PETIT SEMINAIRE HIGHER SECONDARY SCHOOL, PUDUCHERRY

18. GENETICS

X std SELF – EVALUATION BIOLOGY

I. Choose the best answer :

01. According to Mendel, alleles have the following character **Pair of genes**.
a) pair of genes b) responsible for character
c) production of gametes d) Recessive

02. 9 : 3 : 3 : 1 ratio is due to **Independent Assortment**.
a) Segregation b) Crossing Over
c) Independent Assortment d) Recessiveness

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

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

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

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

07. The number of chromosomes found in human beings are **22 pairs of autosomes and 1 pair of allosomes**.
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

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

II. Fill in the blanks :

01. The pairs of contrasting character (traits) of Mendel are called **Alleles**.

02. Physical expression of a gene is called **Phenotype**.

03. The thin thread like structures found in the nucleus of each cell are called **Chromosomes**.

04. DNA consists of two **Polynucleotide** chains.

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

III. State whether True or False. If False, write the Correct statement :

01. A typical Mendelian dihybrid ratio of F_2 generation is 3 : 1. **FALSE**

Correct Statement : A typical Mendelian dihybrid ratio of F_2 generation is **9 : 3 : 3 : 1.**

02. A recessive factor is altered by the presence of a dominant factor. **FALSE**

Correct Statement : The **expression** of a recessive factor is altered by the presence of a dominant factor.

03. Each gamete has only one allele of a gene. **TRUE**

04. Hybrid is an offspring from a cross between genetically different parent. **TRUE**

05. Some of the chromosomes have an elongated knob-like appendages known as Telomere. **FALSE**

Correct Statement : Some of the chromosomes have an elongated knob-like appendages known as **Satellite.**

06. New Nucleotides are added and new complementary strand of DNA is formed with the help of enzyme DNA polymerase. **TRUE**

07. Down's syndrome is the genetic condition with 45 chromosomes. **FALSE**

Correct Statement : Down's syndrome is the genetic condition with **47** chromosomes.

IV. Match the following :

01. Autosomes	-----	**22 pairs of chromosome**
02. Diploid condition	-----	**2n**
03. Allosome	-----	**23rd pair of chromosome**
04. Down's syndrome	-----	**Trisomy 21**
05. Dihybrid ratio	-----	**9:3:3:1**

V. Answer in a sentence :

01. What is a cross in which inheritance of two pairs of contrasting characters are studied?

Dihybrid cross

02. Name the conditions when both the alleles are identical.

Homozygous condition/ **Pure breed**

03. A garden pea plant produces axial white flowers. Another of the same species produced terminal violet flowers. Identify the dominant trait?

Position of flowers : **Axillary** position is **dominant over terminal** position of flowers.
Colours of flowers : **White** colour is **dominant over Violet** colour.

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

Genes

05. Name the bond which binds the nucleotides in a DNA.

Hydrogen bonds : A=T; G≡C

VI. Short answer questions :

01. Why did Mendel select pea plant for his experiment?

Mendel selected pea plant because:

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

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

External expression of a particular trait is known as phenotype. Eg: **Tall** & **Dwarf**.
A genotype is the **genetic expression** of an organism. Eg: **TT**, **Tt** & **tt.**

03. What are Allosomes?

i) Allosomes are chromosomes which are responsible for determining the **sex** of an individual.
ii) They are also called as **sex chromosomes** or **hetero-chromosomes**.
iii) There are two types of sex chromosomes, X and Y – chromosomes.

04. What are Okazaki fragments?

During the **replication** of a DNA molecule, the new strand is synthesized in **short segments** which are called Okazaki fragments. There are joined together by the enzyme *DNA ligase*.

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

i) Organisms with **more than 2 sets of chromosomes** are called Euploids.
ii) Eupolidy plants often result in **increased fruit** and **flower size**. Therefore, it is advantageous.
iii) The euploid **animals** are **sterile**.
iv) They are also **drought resistant** and **disease resistant**.

06. A pure tall plant (TT) is crossed with pure dwarf plant (t), what would be the F_1 and F_2 generations? Explain.

PARENTAL GENERATION: Pure breeding Tall and dwarf plants are crossed (TT × tt).

