

27-04-2018 (FN)



INDIAN INSTITUTE OF TECHNOLOGY KHARAGPUR  
End-Spring Semester 2017-18

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Date of Examination: 27-04-2018 Session (FN/AN): FN Duration: 3 hrs Full Marks: 100  
Subject No.: BS20001 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

Attempt ALL questions. Write the answers of all parts of each question in one place.

1. Write down the correct answer (ONE) in your answer script (10 X 1 = 10 MARKS)

A. Enzyme catalyzing rearrangement of atomic groups without altering molecular weight or number of atoms is  
(a) ligase (b) isomerase (c) hydrolase (d) oxidoreductase

B. The general mechanism of enzyme action is by  
(a) reducing the activation energy (b) increasing the activation energy  
(c) reducing the pH (d) increasing the pH

C. Which of the following cytoskeletal components is the smallest?  
(a) Protofilament (b) Microtubule (c)  $\alpha$ -tubulin (d) Tubulin dimer

D. In a Lock and Key model of enzyme action, the part of the enzyme that recognizes the substrate is known as  
(a) enzyme-substrate complex (b) product-substrate complex (c) active site (d) co-enzyme

E. Pepsin, a digestive enzyme which is secreted in stomach, acts best at pH  
(a) 10 (b) 7 (c) 6 (d) 2

F. Bacterial peptidoglycan is a polymer of  
(a) sugar (b) sugar and nucleotide (c) sugar and lipid (d) sugar and amino acid

G. Which of the following statements about cytoskeletal function is FALSE?  
(a) Most actin filaments orient their minus ends towards the leading edge of a moving cell  
(b) Intracellular transport is carried out by Dynein and Kinesin motor proteins that can walk on microtubules  
(c) The force for chromosome segregation during cell division is contributed by microtubules  
(d) Contractile ring that forms during cytokinesis stage of cell division is composed of actin filaments

H. Number of mitotic divisions required to produce 256 cells from a single cell is  
(a) 7 (b) 8 (c) 32 (d) 64

I. CD8 is present on the surface of  
(a) helper T cells (b) activated macrophages (c) natural killer cells (d) cytotoxic T cells

J. Which of the following cellular structures always disappears during mitosis and meiosis?  
(a) Plasma membrane (b) Cytoskeleton (c) Nuclear envelope (d) Mitochondria

2. Answer the following questions

(5 X 2 = 10 MARKS)

- A. During actin polymerization in a test tube, the "lag phase" corresponds to \_\_\_\_\_.
- B. B cells that produce and release large amounts of antibody are called \_\_\_\_\_ cells.
- C. Two key proteins involved in cell cycle regulation are \_\_\_\_\_ and \_\_\_\_\_.
- D. \_\_\_\_\_ microscope is used to image surface features of specimens.
- E. \_\_\_\_\_ cells are the link between innate and adaptive immune systems.

Answer the following questions

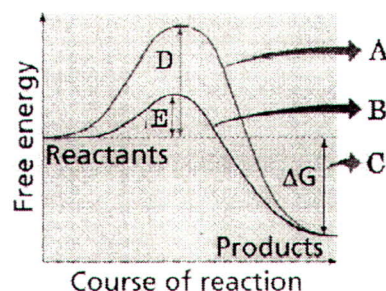
(5 X 16 = 80 MARKS)

3. (a) Write down the Michaelis-Menten equation. What is the assumption used to derive this equation? 2+1

(b) Using both Michaelis-Menten plot and Lineweaver-Burk plot show how competitive inhibition works. 4

(c) Match the letters of the graph (A to E) of an enzymatic reaction with their appropriate description below (i to v): 5

- (i) Energy path of uncatalyzed reaction
- (ii) Energy released from this reaction
- (iii) Activation energy of a catalyzed reaction
- (iv) Activation energy of uncatalyzed reaction
- (v) Energy path of catalyzed reaction



(d) Calculate  $K_M$  and  $V_{max}$  from the following data (show calculations in details): 2

[S] ( $\mu M$ )	$v_o$ (mM/sec)
0.1	0.34
0.2	0.52
0.4	0.74
0.8	0.91
1.6	1.04
2.0	1.05

(e) Write two differences between uncompetitive and allosteric inhibition. 2

4. (a) Differentiate between resolution and magnification of a microscope. 2

(b) Match the following cytoskeletal classes with their functions: 3

- |                            |                                  |
|----------------------------|----------------------------------|
| (i) Actin filament         | (a) Mechanical Strength of cells |
| (ii) Intermediate filament | (b) Intracellular transport      |
| (iii) Microtubule          | (c) Whole cell locomotion        |

(c) If each kind of cytoskeletal filament is made up of subunits that are held together by weak non-covalent bonds, how can human beings lift heavy objects? 2

(d) How many types of endoplasmic reticulum (ER) are present in a typical cell? Pancreatic cells make and secrete large amounts of enzymes; which type of ER will be most abundantly found in this cell type and why? 1+2

(e) Write two biochemical features of programmed cell death (PCD)? Mention one difference between PCD and necrosis? 2+1



(f) High dose of caffeine interferes with DNA damage response in mammalian cells. One cup of coffee (150 mL) contains approximately 3.3 mM of caffeine (MW: 200g/mol). How many cups of coffee would one need to drink to reach the dose of 20 gm required to interfere with DNA damage response? 3

