



INDIAN INSTITUTE OF TECHNOLOGY KHARAGPUR

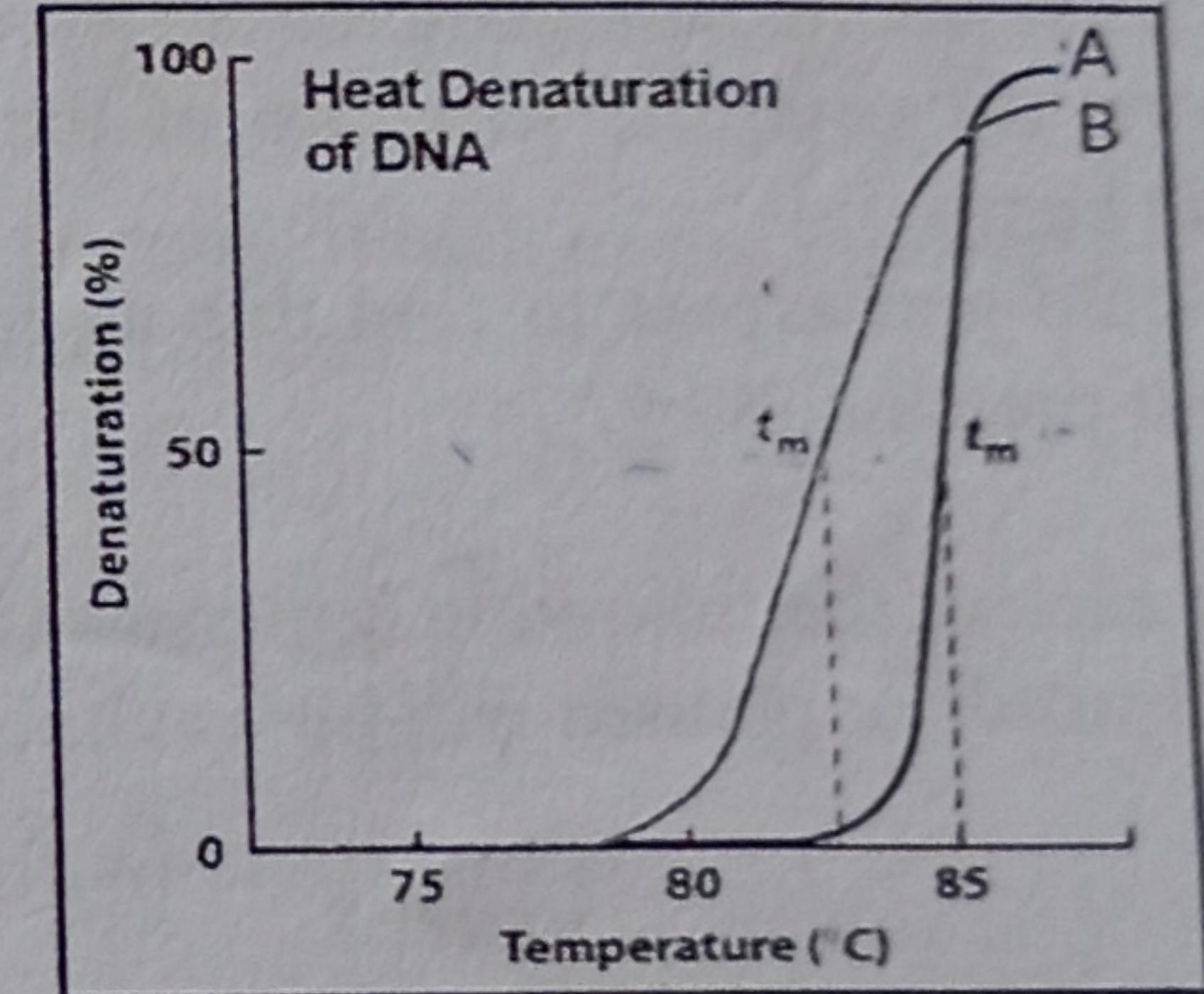
Mid-Autumn Semester 2022-23

Date of Examination: /12/2022 Session (FN/AN): Duration: 2 hrs Full Marks: 60
 Subject No.: BS10003 Subject: Science of Living System
 Department/Center/School: School of Bioscience
 Specific charts, graph paper, log book etc., required: None
 Special Instructions (if any): None

