UNIT

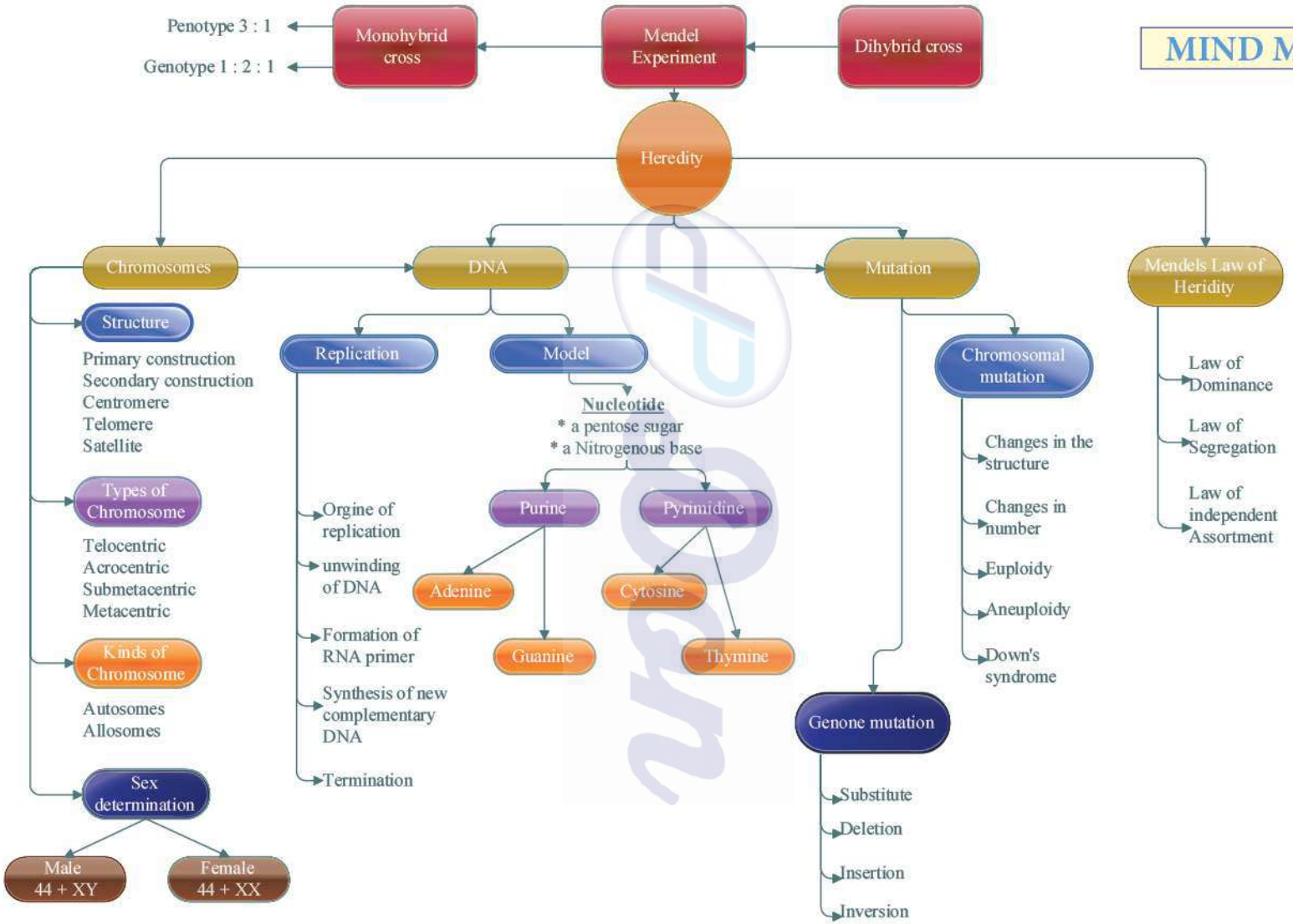
18

Heredity

POINTS TO REMEMBER

Mendel	Discovered the basic principle of heredity
Monohybrid cross	Inheritance of only one pair of contrasting characteristics.
Genotype	Genetic expression of an organism
Phenotype	External expression of a particular trait.
Genes	Segments of DNA responsible for inheritance of particular phenotypic character.
(TT) or (tt)	homozygous
(Tt)	heterozygous
Allele	Two factors making up a pair of contrasting character
DNA replication	Process by which DNA makes exact copies of itself.
Mutation	Sudden change in the genetic material (DNA) of an organism.
Ploidy	Addition or deletion in the number of chromosomes present in a cell.
Gene / Point mutation	Changes occurring in the nucleotide sequence of a gene.
Hybrid	An offspring resulting from a cross between two genotypically differnt parents.
Karyotype	Karyotype is the number, size and shape of chromosomes in the cell nucleus of an organism.
Dominant	Character which express itself.
Recessive	Character which is masked.
Dihybrid cross	Inheritance of two pairs of contrasting characteristics.
Chromosome	Thin, thread like structure found in cell.
Waldeyer	Term chromosome coined
T.H. Morgan	Determining the role of chromosomes in heredity.