F_1 GENERATION: Monohybrids are **heterozygous tall**.

F_2 GENERATION: Selfing of the F_1 monohybrids takes place. Tall and dwarf plants are obtained in the ratio of **3:1** which is the **phenotypic ratio**.

Genotypically plants are of three types as shown above and therefore **genotypic ratio** is **1:2:1**.

(OR)

- When pure breeding (**homozygous**) tall (TT) and dwarf (tt) plants were crossed, all the plants produced in the **F1** generation were **heterozygous tall** (Tt).
- When the F1 hybrids were **self-crossed**, tall and dwarf plants were obtained in **F2** generation of the ratio **3:1** (**Phenotypic** ratio) 3 tall & 1 dwarf.
- Genotypically plants were of three types : 1 **homozygous tall** (TT); 2 **heterozygous tall** (Tt); and 1 **homozygous dwarf** (tt) of the ratio **1:2:1**.

07. Explain the structure of a chromosome.

Structure of chromosome:

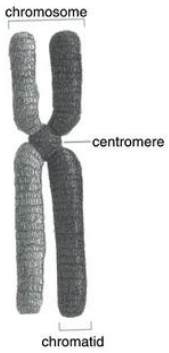
i) The chromosomes are thin, long and thread like structures consists of two identical strands called **sister chromatids**.

ii) They are held together by the **centromere**.

iii) Each chromatid is made up of spirally coiled thin structure called **chromonema**.

iv) The chromonema has number of bead-like structures along its length which are called **chromomeres**.

v) They 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.



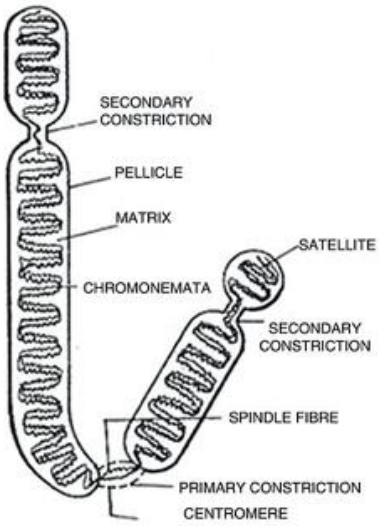
- A chromosome consists of the following regions:

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 chromosomes during **cell division**.

Secondary constriction: Apart from the primary 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. 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**.



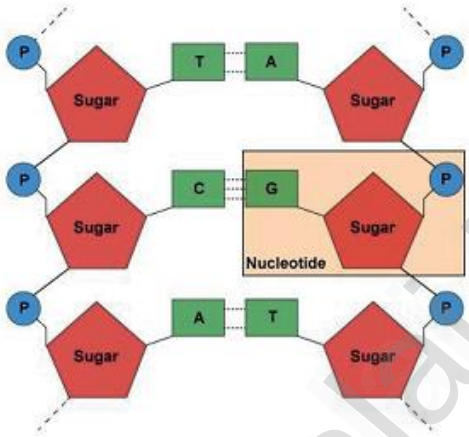
08. Label the parts of the DNA in the diagram given below. Explain the structure briefly.

Watson and Crick model of DNA:

i) DNA molecule consists of **two polynucleotide chains**.

ii) These chains form a **double helix** structure with two strands which run **anti-parallel** to one another.

iii) **Nitrogenous bases** in the **centre** are linked to **sugar-phosphate** units which form the **backbone** of the DNA.



iv) **Pairing** between the nitrogeneous bases is very **specific** and is always between purine and pyrimidine linked by **hydrogen bonds**.

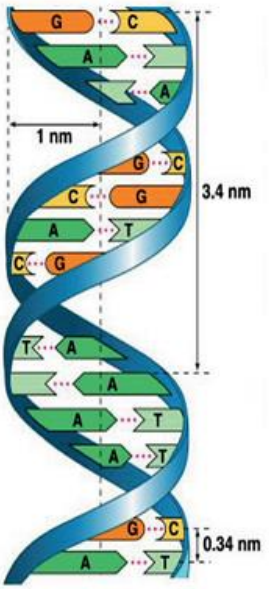
- Adenine (A) links Thymine (T) with **two** hydrogen bonds (A = T)
- Cytosine (C) links Guanine (G) with **three** hydrogen bonds (C ≡ G)

This is called complementary base pairing.

v) **Hydrogen bonds** between the nitrogenous bases make the **DNA molecule stable**.

vi) Each turn of the double helix is 34 A° (3.4 nm). There are **ten base pairs** in a complete turn.

vii) The nucleotides in a helix are joined together by phosphodiester bonds.



