	INDIAN SCHOOL AL WADI AL KABIR	
CLASS: XII	**DEPARTMENT: SCIENCE 2026 – 2027** **SUBJECT: BIOLOGY**	**DATE: 17/08/2026**
WORKSHEET NO. 5	**UNIT- VII- GENETICS** **CHAPTER:05 MOLECULAR BASIS OF INHERITANCE**	**NOTE:** **A4 FILE FORMAT**
CLASS & SEC:	**NAME OF THE STUDENT:**	**ROLL NO.**

I. OBJECTIVE-TYPE QUESTIONS

1. In a DNA strand, the nucleotides are linked together by:
   A. glycosidic bonds
   B. phosphodiester bonds
   C. peptide bonds
   D. hydrogen bonds
2. A nucleoside differs from a nucleotide. It lacks the:
   A. base
   B. sugar
   C. phosphate group
   D. hydroxyl group
3. Both deoxyribose and ribose belong to a class of sugars called:
   A. trioses
   B. hexoses
   C. pentoses
   D. polysaccharides
4. The fact that a purine base always pairs through hydrogen bonds with a pyrimidine base in the DNA double helix leads to:
   A. the antiparallel nature
   B. the semiconservative nature
   C. uniform width throughout DNA
   D. uniform length in all DNA
5. The net electric charge on DNA and histones is:
   A. both positive
   B. both negative
   C. negative and positive, respectively
   D. zero
6. The promoter site and the terminator site for transcription are located at:
   A. 3' (downstream) end and 5' (upstream) end, respectively, of the transcription unit
   B. 5' (upstream) end and 3' (downstream) end, respectively, of the transcription unit
   C. the 5 ' (upstream) end
   D. the 3 ' (downstream) end
7. Which of the following statements is the most appropriate for sickle cell anaemia?

A. It cannot be treated with iron supplements
B. It is a molecular disease
C. It confers resistance to acquiring malaria
D. All of the above

8. Which of the following is true with respect to AUG?
   A. It codes for methionine only
   B. It is an initiation codon
   C. It codes for methionine in both prokaryotes and eukaryotes
   D. All of the above

II. ASSERTION AND REASONING

For the following questions, two statements are given, one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (i), (ii), (iii), and (iv) as given below:

A. Both A and R are true, and R is the correct explanation of the assertion.
B. Both A and R are true, but R is not the correct explanation of the assertion
C. A is true, but R is false.
D. A is false, but R is true

9. **Assertion (A):** Splicing removes introns from hnRNA.
   Reason (R): Introns are non-coding sequences.

10. **Assertion (A):** Translation begins at the start codon AUG.
    Reason (R): AUG codes for methionine and acts as the initiation codon.

11. **Assertion (A):** In the absence of lactose, the repressor binds to the operator gene.
    Reason (R): Binding of the repressor prevents RNA polymerase from transcribing the structural genes.

12. **Assertion (A):** DNA ligase is more active on the lagging strand than on the leading strand.
    Reason (R): The lagging strand is synthesised discontinuously as Okazaki fragments.

III. VERY SHORT QUESTIONS (2M):

13. Distinguish between heterochromatin and euchromatin. Which of the two is transcriptionally active?
14. The enzyme DNA polymerase in E. coli is a DNA-dependent polymerase and can also proofread the DNA strand being synthesised. Explain. Discuss the dual polymerase.
15. Given below is the sequence of the coding strand of DNA in a transcription unit:
    3 'A ATG C A G C TATTAGG-5'
    Write the sequence of:
    a) its complementary strand
    b) the mRNA
16. Based on your understanding of the genetic code, explain the formation of any abnormal haemoglobin molecule. What are the known consequences of such a change?

IV. SHORT ANSWER TYPE QUESTIONS: (3M)

17. During DNA replication, why is it that the entire molecule does not open in one go? Explain the replication fork.
18. (i) In an experiment, DNA is treated with a compound which tends to place itself amongst the stacks of nitrogenous base pairs. As a result of this, the distance between two consecutive base pairs increases. From 0.34 nm to 0.44 nm, calculate the length of the DNA double helix (which has 2×10^9bp) in the presence of a saturating amount of this compound.