MIND MAP



Locus	Gene is present at a specific position on a chromosome.
Chromonema	Chromatids are made up of spirally coiled thin structure.
Centromere	Two arms of a chromosome meet at a point.
Satellite	Knob like appendage at the end of chromosome.
Telomere	Protective sequences of nucleotides found in chromosomes.
Telocentric	Centromere found on the proximal end.
Acrocentric	Centromere found at the one end with a short arm and a long arm.
Submetacentric	Centromere at the centre of chromosome.
Metacentric	Two equal arms, 'V' shaped.
Autosome	Determines the somatic characters.
Allosome	Determines the sex of the individual.
Diploid(2n)	Chromosome occurs in pairs.
Haploid(n)	Chromosome occur in single.
Idiogram	Diagrammatic representation of karyotype of a species.
Watson and Crick	Three dimensional model of DNA
Purine	Adenine and Guanine
Pyrimidines	Cytosine and Thymine
Nucleoside	Nitrogen base + sugar
Nucleotide	nucleoside + phosphate
Helicase	binds to the origin of replication site.
DNA polymerase	After the formation of RNA primer, nucleotides are added with the help of an enzyme
DNA ligase	Fragments are joined together
Homogametic	Female gametes (22+XX)
Heterogametic	Male gametes (22 +XY)
Hugo De Vries	Introduced the term mutation was introduced
Ploidy	Addition or deletion of chromosomes
Euploidy	It bears more than the usual number of chromosomes.
Triploidy	Three haploid sets of chromosomes
Aneuploidy	loss or gain of one or more chromosomes in a set.
Trisomy	Extra copy of chromosome 21
Sickle cell anaemia	Caused by mutation of a single gene.

Textbook Evaluation

I. Choose the most suitable answer from the given four alternatives and write the option code and corresponding answer:

1. **According to Mendel alleles have the following character**
   a) Pair of genes
   b) Responsible for character
   c) Production of gametes
   d) Recessive factors

2. **9 : 3 : 3 : 1 ratio is due to** ★★
   a) Segregation
   b) Crossing over
   c) Independent assortment
   d) Recessiveness

3. **The region of the chromosome where the spindle fibres get attached during cell division**
   a) Chromomere
   b) Centrosome
   c) Centromere
   d) Chromonema

4. **The centromere is found at the centre of the _____ chromosome.**
   a) Telocentric
   b) Metacentric
   c) Sub-metacentric
   d) Acrocentric

5. **The _____ units form the backbone of the DNA.** ★★
   a) 5 carbon sugar
   b) Phosphate
   c) Nitrogenous bases
   d) Sugar phosphate

6. **Okasaki fragments are joined together by _____.**
   a) Helicase
   b) DNA polymerase
   c) RNA primer
   d) DNA ligase

7. **The number of chromosomes found in human beings are _____.** ★★
   a) 22 pairs of autosomes and 1 pair of allosomes.
   b) 22 autosomes and 1 allosome
   c) 46 autosomes
   d) 46 pairs autosomes and 1 pair of allosomes.

8. **The loss of one or more chromosome in a ploidy is called _____.**
   a) Tetraploidy
   b) Aneuploidy
   c) Euploidy
   d) polyploidy

Ans:

1.	b)	Responsible for character	2.	c)	Independent assortment
3.	c)	Centromere	4.	b)	Metacentric
5.	d)	Sugar phosphate	6.	d)	DNA ligase
7.	a)	22 pairs of autosome and 1 pair of allosomes	8.	b)	Aneuploidy

II. Fill in the blanks

1. **The pairs of contrasting character (traits) of Mendel are called _____.**
2. **Physical expression of a gene is called _____ .**
3. **The thin thread like structures found in the nucleus of each cell are called _____.**
4. **DNA consists of two _____ chains.** ★★

5. **An inheritable change in the amount or the structure of a gene or a chromosome is called _____.**

Ans:

1.	Alleles	2.	Phenotype
3.	Chromosomes	4.	polynucleotide
5.	mutation		

III. Identify whether the statement are True or False. Correct the false statement

1. **A typical Mendelian dihybrid ratio of F_2 generation is 3:1.** **False**
   A typical Mendelian dihybrid ratio of F_2 generation is 9: 3: 3: 1
2. **A recessive factor is altered by the presence of a dominant factor.** **True**
3. **Each gamete has only one allele of a gene.** **True**
4. **Hybrid is an offspring from a cross between genetically different parent.** **True**
5. **Some of the chromosomes have an elongated knob-like appendages known as telomere.** ★★ **False**
   Some of the chromosomes have an elongated knob-like appendages known as satellite
6. **New nucleotides are added and new complementary strand of DNA is formed with the help of enzyme DNA polymerase.** **True**
7. **Down's syndrome is the genetic condition with 45 chromosomes** **False**
   Down's syndrome is the genetic condition with 47 chromosomes

IV. Match the following

1. 1) Autosomes	- a) Trisomy 21	(c)
2) Diploid condition	- b) 9:3:3:1	(d)
3) Allosome	- c) 22 pair of chromosome	(e)
4) Down's syndrome	- d) 2n	(a)
5) Dihybrid ratio	- e) 23rd pair of chromosome	(b)

V. Answer in a sentence

1. **What is a cross in which inheritance of two pairs of contrasting characters are studied?**
   Dihybrid cross is a cross in which inheritance of two pairs of contrasting characters are studied.
2. **Name the conditions when both the alleles are identical?**
   The both alleles are identical in **homozygous condition.**
3. **A garden pea plant produces axial white flowers. Another of the same species produces terminal violet flowers. Identify the dominant trait.** ★★
   The dominant character or trait is axial white flower.

4. What is the name given to the segments of DNA, which are responsible for the inheritance of a particular character?

The name of the segment of DNA is **gene**.

5. Name the bond which binds the nucleotides in a DNA. ★★

Hydrogen bond which binds the nucleotides in a DNA.

VI. Short answers questions

1. Why did Mendel select pea plant for his experiments?

- It is naturally **self-pollinating** and so is very easy to raise **pure breeding** individuals.
- It has a short life span as it is an annual and so it was possible to follow **several generations.**
- It is easy to **cross-pollinate.**
- It has deeply defined **contrasting characters.**
- The flowers are **bisexual**.

2. What do you understand by the term phenotype and genotype? ★★

- **External expression** of a particular trait is known as phenotype.
- A genotype is the **genetic expression** of an organism.

