Ref. No. Ex/MSBT 231/2022

# M. Sc. (Biotechnology) Examination, 2022

( 1st Year, 2nd Smester)

## Subject : Molecular Biology - II and Genetics

## Paper : MSBT 231

Time : Two hours Full Marks : 50 (Written 40 + Internal Assessment 10 )

**M.Sc. (Biotechnology) Examination, 2022**
**Molecular Biology-II and Genetics**
**MSBT 231**
**Full Marks – 50 (40+10 internal assessment)**
**Time 2 Hours**

**Group A**

**Answer Question Number 1 and any *THREE* questions from the rest**

**Q. 1. Answer any five questions** **1 X 5 = 5**

(a) Mention two technical advantages that are offered by baker's yeast as a model eukaryote.

(b) Mention the fundamental structural feature of DNA site involved in site-specific recombination.

(c) "The *Chi* sites provide a resistance to *E. coli* from the infection of bacteriophage lambda"- Justify this statement.

(d) What is plasmid shuffling? Mention one application of this process.

(e) What do mean by the term "tetrad"? What advantage a tetrad offers to a geneticist during the analysis of genetic recombination?

(f) What is 'heteroduplex' DNA? Where heteroduplex DNA is found in the genome?

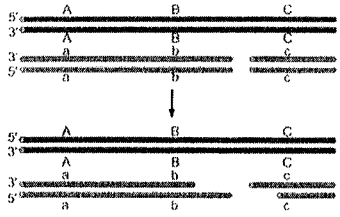
(g) Explain with the help of a diagram why the replication machinery is unable to complete the replication at the ends of the linear chromosome?

(h) What is counter selection? Provide an example of counter selection procedure routinely used in yeast genetic procedure.

(i) Provide one evidence that the way the "Chi (X) structure" formed during homologous recombination according to "Holliday Model" is incorrect.

(j) Write one major difference between site-specific recombination and transposition.

3. (a) Following the formation of a double strand break the enzyme process the double stranded DNA to form single stranded DNA as shown in following figure.



Does it matter if resection occur in the 5′ to 3′ direction or in the 3′ to 5′ direction? Justify your answer. 3

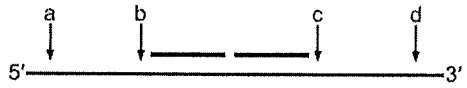
4. (a) Ethylmethane sulfonate (EMS) is an alkylating agent that has often been used in the lab to induce mutations in model organisms such as *Drosophila*. X-rays have also been extensively used to generate mutations. What types of mutations do you think each of these agents will tend to produce? 3

(b) Why the repair of the methylated nucleotide in *E. coli* is very costly 3

5. (a) In an eukaryotic cell, if a 1500 kb fragment of DNA has evenly fifteen symmetric replication origin and DNA polymerase moves at 1 kb per minute, how many minutes will it take to produce two daughter molecules ignoring the potential problem of replication at the end of the linear piece of DNA? Assume that all origins are fired at the same time and none of them is passively replicating 3

(b) Explain the strategy how would you isolate a yeast mutant defective in DNA replication noting that DNA replication is an essential function 2

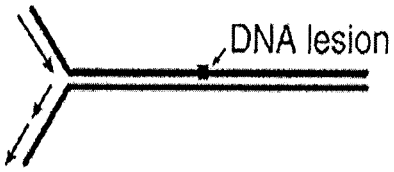
6. (a) Shown below is a long template strand of DNA, where lagging strand DNA synthesis is occurring. The short horizontal lines represent two Okazaki fragments that have already been made. In the context of the replication fork, select the letter (a–d) that indicates where primase will synthesize the next RNA primer. Why did you choose that location? Justify your answer.