Date of 1
 Subject
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- Part A**
- ~~100 μl → 100 × 2²⁵, 2 → 2²⁴ → 8, 100 × 2 → 100 × 2²⁴ → 100 μl, 0.01~~
- Answer the following questions showing full calculations: [3 X 2 = 6]
 - 100 template DNA molecules are PCR amplified for 25 cycles in a 100 μl reaction mixture. How many amplified products will be there in 0.01 μl of solution after amplification?
 - One undergrad student is repeating Anfinsen's experiment with an enzyme that has TEN cysteine residues and forms FIVE disulfide bonds. What is the total number of possible disulfide bond combinations that can be formed randomly in the denatured protein? $(10C_2 \cdot 8C_2 \cdot 6C_2 \cdot 4C_2 \cdot 2C_2)/5$
 - 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) The diagram on the right represents heat denaturation curves of nucleic acids. State the difference between sample A and B (both are double stranded DNA samples) in terms of their base composition and explain your answer. [2]

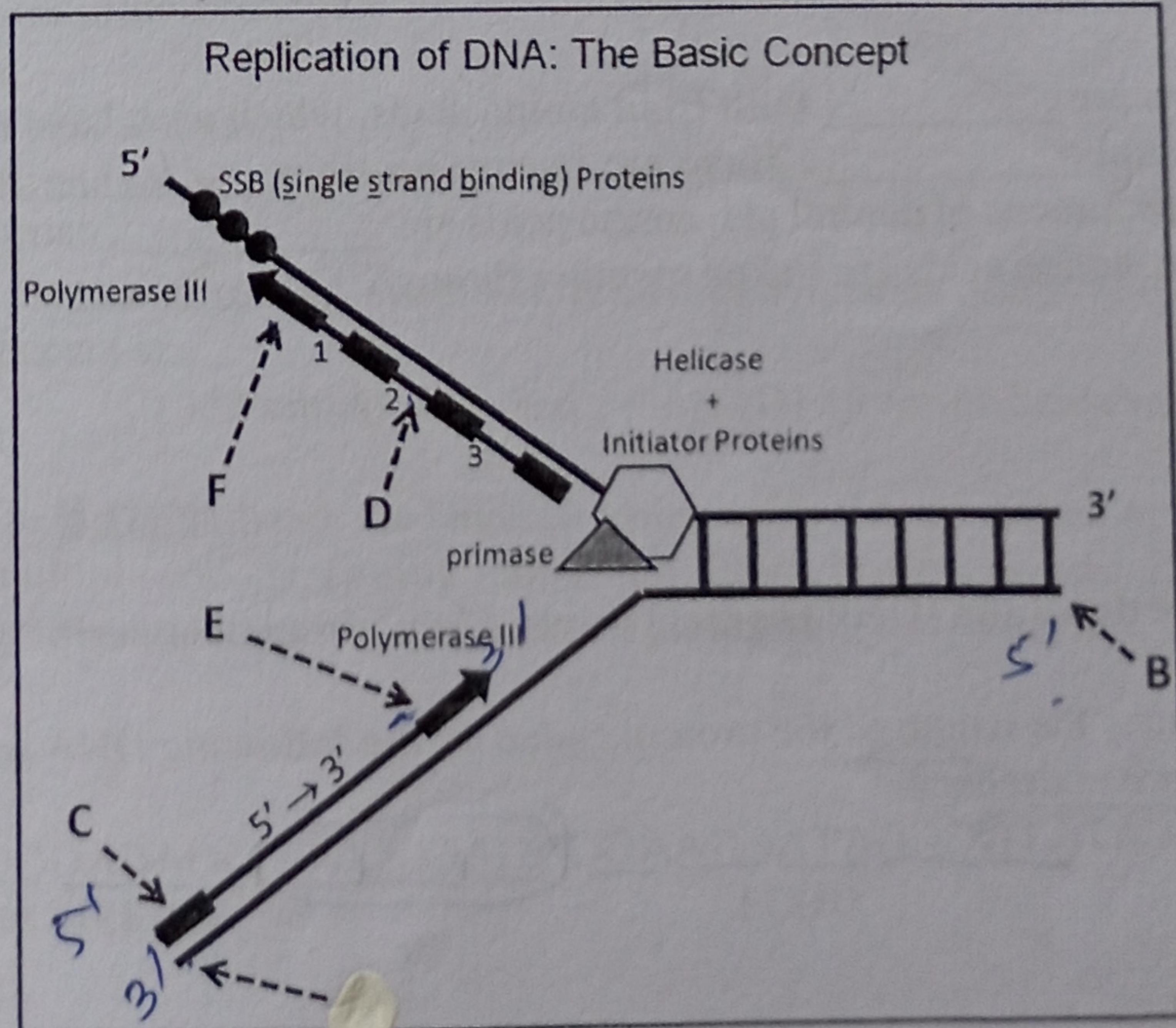


- (b) The diagram on the right depicts the process of replication. Identify these letters (i.e., A to F) from the following list (each option will be used only ONCE): [3]

DNA primer	RNA primer	Leading strand
5' end	3' end	Lagging strand
Polymerase I	Ligase	Okazaki fragment

Write your answers as per the following table:

A	
B	
C	
D	
E	
F	/



KHARAGPUR
on 2025-26

Duration: 2 Hrs
Soft Computing

INSTITUTE OF TECHNOLOGY
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Examination for the Session AUTUMN

ERING
3.Tech 4Y)

The Schedule and Sitting Pattern

NT/DEPT	Date	Room
CNT	2025-09-21	F142
CNT	2025-09-22	NR223
CNT	2025-09-26	F116

TECHNOLOGY
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Examinations :
Identity Card is not permitted.

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authorized documents/papers, bag is not

on the question paper or on the admis-

on Hall at his/her own risk. Small mon-

and appropriate seating pattern preferable

is will be closed 5 minutes before the s-

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the Examination Hall 15 minutes after

question paper, etc. is not allowed.