    (ii)Recall the experiments done by Frederick Griffith, Avery, MacLeod and McCarty, where DNA was speculated to be the genetic material. If RNA, instead of DNA, was the genetic material, would the heat-killed strain of Pneumococcus have transformed the R-strain into a virulent strain? Explain.

    (iii)A single base mutation in a gene may not 'always' result in loss or gain of function. Do you think the statement is correct? Defend your answer.

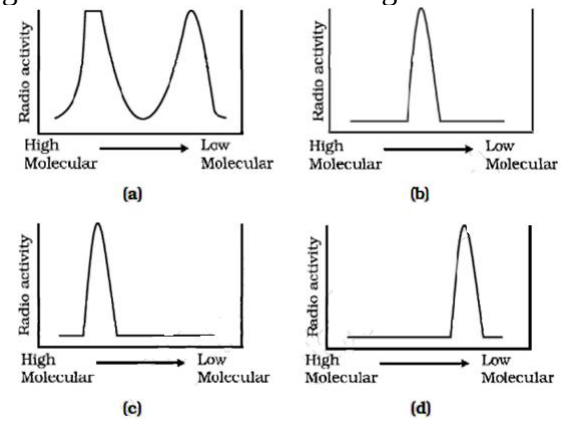
V. SOURCE-BASED/ CASE STUDY-BASED QUESTIONS

19. The Human Genome Project successfully determined the complete nucleotide sequence of the human genome. Scientists found that humans possess about 20,000–25,000 genes and that only a small percentage of the genome codes for proteins.
    A. Approximately what percentage of the human genome codes for proteins?
    B. Name one major objective of the Human Genome Project.
    C. Mention two benefits of sequencing the human genome.

VI. LONG ANSWER TYPE QUESTIONS. (5M)

20. (i) During the course of evolution, why was DNA chosen over RNA as genetic material? Give reasons by first discussing the desired criteria in a molecule that can act as genetic material and in the light of biochemical differences between DNA and RNA.

    (ii)Replication was allowed to take place in the presence of radioactive deoxynucleotide precursors in E.coli that was a mutant for DNA ligase. Newly synthesised radioactive DNA was purified, and strands were separated by denaturation. These were centrifuged using density gradient centrifugation. Which of the following would be a correct result?



VII. BOARD QUESTIONS

21. Differentiate between Euchromatin and Heterochromatin based on:
    i) Packing density & staining property
    ii) Transcriptional activity [CBSE 2025 Sample / Board Alignment]
22. i) The Lac Operon is a classic model for gene regulation in prokaryotes. Name the structural genes z, y, and a, and write down the specific enzyme synthesised by each.
    ii) Explain the state of the Lac Operon when:
        a) Lactose is absent in the medium.
        b) Lactose is present in the medium.
    iii) Why is the Lac Operon categorised as an inducible operon? [CBSE 2024]
23. Explain the Hershey and Chase experiment with labelled diagrams. What conclusion was drawn? [CBSE 2024]
24. Describe DNA replication in prokaryotes under the following headings:
    i) Initiation
    ii) Elongation
    iii) Termination [CBSE 2024]
25. A bacterial culture was transferred from lactose-free medium to lactose-containing medium. Answer the following:
    a) Which genes become active?
    b) Which substrate acts as the inducer?
    c) Why is the lac operon called an inducible system? [CBSE 2024]
26. Explain the process of DNA fingerprinting. Mention one forensic application. [CBSE 2025]
27. Mention the role of:
    i) DNA polymerase
    ii) Helicase
    iii) Ligase
    iv) Primase [CBSE 2025]

ANSWER KEY	
I. OBJECTIVE-TYPE QUESTIONS	
1.	B. phosphodiester bonds
2.	C. phosphate group
3.	C. pentoses
4.	C. uniform width throughout DNA
5.	C. negative and positive, respectively
6.	B. 5' (upstream) end and 3' (downstream) end, respectively, of the transcription unit
7.	D. All of the above
8.	D. All of the above
II. **ASSERTION AND REASONING**	
9.	A. Both A and R are true, and R is the correct explanation of the assertion.
10.	A. Both A and R are true, and R is the correct explanation of the assertion
11.	A. Both A and R are true, and R is the correct explanation of the assertion.