3. What are allosomes? ★★★

- Allosomes are chromosomes which are responsible for **determining** the **sex** of an individual.
- They are also called as sex chromosomes or **hetero-chromosomes.**

4. What are Okazaki fragments? ★★

- In the **DNA replication** after the formation of **RNA primer** two strands are formed.
- In one strand short segments of **DNA** are synthesised.
- This strand is called lagging strand. The short segments of DNA are called **okazaki fragments.**

5. Why is euploidy considered to be advantageous to both plants and animals?

- Euploidy is the condition in which the individual bears more than the **usual number** of **diploid (2n)** chromosomes.
- Tetraploidy plants are advantageous as they often result in increased fruit and flower size

6. A pure tall plant (TT) is crossed with pure dwarf plant (tt), What would be the F_1 and F_2 generations? Explain.

Parental generation:

- Pure breeding tall plant and a pure breeding dwarf plant.

F_1 generation:

- Plants raised from the seeds of pure breeding parental cross in F_1 generation were **tall** and **monohybrids**.

F_2 generation:

- Selfing of the F_1 monohybrids resulted in tall and dwarf plants respectively in the ratio of **3:1.**
- The actual number of tall and dwarf plants obtained by Mendel was **787 tall** and **277 dwarf.**

- External expression of a particular trait is known as phenotype. So the phenotypic ratio is **3:1.**

In the F_2 generation 3 different types were obtained:

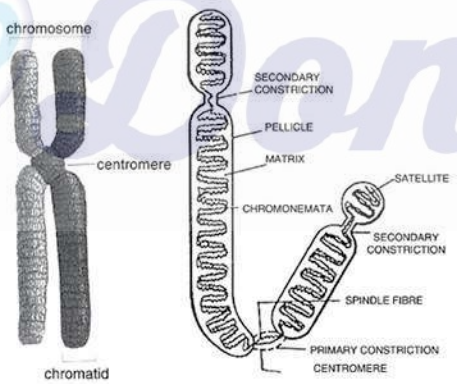
- Tall Homozygous – TT (Pure) – 1
- Tall Heterozygous – Tt – 2
- Dwarf Homozygous – tt – 1

So the genotypic ratio 1:2:1. A genotype is the genetic expression of an organism

7. Explain the structure of a chromosome. ★★

Structure of a Chromosome:

- The chromosomes are **thin, long** and **thread like** structures consisting of two identical strands called sister chromatids.
- They are held together by the **centromere**.
- Each chromatid is made up of spirally coiled thin structure called **chromonema**.
- The chromonema has number of bead-like structures along its length which are called **chromomeres**.
- The chromosomes are made up of **DNA,RNA, chromosomal proteins** (histones and non-histones) and certain **metallic ions.**
- These proteins provide structural support to the chromosome



Structure of chromosome

A chromosome consists of the following regions

Primary constriction:

- The two arms of a chromosome meet at a point called primary constriction or centromere.
- The centromere is the region where spindle fibres attach to the chromosomes during cell division.

Secondary constriction:

- Some chromosomes possess secondary constriction at any point of the chromosome.
- They are known as the nuclear zone or nucleolar organizer (formation of nucleolus in the nucleus).

Telomere:

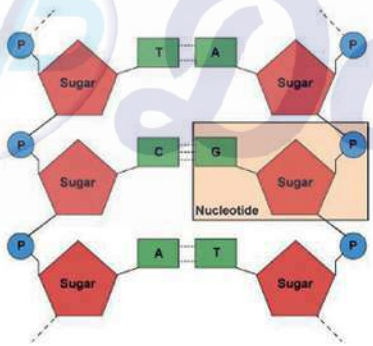
- The end of the chromosome is called telomere. Each extremity of the chromosome has a polarity and prevents it from joining the adjacent chromosome.
- It maintains and provides stability to the chromosomes.

Satellite:

- Some of the chromosomes have an elongated knob-like appendage at one end of the chromosome known as satellite.
- The chromosomes with satellites are called as the sat-chromosomes

8. Label the parts of the DNA in the diagram given below. Explain the structure briefly

- DNA molecule consists of **two polynucleotide** chains.
- These chains form a **double helix structure** with two strands which run anti-parallel to one another.
- Nitrogenous bases in the centre are linked to sugar-phosphate units which form the **backbone** of the **DNA**.
- Pairing between the nitrogenous bases is very specific and is always between purine and pyrimidine linked by hydrogen bonds. * Adenine (A) links Thymine (T) with two hydrogen bonds **(A = T)** * Cytosine (C) links Guanine (G) with three hydrogen bonds **(C ≡ G).** This is called complementary base pairing.
- Hydrogen bonds between the nitrogenous bases make the **DNA** molecule **stable**.
- Each turn of the double helix is **34 A° (3.4 nm)**. There are ten base pairs in a complete turn.
- The nucleotides in a helix are **joined** together by phosphodiester bonds.



Nucleotides in a DNA

VII. Long answer questions

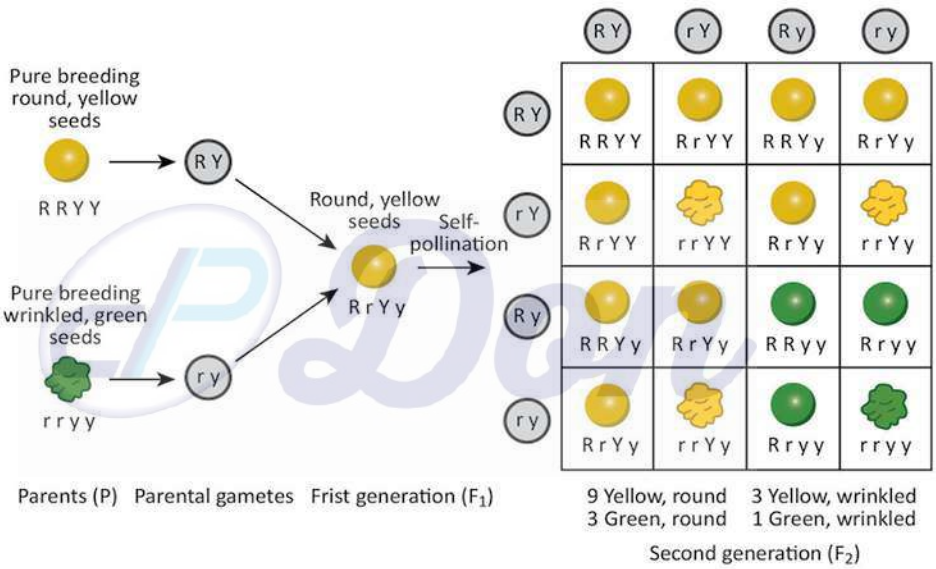
1. Explain with an example the inheritance of dihybrid cross. How is it different from monohybrid cross? ✶ ✶ ✶