3

(b) What is the role of base flipping in DNA repair? What does the repair machinery accomplish by relying on this phenomenon? 2

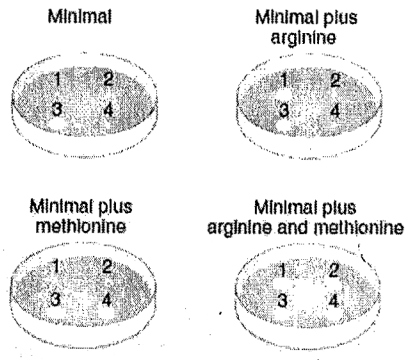
7. (a) Using a diagram explain what happens if the replication machinery encounters a lesion in the template DNA that prevents its progression as shown below? What options exist for the fork for getting past the lesion? 3



(b) "Among the three phages, λ, P22 and P1, it is P1 which contributed maximally in causing genetic diversity in the bacterial kingdom" - Justify the statement. 2

8. (a) Using necessary diagram, explain how an exogenous gene can be integrated at a specific locus within the yeast genome? 3

(c) Deduce the genotypes of the following four *E. coli* strains:

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## Group-B

**Answer question no. 9 and any two questions**

Find out correct answer of the following questions:

**9.** **4 x1 = 5**

(i) Regarding gene expression in eukaryotes, which statements is correct

(a) mRNA and DNA are colinear,
(b) RNA polymerase can bind to promoters situated upstream to gene,
(c) mRNA and protein synthesis can occur simultaneously,
(d) processing of hnRNA yields mRNA.

**(ii)** Which of the following is necessary for transport of mRNA from nucleus?

(a) Splicing, (b) 3'-capping, (c) Secondary structure, (d) 5'-capping.

**(iii)** siRNAs and miRNAs are used for achieving gene silencing. Although, major steps are similar there are distinct differences in the key players of the two processing pathways. Following statements relate to some characteristic features of gen silencing.
(a) Both siRNAs and miRNAs are processed by cytoplasmic endonuclease Dicer.
(b) Both siRNAs and miRNAs show association with argonaut protein.
(c) 'Dorsa' is needed for [processing miRNAs and precursor siRNAs).
(d) Both the processing pathways involve RSIC complex.

Which of the following combinations is NOT correct?

(a) A and C, (b) A and B, (c) C and D, (d) D and A.

**(iv)** DNA methylation plays an important role in transcription regulation in vertebrates. There is an inverse correlation between the level of DNA methylation in the vicinity of a gene and its transcription rate, whereas there is a direct correlation between histone acetylation and increased transcription. β-thalassemia is a common genetic impairment of haemoglobin β-chain synthesis in humans. If these patients can synthesize haemoglobin-F instead of haemoglobin β-chain in its place, they would be notably benefited. Administration of 5-azacytidine to thalassemia patients increases haemoglobin-F level in erythrocytes and thus benefit the patients.
Which one of the following statements about 5-azacytidine is NOT correct?

(a) 5-azacytidine decreases DNA methylation
(b) Cells exposed to 5-azacytidine incorporate it into DNA in place of cytidine,
(c) 5-azacytidine does not promote gene expression,
(d) 5-azacytidine promotes histone acetylation.

**10. (a)** Describe the process of stepwise assembly of eukaryotic transcription initiation complex with labelled diagram. **(3)**

(b) What is the significance of the CTD of the largest subunit of RNApol-II in the transition of the enzyme from the initiation to elongation phase? **(2)**

(c) Mention the functions of the following enzymes in capping enzyme complex: RNA terminal phosphatase, Guanylyl transferase **(3)**

**11. (a)** "Eukaryotic genes are split in nature" – explain. Describe an experiment to prove the presence of introns. **(1+3)**

**(b)** Mention the full name and mechanism of action of the following factors with eukaryotic pre-mRNA: CPSF, CstF, PAP, PAB2 **(4)**

**12. (a)** What is epigenetic regulation of gene expression in eukaryotes? What is histone code? Write the names of different tools of histone code with examples. Describe the epigenetic regulation of gene expression by covalent modification of histone, with diagram **(1+1+3+3)**