



**INDIAN INSTITUTE OF TECHNOLOGY KHARAGPUR**  
**End-Spring Semester 2016-17**

Date of Examination : 25.04.2017

Session (FN/AN) FN Duration 3 hrs

Subject No. : BS20001

Subject Name : Science Of Living System

Department/Center/School : School of Bioscience

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

Max marks: 100

Answer all questions.

1. Write down very brief answers to the following questions:

(28 marks)

- a. The nucleotide bound by Actin filaments is \_\_\_\_\_
- b. How does the Golgi apparatus divide in to the two daughter cells?
- c. What is the function of lysosome?
- d. What are histone proteins?
- e. Why rough Endoplasmic Reticulum (ER) is rough?
- f. During chemi-osmotic phosphorylation in mitochondria, \_\_\_\_\_ (an enzyme complex) helps in the generation of ATP.
- g. What substance is produced by the oxidation of pyruvate and feeds into the citric acid cycle?
- h. Write down the cellular locations of glycolysis and Kreb's cycle during respiration.
- i. Indicate whether each of the following descriptions better applies to the light (L) or dark (D) reactions in plant chloroplasts.
  - (i) It involves the electron-transfer chain embedded in the thylakoid membrane.
  - (ii) It involves  $O_2$  production.
  - (iii) It involves fixation of  $CO_2$ .
  - (iv) It generates ATP.
- j. Bacterial peptidoglycan is a polymer of \_\_\_\_\_ and \_\_\_\_\_.
- k. Briefly write the significance of chloroplast or mitochondrial membrane bound proteins in photosynthesis or respiration.
- l. An antibody consists of \_\_\_\_\_ polypeptide chains, and thereby an antibody molecule is an example of \_\_\_\_\_ structure of a protein
- m. Agarose gel electrophoresis separates DNA molecules on the basis of \_\_\_\_\_
- n. Red blood cells (RBC) are generated from \_\_\_\_\_

Answer all parts of each question below in one place:

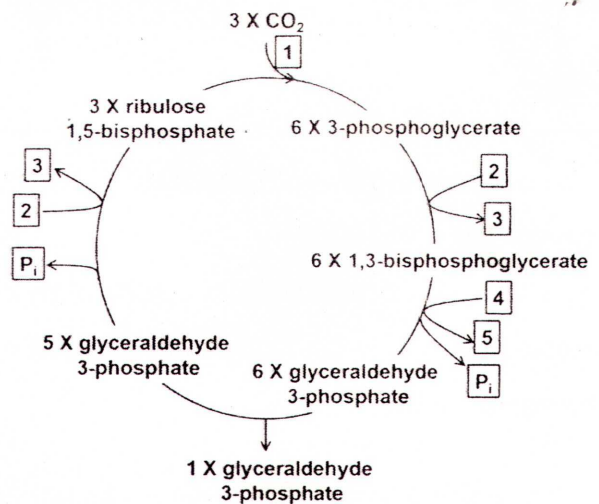
2. (a) Identify the cycle shown in the figure. Mention the organelle and the location within the organelle where this cycle occurs. (3 marks)

(b) Important molecules in the cycle are labeled 1 – 5. Identify them. (5 marks)

(c) Mention the number of carbons in each of the following molecules: (2 marks)

- 3-phosphoglycerate
- 1,3-bisphosphoglycerate
- glyceraldehyde-3-phosphate
- ribulose-1,5-bisphosphate

(d) Is the carbon count balanced in the cycle shown in the figure? Explain. (2 marks)



3. (a) Place the following in order of size, from the smallest to the largest. Explain your answer.

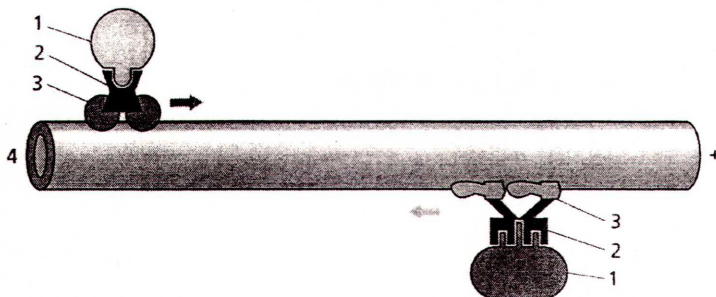
(4 marks)

- A. protofilament
- B. microtubule
- C.  $\alpha$ -tubulin
- D. tubulin dimer

(b) Match the following labels (A to D) to the numbers (1 to 4) in the following figure

(2 marks)

- A. microtubule
- B. tail of motor protein
- C. cargo of motor protein
- D. head of motor protein



(c) 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 may be used more than once.

(5 marks)

The four phases of the cell cycle, in order, are G<sub>1</sub>, \_\_\_\_\_, \_\_\_\_\_, and \_\_\_\_\_. A cell contains the most DNA after \_\_\_\_\_ phase of the cell cycle. A cell is smallest in size after \_\_\_\_\_ phase of the cell cycle. Growth occurs in \_\_\_\_\_, \_\_\_\_\_, and \_\_\_\_\_ phases of the cell cycle. A cell does not enter mitosis until it has completed \_\_\_\_\_ synthesis. Few cells may escape from the cell cycle and enter \_\_\_\_\_ phase of the cell cycle and reside there for a long period of time.