VII. Long answer questions :

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

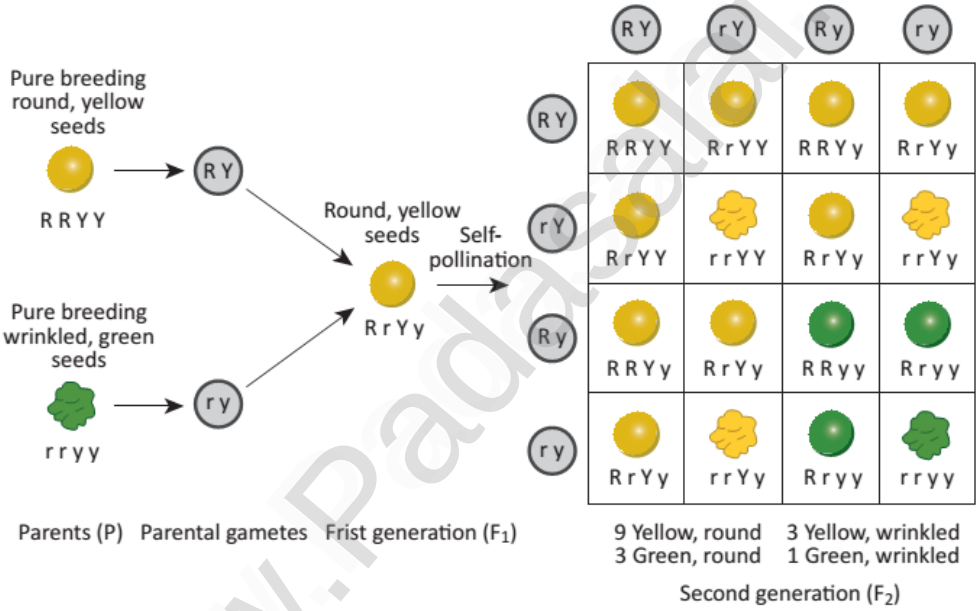
i) Mendel first crossed pure breeding pea plants having **round-yellow** seeds with pure breeding pea plants having **wrinkled-green** seeds and found that only **round-yellow** seeds were produced in the first generation (F_1).

ii) 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.

iii) When the hybrids of F_1 generation pea plants having round-yellow seeds were cross-bred by **self-pollination**, then four types of seeds having different combinations of shape and color were obtained in second generation or F_2 generation. They were **round yellow**, **round-green**, **wrinkled yellow** and **wrinkled green** seeds.

iv) 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.

v) 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).



Mendel got the following results from his dihybrid cross:

i) **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.

ii) **New combination**: Two new combinations of traits with round green and wrinkled yellow had appeared in the dihybrid cross (F_2 generation).

Sl. No.	DIHYBRID CROSS	MONOHYBRID CROSS
01.	Two pairs of contrasting characters are studied	Only one pair of contrasting characters studied
02.	F1 hybrid produces 4 types of gametes	F1 hybrid produces 2 types of gametes
03.	Phenotypic ratio is **9:3:3:1**	Phenotypic ratio is **3:1**
04.	Genotypic ratio is **1:2:2:4:1:2:1:2:1**	Genotypic ratio is **1:2:1**

02. How is the structure of DNA organized? What is the biological significance of DNA?

Chemical Composition of DNA molecule:

DNA is a large molecule consisting of millions of **nucleotides**. Hence, it is also called a **polynucleotide**.

Each nucleotide consists of three components.

i) A **sugar** molecules – Deoxyribose sugar.

ii) A **nitrogenous base**.
There are types of nitrogenous bases in DNA. They are
   a) **Purines** (Adenine and Guanine)
   b) **Pyrimidines** (Cytosine and Thymine)

iii) A **phosphate** group

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:

i) DNA molecule consists of **two polynucleotide chains**.

ii) These chains form a **double helix** structure with two strands which run **anti-parallel** to one another.

iii) **Nitrogenous bases** in the **centre** are linked to **sugar-phosphate** units which form the **backbone** of the DNA.

