

**Q. 1 – Q. 25 carry one mark each.**

- Q.1 Which one of the following complement proteins is the initiator of the membrane attack complex?  
 (A) C3a (B) C3b (C) C5a (D) C5b
- Q.2 Levinthal's paradox is related to  
 (A) protein secretion (B) protein degradation  
 (C) protein folding (D) protein trafficking
- Q.3 Which one of the following is a second generation genetically engineered crop?  
 (A) Bt brinjal (B) Roundup soyabean  
 (C) Golden rice (D) Bt rice
- Q.4 Based on the heavy chain, which one of the following antibodies has multiple subtypes?  
 (A) IgM (B) IgD (C) IgE (D) IgG
- Q.5 The cytokinetic organelle in plant cells is  
 (A) centriole (B) phragmoplast (C) proplastid (D) chromoplastid
- Q.6 Anergy refers to  
 (A) mitochondrial dysfunction (B) allergy to environmental antigens  
 (C) unresponsiveness to antigens (D) a state of no energy
- Q.7 ABO blood group antigens in humans are differentiated from each other on the basis of  
 (A) sialic acid (B) lipids (C) spectrin (D) glycoproteins
- Q.8 Which one of the following organisms is used for the determination of phenol coefficient of a disinfectant?  
 (A) *Salmonella typhi* (B) *Escherichia coli*  
 (C) *Candida albicans* (D) *Bacillus psychrophilus*
- Q.9 A single subunit enzyme converts 420  $\mu$ moles of substrate to product in one minute. The activity of the enzyme is  $\text{_____} \times 10^{-6}$  Katal.
- Q.10 Which one of the following amino acids has the highest probability to be found on the surface of a typical globular protein in aqueous environment?  
 (A) Ala (B) Val (C) Arg (D) Ile
- Q.11 Which one of the following is **NOT** a product of denitrification in *Pseudomonas*?  
 (A)  $\text{N}_2$  (B)  $\text{N}_2\text{O}$  (C)  $\text{NO}_2^-$  (D)  $\text{NH}_4^+$
- Q.12 The determinant of the matrix  $\begin{bmatrix} 3 & 0 & 0 \\ 2 & 5 & 0 \\ 6 & -8 & -4 \end{bmatrix}$  is \_\_\_\_\_.
- Q.13 Which one of the following features is **NOT** required in a prokaryotic expression vector?  
 (A) *oriC* (B) Selection marker (C) CMV promoter (D) Ribosome binding site

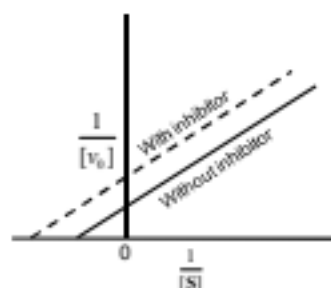
- Q.14 Production of monoclonal antibodies by hybridoma technology requires  
 (A) splenocytes (B) osteocytes (C) hepatocytes (D) thymocytes
- Q.15 Which one of the following is **INCORRECT** about a typical apoptotic cell?  
 (A) Phosphatidylserine is presented on the outer cell surface  
 (B) Cytochrome *c* is released from mitochondria  
 (C) Mitochondrial membrane potential does not change  
 (D) Annexin-V binds to the cell surface
- Q.16 Identify the file format given below:  
 >P1; JMFD  
 Protein X – *Homo sapiens*  
 MKALTARQQEVFDLIRDHISRTLRLQGGDWL  
 (A) GDE (B) FASTA (C) NBRF (D) GCG
- Q.17 Which one of the following relations holds true for the specific growth rate ( $\mu$ ) of a microorganism in the death phase?  
 (A)  $\mu = 0$  (B)  $\mu < 0$   
 (C)  $\mu = \mu_{\max}$  (D)  $0 < \mu < \mu_{\max}$
- Q.18 How many 3-tuples are possible for the following amino acid sequence?  
 MADCMWDISEASE  
 (A) 4 (B) 5 (C) 11 (D) 12
- Q.19 How many different protein sequences of 100 residues can be generated using 20 standard amino acids?  
 (A)  $100^{20}$  (B)  $100 \times 20$  (C)  $20^{100}$  (D)  $100! \times 20!$
- Q.20 In DNA sequencing reactions using the chain termination method, the ratio of ddNTPs to dNTPs should be  
 (A) 0 (B)  $< 1$   
 (C) 1 (D)  $> 1$