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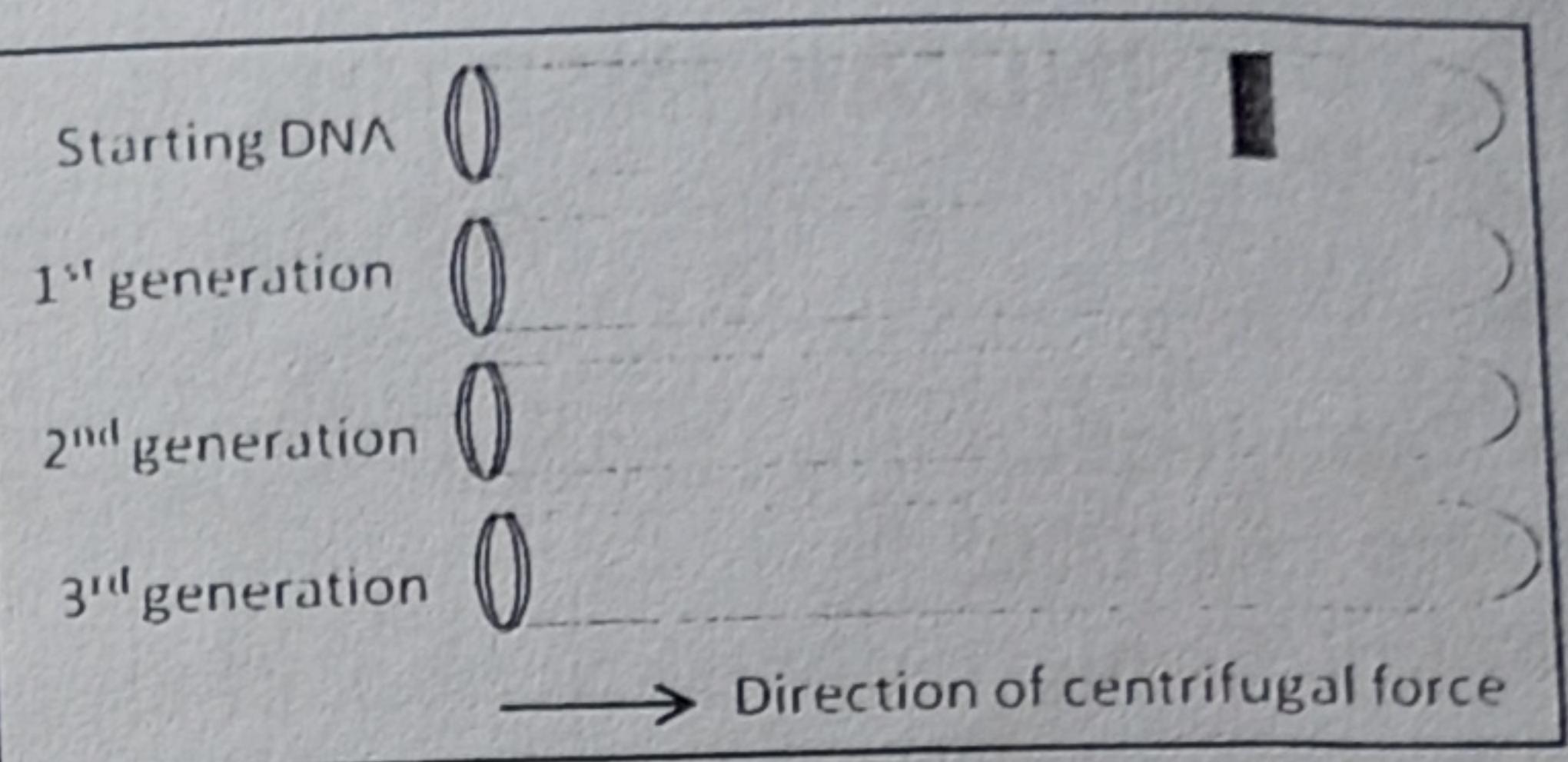
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information with others or any such atten-

ted to Malpractice committee. This

from scholarships, awards and

- (c) Show the results of Meselson-Stahl experiment in the format given in the figure on the right. Indicate the location of the DNA band(s) after 1st generation, after 2nd generation and after 3rd generation using 3 test tubes as shown in the diagram. Location of DNA at the beginning of experiment is shown in the top most tube. [3]



3. (a) You have discovered a new gene which contains two exons (Ex-1 and Ex-2) and one intron with the following lengths: Ex-1: 180 bp; Ex-2: 165 bp; Intron: 180 bp.

(i) Draw a schematic diagram of mature mRNA (i.e., after processing) transcribed from the above-mentioned gene. Indicate the following in your diagram: 5' and 3' ends, mRNA cap and poly A tail. [2]

(ii) What will be the length of the translated protein? [1]

(iii) Is it possible to calculate the exact length of mature mRNA from the information provided above? [1]

