

**Section-I: General Ability**  
**Q. No. 1 - 5 Carry One Mark Each**

1. Until Iran come along. India had never been \_\_\_\_\_ in kabaddi.  
 (A) defeated (B) defeating  
 (C) defeat (D) defeatist

**Key: (A)**

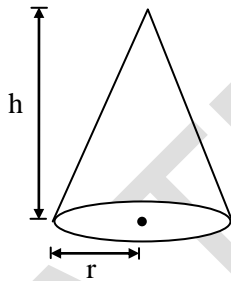
2. The fishermen, \_\_\_\_\_ the flood victims owed their lives, were rewarded by the government  
 (A) whom (B) to which (C) to whom (D) that

**Key: (C)**

3. The radius as well as the height of a circular cone is increases by 10%. The percentage increase in its volume is \_\_\_\_\_.  
 (A) 17.1 (B) 21.0 (C) 33.1 (D) 72.8

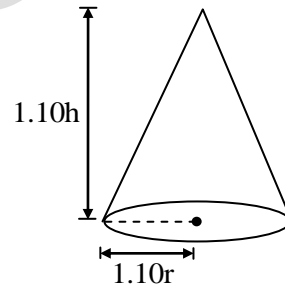
**Key: (C)**

**Sol:** Initial Stage After increasing 10% for radius & height



Volume of circular cone,

$$V_i = \frac{1}{3} \pi r^2 h$$



$$\begin{aligned} \text{Volume, } V_f &= \frac{1}{3} \pi (1.1r)^2 (1.1h) \\ &= \frac{1.331}{3} \pi r^2 h \end{aligned}$$

$$\text{Percentage increase} = \frac{V_f - V_i}{V_i} \times 100 = \frac{\frac{1.331}{3} \pi r^2 h - \frac{1}{3} \pi r^2 h}{\frac{1}{3} \pi r^2 h} \times 100 = \frac{1.331 - 1}{1} \times 100 = 33.1\%$$

4. Five numbers 10, 7, 5, 4, 2 are arranged in a sequence from left to right following the directions given below:  
 (1) No two odd or even numbers are next to each other.  
 (2) The second number from left is exactly half of the left -most number.

(3) The middle number is exactly twice the right most number.

Which is the second number from the right ?

- (A) 2                                      (B) 4                                      (C) 7                                      (D) 10

**Key:** (C)

**Sol:** Numbers are 2, 4, 5, 7, and 10

The correct order of arrangement 10, 5, 4, 7, and 2

Thus an arrangement follows given three conditions

Second number from right = 7

5. "Some students were not involved in the strike". If the above statement is true, which of the following conclusions is/are logically necessary ?

1. Some who were involved in strike were students.
2. No student was involved in the strike.
3. At least one student was involved in the strike.
4. Some who were not involved in the strike were students.

- (A) 1 and 2                                      (B) 3                                      (C) 4                                      (D) 2 and 3

**Key:** (C)

#### Q. No. 6 - 10 Carry Two Marks Each

6. "I read somewhere that in ancient times the prestige of a kingdom depended upon the number of taxes that it was able to levy on its people. It was very much like the prestige of a head - hunter in his own community".

Based on the paragraph above, the prestige of a head- hunter depended upon \_\_\_\_

- (A) the prestige of the kingdom  
(B) the prestige of the heads  
(C) the number of taxes he could levy  
(D) the number of head she could gather

**Key:** (D)

7. Two trains started at 7 AM from the same point. The first train travelled towards north at a speed of 80 km/h and the second train travelled south at a speed of 100 km/h. The time at which they were 540 km apart is \_\_\_\_\_ AM.

- (A) 9                                      (B) 10                                      (C) 11                                      (D) 11:30

**Key:** (B)

**Sol:** For X

Time taken = t

Distance  $x = \text{velocity} \times \text{time}$

$$x = 80t \Rightarrow t = \frac{x}{80} \quad \dots(1)$$

For  $y$  time taken =  $t$

$$\text{Distance } y = 100t \Rightarrow t = \frac{y}{100} \quad \dots(2)$$

$$x + y = 540\text{km} \quad \dots(3)$$

From (1) and (2)

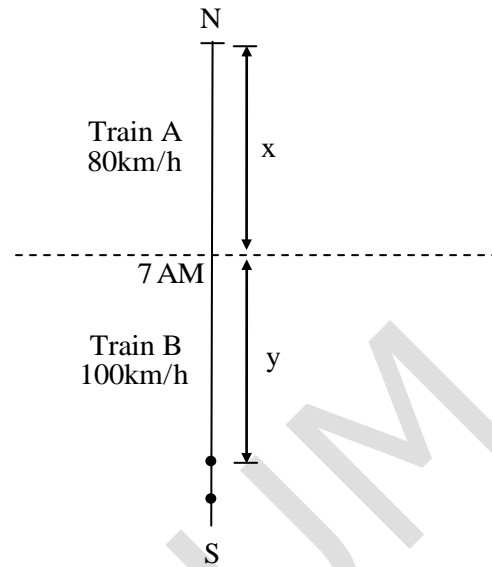
$$t = \frac{x}{80} = \frac{y}{100} \Rightarrow x = 0.8y$$

