



INDIAN INSTITUTE OF TECHNOLOGY KHARAGPUR

Mid-Spring Semester Examination 2022-23

Date of Examination: _____ Session: (FN/AN) _____ Duration: 2 hrs. Full Marks: 60

Subject No.: BS10003

Subject: Science of Living Systems

Department/Center/School: School of Bioscience

Specific charts, graph paper, log book etc., required: None

Special Instructions (if any): 1. WRITE ALL PARTS OF A QUESTION IN ONE PLACE. 2. WRITE YOUR SECTION NO. ON THE FRONT PAGE OF ANSWER SCRIPT. 3. ANSWER ALL QUESTIONS.

PART A (30 marks)

Answer the following questions in brief.

1. (a) In Griffith's experiment, two different strains of *Streptococcus pneumoniae* were used: "R" and "S". Complete the following table in your answer sheet with suitable results and explanations related to the famous experiment. [4]

		Results (survive or die)	Reason
+ Live "R" strain	→	SURVIVE	It is non-virulent

+ Live "S" strain →

+ heat-killed "S" strain →

+ (Live "R" strain+
heat-killed "S" strain) →

- (b) Why do we not use Helicase enzyme for unwinding DNA during PCR? [2]

- (c) During DNA replication within a cell, Okazaki fragments are formed. Do you think Okazaki fragments will be generated during PCR reactions? Explain in brief. [2]

2. You have isolated an RNA from a bacterial cell and found the following sequence; initial and end parts are shown, start codon is underlined, stop codon is in bold letters:

5' UGCAAGGAUGGAAUACCUG.....GUACAU**UGA**ACUGACGCC 3'

- (a) Write down the partial sequence of the double stranded DNA (the gene) with directions, from which this RNA was transcribed. Also indicate the coding and template strands in your figure. [4]

- (b) If there are 1500 nucleotides between the two arrows in the figure, then what would be the length of the protein coded by the mRNA? 500 [1]

- (c) If the above sequence belonged to a mature mRNA of a eukaryote, would it be possible to find out the length of the gene (double stranded DNA) coding for the mRNA? Why? [2]

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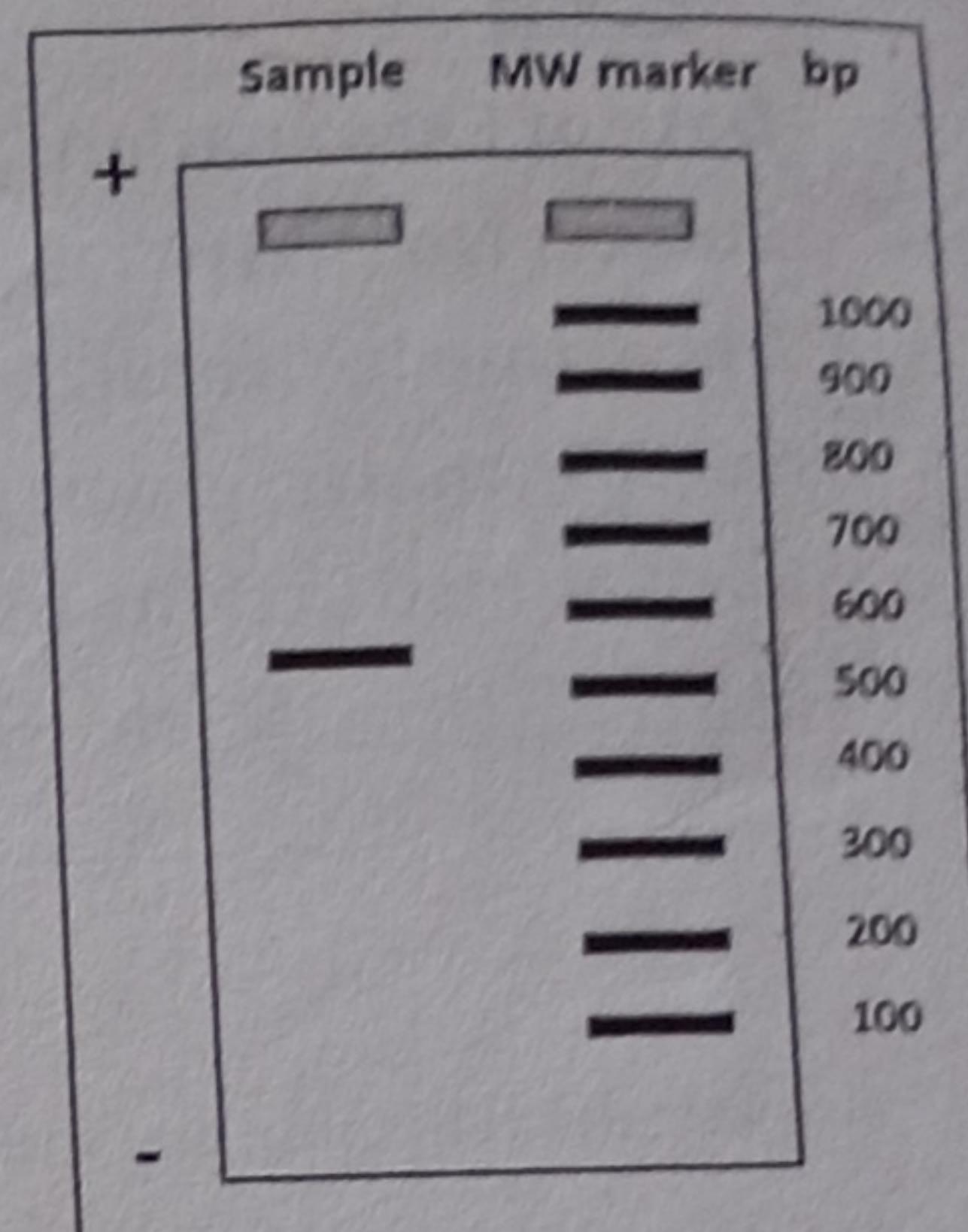
3. You want to amplify an 800 bp long gene by PCR; its sequence at two ends is given below (only one strand is shown):