- Dihybrid cross involves the inheritance of two pairs of contrasting characteristics (or contrasting traits) at the same time.
- The two pairs of contrasting characteristics chosen by Mendel were shape and colour of seeds: round-yellow seeds and wrinkled-green seeds.
- Mendel crossed pea plants having roundyellow seeds with pea plants having wrinkledgreen seeds.

Mendel made the following observations:

- Mendel first crossed pure breeding pea plants having **round-yellow** seeds with pure breeding pea plants having **wrinkledgreen** seeds and found that only roundyellow seeds were produced in the **first generation (F_1).**

- No wrinkled-green seeds were obtained in the F_1 generation.
- From this it was concluded that round shape and yellow colour of the seeds were dominant traits over the wrinkled shape and green color of the seeds.
- When the hybrids of **F_1 generation** pea plants having round-yellow seeds were **cross-breed** by **self pollination**, then four types of seeds having **different combinations** of shape and colour were obtained in second generation or **F_2 generation.**
- They were round yellow, round-green, wrinkled yellow and wrinkled-green seeds.
- The ratio of each phenotype (or appearance) of seeds in the F_2 generation is **9:3:3:1.** This is known as the Dihybrid ratio.
- From the above results it can be concluded that the factors for each character or trait remain independent and maintain their identity in the gametes.
- The factors are independent to each other and pass to the offsprings (through gametes).



Dihybrid cross

Results of a Dihybrid Cross:

- Mendel got the following results from his dihybrid cross

Four Types of Plants:

- A dihybrid cross produced four types of F_2 offsprings in the ratio of 9 with two dominant traits, 3 with one dominant trait and one recessive trait, 3 with another dominant trait and another recessive trait and 1 with two recessive traits.

New Combination:

- Two new combinations of traits with round green and wrinkled yellow had appeared in the dihybrid cross (F_2 generation)

Monohybrid Cross	Dihybrid Cross
Cross involving inheritance of **only one pair** of contrasting character	Cross involves the inheritance of **two pair** of contrasting character.
E.g) Stem length	E.g) seed shape and seed colour

2. How is the structure of DNA organised? What is the biological significance of DNA? ✶ ✶ ✶

DNA is a large molecule consisting of millions of nucleotides. Hence, it is also called a polynucleotide. Each nucleotide consists of three components.

- A sugar molecules – Deoxyribose sugar.
- A nitrogenous base.
- There are two types of nitrogenous bases in DNA.
- They are

  Purines (Adenine and Guanine)

  Pyrimidines (Cytosine and Thymine)
- A phosphate group

Nucleoside and Nucleotide

- Nucleoside = Nitrogen base + Sugar
- Nucleotide = Nucleoside + Phosphate
- The nucleotides are formed according to the purines and pyrimidines present in them

Watson and Crick model of DNA

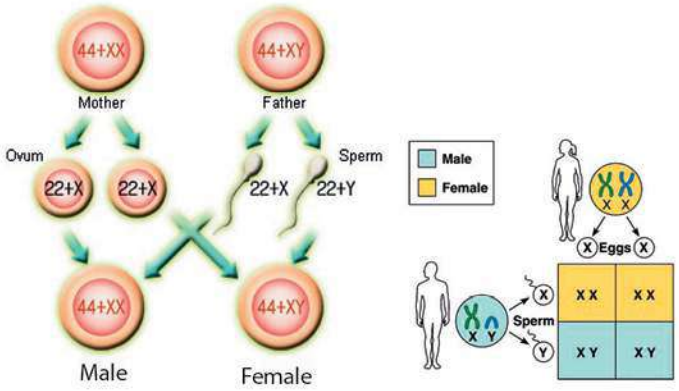
- DNA molecule consists of two polynucleotide chains.
- These chains form a double helix structure with two strands which run anti-parallel to one another.
- Nitrogenous bases in the centre are linked to sugar-phosphate units which form the backbone of the DNA.
- Pairing between the nitrogenous bases is very specific and is always between purine and pyrimidine linked by hydrogen bonds. Adenine (A) links Thymine (T) with two hydrogen bonds (A = T) Cytosine (C) links Guanine (G) with three hydrogen bonds(C ≡ G). This is called complementary base pairing.
- Hydrogen bonds between the nitrogenous bases make the DNA molecule stable.
- Each turn of the double helix is 34 A° (3.4 nm). There are ten base pairs in a complete turn.
- The nucleotides in a helix are joined together by phosphodiester bonds.

Significance of DNA

- It is responsible for the transmission of hereditary information from one generation to next generation.
- It contains information required for the formation of proteins.
- It controls the developmental process and life activities of an organism.

3. The sex of the new born child is a matter of chance and neither of the parents may be considered responsible for it. What would be the possible fusion of gametes to determine the sex of the child? ✶

- Human beings have 23 pairs of chromosomes out of which 22 pairs are autosomes and one pair (23^{rd} pair) is the sex chromosome.
- The female gametes or the eggs formed are similar in their chromosome type (22+XX).
- Therefore, human females are homogametic.



