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HEREDITY & INHERITANCE

13.1 HEREDITY :

In includes those traits or characters which are transmitted from generation to generation and are therefore fixed for a particular individual.

- **Genetics :** Study of Heredity and variation is said to be known as **genetics.** The term genetics was first of all used by **W. Bateson** in 1905. An Austrian monk namely **Gregor Johann Mendel** was the first person to study genetics. He was therefore regarded at the **'Father of Genetics'.**

13.2 VARIATIONS :

Variation is concerned with the difference between the individuals of same species and also between the offspring of the same parents.

- **Variations could be of two types :**

(i) Somatic variation **(ii) Germinal variation**

(i) Somatic variation : Somatic variation affects the somatic cells of an organism. It is neither inherited from parents nor transmitted to next generation. It is acquired by individual during it's own life and is lost with it's death. It is therefore also called a **acquired variation** or **blastogenic variation.**

- **Somatic variations are due to :**

(A) Environment : This includes the factors that affect the organisms such as food, air, pressure, humidity, after etc. Environment affects all the organisms however they also affect the plants because they cannot move or hide themselves.

- **Light :** Strong sunlight affects the human skin by increasing the dark pigment melanin in the epidermal cells. Melanin protects the underlying cells by absorbing the ultra violet rays of the sun. Plants grown in shade become weak and pale and acquire long internodes and broad leaves.
- **Habitat :** It also affects the genetic make - up of an individual and leads to variations.
- **Nutrition :** It is also one of the various factors that cause variations.

(B) Use of disuse of organs : Continuous use of an organ makes it better developed whereas constant disuse makes it reduced.

(C) Conscious efforts : Conscious efforts by man produce somatic variations in humans themselves, in domestic animals and plants.

(ii) Germinal variation : This variation affects the germ cells of an organism and is consequently inheritable. It is received by the individual from the parents and is transmitted to the next generation.

- **Germinal variation could be of two types :**

(A) Continuous variations : [Fluctuating variations] The continuous variations are very common in nature. These are found in all animals and plants and affect all of their organs. These various are unstable and do not contribute to the formation of new species.

- **Causes of continuous variations :**
- New combination of character
- Crossing over [recombination of genes]

(B) Discontinuous variations : This variation refers to large conspicuous differences of the offspring from the parents. This variation is also known as **mutation** and the individual with this kind of variation is called as **mutant. This** is not common in nature. It appears suddenly. It is stable and inheritable.

- **Causes of discontinuous variations :**
- Modification in structure of chromosomes.
- Alteration in the chemical nature of genes.
- Change in the number of chromosomes.
- Radiations and chemicals may also cause mutation.
- **Significance of Variation :**
- Variation enables the organisms to adapt themselves to the changing environment.
- If forms raw material for evolution.
- It enables the organisms to face the struggle for existence in a better way.
- It helps men in improving the races of useful animals and plants.
- It is the basis of heredity.
- It also leads to the existence of new traits.

13.3 HEREDITY AND VARIATION IN ASEQUAL REPRODUCTION :

There are organisms in which reproduction occurs by asexual means. These include Bacteria, Amoeba, Euglenas, fungi etc. many plants such as rose and sugarcane, lower animals namely Hydra, planaria etc.

This asexual reproduction is monoparental and the organism produced by it inherits all the traits of it's single parent. It is almost a carbon copy of the parent and is known as it's **clone.** It is also called as **clonal reproduction. Here**, one thing to the noted is the term **'offspring'** is not used in case of asexual reproduction.

- **The clones may develop variations :**
- By environmental factors
- By mutation

The variations causes due to environmental factors are not transferable but these variations which are caused by mutation are stable and inheritable.

13.4 HEREDITY AND VARIATIONS IN SEXUAL REPRODUCTION :

Variation is very much common in animals and plants which carry reproduction by sexual means. The reason for this is the sexual reproduction is biparental and the offspring receives some traits from one parent and some traits from other parent. Interbreeding of closely related individuals reduces the occurrence of variations in the offspring's produced by the sexual reproduction.

13.4 (A) Earlier Views of Heredity :

Different theories have been put forward to explain in what physical form the traits pass from the parents to the offspring's.

(i) Vapour theory: This theory was proposed by a **Greek Philosopher Pythagoras.** he states that each organ of an animal body emitted some kind of water vapour and that a new individual was formed by the combination of these vapours from different organs.