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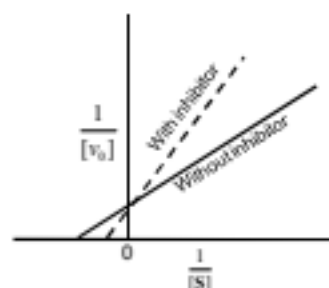
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Q.21 Which one of the following graphs represents uncompetitive inhibition?

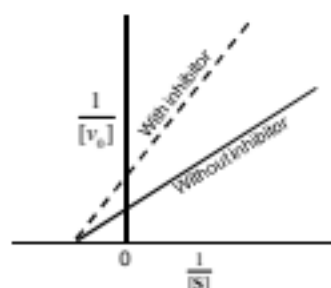
(A)



(B)



(C)



(D)



Q.22 Choose the appropriate pair of primers to amplify the following DNA fragment by the polymerase chain reaction (PCR).

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5' -GACCTGTGG-----ATACGGGAT-3'
3' -CTGGACACC-----TATGCCCTA-5'
    
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**Primers**

- P. 5' -GACCTGTGG-3'  
 Q. 5' -CCACAGGTC-3'  
 R. 5' -TAGGGCATA-3'  
 S. 5' -ATCCCGTAT-3'

- (A) P and R      (B) P and S      (C) Q and R      (D) Q and S

Q.23 Consider the following infinite series:

$$1 + r + r^2 + r^3 + \dots \dots \dots \infty$$

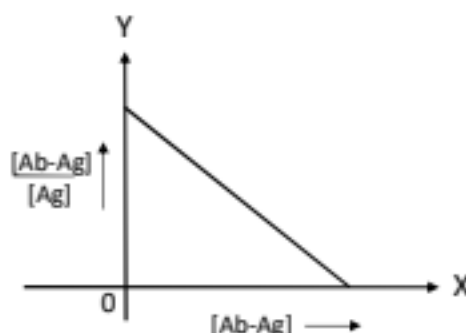
 If  $r = 0.3$ , then the sum of this infinite series is \_\_\_\_\_.

Q.24

$$\begin{aligned} 2x_1 + x_2 &= 3 \\ 5x_1 + bx_2 &= 7.5 \end{aligned}$$

 The system of linear equations in two variables shown above will have infinite solutions, if and only if,  $b$  is equal to \_\_\_\_\_.

- Q.25 The interaction between an antigen (Ag) and a single-chain antibody (Ab) was studied using Scatchard analysis. The result is shown below.



The affinity of interaction and the total concentration of antibody, respectively, can be determined from

- (A) slope and Y-intercept  
(B) Y-intercept and slope  
(C) X-intercept and slope  
(D) slope and X-intercept

Q. 26 – Q. 55 carry two marks each.

- Q.26 An isolated population on an island has the following genotypic frequencies:

Genotype	AA	Aa	aa
Frequency	0.3	0.4	0.3

Assuming that there are only two alleles (A and a) for the gene, the genotypic frequency of AA in the next generation will be \_\_\_\_\_

- Q.27 How many rooted and unrooted phylogenetic trees, respectively, are possible with four different sequences?

- (A) 3 and 15  
(B) 15 and 3  
(C) 15 and 12  
(D) 12 and 3

- Q.28 Match the compounds in **Group I** with the correct entries in **Group II**.