Sex det

- The male gametes or sperms produced are of two types.
- They are produced in equal proportions.
- The sperm bearing (22+X) chromosomes and the sperm bearing (22+Y) chromosomes.
- The human males are called heterogametic.
- It is a chance of probability as to which category of sperm fuses with the egg.
- If the egg (X) is fused by the X-bearing sperm an XX individual (female) is produced.
- If the egg (X) is fused by the Y-bearing sperm an XY individual (male) is produced.
- The sperm, produced by the father, determines the sex of the child. The mother is not responsible in determining the sex of the child.
- Now let's see how the chromosomes take part in this formation.
- Fertilization of the egg (22+X) with a sperm (22+X) will produce a female child (44+XX) while fertilization of the egg (22+X) with a sperm (22+Y) will give rise to a male child (44+XY).

VIII. Higher Order Thinking Skills (HOTS)

1. Flowers of the garden pea are bisexual and self-pollinated. Therefore, it is difficult to perform hybridization experiment by crossing a particular pistil with the specific pollen grains. How Mendel made it possible in his monohybrid and dihybrid crosses?

He had worked on nearly **10000 pea plants** of 34 different varieties, Mendel noticed that they different from one another in many ways. He were chose 7 pair of contrasting character for his study. They are,

1.	Seed shape	round	wrinkled
2.	Seed colour	yellow	green
3.	Seed constricted	coloured	white
4.	Pod shape	inflated	constricted
5.	Pod colour	green	yellow
6.	Flower position	axillary	terminal
7.	Stem length	long	short

He chose only one character among the seven. In monohybrid cross he chose only characters using stem height. In dihybrid cross he chose shape and colour of the seed.

2. Pure-breed tall pea plants are first crossed with pure-breed dwarf pea plants. The pea plants obtained in F_1 generation are then cross-breed to produce F_2 generation of pea plants.

a. What do the plants of F_1 generation look like?

b. What is the ratio of tall plants to dwarf plants in F_2 generation?

c. Which type of plants were missing in F_1 generation but reappeared in F_2 generation?

a) The F_1 generation plants **are tall.**

b) In the F_2 generation there were **3 tall plants** and **a dwarf plant.** The ratio is **3 : 1.**

c) The dwarf plants were missing in F_1 generation but reappeared in F_2 generation.

3. Kavitha gave birth to a female baby. Her family members say that she can give birth to only female babies because of her family history. Is the statement given by her family members true. Justify your answer.

Kavitha's family member statement is false, because the sex is determined by male. In human being female gametes form the chromosome type **22+ x x.** But in male gametes two types of chromosomes are formed. One is **(22 + x)** another one is **(22 + y)**

- If a female gametes are **(22+ x)** fuses with a male gamete **(22 + x)** its forms a female child.
- If a female gamete **(22 + x)** is fuses with the male gamete **(22 + y)** it forms a male child.
- The sex is determinied by the male gamete.

XI. Value based question

1. Under which conditions does the law of independent assortment hold good and why?

- In the dihybrid cross the law of independent assortment holds good because two factors making up a pair of contrasting characters are called alleles or allelomorphs.
- Mendel crossed two pairs of contrasting characteristics at the same time.
- He chose shape and colour of seeds, round yellow seeds and wrinkled green seeds.
- The F_1 generation round yellow seed was formed. In the F_2 generation **9 : 3 : 3 : 1** plants were formed.
- From the above results it can be concluded that the factors for each character or trait remains independent and maintains their identity in the gametes.
- The factors are independent to each other and pass on to the offsprings(through gametes)

Additional Questions

I. Choose the most suitable answer from the given four alternatives and write the option code and corresponding answer:

1. _____ discovered the basic principles of heredity. ★
   a) T.H. Morgan b) Mendel c) J.Watson d) Francis Crick.
2. Mendel started his famous experiments on the garden _____ plant.
   a) Hibiscus b) pea c) Tulasi d) Tomato
3. In the monohybrid cross the phenotypic ratio is _____.
   a) 3 : 1 b) 9 : 2 c) 3 : 2 d) 1 : 3
4. Two factors making up a pair of contrasting characters are called _____.
   a) dominant b) recessive c) allele d) chromosome
5. _____ is a checker board form devised by R.C. Punnet for study of genetics.
   a) Anna square b) Punnet square
   c) Mendel square d) Morgan square
6. T.H.Morgan was awarded Nobel Prize in _____-
   a) 1995 b) 1994 c) 1993 d) 1992
7. The term chromosome was first coined by _____. ★
   a) T.H.Morgan b) Punnet c) Mendel d) Waldeyer
8. Each gene is present at a specific position in a chromosome called its _____.
   a) Gene b) Locus c) Chromonema d) Chromatid
9. Chromosomes are held together by the _____.
   a) Centromere b) Chromomere
   c) Satellite d) Telomere
10. _____are protective sequences of nucleotides found in chromosomes.
    a) Centromere b) Satellit
    e) Telomere d) Chromomere
11. Rod shaped chromosomes are called as _____. ★
    a) Metacentric b) submetacentric
    c) Acrocentric d) Telocentric
12. The centromere occurs that in the centre of the chromosome are called _____.
    a) Metacentric b) Submetacentric
    c) Acrocentric d) Telocentric
13. Chromosome occurs in pairs called as _____.
    a) Haploid b) Diploid c) Triploid d) Tetraploid
14. _____is the diagrammatic representation of karyotype of a species.
    a) Diploid b) Haploid c) Idiogram d) Allosomes
15. _____were awarded Nobel Prize for medicine in 1962.
    a) Watson b) F.Crick c) Franklin d) Wilkins

16. DNA molecules consists of _____polynucleotide chains.
a) one b) two c) three d) four

17. _____bonds between the nitrogenous base makes the DNA molecule stable.
a) Nitrogen b) Oxygen c) Hydrogen d) carbon

18. The enzyme called _____binds to the origin of replication site.
a) topoisomerase b) DNA ligase
c) DNA polymerase d) helicase

