(B) Colour blindness – Y-linked disease

(C) Erythroblastosis - X-linked disease

(D) Down's syndrom – 44 Autosomes + XO

(314) It is true for ADA (Adenosine De Aminase) Deficiency.

(A) By activaters of ADA

(B) Bone marrow transplantation from matched sibling donor.

(C) By enzyme replacement therapy

(D) By introducing lymphocytes at short interval which produced through genetic engineering having active ADA

(315) In pea plants, yellow seeds are dominant to green. If a Homozygous yellow seeded is crossed with a green plant. What ratio of green seeded plants would you expect in F_2 generation ?

(A) 50% (B) 25% (C) 75% (D) 100%

(Hint) : Mendels Monohybrid cross.

(316) It is a mutagen ..... .

(A) IR- rays (B) IAA (C) Ehylene (D) Gama-rays

(Hint) : IR short wavelength rays which having capacity to penetrate in deep of body and change the base sequences of DNA. So it called mutagen.

(317) Mating between two different pure-bred lines that lead to best offsprings because ..... .

(A) Heterosis (B) Transformation (C) Splicing (D) Metamorphosis

(Hint) : Heterosis also called hybrid vigour, the increase in such characteristics as size, growth rate, fertility and yield of a hybrid organism over those of its parents.

Plant and animal breeders exploit heterosis by mating two different pure-bred lines that have certain desirable traits.

(318) The zygotic cell will develop into female child due to presence of ..... .

(A) XX (B) Y (C) X (D) XY

(Hint) : Sex-determination in woman, twenty third pair consists of two similar x- sex chromosomes.

(319) 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

(320) It is true for hemophilia.

(A) Hemoglobin is not produced. (B) Melanin accumulate in skin.

(C) Blood clotting is not induced. (D) Delayed blood clotting.

(321) A dihybrid for qualitative trait is crossed with homozygous recessive individual of its type, the phenotypic ratio is : ..... .

(A) 1:2:1 (B) 3:1 (C) 1:1:1:1 (D) 9:3:3:1

(322) In a medico-legal case of accidental interchange between two babies in a hospital; the baby of blood group A could not be rightly given to a people.

(A) Husband of group A and wife of group O (B) Husband of group O and wife of group A

(C) With both husband and wife of group O (D) Both husband and wife of group A

(323) If Mother is A blood group and father is AB blood group. What will be the possible blood group in their progeny.

(A) O, A (B) A, B, AB (C) O, A, B (D) O, A, B, AB

(324) Which chromosome determine sex in human ?

(A) X - chromosome (B) Y - chromosome

(C) A/X - chromosome (D) A and B both

(325) If dwarf pea plant was treated with Gibberellic acid, it grew as tall as the pure tall pea plant. If this treated plant is crossed with pure tall plant then the phenotypic ratio of is likely to be ..... .

(A) all dwarf (B) 50% dwarf 50% tall

(C) 75 % tall 25% dwarf (D) All tall

(326) It is true for Turner's syndrome ..... .

(A) XO (B) XXY (C) XXX (D) XYY

(Hint) : This is a sex-linked disorder. When woman has only one X-sex chromosome, instead of the normal two, this Turner's syndrome occur. This disorder is caused by manosomy of sex chromosomes.

(327) Complete linkage : ..... .

(A) Male drosophila (B) Female drosophila

(C) Female butterfiles (D) Nome of above

(Hint): No crossing over occurs in male drosophila such results represent complete linkage.

(328) Which chemical induced artificial polyploidy in plant ?

(A) colchicine (B) Benzene (C) Acetocarmine (D) None of above

(329) The loss of a chromosomal segment is due to ..... .

(A) inversion (B) duplication (C) deletion (D) transversion

(330) It shows genotypic ratio and phenotypic ratio similar.