**Group I**

- P) Cyanide  
Q) Antimycin A  
R) Valinomycin  
S) Aurovertin

**Group II**

- 1)  $K^+$  ionophore  
2) Electron transfer from cytochrome *b* to cytochrome *c*<sub>1</sub>  
3)  $F_1$  subunit of ATP synthase  
4) Cytochrome oxidase  
5) Adenine nucleotide translocase

- (A) P-5, Q-2, R-3, S-1  
(B) P-5, Q-2, R-1, S-3  
(C) P-4, Q-2, R-1, S-3  
(D) P-4, Q-5, R-3, S-1

- Q.29 What are the eigenvalues of the following matrix?

$$\begin{bmatrix} 1 & 1 \\ -2 & 4 \end{bmatrix}$$

- (A) 2 and 3  
(B) -2 and 3  
(C) 2 and -3  
(D) -2 and -3

- Q.30 For a discrete random variable  $X$ ,  $\text{ran}(X) = \{0, 1, 2, 3\}$  and the cumulative probability  $F(X)$  is shown below:

$X$	0	1	2	3
$F(X)$	0.5	0.6	0.8	1.0

The mean value of  $X$  is \_\_\_\_\_.

- Q.31 Match the drugs in **Group I** with their mechanism of action in **Group II**.

**Group I**

- P) Paclitaxel  
Q) Colchicine  
R) Etoposide  
S) Methotrexate

**Group II**

- 1) Inhibits protein translation  
2) Inhibits microtubule depolymerization  
3) Inhibits DNA replication  
4) Alkylates DNA  
5) Inhibits dihydrofolate reductase  
6) Inhibits microtubule polymerization

- (A) P-1, Q-6, R-3, S-4  
(C) P-1, Q-3, R-6, S-5

- (B) P-2, Q-6, R-3, S-5  
(D) P-2, Q-3, R-6, S-4

- Q.32 The limit of the function  $(1 + \frac{x}{n})^n$  as  $n \rightarrow \infty$  is

(A)  $\ln x$

(B)  $\ln \frac{1}{x}$

(C)  $e^{-x}$

(D)  $e^x$

- Q.33 Match the cells in **Group I** with their corresponding entries in **Group II**.

**Group I**

- P) Mast cells  
Q) Natural killer cells  
R) Neutrophils  
S) Dendritic cells

**Group II**

- 1) Activation of the complement pathway  
2) Expression of CD56  
3) Contains azurophilic granules  
4) Defense against helminthic infection  
5) Production of antibodies specific to bacteria  
6) Contains long membranous projections

- (A) P-4, Q-2, R-3, S-5  
(C) P-3, Q-1, R-2, S-5

- (B) P-4, Q-2, R-3, S-6  
(D) P-3, Q-1, R-2, S-6

- Q.34 Oxygen transfer was measured in a stirred tank bioreactor using dynamic method. The dissolved oxygen tension was found to be 80% air saturation under steady state conditions. The measured oxygen tensions at 7 s and 17 s were 55% and 68% air saturation, respectively. The volumetric mass transfer coefficient  $K_{La}$  is \_\_\_\_\_  $s^{-1}$ .

Q.35 Match the microorganisms in **Group I** with their fermentation products in **Group II**.

**Group I**

- P) *Leuconostoc mesenteroides*  
 Q) *Rhizopus oryzae*  
 R) *Gluconobacter suboxydans*  
 S) *Streptomyces olivaceus*

- (A) P-5, Q-4, R-2, S-1  
 (C) P-3, Q-4, R-1, S-2

**Group II**

- 1) Cobalamin  
 2) Sorbose  
 3) Dextran  
 4) Lactic acid  
 5) Butanol

- (B) P-5, Q-3, R-2, S-4  
 (D) P-3, Q-4, R-2, S-1

Q.36 Plasmid DNA (0.5  $\mu\text{g}$ ) containing an ampicillin resistance marker was added to 200  $\mu\text{l}$  of competent cells. The transformed competent cells were diluted 10,000 times, out of which, 50  $\mu\text{l}$  was plated on agar plates containing ampicillin. A total of 35 colonies were obtained. The transformation efficiency is \_\_\_\_\_  $\times 10^6 \text{ cfu} \cdot \mu\text{g}^{-1}$ .