19. The DNA fragments are joined together by the enzymes_____.
a) topoisomerase b) DNA ligase
c) helicase d) DNA polymerase

20. Down syndrome was first identified by a doctor _____ in 1866. ★
a) Watson b) Wilkins c) Langdon Down d) Mendel

21. Gene alteration results in abdominal _____formation in an organism.
a) carbohydrate b) fat c) lipid d) protein

22. _____is caused by the mutation of a single gene.
a) Lagging strand b) Leading strand
c) Okazaki fragments d) Sickle cell

Ans:

1.	b)	Responsible for character	2.	c)	Independent assortment
3.	c)	Centromere	4.	b)	Metacentric
5.	d)	Sugar phosphate	6.	d)	DNA ligase
7.	a)	22 pairs of autosome and 1 pair of allosomes	8.	b)	Aneuploidy

II. Fill in the blanks

1. Mendel was an _____ monk.
2. Mendel had chosen _____ pairs of contrasting character for his study. ★
3. Mendel used the character in his experiment _____ is the dominant character of flower position.
4. The genotypic ratio of monohybrid cross is _____.
5. Factors are passed on from one generation to another is referred as _____.
6. Punnet square is a checker board form devised for study of _____.
7. Mendel proposed three important laws called as Mendel's _____.
8. The term _____ was first coined by Waldeyer in 1888. ★
9. The end of the chromosome is called _____.
10. The two arms of a chromosome meet at a point called _____.
11. Some of chromosome have knob like appendages called _____.
12. The centromere found at one end with a short arm and a long arm is ____.

13. _____ contain genes that determine the Somatic character.
14. _____ are responsible for determining the sex of an individual.
15. The gametes produced by organisms contains single set of chromosome called _____.
16. Watson and Crick proposed the _____ of DNA. ✶
17. There are _____ types of nitrogenous bases in DNA.
18. The DNA polynucleotide chains form a _____ structure.
19. The human male chromosomes are called _____.
20. The addition or deletion in the number of chromosomes are called _____. ✶
21. _____ is one of the commonly known aneuploid condition.
22. Monosomy means _____ number of chromosomes.
23. _____ is transmission of characters from one generation to the next generation.
24. _____ is a graphical representation of possible genotypes in a genetic cross.
25. The secondary constriction zone of the chromosome is known as _____.
26. The chromosomes with satellites are called _____.
27. The plant taken for experiments by Hugo De. Vries is _____.
28. R.N.A primer is synthesized by _____.
29. Sex is determined by the _____.
30. _____ states that in D.N.A. the proportion of adenine is always equal to that of thymine.

Ans:

1.	Austrian	2.	7 (seven)
3.	Auxillary	4.	1 : 2 : 1
5.	Genes	6.	Genetics
7.	Laws of heredity	8.	Chromosomes
9.	Telomere	10.	centromere
11.	Satellite	12.	Acrocentric
13.	Autosomes	14.	Allosomes
15.	Haploid	16.	Three dimensional model
17.	Two	18.	Double helix
19.	heterogametic	20.	ploidy
21.	Down's syndrome	22.	(2n - 1)
23.	Heredity	24.	Punnett square
25.	Nuclear zone or nucleolar organizer	26.	Sat chromosomes
27.	Evening primrose or Oenothera Lamarckiana	28.	D.N.A template
29.	Chromosomes	30.	Erwin Chargaff

III. Identify whether the statement are True or False. Correct the false statement

1. **Watson discovered the basic principles of heredity.** ★ **False**
   Mendel discovered the basic principles of heredity.
2. **The inheritance of only one pair of contrasting characters are called dihybrid crosses.** **False**
   The inheritance of only one pair of contrasting characters are called Monohybrid crosses.
   (Or)
   The inheritance of two pairs of contrasting characters are called dihybrid crosses.
3. **The nucleus of each cell contains thin thread like structures called centromere.**
   The nucleus of each cell contains thin thread like structures called chromosomes. **False**
4. **Satellite are protective sequences of nucleotides found in chromosomes** **False**
   Telomeres are protective sequences of nucleotides found in chromosomes
5. **In telocentric the centromere is found in the proximal end.** ★ **True**
6. **Allosome contains genes that determine the somatic character.** **False**
   Autosome contains genes that determine the somatic character. (or)
   Allosome contains genes that determine the sex of an individual.
7. **In human each cell normally contains 21 pairs of chromosomes.** **False**
   In human each cell normally contains 23 pairs of chromosomes.
8. **Adenine and guanine is collectively called as pyrimidines.** ★ **False**
   Adenine and guanine is collectively called as purines.
9. **In a DNA model there are eight base pairs in a complete turn.** **False**
   In a DNA model there are ten base pairs in a complete turn.
10. **The fragments are joined together by the enzyme helicase.** **False**
    The fragments are joined together by the enzyme DNA ligase
11. **The term mutation was introduced by Hugo De Vries.** **True**

IV. Match the following

1.

1) Basic principle of heredity	- a) Watson & Crick ★	(e)
2) Chromosomes	- b) Hugo De vries	(d)
3) DNA model	- c) T.H. Morgan	(a)
4) Role of chromosome in heredity	- d) Waldeyer	(c)
5) Mutation	- e) Mendel	(b)

2.