- |     |                |           |                |             |
|-----|----------------|-----------|----------------|-------------|
| DNA | M              | protein   | G <sub>1</sub> | nucleotide  |
| S   | G <sub>2</sub> | organelle | G <sub>0</sub> | cytokinesis |



4. (a) In a cell biology lab, students were observing division of different types of cells from a particular organism under microscope and recorded the time taken by each phase of the cell cycle. The average and standard deviation of the time taken by each phase was calculated from the compiled data of all students. It was observed that the time taken by the S phase had the least variation. Explain this observation.

(2 marks)

(b) Name the phase of the cell cycle in which the following events occur. Place the numbers 1–6 next to the letter headings to indicate the normal order of events.

(3 marks)

A. alignment of the chromosomes at the spindle equator

B. breakdown of nuclear envelope

C. pinching of cell in two daughter cells

D. re-formation of the nuclear envelope

E. condensation of the chromosomes

F. separation of sister chromatids

(c) A Japanese scientist Dr. Yoshio Masui discovered that a cytoplasmic enzyme named 'Maturation Promoting Factor (MPF)' controls the entry of a cell into the M-phase of cell cycle. Later on it was discovered that MPF activity oscillates throughout the cell cycle. Drs. Tim Hunt, Paul Nurse and Leland Hartwell discovered that MPF is composed of two proteins and were awarded the Nobel Prize in Physiology & Medicine in 2001 for this discovery.

i. Based on what you have learnt in this course, name the two proteins of MPF.

(2 marks)

ii. Which component of MPF has catalytic activity and what is its function?

(2 marks)

(d) Why apoptosis is important?

(1 marks)

State three biochemical changes of a cell undergoing apoptosis or programmed cell death.

(3 marks)

5. (a) State the working principle of drugs and vaccines with appropriate examples.

(4 marks)

(b) Design and explain a simple experiment to prove that an antimicrobial peptide 'P' present on our skin can protect us from some bacterial infection using the following information.

(4 marks)

i) antimicrobial peptide P present on our finger tips can prevent growth of bacteria X

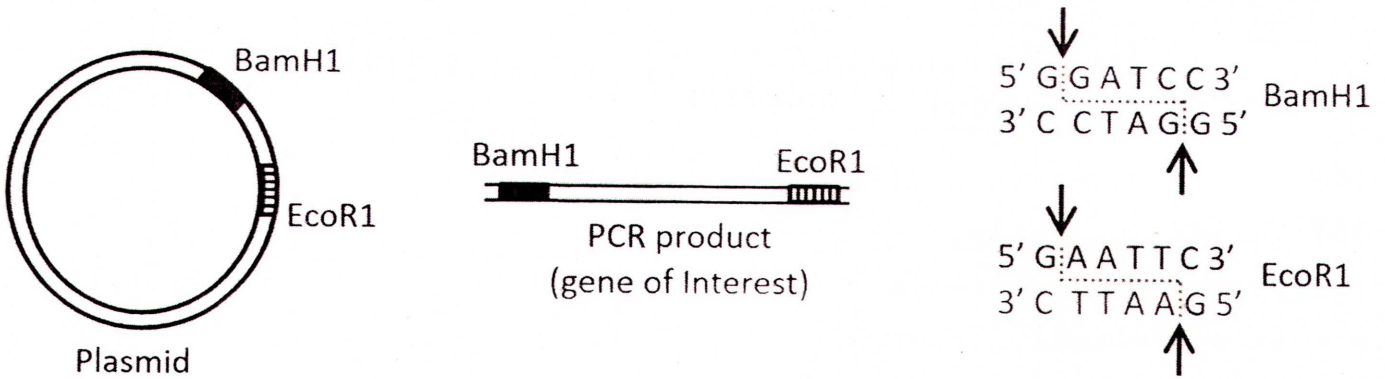
ii) antimicrobial peptide P present on our finger tips cannot prevent growth of bacteria Y

6. (a) As a summer intern in a biochemistry lab, your friend has obtained a sample that contains DNA fragments of varying lengths (200 bp, 300 bp, 500 bp and 1000 bp). Design an experiment that will help your friend to check how many different lengths of DNA fragments are there and what are their lengths. Answer this question with proper explanation and schematic diagrams.

(3 marks)

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

(i) Plasmid with known restriction sites (EcoR1 and BamH1) (ii) Restriction enzymes (EcoR1 and BamH1) and related buffers (iii) PCR product containing your gene of interest flanked by EcoR1 and BamH1 restriction sequence (iv) T4 DNA ligase and related buffer.



7. State the differences between

**(5x2=10)**

- (a)** *E. coli* chromosome (DNA) and human chromosome (DNA).
- (b)** Stem cells and differentiated cells.
- (c)** Innate and adaptive immunity.
- (d)** Gram positive and Gram negative bacteria.
- (e)** Transmission electron microscope and scanning electron microscope.

**8. Analyze the following statements:**

**(5x2=10)**

- (a)** The dark reaction depends on light reaction during photosynthesis
- (b)** Antibiotic penicillin prevents the growth of bacterial cells but not our own cells
- (c)** Meiotic division generates genetic diversity that can stimulate evolution
- (d)** Macrophage and Dendritic cells are the link between innate and adaptive immune systems
- (e)** Location of actin filaments and microtubules are dynamic but not static inside a moving cell

~~~~~**END OF QUESTION PAPER**~~~~~