(ii) Fluid theory : Another **Greek Philosopher Aristotle** [384 - 322 B.C.] stated that

(A) Man's semen is highly purified blood.

(B) Woman's menstrual fluid is the female semen, which was not as pure as man's semen.

(C) The two combines during intercourse and female semen provides substance for embryo formation and male semen provides from and vitality to embryo. This is called as **Blending theory of inheritance.**

(iii) Preformation theory : This theory was proposed by **Anton Von Leeuwenhoek** who was the first to observe human sperm. He called them **"animalcules".** He states that each sperm has a potential to develop into a new individual when introduced into the woman's womb where it could get nourishment. This theory was rejected because it failed to explain the inheritance of maternal characters by offsprings.

(iv) Particulate theory : A French biologist Maupertius proposed that each animal produces minutes particles for reproduction and a new individual is formed by the union of the particles of the two parents. Then a famous **English Naturalist Charles Darwin** forwarded the theory of **pangenesis** for the inheritance of characters. He assumed that tiny particles called **pangenes** or **gemmules** by his were formed in the various parts of the body and migrate to the reproductive cells and hence to the offsprings to guide the formation of the respective parts. Thus the young one has a blend (mixture) of the pangenes hence here is a presence of the characters of both the parents.

Mendel was the first to give the **particulate theory of heredity.** He had experimented on pea plants to study how traits are transferred or inherited. He unfortunately failed to explain the cause of inheritance. He also proposed various principles to explain the inheritance. Later on other scientists led to the discovery of genes and chromosomes.

13.5 MENDEL'S EXPERIMENTS AND LAWS OF INHERITANCE :

Gregor Johann Mendel is appropriately called as **Father of genetics.** With the help of his experiments on garden pea, he was able to formulate laws which explain the manner of inheritance of characters. Although Mendel described his **results in 1866,** his work was recognized only in 1900, when Mendel's laws were rediscovered simultaneously y **Hugo de varies a Dutch biologist, Carl Correns a German botanist** and **Erich von Tschermak as Austrian botanist.**

- **Some general terms used by him are :**
- **Dominant trait :** The trait which appears in F_1 generation is called as dominant trait. It is denoted by capital letter. **e.g. TT (tall).**
- **Recessive trait :** The traits which does not appear in F_1 generation is called as recessive trait. It is denoted by small letter, **e.g. tt (dwarf)**
- **Monohybrid cross :** It involves the study of inheritance of one pair of contrasting character. **e.g.** Inheritance of tall and dwarf characters.
- **Dihybrid Cross :** It is the inheritance of two pairs of contrasting characters.
- **Trihybrid cross :** it is the inheritance of three pairs of contrasting characters.

- **Back cross :** The cross between F_1 generation with any of the parents is known as **back cross.**
- **Test cross :** The cross between F_1 generation and the recessive parent is called as **test cross.**
- **Genotype :** It is the genetic representation of a trait. **e.g. TT** or **Tt for a tall plant.**
- **Reciprocal cross :** The reciprocal cross involves two crosses concerning the same characteristic but with reverse sex. It means if in the first cross A is female and B is male then in the second cross A will be male and B will be female.
- **Phenotype :** it is the expression of a trait **e.g. Tall pea plant,** it can be noted by direct observation of an individual.
- **Allele :** Term allele refers to each of the members of a genetic pair.
- **Homozygous traits :** They have similar alleles for specific trait (TT or tt). They produce only one type of gametes.
- **Heterozygous traits :** They have dissimilar alleles for a specific trait (Tt). They produce two types of gametes

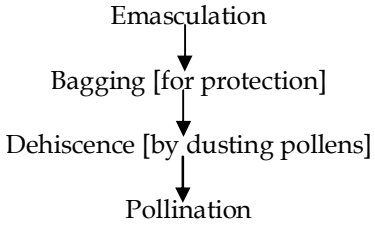
13.6 MENDEL'S EXPERIMENT

Mendel chose garden pea as plant material for his experiments, since it has following advantages.