(A) Mirabilis (B) Drosophila (C) Pisum sativum (d) Silkworm

(331) A woman is married for second time. Her first husband was ABO blood type A, and her child by that marriage was Type O. Her new husband is Type B and their child is type AB. What is the woman's ABO genotype and blood type ?

(A) I^AI^O : Blood type A (B) I^AI^B : Blood type B

(C) I^BI^O : Blood type B (D) I^OI^O : Blood type O

(332) Name the sex linked disorder when a woman has extra two x-sex chromosome, instead of the normal two.

(A) Turner's syndrome (B) Kline felter's syndrome

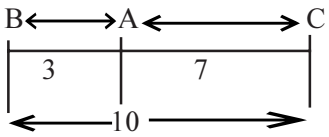
(C) Super female (D) Down's syndrome

(Hint) : Non disjunction of chromosomes lead to change the member of chromosomes in gametes. Such gametes take part in the process of fertilization and causes abnormality.

(333) The map distance between genes A and B is 3 units between B and C 10 units and between C and A 7 units; the order of the genes in a linkage map constructed on the above data would perhaps be ..... .

(A) A, B, C (B) A, C, B (C) B, C, A (D) B, A, C

(Hint):



(334) How many linked gene present in bacteria ?

(A) 4 (B) 2 (C) 1 (D) 5

(Hint) : Number of linked gene is always same then the number of chromosome.

(335) How may linked gene group present in pisum sativum ?

(A) 2 (B) 5 (C) 7 (D) 9

(Hint) : Prokaryotic bacteria E.coli having only one circular DNA hence no. of linked gene in bacteria will be 1.

(336) If Maize having 10 pairs of chromosomes : then the number of linked genes in maize is ....

(A) 5 (B) 10 (C) O (D) 20

(Hint) : In maize n = 10, hence number of linked gene is also 10.

(337) It is true for descending order :

(A) Gene → Cistrone → muton → Recon (B) Gene → muton → Cistrone →Recon

(C) Gene → Recon → Cistrone → muton (D) Gene → Cistrone → Recon → muton

(338) Jumping genes are found in ..... .

(A) Eukaryotes (B) Bacteriophage

(C) Bacteria (D) Eukaryotes and prokaryotes

(Hint) : Jumping gene found both in eukaryota and prokaryota it is discovered by mac.clintock in maize.

(339) Smallest structure having the power of replicating itself is ..... .

(A) Chloroplast (B) Gene

(C) Mitochondria (D) Ribosome

(340) Nucleosome consists of : ..... .

(A) Nucleolus (B) Genes (C) Micro filaments (D) Histones

(Hints) : Histones are main structural Protein found in eukaryotic cells.

(341) Plant A is having chromosome no. 2n = 12 and B having zn = 16 Both are crossed to form allotetraploid C what is the Chromosome number of C.

(A) 32 (B) 14 (C) 28 (D) 7

(342) From a cross AABb × aaBb, the genotypes AaBB : AaBb : Aabb: aabb will be obtained in the following ratio.

(A) 1:1:1:1 (B) 1:2:1:0 (C) 0:3:1:0 (D) 1:1:1:0

(Hint): ♂ AABb × aaBb ♀

Male →

	Gametes →	AB	Ab	AB	Ab
↓	aB	AaBB	AaBb	AaBB	AaBb
FeMale	ab	AaBb	Aabb	AaBb	Aabb
	aB	AaBB	AaBb	AaBB	AaBb
	ab	AaBb	Aabb	AaBb	Aabb

∴ AaBB : AaBb : Aabb : aabb

4 : 8 : 4 : 0

∴ AaBB = 1, AaBb = 2, Aabb = 1, aabb = 0

(343) How many different types of gametes can be formed by F_1 progeny resulting from the following cross ?

AA BB CC X aa bb cc

(A) 3 (B) 8 (C) 27 (D) 64

(344) The cause of cat-cry syndrome is due to : ..... .