$$x + y = 540 \Rightarrow 0.8y + y = 540$$

$$1.8y = 540 \Rightarrow y = 300\text{km}$$

$$\text{Time taken} = \frac{y}{100} = \frac{300}{100} = 3\text{hrs}$$

Time at which these trains = 7.00AM + 3hrs = 10.00AM



8. In a country of 1400 million population, 70% own mobile phones. Among the mobile phone owners only 294 million access the internet. Among these Internet users, only half buy goods from e-commerce portals. What is the percentage of these buyers in the country ?
- (A) 10.50                      (B) 14.70                      (C) 15.00                      (D) 50.00

**Key:** (A)

**Sol:** Total population = 1400 million

Number of people whose having own mobile phones

$$= 70\% \text{ of } 1400 = 0.7 \times 1400 = 980 \text{ million}$$

Number of people whose accesses the internet = 294 million

Number of people who buy goods from e-commercial portals = Half of internet users

$$= \frac{294}{2} = 147 \text{ million}$$

$$\text{Percentage buyers} = \frac{147 \text{ million}}{1400 \text{ million}} \times 100 = 10.5\%$$

9. The nomenclature of Hindustani music has changed over centuries. Since the medieval period *dhrupad* styles were identified as *baanis*. Terms like *gayaki* and *baaj* were used to refer to vocal and instrumental styles, respectively. With institutionalization of music education the term *gharana* became acceptable. *Gharana* originally referred to hereditary musicians from a particular lineage, including disciples and ground disciples. Which one of the following pairings is NOT Correct ?

- (A) Dhruvad, baani  
(C) Baaj, institution
- (B) Gayaki, Vocal  
(D) Gharana, lineage

**Key: (C)**

**10.** Since the last one year, after a 125 basis point reduction in repo rate by the Reserve Bank of India, banking institutions have been making a demand to reduce interest rates on small savings schemes. Finally, the government announced yesterday a reduction in interest rates on small saving schemes to bring them on par with fixed deposit interest rates.

Which one of the following statements can be inferred from the given passage ?

- (A) Whenever the Reserve Bank of India reduces the repo rate, the interest rates on small saving schemes are also reduced.
- (B) Interest rates on small saving schemes are always maintained on par with fixed deposit interest rates.
- (C) The government sometimes takes into consideration the demands of banking institutions before reducing the interest rates on small saving schemes.
- (D) A reduction in interest rates on small saving schemes follow only after a reduction in repo rate by the Reserve Bank of India.

**Key: (D)**

**Section-II: Biotechnology**

**Q. No. 1 to 25 Carry One Mark Each**

1. The mass of 1 kmol of oxygen molecules is \_\_\_\_\_ g (rounded off to the nearest integer).

**Key: (32000)**

2. Which one of the following is a database of protein sequence motifs?

(A) PROSITE (B) TrEMBL (C) SWISSPROT (D) PDB

**Key: (A)**

3. The median value for the dataset (12, 10, 16, 8, 90, 50, 30, 24) is \_\_\_\_\_

**Key: (20)**

**Sol:** Given data set is

12, 10, 16, 8, 90, 50, 30, 24.

The proper ordered data set [increasing order] is

8, 10, 12, 16, 24, 30, 50, 90

$\therefore$  Median value = Average of middle most observations =  $\frac{16+24}{2} = 20$

4. Which one of the following enzymes is encoded by human immunodeficiency virus (HIV) genome?

(A) Reverse transcriptase (B) Phospholipase  
(C) Phosphatase (D) ATP synthase

**Key: (A)**

5. Match the human diseases in Group I with the causative agents in Group II

**Group I**

P. Amoebiasis  
Q. African sleeping sickness  
R. Kala azar  
S. Chagas' disease

**Group II**

1. Leishmania donovani  
2. Trypanosoma cruzi  
3. Entamoeba histolytica  
4. Trypanosoma gambiense

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

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

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

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

**Key: (B)**

6. Which one of the following need NOT be conserved in a biochemical reaction?

- (A) Total mass (B) Total moles  
(C) Number of atoms of each element (D) Total energy

**Key: (A)**

7. Which of the following are geometric series?

P. 1, 6, 11, 16, 21, 26, ....

Q. 9, 6, 3, 0, -3, -6, ...

R. 1, 3, 9, 27, 81, ....

S. 4, -8, 16, -32, 64, ....

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

**Key: (B)**

**Sol:** P: 1, 6, 11, 16, 21, 26, .... → A.P [Common difference = 5]

Q: 9, 6, 3, 0, -3, -6, ... → A.P [Common difference = -3]

R: 1, 3, 9, 27, 81, ... → Geometric series [common ratio = 3]

S: 4, -8, 16, -32, 64, .... → Geometric series [common ratio = -2]