12.	A. Both A and R are true, and R is the correct explanation of the assertion
III. VERY SHORT ANSWER TYPE QUESTIONS: (2M)	
13.	1. Euchromatin: Regions of chromatin that are loosely packed and stained lightly. It is transcriptionally active. 2. Heterochromatin: Regions of chromatin that are densely packed and stained dark. It is transcriptionally inactive.
14.	In bacteria, three types of DNA polymerases are present. All of them can add nucleotides in the 5'→ 3' direction. DNA polymerase III can proofread the newly synthesised strand and sense wrong base insertions. It deletes incorrect bases and helps correct the mistake by inserting the correct one. The only mistake is that it cannot correct the substitution of uracil in place of thymine.
15.	According to base complementary rules, (a) 5'TTACGTCGATAATCC-3' (b) 5'CGAUUAUCGACGUAA-3' RNA uses the base uracil (U) rather than thymine (T). So, in RNA, the base pairs are: Adenine (A) pairs with uracil (U) and Guanine (G) pairs with cytosine (C).
16.	Due to a point mutation in the β-globin chain of the haemoglobin molecule, glutamic acid (Glu) is replaced by valine (Val) at the sixth position. Under stress conditions, erythrocytes lose their circular shape and become sickle-shaped. As a result, the cells cannot pass through narrow capillaries. Blood capillaries are clogged and thus affect blood supply to different organs.
IV. SHORT ANSWER TYPE QUESTIONS (3M)	
17.	While replicating, the entire DNA molecule to keep the whole molecule stabilised does not open in one go because it would be highly expensive energetically. Actually, unwinding creates tension in the molecule as uncoiled parts. Actually, unwinding creates tension in the molecule as uncoiled regions form supercoils due to interactions among exposed nucleotides. Instead, the helicase enzyme acts on the double strand at the ori site (origin of replication), and a small stretch is unzipped. Immediately, it is held and stabilised by single-strand binding proteins. Slowly, with the help of enzymes, exposed strands are copied as the point of unwinding moves ahead in both directions. It gives an appearance of a Y-shaped structure, which is called a replication fork. The two functions that the monomer units of NTPs play are (i) They pair up with exposed nucleotides of the template strand and make phosphodiester linkages and release a pyrophosphate. (ii) Hydrolysis of this pyrophosphate by the enzyme pyrophosphatase releases energy that will facilitate making hydrogen bonds between free nucleotides and bases of the template strand.
18. (i)	The length of the DNA double helix = $2 \times 10^9 \times 0.44 \times 10^{-9}$ / bp.
(ii)	RNA is more labile and prone to degradation (owing to the presence of a 2' OH group in its ribose). Hence, heat-killed S-strain may not have retained its ability to transform the R-strain into a virulent form if RNA was its genetic material.
(iii)	The statement is correct. Because of the degeneracy of codons, mutations at the third base of a codon usually do not result in any change in phenotype. This is called a silent mutation.
V. SOURCE-BASED/ CASE STUDY-BASED QUESTIONS	
	A. Less than 2%.

19. B. To identify all human genes or determine the complete DNA sequence.

C**.** Identification of genes responsible for inherited disorders.

Development of improved methods for disease diagnosis and treatment.

VI. LONG ANSWER TYPE QUESTIONS. (5M)

20. (i) A molecule that can act as a genetic material must fulfil the following
(i) It should be able to generate its replica (replication).
(ii) It should be chemically and structurally stable.
(iii) It should provide the scope for slow changes (mutation) that are required for evolution.
(iv) It should be able to express itself in the form of Mendelian inheritance.