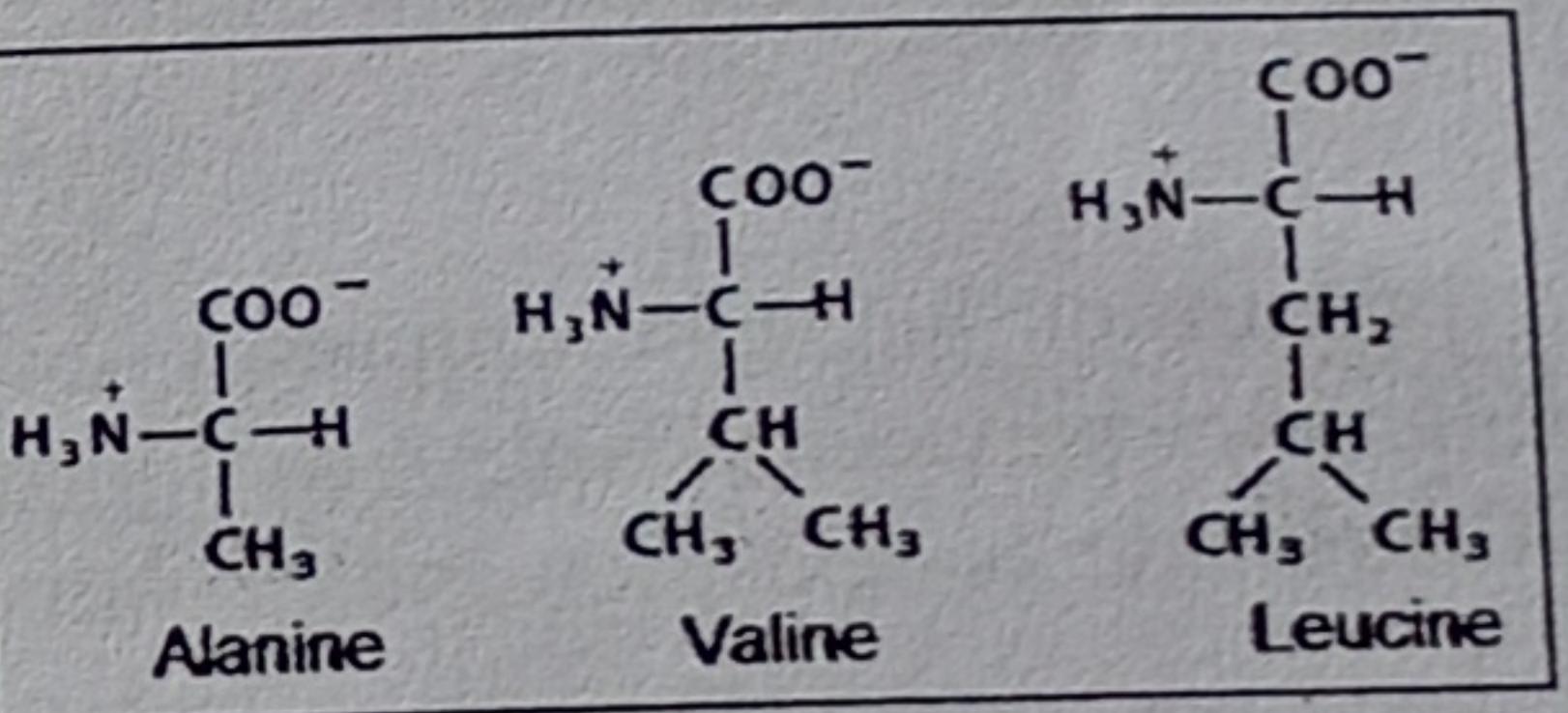
- (b) Match the following statements with rRNA, mRNA, or tRNA:

- (i) RNA that makes up the highest percentage of RNA in the cell
- (ii) RNA that combines with proteins to form ribosomes
- (iii) RNA that brings amino acids to the ribosomes for protein synthesis
- (iv) RNA that acts as a template for protein synthesis

4. (a) Structure of 3 amino acids are shown in the figure. Based on that:

(i) Draw the complete structure of the peptide Val-Ala-Leu and label the peptide bonds. [2]

(ii) Would you expect to find this segment at the core or at the surface of globular proteins. Why? [3]



- (b) For each of the following sentences, fill in the blanks with the best word or phrase selected from the list below:

(Not all words or phrases will be used; each word or phrase should be used only once)

- | | | | |
|---------------|-------------|--------------|------------------|
| amino | ionized | polypeptides | α -carbon |
| peptide bonds | side chains | noncovalent | carboxyl |

Proteins are _____ built from amino acids, which each have an amino group and a _____ group attached to the central _____. There are twenty possible _____ that differ in structure and are generally referred to as "R." In solutions of neutral pH, amino acids are _____, carrying both a positive and negative charge. When a protein is made, amino acids are linked together through _____. [3 marks]

Part B

5. Write down the (ONE) correct answer in your answer script.

[10 X 2 = 20 marks]

- (i) Estimate the length of the protein coded by the following DNA sequence. Start and stop codons are in bold letters; introns are underlined.

