RAMAKRISHNA MISSION VIDYAMANDIRA

(Residential Autonomous College affiliated to University of Calcutta)

B.A./B.Sc. THIRD SEMESTER EXAMINATION, DECEMBER 2017

SECOND YEAR [BATCH 2016-19]

Date : 12/12/2017 **MICROBIOLOGY [Honours]**

Time : 11 am – 3 pm **Paper : III** Full Marks : 100

[Use a separate Answer Book for <u>each Group</u>]

<u>Group – A</u>

Answer <u>any six</u> question from <u>Question Nos. 1 to 12</u> : [6×10]

1. a) In eukaryotic cells transcription occurs in nucleus but translation occurs in cytoplasm. Which strategy is taken by mRNA to protect its 5´-end before its transport into cytoplasm. [2]

   b) What is catabolite repression? How does the presence of glucose in the medium exert its effect on *lac* gene expression in *E. coli*? [1+2]

   c) Apart from RNA splicing, is there any mechanism by which the base sequence of RNA can be changed before translation? If so, then mention an example where from the same RNA two kinds of polypeptides are synthesized. [2]

   d) Why is RNA synthesis not as carefully monitored for errors as in DNA synthesis. [3]

2. a) Explain the function of leader peptides and consequences of the coupling of transcription and translation in the regulation of several biosynthetic operons. [4]

   b) How did nature select only about 32 types of tRNA to read 61 sense codons leading to polypeptide synthesis? [3]

   c) Mention the names of the essential domains of non-ribosomal peptide synthetases and state their functions. Cite an example of a peptide antibiotics synthesized using this enzyme. [2+1]

3. a) How did Nirenberg's team deciphered the genetic code by means of triplet binding assay? [3]

   b) During the analysis of *lac* operon of *E.coli*, when a plasmid containing lac^- gene was introduced into a plasmid free lac^- *E.coli* cell, occasionally lac^+ phenotype resulted. How was it explained? [2]

   c) How is the initiating AUG identified by the prokaryotic small ribosomal subunit? [2]

   d) How does the activation of t_{RNA} with suitable aminoacid take place? [3]

4. a) Mention the name of the components of tRNA necessary for formylation, to be recognized by IF2, needed to enter P site of ribosome. [3]

   b) To maintain a steady-state of mRNA, there should remain a balance between its synthesis and degradation. How are these mRNA degraded? [2]

   c) Does there remain any difference between the products of standard splicing and alternative splicing methods? Explain citing proper examples. [1·5+1·5]

   d) What would be the effect on reading frame and gene function if two bases are inserted into the middle of an mRNA? [2]

5. a) How do release factors respond to stop codons in prokaryotic translation? [3]

   b) State the functions of the following factors associated with translation – EF–Tu, EF–G, IF–2. Do you find any similarity among these factors? [2+1]

c) What will be the phenotype of the partial diploids with proper explanation. [2]

i) $I^{s}O^{+}Z^{-} / F'I^{+}O^{+}Z^{+}$

ii) $I^{+}O^{+}Z^{+} / I^{-d}O^{+}Z^{-}$

d) Name two types of regulatory RNA associated with gene regulation. How do they play their roles? [2]

6. a) Name the domains present within the sigma factor of bacterial RNA polymerase and mention their functions. [3]

b) Why does RNA polymerase undergo the period of abortive initiation? [2]

c) What are the major sequence features of promoters for prokaryotic mRNA genes? How does upstream element act to facilitate transcription? [2+1]

d) How does RNA polymerase catalyse the polymerization reaction during mRNA synthesis? [2]

7. a) How can you determine the size of the region of DNA that is in contact with RNA polymerase during transcription initiation. [3]

b) In the analysis of *lac* operon lactose is not used as an inducer. Why? Mention the name and structure of one substance which is used for this purpose. [2+1]

c) There should be a problem for DNA polymerase to replicate the telomeric DNA. What problem might be encountered by the DNA polymerase? [2]

d) You are comparing two promoters that have –10 element sequences of TATGAT and CATGAT respectively. Which would you expect to be transcribed more efficiently? [1]

e) How many high-energy molecules are required per ribosomal cycle leading to protein synthesis. [1]

8. a) Sometimes it has been observed that two cellular proteins that do not show any relationship between them possess one or more almost identical domains. Can you present any explanation for the origin of this variation in course of evolution? [3]

b) The telomeric DNA eukaryotic chromosomes exhibit a peculiar structure. What is the peculiarity and how is it maintained? [3]

c) When lactose is used as an inducer a lag occurs before the enzymes of the *lac* operon are synthesized. With IPTG synthesis starts without a lag. Explain this observation. [3]

d) Cite an example of a compound used for *in situ* localization of β galactosidase activity. [1]

9. a) What is a rare codon? Cite example. [1]

b) What will happen it puromycin is added to a growing *E.coli* culture medium? [3]

c) Cancer cells possess higher telomerase activity. Why? [2]

d) If deletion takes place at *ara*O_2 site, what would be the expression of *ara*BAD operon? [2]

e) The secondary structure of tRNA assumes the structure of clover leaf. Do you think that all the arms of the tRNA are necessary for translation? Give proper reasons in support of your answer. [2]