Biochemical differences between DNA and RNA
(i) Both nucleic acids (DNA and RNA) can direct their duplication; proteins fail the first criterion.
(ii) RNA is reactive; it also acts as a catalyst; hence DNA is less reactive and structurally more stable than RNA.
(iii) Presence of thymine at the place of uracil also confers additional stability to DNA.

(ii) In the above case, as E.coli is a mutant for DNA ligase, it will result in no further joining of Okazaki fragments on the lagging strand. This will ultimately result in the formation of both high molecular weight fragments (on the leading strand) and low molecular weight fragments (on the lagging strand). Hence, only graph (a) could be the appropriate result after centrifugation.

VII. BOARD QUESTIONS

21.

Basis	**Euchromatin**	**Heterochromatin**
i) Packing density & staining property	Loosely packed; lightly stained	Highly condensed; darkly stained
ii) Transcriptional activity	Transcriptionally active (genes are expressed)	Transcriptionally inactive (genes are not expressed)

22.

i) Structural Gene	**Enzyme Produced**	**Function**
z	β-Galactosidase	Breaks lactose into glucose and galactose
y	Permease	Increases permeability of the bacterial cell to lactose
a	Transacetylase	Transfers an acetyl group to β-galactosides (helps in detoxification)

ii) **a) When lactose is absent**

- The **regulatory gene (i)** produces a **repressor protein**.
- The repressor binds to the **operator (O)**.
- RNA polymerase cannot transcribe the structural genes (**z, y, a**).
- Therefore, the operon remains **switched OFF**.

b) When lactose is present

- Lactose (actually **allolactose**, formed from lactose) acts as an **inducer**.
- It binds to the repressor and inactivates it.
- The repressor cannot bind to the operator.

	• RNA polymerase transcribes the structural genes. • β-Galactosidase, permease, and transacetylase are synthesised. • Therefore, the operon is **switched ON**. iii) The lac operon is called an **inducible operon** because it is normally **OFF** and is **switched ON only in the presence of the inducer (lactose/allolactose)**, which inactivates the repressor and allows transcription of the structural genes.
23.	DNA as a genetic material in viruses (bacteriophage) was discovered by Alfred Hershey and Martha Chase (1952). They grew some viruses on a medium that contained radioactive phosphorus and some others on a medium that contained radioactive sulfur. Viruses grown in the presence of radioactive phosphorus contained radioactive DNA but not radioactive protein because DNA contains phosphorus but protein does not. Similarly, viruses grown on radioactive sulfur contained radioactive protein but not radioactive DNA because DNA does not contain sulfur. Bacteria which was infected with viruses that had radioactive DNA were radioactive, indicating that DNA was the material that passed from the virus to the bacteria. Bacteria that were infected with viruses that had radioactive proteins were not radioactive. This indicates that proteins did not enter the bacteria from the viruses. DNA is therefore the genetic material that is passed from virus to bacteria. (REF.FIF 5.5 FROM NCERT TB)
24.	Initiation □ Helicase unwinds DNA. □ Replication begins at the origin. Elongation □ Primase synthesizes an RNA primer. □ DNA polymerase adds nucleotides. □ Leading strand synthesised continuously. □ Lagging strand is synthesised discontinuously as Okazaki fragments. Termination □ RNA primers removed. □ DNA ligase joins fragments. □ Two identical DNA molecules formed.
25.	(a) Structural genes lac Z, lac Y and lac A (b) Lactose (c) Because lactose activates gene expression only when present.
26.	DNA fingerprinting is a technique used to identify individuals based on differences in their DNA sequences (VNTRs). Steps: □ DNA isolation □ Restriction digestion □ Gel electrophoresis □ Southern blotting □ Hybridisation with radioactive probes □ Autoradiography Application: Criminal identification, paternity testing, disaster victim identification.

27.	Role of enzymes Helicase Unwinds DNA. Primase Synthesises RNA primers. DNA Polymerase Adds nucleotides in the 5’ → 3’ direction. Ligase Joins Okazaki fragments on the lagging strand.

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