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- Adenine (A) links Thymine (T) with **two** hydrogen bonds (A = T)
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This is called complementary base pairing.

v) **Hydrogen bonds** between the nitrogenous bases make the **DNA molecule stable**.

vi) 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:

i) It is responsible for the transmission of hereditary information from one generation to next generation.

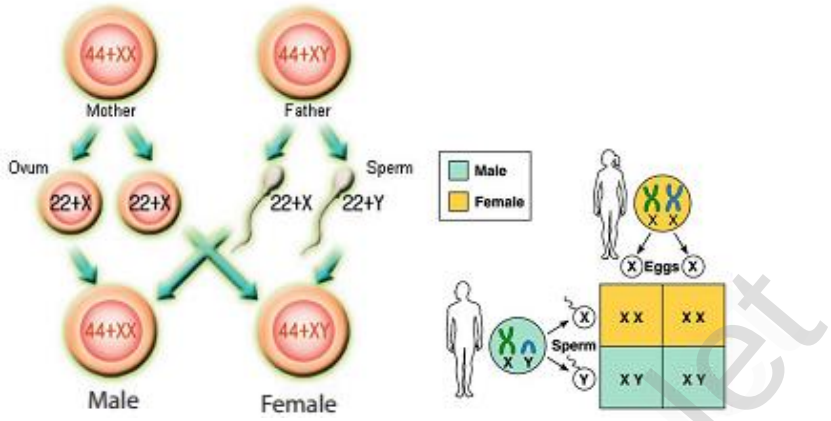
ii) It contains information required for the formation of proteins.

iii) It controls the developmental process and life activities of an organism.

03. 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 (23rd pair) is the **sex chromosome**.
- The female gametes or the eggs formed are similar in their chromosome type (22 + X). Therefore, human females are homogametic.

- The male gametes or sperms produced are of two types. 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 type 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.

VIII. Higher Order Thinking Skills :

01. 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 the monohybrid and dihybrid crosses?

Mendel selected the male and female parent plant. He **removed** the **stamens** from the flower of the **female parent** plant. Self-pollination will not be possible in this flow. Further, he also kept the **stigma covered** so that no other pollen other than the desired variety will fall onto that. Thus, Mendel made cross pollination possible in those self-pollinating garden pea plants having bisexual flowers.

02. Pure-bred tall pea plants are first crossed with pure-bred dwarf pea plants. The pea plants obtained in F_1 generation are then selfed to produce F_2 generation of pea plants.

a) What do the plants of F_1 generation look like?
All the plants of F_1 generation will be **tall**.

b) What is the ratio of tall plants to dwarf plants in F_2 generation?
In F_2 generation, the ratio of tall : dwarf plants (phenotypically) will be **3** : **1.**

c) Which type of plants were missing in F_1 generation but reappeared in F_2 generation?
The dwarf plants were missing in the F_1 generation, but reappeared in F_2 generation.

03. 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.

No. The statement given by her family members is False. The birth of male / female off-springs is due to the **random combination of Sperm with Egg**. A sperm may contain either X or Y (haploid) sex-chromosome. Whereas all eggs have only X chromosomes.

- If a sperm containing X chromosome fuses with an egg (X), Female (XX) baby is produced.
- And, If a sperm containing Y chromosome fuses with an egg(X), Male (XY) baby is produced.

Therefore, it is clear that the **sex of a child depends on the sperm** (nature of chromosome) that fertilizes the ovum.

IX. Value Based Question :

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

The law of Independent Assortment was proposed based on Mendel's Dihybrid cross. This cross involves the inheritance of two pairs of contrasting characters.

- ✓ Each trait is determined by a **pair of alleles**. (**Dominant / Recessive**).
- ✓ Each allele is contributed by a **parent** to the offspring.
- ✓ The results of dihybrid cross shows **four combination of characters** in the ratio 9 : 3 : 3 : 1.
- ✓ Thus, it can be concluded that the factors for each character or trait remain independent and maintain their identity in the gametes as well as passed on to the off-springs (through gametes).