Character	Dominant	Recessive
Seed Shape	Auxillary	Green
Seed Colour	Round	Short
Flower position	Long	Constricted
Stem length	Yellow	Wrinkled
Pod shape	Inflated	Terminal

Ans:

Character	Dominant	Recessive
Seed shape	Round	wrinkled
Seed colour	Yellow	Green
Flower position	Auxillary	Terminal
Stem length	Long	Short
Pod shape	Inflated	constricted

3. 1) Spirally coiled structure - a) Satellite (c)
   2) Bread like structure - b) Polynucleotide (e)
   3) Knob like appendage - c) Chromonema (a)
   4) Double helix structure - d) Triploidy (b)
   5) Three haploid sets of chromosomes - e) Chromomeres (d)

4. 1) V-shaped cromosome - a) Submetacentric (b)
   2) One end short arm and other long arm - b) Metacentric (d)
   3) J shaped chromosome - c) Telocentric (a)
   4) centromere is found in the proximal end - d) Acrocentric (c)

V. Assertion and Reason

a) A and R are corrrect, R explains the A
b) Both A and B are wrong.
c) A is correct, R is wrong.
d) A and R are correct, R does not explains A

1. **Assertion (A)**: In monohybrid cross the genotypic ratio is 1 : 2 :1.
   Reason (R) : A genotype is the genetic expression of an organism.
   Ans:: a) A and R are corrrect, R explains the A

2. **Assertion (A):** The two arms of a chromosome meet at a point called centromere.
   Reason (R) : The end of the chromosomes is called telemere.
   Ans: d) A and R are correct, R does not explains A

3. **Assertion (A):** In a DNA the nucleotide is polynucleotide.
   Reason (R) : DNA consists of millions of nucleotide.
   Ans: a) A and R are correct, R explains the A

4. **Assertion (A) :** Adenine and Guanine are called as pyrimidines. ★
   Reason(R): Cytosine and Thymine are called purines
   Ans: b) Both A and R are wrong.

VI. Answer in a sentence

1. **Human females are homogametic Why?**
   The female gametes or the eggs formed are similar in their **chromosome** type **(22+XX)**

2. **What is the reason for the changes in the number of chromosome?**
   This is due to **errors** in cell division.

3. **What are the three types of Aneuploidy ?**

Monosomy (2n-1), Trisomy (2n+1), Nullisomy (2n – 2)

4. **Which part of the blood is affected by sickle cell anaemia?**

Alteration in the gene brings a change in the structure of the **protein part of** haemoglobin molecule.

5. **What are the 3 different types of plants obtained in monohybrid cross- F2 gemeration?** ★

- Tall Homozygous – TT
- Tall Heterozygous - Tpt
- Dwarf Homozygous – tt

VII. Short answers questions

1. **List the elements select Mendel in his experiment in pea plant:**

- Seed shape
- Seed colour
- Seed coat colour
- Pod shape
- Pod colour
- Flower position
- Stem length.

2. **Define – Allelomorphs.**

Two factors making up a pair of contrasting character are called allelomorphs.

3. **What is checker board?**

Checker board is a graphical representation to **calculate** the **probability** of all possible genotype offsprings in a genetic cross.

4. **Write the Law of Dominance:**

When two homozygous individuals with one or more sets of contrasting characters are crossed, the characters that appear in the F1 hybrid are dominant and those that do not appear in F1 are recessive characters.

5. **Write the law of segregation**

When a pair of contrasting factors or genes or allelomorphs are brought together in a heterozygote or hybrid, the two members of the allelic pair remain together without mixing and when gametes are formed, the two separate out, so that only one enters each gamete.

6. **What is diploid and haploid?**

Diploid:

- In the body cells of sexually reproducing organisms, the chromosomes generally occur in pairs.
- This condition is called diploid (2n)

Haploid:

- The gametes produced by a organisms contain a single set of chromosomes.
- This condition is called haploid (n)

7. Name the nitrogenous base.

There are two types of nitrogenous bases in DNA, They are

- Purines (Adenine and Guanine)
- Pyrimidine (cytosine and thyamine)

8. How nucleoside and nucleotide formed?

- Nucleoside is Nitrogen base and sugar molecule
- Nucleotide is nucleoside and phosphate molecule.

9. What is sex determination?

The **formation of zygote** with male or female sex during development is called sex determination.

10. How is a male child and a female child formed?

- Fertilization of the egg (22 + x) with a sperm (22 + x) will produce a female child (44 + xx).
- Fertilization of the egg (22 + x) with a sperm (22 + y) will produce male child (44 +xy).

11. What is ploidy?

Addition and deletion in the number of chromosomes present in a cell is called ploidy.

12. Define chromosomal mutation.

The sudden **change in the structure** or number of chromosomes is called chromosomal mutation.

13. Define aneuploidy and write its types. ★

- It is the loss or gain of one or more chromosomes in a set.
- It is of three types. Monosomy (2n-1), Trisomy (2n+1)and Nullisomy (2n-2).
- In man, Down's syndrome is one of the commonly known aneuploid condition.

14. What are the conditions seen in Down's syndrome affected child?

Mental retardation, delayed development, behavioural problems, weak muscle tone, vision and hearing disability are some conditions seen in Down's syndrome affected children.

15. Define sickle cell anaemia. ★

- Sickle cell anaemia is caused by the **mutation** of a single gene.
- Alteration in the gene brings a change in the structure of the protein part of haemoglobin molecule.
- Due to the change in the protein molecule, the red blood cell (RBC) that carries the haemoglobin is sickle shaped.

VIII. Long answer questions

1. Write the types of chromosomes based on the position of centromere.

Based on the position of centromere, the chromosomes are classified as Telocentric, Acrocentric, Submetacentric and Metacentric

Telocentric:

- The centromere is found on the **proximal end.**
- They are rod shaped chromosomes.