5' GCACATATGGCGATACGAAGGGGACGGACAGGGCCGTTGCTTAAGGTTGT 3'

(A) 10

(B) 11

(C) 13

(D) 9

(iii) A mutation in the lac-repressor gene removes the allolactose binding site of the lac-repressor protein. What will be the effect on the activity of the lac operon system? Enzymes will be produced irrespective of the presence or absence of lactose.

- effect on the activity of the lac operon system?

(A) Lactose metabolizing enzymes will be produced irrespective of the presence or absence of lactose

(B) Glucose metabolism will be blocked

(C) Lactose will not be metabolized because the enzymes will not be synthesized

(D) lac-repressor protein will not be able to bind the operator site of the operon

(iv) Which one of the following statements regarding Griffith's experiments is INCORRECT? (S=smooth, R=rough)

- (IV) Which one of the following best describes the results of the experiment?

 - (A) S strain bacteria killed the mice.
 - (B) R strain bacteria were not able to kill the mice.
 - (C) Heat-killed S strain bacteria killed the mice.
 - (D) A mixture of heat-killed S strain bacteria and live R

(v) Which of the following is in correct order:

- (v) Which of the following is in correct order:

(A) Transcription, Transport of mRNA from nucleus to cytoplasm, Translation, Protein folding

(B) Transcription, mRNA Splicing, Transport of mRNA from nucleus to cytoplasm, Translation, Protein folding

(C) Transcription, Transport of mRNA from nucleus to cytoplasm, Poly-adenylation, Translation, Protein folding

(D) Transcription, mRNA splicing, translation, Transport of mRNA from nucleus to cytoplasm

(D) Transcription
(vi) How many hydrogen bonds will be formed between a codon of mRNA and an anticodon of tRNA (consider GAC as codon and CUG as anticodon here)?

- (vii) The coding region of a gene is 102 nucleotides long, including both start and stop codons. Which of the following would be the most likely effect of a single nucleotide deletion at position 61 in the coding region?

- (A) There would be no effect on the polypeptide
 - (B) The entire amino acid sequence of the polypeptide would change
 - (C) There would be changes only in the first 20 amino acids
 - (D) There would be changes only after the first 20 amino acids

(viii) In alpha helix and beta sheets, the hydrogen bonds are

- (A) parallel to the helical axis and perpendicular to the beta strands.

(B) parallel to the helical axis and parallel to the beta strands.

(C) perpendicular to the helical axis and perpendicular to the beta strands.

(D) perpendicular to the helical axis and parallel to the beta strands.

(ix) The rate of protein synthesis in prokaryote is limited by the rate of mRNA synthesis. If mRNA synthesis occurs at the rate of 45 nucleotides/sec, then the rate of protein synthesis occurs at:

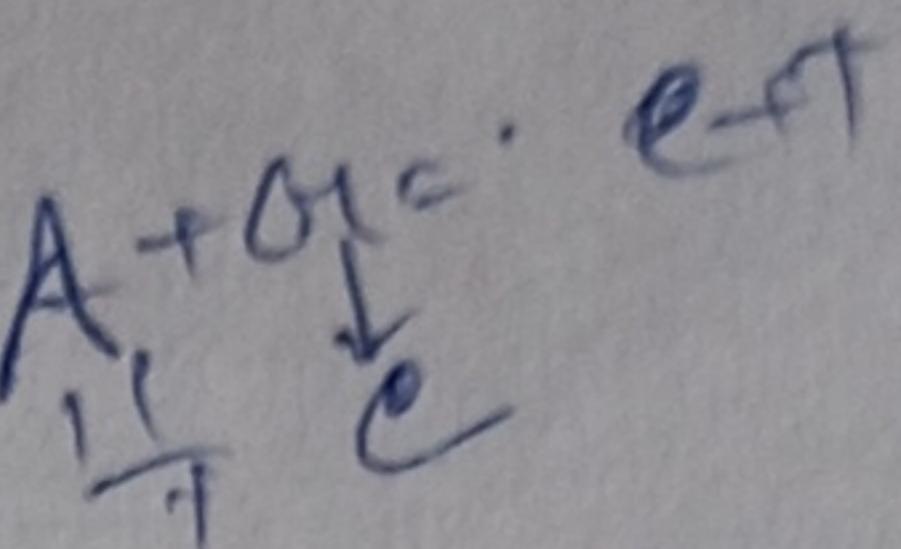
(A) 45 amino acids/sec (B) 20 amino acids/sec (C) 135 amino acids/sec (D) 15 amino acids/sec