- Well defined characters
- Bisexual flowers
- Predominantly self-fertilization
- Easy hybridization
- Cross fertilization is possible

13.6 (a) Crossing Technique Employed by Mendel :

Since garden pea is self- fertilizing, the anthers have to be removed before maturity. This operation is called as **emasculation.** The stigma is protected against any foreign pollen with the help of a bag. The pollens then at the dehiscence stage, is brought from the plant to be used as male parent and is dusted on the feathery stigma of the emasculated flower. At the time of pollination, the pollens should be **mature** and the stigma should be **receptive.**



(i) Traits choosen by Mendel for his experiment : There are seven traits which Mendel has choosen, they are as follows :

S.No.	Characters	Dominant	Recessive
1.	Stem height	Tall	Dwarf
2.	Flower colour	Violet	White
3.	Flower position	Axial	Terminal
4.	Pod shape	Inflated	Constricted
5.	Pod colour	Green	Yellow
6.	Seed shape	Round	Wrinkled
7.	Seed colour	Yellow	Green

(ii) Mendel performed experiments in three stages :

(A) he made sure that, the plant which he had choosen must be true breeding plant, by letting the plant to undergo self-fertilization.

(B) He performed the process of cross palliation of alternate forms of traits. The resultant generation obtained was termed as hybrid, and these hybrids formed are called as **F_1 generation i.e. First filial generation.**

(C) He allowed the hybrid to self pollinate upto five generations and these generations are subsequently termed as F_2, F_3, F_4 and so on.

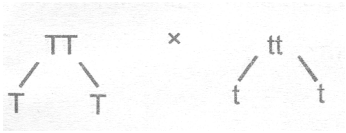
(iii) Result's of Mendel's Experiments :

(A) When the self pollination was made and F_1 generation was obtained, it was found that the resultant generation would express only one of the trait and not the other. The trait which is being expressed is called as **dominant,** whereas the one which is not expressed is called as **recessive** trait.

(B) In the F_1 generation obtained by self p

ollination, the dominant and the recessive traits obtained were in the ratio of **3 : 1** i.e. 75% of the offsprings which appeared in F_2 generation had dominant trait, while 25% had recessive trait. This ratio of 3 : 1 is also said to be known as **Mendelian monohybrid**

ratio .



	T	T
t	Tt	Tt
t	Tt	tt

In F_1 all are tall
($F_1 \times F_1$)

	T	t
T	TT	Tt
t	Tt	Tt

In F_2 we will get 3 : 1 ratio.

TT → Homozyous Tall
Tt → Heterozyous tall] Tall [3]
Tt → Heterozyous tall

tt → Homozygous dwarf] dwarf [1]

Homozygous tall : Heterozygous tall : Homozygous dwarf
1 : 2 : 1

(C) Mendel further found that the phenotypic ratio of 3 : 1 of dominant to recessive form of a trait was actually a genotypic ratio of **1 : 2 : 1 of pure dominant, hybrid and pure recessive forms.** The traits which remain hidden in F_1 generation got expressed in F_2 generation. This was later on proved in F_3 generation.

(iii) Reasons from Mendel's success :

(A) He selected true breeding [pure] pea plant for his experiment.

(B) He studies single trait at time.

(C) He kept an accurate mathematical record of his breeding experiments and noted down the number of each type of offspring produced in each cross.

(D) He was lucky enough to select the seen traits, as the gene for these traits are located on four different chromosomes.

13.7 MENDEL'S LAWS OF INHERITANCE :

On the basis of the experiments performed and the result obtained Mendel formulated four laws. They are :

13.7 (a)The Principle of Paired Factors :

Each character in a n individual is governed by two factors called as **gene.** The alternative form of gene is called as **alleles** or **allelomorphs.** If an individual consists of similar types of **alleles,** they are called as **homozygous e.g.** TT, tt while those having different types of alleles are called as **heterozygous e.g. Tt** etc.

13.7 (b) The Principle of Dominance or Law of Dominance :

When two homozygous individuals with one or more sets of contrasting character are crossed the characters that appear in the F_1 hybrids are dominant characters and those which do not appear in F_1 are recessive characters.