5' -ATGGCAAATGCAACT.....GCTCTGAATTAAGTA-3'

(a) Write down the sequence of the two suitable primers (each 10 nucleotide long) that you will use for performing PCR to amplify the gene. Show where they will bind in the double stranded target DNA. [4]

(b) After PCR you wanted to check whether your desired gene was amplified. You performed a gel electrophoresis for that purpose. A representative result is shown in the figure with two lanes, one for loading your PCR sample and another with DNA fragments of known lengths (MW marker). The gel image has TWO mistakes; draw a picture of the gel image correcting the mistakes of the image. [2]

(c) How many copies of DNA will be generated after 25 cycles if you start the PCR from 100 copies of DNA? [1]

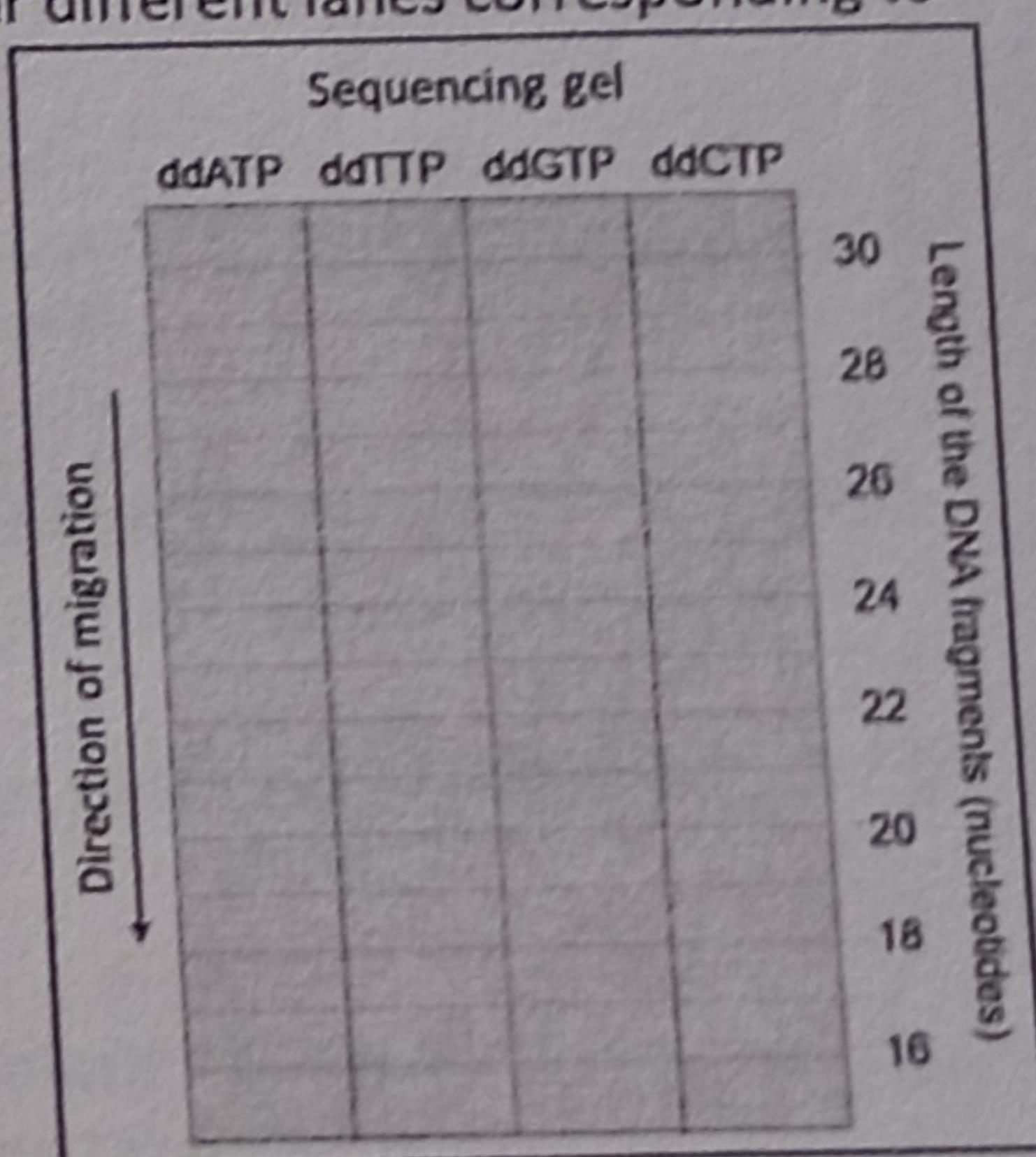


4. Suppose you are trying to sequence the DNA template (A) using the primer (B) radiolabelled at its 5' end (*) through the sanger sequencing method. The outline of the sequencing gel containing four different lanes corresponding to four different ddNTP-containing reactions is provided below.

(A) 3' -ATG CTT AGT CCG AGG AGA TGT TTA CAA -5'

(B) *5' -TAC GAA TCA GGC TCC-3'

- (a) How many bands you would expect to get on the gel as a result of the sequencing reaction? [1]
(b) Draw the resulting image of a gel with bands of DNA fragments following the image of empty gel provided. [4]
(c) Will the total number of bands change if you add same proportion of ddATP and dNTPs for the first reaction? [2]
(d) What is the key difference between dNTP and ddNTP? [1]



PART B (30 MARKS)