(A) loss of a segment of X-chromosome (B) loss of a segment of 5^{th} chromosome

(C) loss of segment of Y-chromosome (D) none of the above

(345) Transition type of gene mutation is caused when, ...

(A) GC is replaced by TA (B) CG is replaced by a GC

(C) AT is replaced by CG (D) AT is replaced by GC

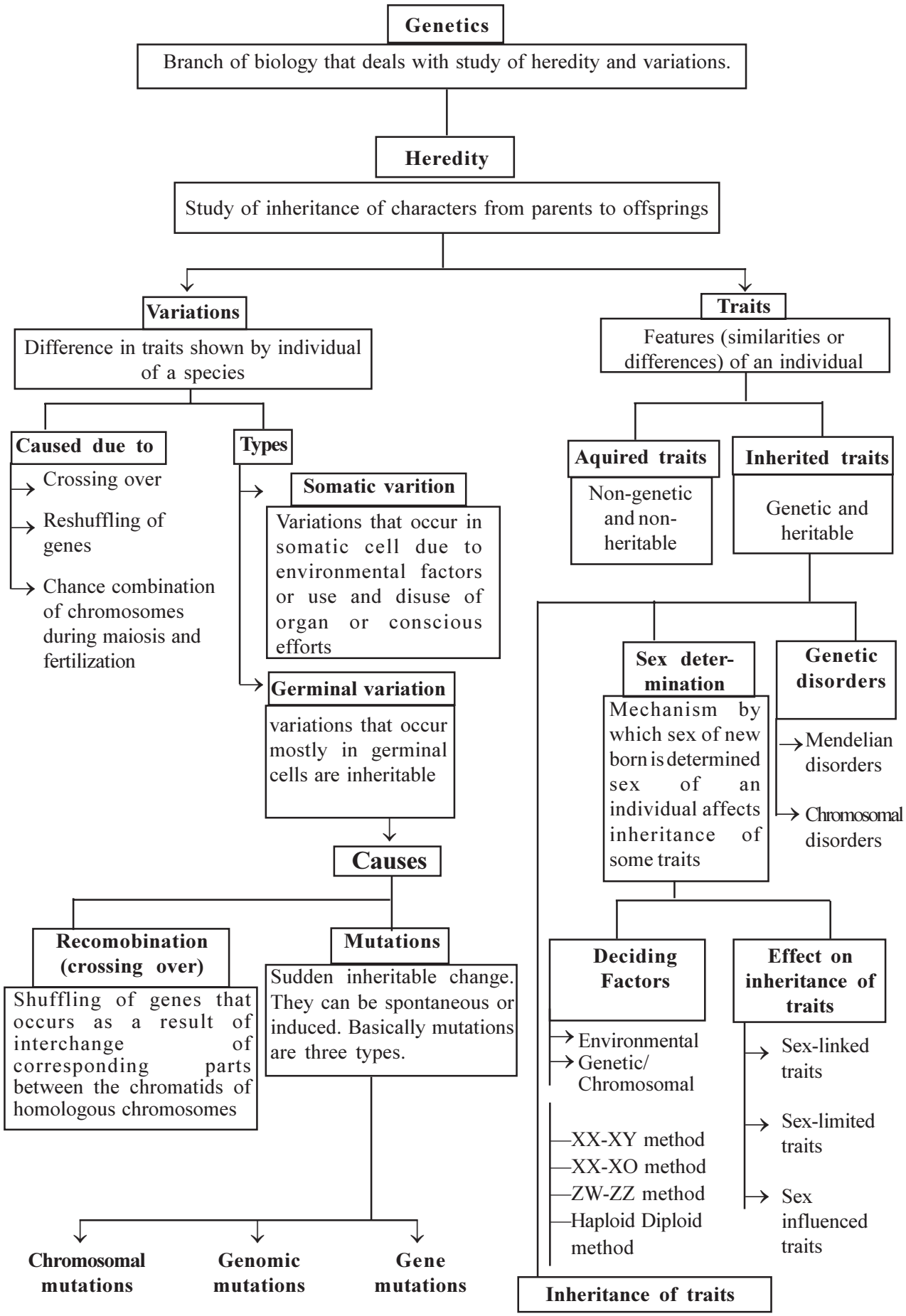
(Hint) :In transition a nitrogen base is replaced by another of its type. i.e. one purine is replaced by another purine (A=G) while one pyrimidine by another pyrimidine (C=T or U)

(346) The term 'mutation' was first utilized by ..... .