13.7 (c) The Principle of Segregation of Law of Segregation :

[Law of purity of gametes] The law of segregation states that when a pair of contrasting factors or genes or allels are brought together in a heterozygous condition, the two remains together without being contaminated but when gametes are formed form them the two separate out from each other. This is also known as **Mendel's first law of heredity.**

13.7 (d) The Principle of Independent Assortment or Law of Independed Assortment:

If the inheritance of more than one pair of characters is studied simultaneously, the factors or genes for each pair of characters assort out independently. It is called as **Mendels second law of heredity.**

13.8 DIHYBRID CROSS :

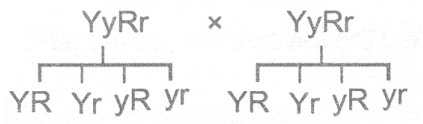
In dihybrid cross Mendel crossed genetically pure yellow round seeded (YYRR) pea plant with green wrinkled (yyrr) pea plant. All the plants of F_1 were all yellow and round seeded (YyRr). In F_2 generation four types of plants appeared as :

- Yellow rounded - 9
- Yellow wrinkled - 3
- Green round-3
- Green wrinkled - 1

So here phenotypic ratio is 9 : 3 : 3 : 1

	yr	yr
YR	YyRr	YyRr
YR	YyRr	YyRr

All F_1 plants are yellow and round seeded



	YR	Yr	yR	yr
YR	YYRR	Yyrr	YyRR	YyRr
Yr	YYRr	Yyrr	YyRr	Yyrr
yR	YyRR	YyRr	yyRR	yyRr
yr	YyRr	Yyrr	yyRr	yyrr

13.9 GENES :

The term **'gene'** was introduced by **Johansson** for Mendelian factor. Gene determines the physical as well as physiological characteristics. They are transmitted from parents to their offsprings generation after generation. Genes are located on chromosomes where they occupy specific position called as **locus. This** was proved experimentally by **T.Bovery** and **W.S. Sutton** in 1902. They are responsible for characteristic features.

13.9 (a) Molecular Structure of Gene :

Chemically gene is formed of DNA. If consists of following parts :

(i) Recon : It is the smallest unit of DNA capable of undergoing crossing over and recombination.

(ii) Muton : It is also the smallest unit of DNA capable of undergoing mutation.

(iii) Cistron : It is a gene is real sense, which consists of number of **nucleotides** and which is capable of synthesizing a polypeptide chain of enzymes.

(iv) Replicon : It is a unit of replication.

OBJECTIVE QUESTIONS

1. When a red flower homozygous pea plant is crossed with a white flower plant what colour is produced in F_1 ?

(A) Red (B) White (C) Pink (D) Red and white

2. Mendel formulated the law of purity of gametes on the basis of

(A) dihybrid cross (B) monohybrid cross (C) back cross (D) test cross

3. A cross between AaBB X aa BB yields a genotypic ratio of

(A) 1 AaBB : 1 aaBB (B) 1 AaBB : 3 aaBB (C) 3AaBB : 1 aa BB (C) All AaBb

4. In monohybrid cross what is the ratio of homozygous dominant and homozygous recessive individual in F_2 - generation ?

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

5. Back cross is a cross between

(A) $F_1 \times F_1$ (B) $F_1 \times$ Recessive (C) $F_1 \times$ Dominant (D) $F_1 \times$ any parent

6. A white flowered mirabilis plant rr was crossed with a red coloured RR, if 120 plants are produced in F_2 generation. The result would be

(A) 90 uniformly coloured and 30 white (B) 90 Non - uniformly coloured and 30 white