[10 X 2 = 20 marks]

5. Choose the correct (only one) answer.

I. In terms of DNA and RNA structure, what is a nucleotide?

- (a) A nucleotide is a Nitrogenous base
(b) A nucleotide is a sugar molecule covalently bonded to a Nitrogenous base
(c) A nucleotide is a sugar molecule bonded to phosphate group/s and a Nitrogenous base
(d) A nucleotide is a Nitrogenous base bonded to phosphate group/s

II. In an alien species, there are only 2 types of nucleotides (instead of 4 types in humans) but codons are 4 nucleotide long. If each type of codon specifies one unique amino acid, how many possible amino acids can be coded. Also consider that they have only one stop codon.

(a) 7

(b) 15

(c) 31

(d) 63

III. A genetic analysis of a new virus reveals that it contains nucleotides G, A, T and C in the proportion 30 %, 35 %, 15 % and 20 %, respectively. Based on this information, the virus is most likely a

(a) double-stranded DNA virus

(b) single-stranded DNA virus

(c) single-stranded RNA virus

(d) not enough information is provided

IV. Which one of the following statements is INCORRECT?

- (a) Leading strand are synthesized from 5' to 3' direction
(b) Lagging strand requires more primers than leading strand during replication
(c) Okazaki fragments are observed during lagging strand synthesis
(d) Lagging strand is synthesized from 3' to 5' direction

V. In an experiment, it was found that the value of T_m for a DNA sample is = 70° C. If that DNA sample has 45% GC at the above T_m , then what will be the value of ' T_m ' if the GC% increases to 55%?