Q.37 Match the reagents in **Group I** with their preferred cleavage sites in **Group II**.

**Group I**

- P) Cyanogen bromide  
 Q) *o*-Iodosobenzoate  
 R) Hydroxylamine  
 S) 2-Nitro-5-thiocyanobenzoate

- (A) P-1, Q-3, R-5, S-4  
 (C) P-1, Q-2, R-5, S-4

**Group II**

- 1) Carboxyl side of methionine  
 2) Amino side of methionine  
 3) Carboxyl side of tryptophan  
 4) Amino side of cysteine  
 5) Asparagine-glycine bonds

- (B) P-2, Q-3, R-1, S-4  
 (D) P-4, Q-2, R-5, S-3

Q.38 *Saccharomyces cerevisiae* produces ethanol by fermentation. The theoretical yield of ethanol from 2.5 g of glucose is \_\_\_\_\_ g.

Q.39 Choose the **CORRECT** sequence of steps involved in cytoplasm production.

- (A) Digestion of cell wall  $\rightarrow$  protoplast viability  $\rightarrow$  cybrid formation  $\rightarrow$  osmotic stabilizer  
 (B) Osmotic stabilizer  $\rightarrow$  digestion of cell wall  $\rightarrow$  protoplast viability  $\rightarrow$  cybrid formation  
 (C) Protoplast viability  $\rightarrow$  osmotic stabilizer  $\rightarrow$  digestion of cell wall  $\rightarrow$  cybrid formation  
 (D) Osmotic stabilizer  $\rightarrow$  digestion of cell wall  $\rightarrow$  cybrid formation  $\rightarrow$  protoplast viability

Q.40 Match the antibiotics in **Group I** with their modes of action in **Group II**.

**Group I**

- P) Chloramphenicol  
 Q) Rifampicin  
 R) Tetracycline  
 S) Quinolone

- (A) P-1, Q-2, R-3, S-5  
 (C) P-3, Q-2, R-1, S-4

**Group II**

- 1) Inhibits protein synthesis by acting on 30S ribosomal subunit  
 2) Interferes with DNA replication by inhibiting DNA gyrase  
 3) Inhibits protein synthesis by acting on 50S ribosomal subunit  
 4) Interferes with RNA polymerase activity  
 5) Inhibits  $\beta$ -lactamase activity

- (B) P-3, Q-4, R-1, S-2  
 (D) P-1, Q-4, R-3, S-2



- Q.41 The diameters of a large and a small vessel are 1.62 m and 16.2 cm, respectively. The vessels are geometrically similar and operated under similar volumetric agitated power input. The mixing time in the small vessel was found to be 15 s. Determine the mixing time (in seconds) in the large vessel.

(A) 15 (B) 30 (C) 61 (D) 122

- Q.42 If  $A = \begin{bmatrix} 4 & 2 \\ 1 & 3 \end{bmatrix}$ , then  $A^2 + 3A$  will be

(A)  $\begin{bmatrix} 30 & 20 \\ 10 & 20 \end{bmatrix}$  (B)  $\begin{bmatrix} 28 & 10 \\ 4 & 18 \end{bmatrix}$   
 (C)  $\begin{bmatrix} 31 & 13 \\ 7 & 21 \end{bmatrix}$  (D)  $\begin{bmatrix} 20 & 10 \\ 5 & 15 \end{bmatrix}$