10. a) What are the major observations of Winogradsky column. [2]

b) What is bioaerosol? Characterize the different types of bioaerosols present in air. [1+2]

c) Write down the principle of electrostatic precipitation of bioaerosol. [3]

d) In what ways phyllospheric organisms promote growth? [2]

11. a) Why are Indole and Methyl Red test positive for *E.coli*? [2]

b) What is the basic principle of citrate utilization test? [2]

c) What is MPN value? What is Thomas equation? [2]

d) What do you mean by coliform bacteria? [2]

e) Give examples on one airborne and one water-borne disease mentioning the names of their causal organisms. [1+1]

12. a) What is BOD_5? How is it measured? [1+2]

b) What are the limitations of trickling filter method? [2]

c) How is sludge produced during sewage treatment? [2]

d) Write down the process of anaerobic digestion of sewage. [3]

Group – B

Unit - I

Answer <u>any two</u> questions from <u>Question Nos. 13 to 16</u> : [2×10]

13. a) What is the significance of Dixon plot? [2]

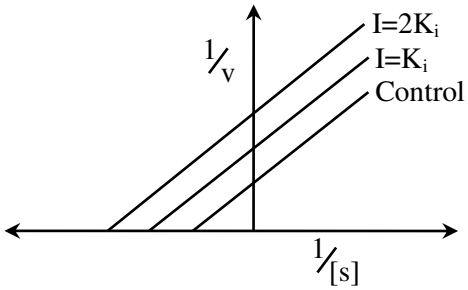
b) Specific activity is related with the purity of the enzyme —Justify. [2]

c) What are the difference between coenzyme and cofactor? [2]

d) Differentiate between synthase and synthetase. [2]

e) What is turnover number? [2]

14. a)



Which inhibition does the above graph represent? Write down the enzyme kinetic reaction and the equation for the above inhibition. [2+3]

b) 1·5 µg of an enzyme (MW = 30,000Da) give a V_{max} of 3 µ moles of product/min.

i) What is the turnover number for this enzyme?

ii) What is the turnover number if the enzyme is trimeric with three identical subunits?

iii) What is the turnover number if 3 µg enzyme gives a V_{max} of 3 µ moles/min? [2+1+2]

15. a) Why do regulatory enzymes often catalyse the first step of a certain metabolic pathway? [2]

b) Explain the pH dependence profile of a typical enzyme with proper drawing. [1+2]

c) Elaborate the different types of feedback inhibition found in metabolic system. [3]

d) One microgram of a pure enzyme (MW = 92,000) catalysed a reaction at a rate of 0·5µ moles/min under optimum conditions. Calculate specific activity of the enzyme in terms of units/mg of protein. [2]

16. a) The substrate concentration corresponding to half maximal velocity is represented as $K_{0.5}$ instead of K_m if the enzyme is allosteric. Explain. [2]

b) Lineweaver-Burk plots give a more accurate estimation of K_m than Michelis-Menten plots in an enzyme catalyzed reaction. Explain why? [2]

c) How does temperature affect enzyme activity? [3]

d) Explain the difference between concerted and sequential model of enzyme activity. [3]

Unit - II

Answer <u>any two</u> questions from <u>Question Nos. 17 to 20</u> : [2×10]

17. a) In the perspective of transport of materials across biomembranes, explain the term diffusion, permeability and partition. Deduce a relationship among the coefficients of the above three terms. [3]

    b) What are ionophores? Name any three and state their mode of functions. [3]

    c) Facilitated diffusion resemble enzyme kinetics in some aspects. Explain. [2]

    d) Show that the space rate of change of chemical potential can be interpreted as an effective driving force in biological systems. [2]

18. a) Active transport through membranes results in solute movement against a concentration of electrochemical gradient – consider both primary and secondary active transports in explaining the above process. [3]

    b) What is the free-energy change for transporting 1 mol of Na^+ out of a typical vertebrate cell and into the blood at 37°C? Assume the concentration of Na^+ inside the cell is 12mM and that in blood plasma is 145mM, and the membrane potential of the cell is –0·070 V (inside negative). [2]

    c) Biological membranes act as capacitor – elaborate the statement. [2]

    d) What will be the consequences of inactivating the Na^+/K^+ ATPases in a cell? Write in terms of immediacy of the events. [3]

19. a) Biological recognition is important in many processes at the molecular, cellular and tissue levels. Select each of the following and for each explain how the process of recognition occurs and give an example.
        i) Neurotransmitters are recognized in the synapse.
        ii) Antigens triggers antibody responses.
        iii) Target cells respond to specific hormones. [2×3]

    b) A boy was admitted with several neurological, visual and liver abnormalities with was later diagnosed with the deficiency of certain peroxisomal enzymes. However, no mutations were detected in the corresponding genes. What could be the issue? [2]

    c) Explain the structural assembly of a clathrin triskelien. [2]

20. a) What are coated pits and how do they facilitate receptor mediated endocytosis? [3]

    b) Briefly describe the process of post-translational transport of a protein in the mitochondrial matrix. Provide proper sketch. [3]

    c) What are "signal sequences"? Mention their importance in transport of macromolecules within the biological system. [4]

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