(C) 60 Non-uniformly coloured and 60 white (D) All coloured and No white

7. Which one caries extra nuclear genetic material ?

(A) Plastids (B) Ribosomes (C) Chromosomes (D) Golgi - complex

8. The ratio of phenotype in F_2 generation of a dihybrid cross is

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

9. Branch of biology deal s with heredity and variation is called

(A) Palaentology (B) Evolution (C) Genetics (D) Ecology

10. The factors which represent the contrasting pairs of characters are called

(A) Dominant (B) Recessive (C) Determinants (D) Alleles

SUBJECTIVE QUESTIONS

SHORT ANSWERT YPE QUESTIONS

1. What are autosomes ?

2. Name the four nitrogen bases of a nucleotide.

3. Define the term genetics.

LONG ANSWER TYPE QUESTIONS

4. What does the science of genetics deals with ?

5. Differentiate between submetacentric and metacentric chromosomes with diagram.

6. Explain the structure of a gene.

7. What is genetic engineering ?

8. Why did Mendel choose pea (Pisum sativum) for his experiment ?

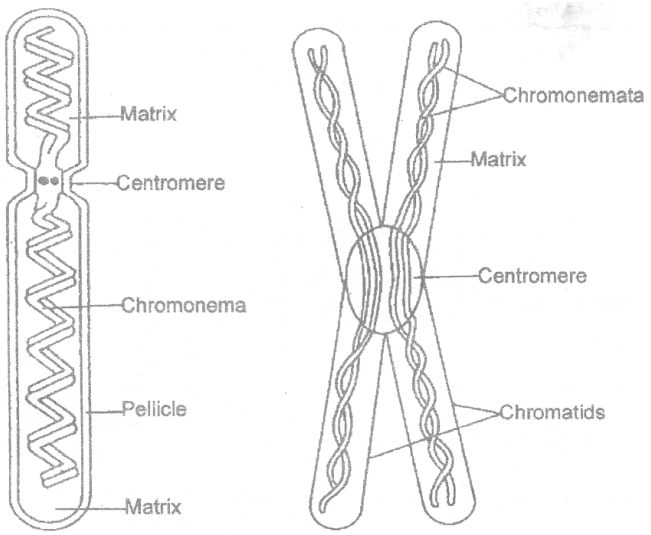
14.1 CHROMOSOMES :

E.Strasburger discovered chromosomes in 1875. They are thread like structure and are called as chromosomes due to their affinity towards **dyes [chroma = colour]. Genes** are located on chromosomes and the genetic material of chromosomes is DNA. These are also called as **"hereditary vehicles "** as they are capable to transmit hereditary material to the next generation.

- **Chromosomal theory of Inheritance: Sutton and Boveri** Proposed this theory in 1902. This theory consists of following salient features :
- Somatic cells are diploid in number i.e. these consist of two sets of chromosomes, one set from the mother and other set from the father.
- The chromosomes retain their structural uniqueness, identity and continuity.
- The paired condition of chromosomes is resorted during fertilization.
- The behavior of chromosomes during meiosis at the time of gamete formation provides an evidence that genes are located on chromosomes. This also explain the mechanism of segregation of characteristic at the time of gamete formation.

14.1 (a) Structure of chromosomes :

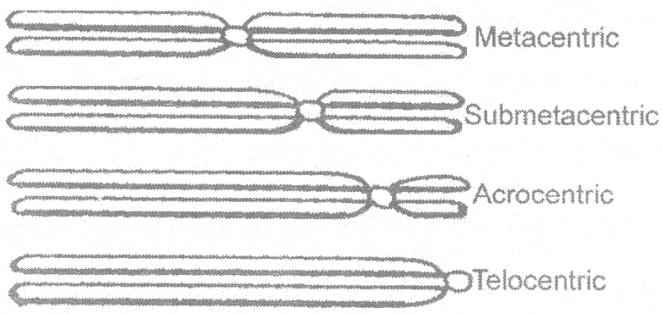
Each chromosome consists of two strands which are called as **chromatids.** The two chromatids of a chromosome are joined together at a point called as **centromere.**



(a) Structure of chromosome (b) Metaphase chromosome.

- Depending on the position of centromere a chromosome can be of different types and attain different shapes during anaphase. They are :

(i) **Metacentric :** They are V - shaped. These have centromere in the middle of chromosome so that the two arms are almost equal.
(ii) **Sub metacentric :** They are L shaped. In this centromere is slightly away from the mid point, so that the two arms are unequal.
(iii) **Acrocentric :** They are J-shaped with centromere at subterminal position.
(iv) **Telocentric :** They are rod shaped, having terminal centromere.



Types of chromosomes.

14.1 (b) Size and Shape of Chromosomes :

Size of chromosomes greatly very during cell cycle.
(i) **Interphase :** It forms long thread like structure called as **chromatin.**
(ii) **Metaphase :** Chromosomes are thickest and shorted and therefore have definite shape and size. At this stage chromosomes can be counted easily.
(iii) **Anaphase :** They have rod like J-shaped or V- shaped structures during this phase.
(iv) **Telophase :** They have thread like structure.

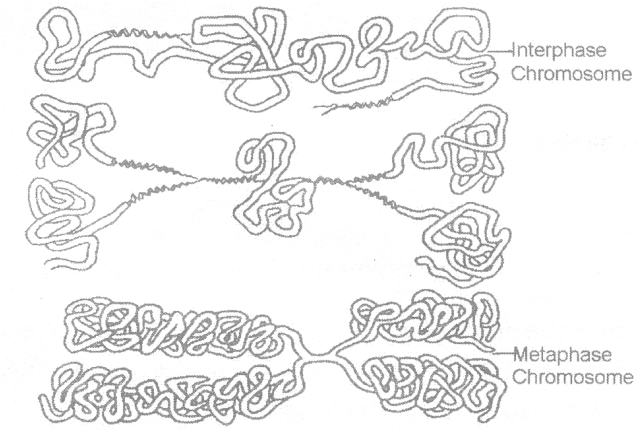


Fig : To show condensation of chromatin network.