- Q.43 Consider the following multiple sequence alignment of four DNA sequences.

```

A C T A
A C T G
A G T C
A G C T
    
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Shannon's entropy of the above alignment is \_\_\_\_\_.

- Q.44 The  $K_i$  of a novel competitive inhibitor designed against an enzyme is 2.5  $\mu\text{M}$ . The enzyme was assayed in the absence or presence of the inhibitor (5  $\mu\text{M}$ ) under identical conditions. The  $K_m$  in the presence of the inhibitor was found to be 30  $\mu\text{M}$ . The  $K_m$  in the absence of the inhibitor is \_\_\_\_\_  $\mu\text{M}$ .

- Q.45 A heterozygous tall plant ( $Tt$ ) was crossed with a homozygous dwarf plant ( $tt$ ). The resultant seeds were collected. If five seeds are chosen at random, then the probability (in %) that exactly two of these seeds will yield dwarf plants is \_\_\_\_\_.

- Q.46 Assuming random distribution of nucleotides, the average number of fragments generated upon digestion of a circular DNA of size  $4.3 \times 10^5$  bp with *AluI* ( $5' \text{--AG}\downarrow\text{CT--}3'$ ) is \_\_\_\_\_  $\times 10^3$ .

- Q.47 A synchronous culture containing  $1.8 \times 10^5$  monkey kidney cells was seeded into three identical flasks. The doubling time of these cells is 24 h. After 24 h, the cells from all the three flasks were pooled and dispensed equally into each well of three 6-well plates. The number of cells in each well will be \_\_\_\_\_  $\times 10^4$ .

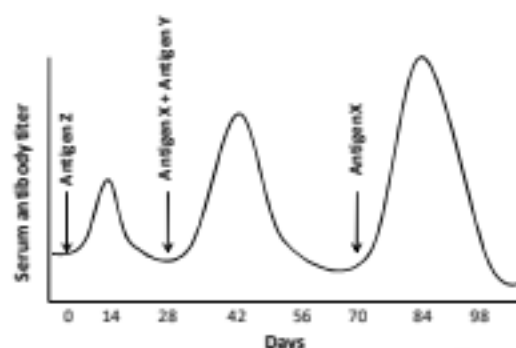
- Q.48 An *in vitro* translation system can synthesize peptides in all three reading frames of the RNA template. When  $5' \text{--UCUCUCUC---(UC)}_n\text{---UCUCUCUC--}3'$  was used as the template in this *in vitro* translation system, the synthesized peptides contained 50% each of serine and leucine. When  $5' \text{--CCUCCUCCU---(CCU)}_n\text{---CCUCCU--}3'$  was used as the template, the synthesized peptides contained 33.3% each of serine, leucine, and proline. Deduce the codon for proline.

(A) UCU (B) CUC (C) CCU (D) UCC

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- Q.49 Three distinct antigens X, Y and Z were used to raise antibodies. Antigen Z was injected in a mouse on day zero followed by the administration of antigens X and Y on day 28. A second injection of antigen X was administered on day 70. The antibody titers were monitored in the serum every day and the results are shown below:



Which one of the following statements regarding the antibody titers in the serum is **INCORRECT**?

- (A) Z-specific IgG will be high on day 14  
 (B) X-specific antibody titer will be high on day 84  
 (C) X-specific IgG will be high on day 42  
 (D) Y-specific IgG will be high on day 84
- Q.50 The standard free energy change ( $\Delta G'^{\circ}$ ) for ATP hydrolysis is  $-30 \text{ kJ}\cdot\text{mole}^{-1}$ . The *in vivo* concentrations of ATP, ADP and  $P_i$  in *E. coli* are 7.90, 1.04 and 7.90 mM, respectively. When *E. coli* cells are cultured at  $37^\circ\text{C}$ , the free energy change ( $\Delta G$ ) for ATP hydrolysis *in vivo* is \_\_\_\_\_  $\text{kJ}\cdot\text{mole}^{-1}$ .