- (x) We have 64 codons, out of those three are stop codons. protein. As a result of that one amino acid can be coded by amino acid at the translation site and recognize codon through which one of the following statements is most plausible?

- (A) Should have 20 different types of tRNA
 - (B) Should have less than 20 different types of tRNA
 - (C) Should have 64 different types of tRNA
 - (D) Should have more than 20 and less than 64 different types of tRNA

6. Write down the (ONE) correct answer in your answer script.

[10 X 1 = 10 marks]



$$\text{AF}T = \text{ATC}$$

30 95 15 70

- (i) A genetic analysis of an unknown infectious agent reveals that it contains only nucleotides G, A, T and C, in the proportion 30 %, 35 %, 15 % and 20 %, respectively. Based on this information, this infectious agent is most likely
- (A) Double-stranded DNA virus (B) Single-stranded DNA virus
(C) Single-stranded RNA virus (D) Not enough information is provided

(ii) Which of the following best describes a promoter:

- (A) A specific DNA sequence from where transcription 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

(iii) In gel electrophoresis different sized DNA migrate at different rate; which of the following statements is FALSE regarding this?

- (A) Smaller DNA molecules migrate faster
(B) Different DNA molecules separate according to mass
(C) DNA is positively charged and hence migrates towards the negative terminal in the applied electric field gradient
(D) DNA is visualized in the gel by staining with ethidium bromide, which fluoresces under UV light

(iv) DNA present in *E. coli* is

- (A) single-stranded, left-handed, linear (B) Double stranded, right-handed, circular
(C) Single stranded, right-handed, circular (D) Double stranded, right-handed, linear

(v) Backbone of DNA and RNA is covalently linked through _____ and is _____ in nature.

- (A) phosphoester bond, hydrophobic (B) phosphodiester bond, hydrophobic
(C) phosphoester, hydrophilic (D) phosphodiester bond, hydrophilic

(vi) How are secondary structures stabilized in proteins?

- (A) Through ionic bonds between oppositely charged amino acid side chains.
(B) Through covalent bonds joining different parts of the peptide backbone.
(C) Through hydrogen bonds between different amino acid side chains.
(D) Through hydrogen bonds joining different parts of the peptide backbone.

5. (a) used
(b) H
(c) W help i

(vii) The amino acid of a protein which occupies the largest area in the Ramachandran plot is

- (A) Alanine (B) Glycine (C) Cysteine (D) Phenylalanine

(viii) Hemoglobin and RNA polymerase are examples of

- (A) Two of the most complex proteins present in our body.
(C) Quaternary structures of protein.

(B) Tertiary structures of protein.

(D) Proteins that are available in all of our cells.

(ix) Which of the following pairs of amino acids might contribute to protein conformation by forming electrostatic interactions? (Hints: Nonpolar: Glycine, Phenylalanine and Tyrosine; Positively charged: Lysine and Arginine; Negatively charged: Glutamate and Aspartate)

- (A) Glycine and aspartate
(C) Phenylalanine and tyrosine

(B) Glutamate and lysine
(D) Lysine and arginine

(x) Choose the enzyme that is not a protein:

- (A) RNA polymerase (B) DNA polymerase (C) DNA ligase (D) Peptidyl transferase