14.1 (c) Number of Chromosomes :

Each species has a fixed number of chromosomes in it's cells. In case of human beings, there are 46 number of chromosomes in each body cell. 46 chromosomes in an ordinary human cell are of 23 different types. So, there are two chromosomes, of each kind. The two chromosomes of each kind are called as homologous chromosomes. A cell which has the full number of chromosomes with two of each kind is called as diploid cell. In other words a diploid cell has two sets of each type chromosomes. The gametes (or sex cells) of human being are different from their other body cells because they contain only half the number of chromosomes.

A cell which has half the number of chromosomes, with one of each kind, is called as haploid cell. In other words a haploid cell has only one set of each type of chromosomes **e.g. sperm** and **eggs** have only 23 chromosomes each, which is half the number of chromosomes of other body cells. So, the gamete is a

haploid cell. Females consists of two similar gametes and therefore called as homogametic and males consist of dissimilar gametes and therefore called as heterogametic. The term homomorphism and heteromorphy are also used for females and males respectively. During spermatogenesis two types of sperm cells will be produced one which contains X chromosome and the other which contains Y chromosome. During oogenesis each egg will produce two X chromosomes. If X-chromosome of male fuses with X-chromosome of female it will produce a female child. If Y-chromosome of male fuses with X-chromosome of female it will produce a male child.

14.1 (d) Properties of Chromosomes :

The chromosomes must poses five important properties :

(i) Replication : Synthesis of new DNA molecule which is identical to the parent DNA molecule.

(ii) Transcription : Synthesis of RNA molecule from DNA molecule.

(iii) Change in appearance.

(iv) Repair : It means repair of damaged parts of DNA.

(v) Mutation : Development of genetic changes.

14.1 (e) Functions of Chromosomes :

(i) They carry hereditary characters from parents to offsprings.

(ii) They help the cell to grow, divide and maintain itself by synthesis of proteins.

(iii) They undergo mutation and thus contributed to the evolution of animals.

(iv) They guide cell differentiation during development.

(v) They also help in metabolic processes.

(vi) They bring about continuity of life.

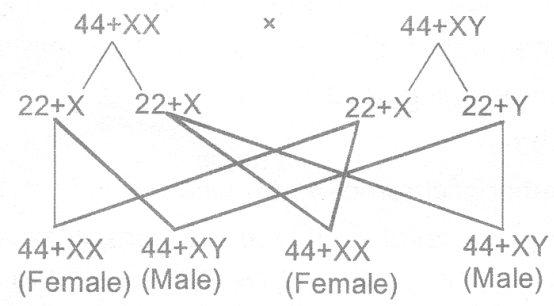
14.2 SEX DETERMINATION :

- **Chromosomes are of two types :**
- **Autosomes or Somatic chromosomes :** These regulate somatic characters.
- **Allosomes or Heterosomes or Sex chromosomes :** These chromosomes are associated with sex determination. Sex chromosomes were first discovered by **"Mc Clung"** in grasshopper. X chromosome was discovered by **Henking.**

14.2 (a) X X - XY Type or Laygaues Type :

This type of sex determination is first observed by **Wilson** and Stevens in **Laygaeus insect.** It is of two types :

(i) X X female and XY male : In this type of sex determination female is **homogametic** while males is **heterogametic e.g. Humans**



(ii) XY female and XX male : In this type of sex determination female is **heterogametic** while males is **homogametic. e.g.** Butter flies, moth and vertebrates like birds, fishes and reptiles.