- Q.51 In a fed-batch culture,  $200 \text{ g}\cdot\text{L}^{-1}$  glucose solution is added at a flow rate of  $50 \text{ L}\cdot\text{h}^{-1}$ . The initial culture volume (at quasi steady state) and the initial cell concentration are 600 L and  $20 \text{ g}\cdot\text{L}^{-1}$ , respectively. The yield coefficient ( $Y_{x/s}$ ) is  $0.5 \text{ g cell mass}\cdot\text{g substrate}^{-1}$ . The cell concentration ( $\text{g}\cdot\text{L}^{-1}$ ) at quasi steady state at  $t=8 \text{ h}$  is
- (A) 40                      (B) 52                      (C) 60                      (D) 68



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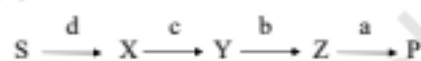
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- Q.52 Cytoplasmic extract from the wild type strain of a bacterium has the ability to convert a colorless substrate (S) to a colored product (P) via three colorless intermediates X, Y and Z, in that order. Each step of the pathway involves a specific enzyme coded by a distinct gene. Four mutant strains ( $a^-$ ,  $b^-$ ,  $c^-$ ,  $d^-$ ) were isolated, whose extracts are incapable of producing the colored product in the presence of S. In a series of experiments, extracts from the individual mutants were incubated with X, Y, or Z and scored for color development. The data are summarized in the table below. (Yes: color developed, No: no color developed)

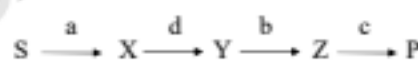
		Compounds		
		X	Y	Z
Mutants	$a^-$	No	No	No
	$b^-$	No	Yes	Yes
	$c^-$	Yes	Yes	Yes
	$d^-$	No	No	Yes

Based on the data, which one of the following is the correct order of enzymes involved in the pathway?

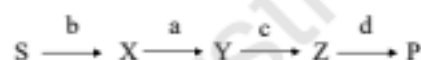
(A)



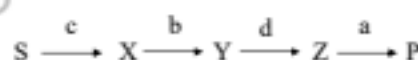
(B)



(C)



(D)



- Q.53 Samples of bacterial culture taken at 5 PM and then the next day at 5 AM were found to have  $10^4$  and  $10^7$  cells·mL<sup>-1</sup>, respectively. Assuming that both the samples were taken during the log phase of cell growth, the generation time of this bacterium will be \_\_\_\_\_ h.

- Q.54 Biomass is being produced in a continuous stirred tank bioreactor of 750 L capacity. The sterile feed containing  $8 \text{ g} \cdot \text{L}^{-1}$  glucose as substrate was fed at a flow rate of  $150 \text{ L} \cdot \text{h}^{-1}$ . The microbial system follows Monod's model with  $\mu_m = 0.4 \text{ h}^{-1}$ ,  $K_s = 1.5 \text{ g} \cdot \text{L}^{-1}$  and  $Y_{x/s} = 0.5 \text{ g cell mass} \cdot \text{g substrate}^{-1}$ . Determine the cell productivity ( $\text{g} \cdot \text{L}^{-1} \cdot \text{h}^{-1}$ ) at steady state.

(A) 0.85

(B) 0.65

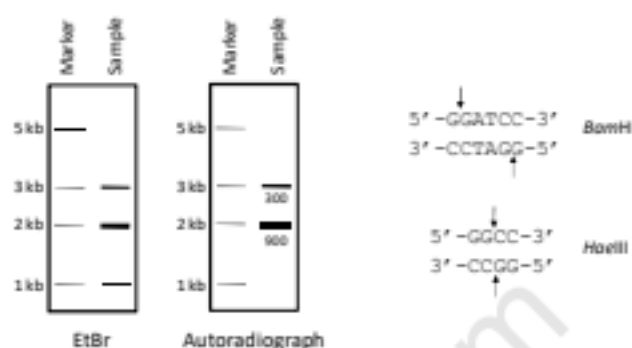
(C) 0.45

(D) 0.25

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- Q.55 A linear double stranded DNA of length 8 kbp has three restriction sites. Each of these can either be a *Bam*HI or a *Hae*III site. The DNA was digested completely with both enzymes. The products were purified and subjected to an end-filling reaction using the Klenow fragment and [ $\alpha$ - $^{32}$ P]-dCTP. The products of the end-filling reaction were purified, resolved by electrophoresis, stained with ethidium bromide (EtBr) and then subjected to autoradiography. The corresponding images are shown below.



The numbers below each band in the sample lane in the autoradiograph represent their mean signal intensity in arbitrary units. Which one of the following options is the correct restriction map of the DNA?

- (A)
- (B)
- (C)
- (D)

**END OF THE QUESTION PAPER**