Acrocentric:

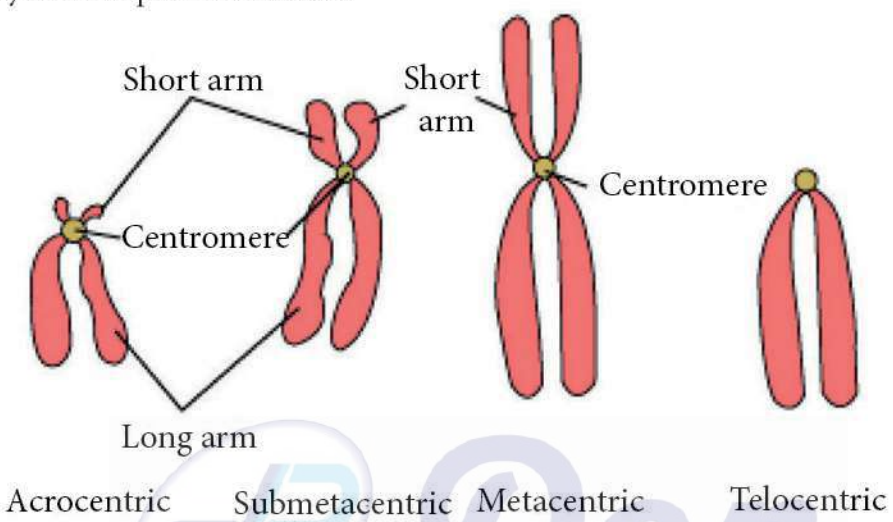
- The centromere is found at the **one end** with a short arm and a long arm.
- They are also rod-shaped chromosomes.

Submetacentric:

- The centromere is found **near the centre** of the chromosome.
- Thus forming two unequal arms.
- They are **J** shaped or **L** shaped chromosomes.

Metacentric:

- The centromere occurs in the **centre** of the chromosome and form two equal arms.
- They are **V** shaped chromosomes



Types of chromosome based on position of centromere

2. Describe mutation and its types. ★

- The term mutation was introduced by **Hugo De Vries** in 1901 when he observed phenotypic changes in the evening primrose plant, Oenothera lamarckiana.
- Mutation is an inheritable sudden change in the genetic material (DNA) of an organism.
- Mutations are classified into two main types, namely chromosomal mutation and gene mutation.

1. Chromosomal mutation:

The **sudden change** in the structure or number of chromosomes is called chromosomal mutation. This may result in

Changes in the structure of chromosomes: Structural changes in the chromosomes usually occurs due to errors in cell division. **Changes** in the **number** and arrangement of genes takes place as a result of deletion, duplication, inversion and translocation in chromosomes.

Changes in the number of chromosomes: They involve **addition** or **deletion** in the **number** of **chromosomes** present in a cell. This is called ploidy. There are two types of ploidy (a) Euploidy, (b) Aneuploidy.

a. Euploidy:

- It is the condition in which the individual bears **more than** the usual number of diploid (2n) chromosomes.
- If an individual has **three haploid** sets of chromosomes, the condition is called **triploidy (3n).**
- Triploid plants and animals are typically **sterile**.

- If it has **four haploid** sets of chromosomes, the condition is called **tetraploidy (4n).**
- Tetraploid plants are advantageous as they often result in increased fruit and flower size.

b. Aneuploidy:

- It is the **loss or gain** of one or more chromosomes in a set.
- It is of **three** types. Monosomy (2n-1), Trisomy (2n+1)and Nullisomy (2n-2).
- In man, Down's syndrome is one of the commonly known **aneuploid condition.**

Down's syndrome

- This condition was first identified by a doctor named **Langdon Down in1866.**
- It is a genetic condition in which there is an extra copy of chromosome 21 (Trisomy 21).
- It is associated with mental retardation, delayed development, behavioural problems, weak muscle tone, vision and hearing disability are some of the conditions seen in these children.

2. Gene or point mutation

- Gene mutation is the **changes** occurring in **nucleotide sequence** of a gene.
- It involves substitution, deletion, insertion or inversion of a single or more than one nitrogenous base.
- Gene alteration results in **abnormal protein formation** in an organism.

IX. Higher Order Thinking Skills (HOTS)

1. In Human beings blue eye colour is recessive to brown eye colour. If a brown eyed man has a blue eyed mother then find.

i) What are the possible genotype of his father?

ii) What is the genotype of the man and his mother?

i) Possible genotype BB, Bb

ii) Genotype of man : Bb

Genotype of his mother : bb

2. A woman has only daughters Analyse the situation genetically and provide a suitable explanation?

- Human female have **44+XX** chromosome.
- They do not play significant role in sex determination of child
- Male have **44 +XY** chromosomes.
- Fertilization of egg **22+ X** with sperm carrying **22 + Y** chromosomes give male child **44 + XY** only daughters indicate basis of egg with sperms carrying **22 + X** chromosome every time.
- So she has given one daughter.

Unit Test - 18

Heredity

Time : 1 hr | Marks : 30

I. Choose the most suitable answer and write the code with the corresponding answer. 5 × 1 = 5

1. 9 : 3 : 3 : 1 ratio is due to
   a) Segregation b) Crossing over
   c) Independent assortment d) Recessiveness
2. The region of the chromosome where the spindle fibres get attached during cell division
   a) Chromomere b) Centrosome c) Centromere d) Chromonema
3. Each gene is present at a specific position in a chromosome called its _____
   a) Gene b) Locus c) Chromonema d) Chromatid
4. Rod shaped chromosomes are called as _____.
   a) Metacentric b) submetacentric c) Acrocentric d) Telocentric
5. The centromere occurs in the centre of the chromosome are called _____.
   a) Metacentric b) Submetacentric c) Acrocentric d) Telocentric

II. Answer the following questions in one or two lines. 5 × 2 = 10

1. Why did Mendel select pea plant for his experiments?
2. What do you understand by the term phenotype and genotype?
3. What are Okazaki fragments?
4. Give the genotypic and phenotypic ratio of monohybrid cross.
5. Write the Law of Dominance:

III. Answer the following questions in brief. 2 × 4 = 8

1. i) A woman has only daughters, Analyse the situation genetically and provide a suitable explanation.
   ii) How male child and female child formed?
2. i) Define sickle cell anaemia.
   ii) Why did Mendel select pea plant for his experiments?

IV. Answer the following questions in detail. 1 × 7 = 7

1. Explain with an example the inheritance of dihybrid cross. How is it different from monohybrid cross?