14.2 (b) XX Female and XO Male or Pronetor Type :

sIn this type of sex determination there is a deficiency of one chromosome in male. In this type female is homogametic and male is heterogametic. **e.g. Grasshopper and Cockroach**

14.3 GENETIC ENGINEERING :

In recent years, techniques for manipulation of prokaryotic as well as eukaryotic DNA have witnessed a remarkable development. This has allowed breakage of a DNA molecule at two desired places to isolate a specific DNA segment and than insert it in another DNA molecule at the desired position. The product thus obtained is called as **recombinant DNA** and the process is called as **"genetic engineering".**

14.3 (a) Tools of Genetic Engineering :

The various biological tools used in the synthesis of recombinant DNA are :

(i) Enzymes (ii) Vehicle or vector DNA

(i) Enzymes :

(A) Lysing enzyme : These are used to open up the cells to get DNA for genetic experiment. **Lysozyme** is commonly used to dissolve the bacterial cell wall.

(B) Cleaving enzymes : These are used to break DNA molecule. Three types of cleaving enzymes are known. They are :

- **Exonuclease :** Which cut off nucleotides from 5′ or 3′ ends of DNA molecules.
- **Endonuclease :** Which cleaves the DNA duplex at any point except ends.
- **Restriction endonucleases :** Restriction endounucleases are the enzymes which recognize specific nucleotide sequence and cut the DNA molecules. Restriction endonuclease was discovered by **Arber** in **Eschrichia coli. Nathans (USA), Smith, Arber** won the Noble prize for **Physiology and Medicine** in 1978 for the discovery of restriction endounuclease.

(C) Synthesizing enzymes : These play an important role in the synthesis of DNA strands on suitable templates. They are of two types :

- **Reverse transcriptase :** These help in the synthesis of complimentary DNA strands on RNA templates.
- **DNA polymerase :** This helps in the synthesis of complimentary DNA strands on DNA templates.

(D) Joining enzymes : These help in sealing gaps in DNA fragment which are joined by complimentary base pairing **e.g. T_4 - ligase.**

(E) Alkaline phosphatase : These cut off phosphate groups from free ends of linearized vehicle DNA to prevent recircularization.

(ii) Vehicle or vector DNA : The DNA used as carrier for transferring a fragment of foreign DNA into a suitable host called as vehicle DNA. **e.g. Plasmid and Bacteriophage DNA.**

14.3 (b) Application of Genetic Engineering :

(i) It is applied for modification of plant colours.

(ii) It helps in cloning of transgenic plants.

(iii) It can be proved beneficial in case of plants **e.g. "nif"** gene is transferred in plants which is responsible for N_2 fixation.

(iv) It is used for curing various genetic disorders.

(v) It can be proved beneficial for synthesis of insulin growth, hormone etc.

(vi) It can be used to delay ripening of fruits.

14.4 DNA : (DEOXYRIBOSE NUCLEIC ACID)

DNA was first isolated by **Frederick Meischer** from the nucleus of **pus cells** and called as **nuclin. Watson and Crick** gave the double helix model of DNA. They also won a noble prize for it. Chromosomes consist of nucleoprotein which are made up of nuclei acid and proteins.

14.4 (a) Composition of DNA :

DNA molecule consists of following three components :

(i) Deoxyribose sugar **(ii)** Phosphate group

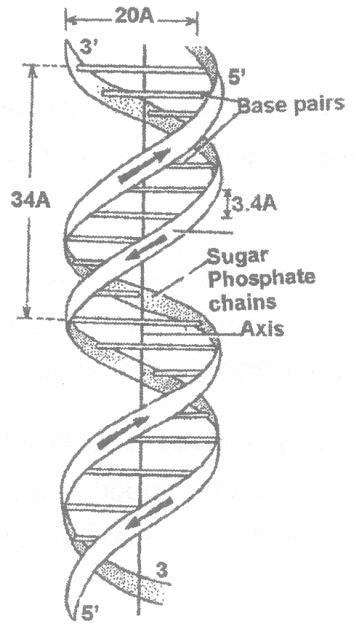
(iii) Nitrogen bases : They could be **purines or pyrimidines.**

(A) Purines are : Adenine [A] and Guanine [G]

(B) Pyrimidines are : Thymine [T] and Cytosine [C]

- One DNA molecule consists of a u nit called **nucleotide.**
- Nucleotide = nucleoside + phosphate
- Nucleoside = nitrogen base + deoxyribose sugar

14.4 (b) Structure of DNA :