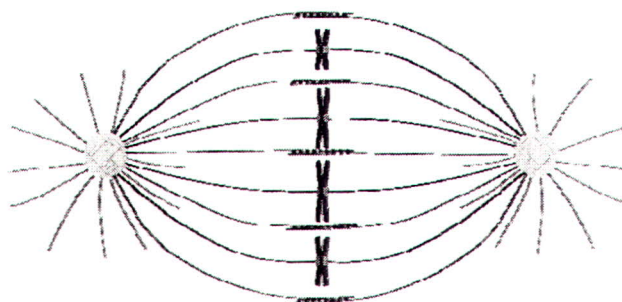
5. (a) By asymmetric cell division both the daughter cells inherit the same genome but they become different cell types. Briefly describe the mechanism of asymmetric cell division and how that ensures this difference? 1+1

(b) During very early embryonic development cell cycles occur at a very fast pace and these cell divisions take place without any significant increase in the weight of the embryo. Which phase(s) of the cell cycle would you expect to be most reduced? Explain your answer. 1+2

(c) State the differences between stem cells and differentiated cells. 2

(d) How meiotic division contributes to genetic diversity required for evolution? Discuss how meiosis and fertilization together ensures that chromosome number of the species remains constant over generations. 2+2

(e) The diagram on the right represents chromosomal arrangement of a diploid cell undergoing mitotic division; which stage of mitosis does it represent? Draw a similar diagram for the same stage in meiosis I (keep total chromosome number same as the given diagram). Draw another diagram for the immediate next cell cycle stage in meiosis I. 1+2+2



6. (a) Distinguish between vaccination and natural infections. 2

(b) A cut in our skin allows entry of pathogens resulting in infections. Explain how innate and adaptive immune systems respond in this event and eliminate these pathogens. 4

(c) What are the hallmarks of inflammation? What responses take place after an injury or a localized infection that lead to inflammatory responses? 2+2

(d) Draw a graph to plot level of microorganisms versus infection duration with respect to the innate and adaptive immune response. 3

(e) Briefly describe how antigen is presented to T cells? 3

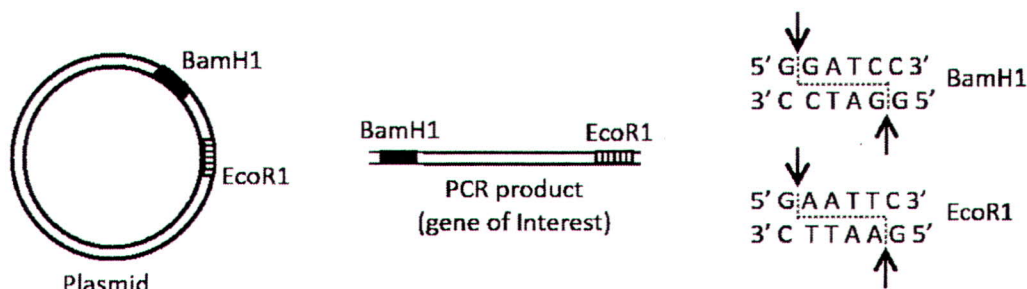
7. (a) Which of the following restriction enzymes would cut a random DNA sequence ( $3 \times 10^9$  base pairs) into a greater number of pieces? 1

- A. A restriction endonuclease that recognizes a four-nucleotide pair sequence
- B. A restriction endonuclease that recognizes an eight-nucleotide pair sequence

(b) Using diagram describe how Dolly, the sheep, was cloned. 4

(c) How can you clone a gene using following reagents/information? (Answer this question with proper explanation and schematic diagrams): 5

- (i) Plasmid with known restriction sites (EcoRI and BamHI) (ii) Restriction enzymes (EcoRI and BamHI) and related buffers (iii) PCR product containing your gene of interest flanked by EcoRI and BamHI restriction sequence (iv) T4 DNA ligase and related buffer



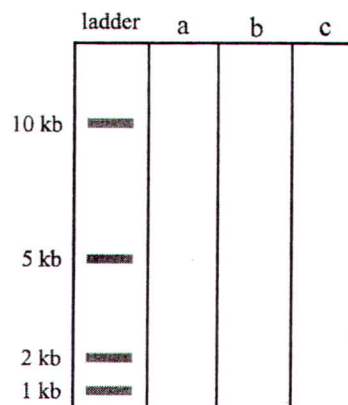
(d) Restriction mapping of a linear piece of double-stranded DNA reveals the following EcoRI restriction sites: 3



(i) This piece of DNA is cut with EcoRI, the resulting fragments are separated by gel electrophoresis, and the gel is stained with ethidium bromide. Draw a picture of the bands that will appear in lane 'a' on the gel.

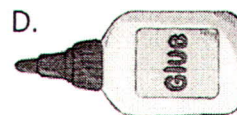
(ii) A mutation alters EcoRI site 1 in this DNA. What will be the banding pattern on the gel? Draw the bands in lane 'b' of the gel.

(iii) If mutations that alter EcoRI site 1 and 2 occur in this piece of DNA, what will be the banding pattern on the gel? Draw the bands in lane 'c' of the gel.



(e) Match the following terms (i to vi) with the most suitable images (A to F): 3

- (i) Restriction Endonuclease
- (ii) DNA ligase
- (iii) Vector
- (iv) Bt cotton
- (v) Sticky end cutting
- (vi) Cloning



E. WAS IT A CAR OR A CAT I SAW

F. GMO

END