(A) Gregor Johann Mendel (B) De Vries

(C) Hardy Weinberg (D) Charles Darwin

Answers : (268-B), (269-B), (270-B), (271-D), (272-C), (273-A), (274-A), (275-C), (276-A), (277-B), (278- A), (279-C), (280-B), (281-B), (282-C), (283-B), (284-C), (285-A), (286-A), (287-D), (288-C), (289-C), (290-A), (291-A), (292-B), (293-D), (294-A), (295-B), (296-B), (297-C), (298-A), (299- C), (300-B), (301-C), (302-C), (303-A), (304-A), (305-B), (306-D), (307-B), (308-C), (309-A), (310-C), (311-B), (312-A), (313-A), (314-B), (315-B), (316-D), (317-A), (318-A), (319-D), (320- D), (321-C), (322-C), (323-A), (324-B), (325-D), (326-A), (327-A), (328-A), (329-C), (330-A), (331-A), (332-C), (333-D), (334-C), (335-C), (336-B), (337-D), (338-D), (339-B), (340-D), (341-C), (342-B), (343-B), (344-B), (345-D), (346-B)


Genetics
Branch of biology that deals with study of heredity and variations.
Heredity
Study of inheritance of characters from parents to offsprings
Variations
Difference in traits shown by individual of a species
Caused due to
Crossing over
Reshuffling of genes
Chance combination of chromosomes during maiosis and fertilization
Types
Somatic varition
Variations that occur in somatic cell due to environmental factors or use and disuse of organ or conscious efforts
Germinal variation
variations that occur mostly in germinal cells are inheritable
Causes
Recomobination (crossing over)
Shuffling of genes that occurs as a result of interchange of corresponding parts between the chromatids of homologous chromosomes
Mutations
Sudden inheritable change. They can be spontaneous or induced. Basically mutations are three types.
Chromosomal mutations
Genomic mutations
Gene mutations
Traits
Features (similarities or differences) of an individual
Aquired traits
Non-genetic and non-heritable
Inherited traits
Genetic and heritable
Sex determination
Mechanism by which sex of new born is determined sex of an individual affects inheritance of some traits
Genetic disorders
Mendelian disorders
Chromosomal disorders
Deciding Factors
Environmental
Genetic/ Chromosomal
XX-XY method
XX-XO method
ZW-ZZ method
Haploid Diploid method
Effect on inheritance of traits
Sex-linked traits
Sex-limited traits
Sex influenced traits
Inheritance of traits

Inheritance of Traits

Pedigree Analysis

Analysis of a family pedigree to find the movement and distribution of certain genetic traits. It helps to find out dominance or recessive etc., nature of certain genes

Mendelism

Factors = genes are the carriers of traits. Their inheritance follow 3 laws.

→ **Low of Dominance**

The allele of a gene shows dominance over other

→ **Law of segregation (or) purity of gametes**

Alleles present in a generation retain their purity (do not mix up) and segregate in next generation

→ **Law of Independent Assortment**

Alleles of genes for two different characters can assort independent of each other

Chromosomal theory of inheritance

Sutton and Boveri (1902) proposed this theory which states that mendelion factors or genes are located at specific loci on chromosomes and it is the chromosome that segregates and assort indepenently during meiosis

Linkage

Phenomenon of certain genes staying together and their enblock inheritance from one generation to another. This affects in heritance of traits and interferes with independent assortment

→ Complete linkage

→ Incomplete linkage