Structure of a DNA molecule

(i) It consists of two helical polypeptide chins which are coiled around each other.
(ii) Both the chains are antiparallel to each other.
(iii) Both chains have complementary base pairing i.e. A = T and G≡C.
(iv) The two strands are held together, by hydrogen bonds.
(v) The diameter of a DNA molecule is 20 Å.
(vi) One helix consists of about 10 bp.
(vii) It's helicle length is 34 Å and the distance between two nearest base pairs is 3.4Å.
(viii) It also consists of major and minor grooves.
(ix) Each strands consists of a backbone made up of alternating deoxyribose sugar and phosphate, they are joined by **phosphodiester bonds.**

14.5 SOME IMPORTANT TERMS :

- **Karyotype :** In includes the details of the number of chromosomes of an organism, their size and shape. It is better achieved in metaphase stage.
- **Idiotype :** It is a diagrammatic representation of a karyotype.
- **Banding technique :** For the purpose of identification chromosomes a special staining technique is sued. It is called as **banding technique.**
- In the process of genetic engineering the gene that is transferred into an organism is called as **transgene.** An organism that contains and express a transgene is called as **transgenic organism or generically modified organism [GMO].**

- Hirudin is a protein that prevents blood clotting. The gene encoding hirudin is chemically synthesized. This is then transferred to Brassica napus, where hirudin is accumulated in seeds. It is then purified and used as medicine.
- A soil bacterium **Bacillus thuringenesis,** produces a crystal **"cry"** protein. This protein is toxic to the larvae of certain insects. There are various types of cry protein each resistant to specific type of insect.
- Viral chromosomes consist of proteins and one nucleic acid i.e. DNA or RNA. Nucleic acid may be single or double stranded, may be circular or linear. Virus with RNA as genetic material is called as **retrovirus e.g. HIV** [Human Immuno Deficiency Virus]
- **Replication :** DNA is the only molecule capable of self duplication so it is termed as "living molecule". All living beings have the capacity to reproduce because of this chrematistic of DNA. DNA replicates in the "S" phase of cell cycle. In the process of replication a new DNA is synthesized in the form of strands.
- **These strands are of two types :**

(i) **Leading strands :** Formation of new strands always takes place in 5′ - 3′ direction. It is a continuous strand.

(ii) **Lagging strand :** it is formed as small fragments known as **okazaki fragments. These** fragments are later on joined by **ligase enzymes.**

OBJECTIVE QUESTIONS

1. The main aim of plant breeding is
(A) to produce improved varieties (B) to make soil fertile
(C) to control pollution (D) to become more progressive

2. Plants having similar genotypes produced by plant breeding are called
(A) clone (B) haploid (C) autopolyploid (D) genome

3. Two allelic genes are located on
(A) the same chromosome (B) two homologous chromosomes
(C) two non-homologus chromosomes (D) any two chromosomes

4. Mendel's law of segregation is based on separation of allels during
(A) gamete formation (B) seed formation (C) pollination (D) embryonic development

5. What is the effect of sexual reproduction ?
(A) Offspring is weak (B) Offspring is like the parent
(C) Offspring is more vigorous (D) Offspring is diseased

6. Disease resistant varieties can be produced by
(A) crossing a plant with wild variety (B) treating with colchicine
(C) crossing with hormones (D) treating with low temperature

7. Heterozygous tall plants were crossed with dwarf plants, what will be the ratio of dwarf plants in the progeny
(A) 50% (B) 25% (C) 75% (D) 100%

8. A pure tall plant can be differentiated from a hybrid tall plant
(A) by measuring length of plant
(B) by spraying gibberellins
(C) if all plants are tall after self-pollination
(D) if all plants are dwarf after self-pollination

9. Allel is the
(A) alternate trait of a gene pair (B) total number of genes for a trait
(C) total number of chromosomes of haploid set (D) total number of genes present a chromosome

10. In animals sex determination is due to
(A) X-chromosome (B) Y - chromosome (C) A - chromosome (D) B - chromosome

SUBJECTIVE QUESTIONS

SHORT ANSWER TYPE QUESTIONS

1. What is karyotype ?

2. What is meant by chromosomes ?

3. Who is known as the father of genetics ?

4. What determines the functional property of a gene ?

5. What was transgenic organisms ?

LONG ANSWER TYPE QUETIONS

6. What does the law of segregation states ?

7. What do you understand by the term nucleoside and nucleotide ?

8. How it was established that genes are located on chromosomes ?

9. Explain the importance of variations.

10. Explain the law of dominance.

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	A	B	A	D	D	B	A	D	C	D

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	A	A	B	A	C	A	A	C	A	B