- (a) Increases (b) Decreases (c) Remains same (d) Cannot be predicted

VI. Which of the following is in correct order in which they occur within a cell:

- (a) Transcription, Translation, mRNA Splicing, Protein folding
(b) Transcription, mRNA Splicing, Translation, Protein folding
(c) Transcription, Translation, poly-adenylation Protein folding
(d) Transcription, Translation, 5' capping of mRNA, Protein folding

VII. Arrange the following according to the number of subunits present in them:

- (a) DNA Polymerase < RNA Polymerase < Ribosome
(b) Ribosome < DNA Polymerase < RNA Polymerase
(c) Ribosome < RNA Polymerase < DNA Polymerase
(d) DNA Polymerase < Ribosome < RNA Polymerase

2.

VIII. Following are the names of some enzymes involved in DNA Replication (in first column) and their functions (in second column). Select the correct match between the columns.

Name of the Enzyme	Role in Replication
A. DNA Polymerase III	1. DNA unwinding
B. DNA Polymerase I	2. Relaxation of Supercoiling
C. Topoisomerase	3. DNA synthesis in leading and lagging strands
D. Helicase	4. Removal of RNA primers

- (a) A - 1; B - 3; C - 4; D - 2
(b) A - 4; B - 3; C - 1; D - 2 -
(c) A - 3; B - 4; C - 2; D - 1
(d) A - 3; B - 2; C - 1; D - 4 -

IX. Choose the correct one from the following options that indicate the number or molecules present per *E. coli* cell in ascending order.

- (a) DNA < mRNA < tRNA < protein
(c) DNA < protein < mRNA < tRNA

- (b) DNA < tRNA < mRNA < protein
(d) DNA < mRNA < Protein < rRNA

X. A researcher has used only a single primer in a PCR reaction of 30 cycles. Starting template is just one piece of double stranded DNA. Which of the following will be synthesized at the end of the PCR reaction?

- (a) 2^{30} copies of double stranded DNA
(c) 30 copies of single stranded DNA

- (b) 2^{30} copies of single stranded DNA
(d) 30 copies of double stranded DNA

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6. Choose the correct (only one) answer.

[10 X 1 = 10 marks]

I. Which of the following is NOT an example of polynucleotide chain?

- (a) tRNA (b) a gene in a virus (c) Poly-A tail of mRNA (d) Pentapeptide

II. Backbone of DNA and RNA is covalently linked through _____ and is _____ in nature.

- (a) glycosidic, hydrophobic (b) phosphodiester bond, hydrophobic
(c) peptide, hydrophilic (d) phosphodiester bond, hydrophilic

III. Complexity of an organism depends on

- (a) genome size (b) number of genes in its genome (c) length of genes (d) multiple factors

IV. A new strain of bacteria was isolated from a natural hot water geyser. Comment on the expected DNA base compositions in this thermophilic organism (living in high temperatures).

- (a) $A+T = G+C$ (b) $A+T > G+C$ (c) $G+C > A+T$ (d) Insufficient data

V. Which one of the following statements is CORRECT?

- (a) Poly-A tailing of mRNA is a template dependent synthesis
(b) 5' end of nascent eukaryotic mRNA acquires a poly A tail
(c) Splicing removes introns from eukaryotic transcripts
(d) Transcription and translation occur in the same cellular compartment in eukaryotes

VI. A 990 nucleotide long Eukaryotic nascent mRNA has a 60-nucleotide long intron. But the mature mRNA available for translation is found to be 1100 nucleotide long. What may have caused the increased length of the mature mRNA?

- (a) Splicing (b) 5' capping (c) Poly-A tailing (d) Reverse transcription

VII. Which of the following best describes a promoter:

- (a) A specific DNA sequence from where translation starts
(b) A specific DNA sequence that promotes termination of transcription
(c) A specific DNA sequence to which RNA polymerase binds
(d) An extracellular inducer that controls genes expression

VIII. Why can we not use human DNA polymerase in PCR?

- (a) Human DNA polymerase cannot work in high temperature
(b) Human DNA polymerase cannot work outside human cells
(c) Human DNA polymerase cannot be used because it requires only RNA primer to work
(d) Human DNA polymerase can only amplify human DNA

IX. What is the nature of the interaction between tRNAs and mRNAs at the translation site?

- (a) Covalent bond (b) Hydrophobic interaction (c) Hydrogen bond (d) Electrostatic interaction

X. Which of the following reactions is catalyzed by an RNA?

- (a) Replication (b) Transcription (c) Translation (d) 5' end Capping of mRNA

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~~~~~ End of Question Paper ~~~~