8. DNA synthesis in eukaryotes occurs during which phase of the mitotic cell cycle?

- (A) M (B) G<sub>1</sub> (C) S (D) G<sub>0</sub>

**Key: (C)**

9. The degree of reduction for acetic acid (C<sub>2</sub>H<sub>4</sub>O<sub>2</sub>) is \_\_\_\_\_.

**Key: (4)**

10. Which one of the following is used as a pH indicator in animal cell culture medium?

- (A) Acridine orange (B) Phenol red  
(C) Bromophenol blue (D) Coomassie blue

**Key: (B)**

11. Which one of the following is NOT a part of the human nonspecific defense system?

- (A) Interferon (B) Mucous (C) Saliva (D) Antibody

**Key: (D)**

12. The solution of  $\lim_{x \rightarrow 8} \left( \frac{x^2 - 64}{x - 8} \right)$  is \_\_\_\_\_

**Key: (16)**

**Sol:**  $\lim_{x \rightarrow 8} \left( \frac{x^2 - 64}{x - 8} \right) = \lim_{x \rightarrow 8} \frac{(x - 8)(x + 8)}{(x - 8)} = \lim_{x \rightarrow 8} (x + 8) = 8 + 8 = 16$

13. Which one of the following is the unit of heat transfer coefficient?  
(A)  $W m^2 K^{-1}$       (B)  $W m^{-2} K$       (C)  $W m^{-2} K^{-1}$       (D)  $W m^2 K$   
**Key: (C)**
14. A mutation in a gene that codes for a polypeptide results in a variant polypeptide that lacks the last three amino acids. What type of mutation is this?  
(A) Synonymous mutation (B) Nonsense mutation  
(C) Missense mutation      (D) Silent mutation  
**Key: (C)**
15. Which one of the following statements is CORRECT for enzyme catalyzed reactions? ( $\Delta G$  is Gibbs free energy change,  $K_{eq}$  is equilibrium constant)  
(A) Enzymes affect  $\Delta G$ , but not  $K_{eq}$       (B) Enzymes affect  $K_{eq}$ , but not  $\Delta G$   
(C) Enzymes affect  $\Delta G$  and  $K_{eq}$       (D) Enzymes do not affect  $\Delta G$  or  $K_{eq}$   
**Key: (A)**
16. Protein concentration of a crude enzyme preparation was  $10 mg mL^{-1}$ .  $10 \mu L$  of this sample gave an activity of  $5 \mu mol min^{-1}$  under standard assay conditions. The specific activity of this crude enzyme preparation is \_\_\_\_\_ units  $mg^{-1}$   
**Key: (0)**
17. Which one of the following is catabolized during endogenous metabolism in a batch bacterial cultivation?  
(A) Internal reserves      (B) Extracellular substrates  
(C) Extracellular products      (D) Toxic substrates  
**Key: (0)**
18. The Bt toxin gene from *Bacillus thuringiensis* used to generate genetically modified crops is  
(A) cry      (B) cro      (C) cdc      (D) cre  
**Key: (A)**
19. Which one of the following can NOT be a limiting substrate if Monod's growth kinetics is applicable?  
(A) Extracellular carbon source      (B) Extracellular nitrogen source  
(C) Dissolved oxygen      (D) Intracellular carbon source  
**Key: (C)**

20. Which one of the following equations represents a one-dimensional wave equation?

(A)  $\frac{\partial u}{\partial t} = C^2 \frac{\partial^2 u}{\partial x^2}$     (B)  $\frac{\partial^2 u}{\partial t^2} = C^2 \frac{\partial^2 u}{\partial x^2}$     (C)  $\frac{\partial^2 u}{\partial t^2} = C^2 \frac{\partial u}{\partial x}$     (D)  $\frac{\partial^2 u}{\partial t^2} + \frac{\partial^2 u}{\partial x^2} = 0$

**Key:** (B)

**Sol:** Clearly,  $\frac{\partial^2 u}{\partial t^2} = c^2 \frac{\partial^2 u}{\partial x^2}$  represents a one-dimensional wave equation.

21. Which of the following processes can increase genetic diversity of bacteria in nature?

P. Conjugation

Q. Transformation

R. Transduction

S. Transfection

(A) P only                      (B) P and Q only            (C) P, Q and R only    (D) P,Q,R and S

**Key:** (C)

22. Matrix  $A = \begin{bmatrix} 0 & 6 \\ p & 0 \end{bmatrix}$  will be skew-symmetric when  $p =$  \_\_\_\_\_.

**Key:** (-6)

**Sol:** Method-1:

$A^T = -A \Leftrightarrow A$  is skew – symmetric

Given  $A = \begin{bmatrix} 0 & 6 \\ p & 0 \end{bmatrix} \Rightarrow -A = \begin{bmatrix} 0 & -6 \\ -p & 0 \end{bmatrix}$

$A^T = \begin{bmatrix} 0 & p \\ 6 & 0 \end{bmatrix}$

$\therefore A^T = -A \Rightarrow \begin{bmatrix} 0 & p \\ 6 & 0 \end{bmatrix} = \begin{bmatrix} 0 & -6 \\ -p & 0 \end{bmatrix}$

$\Rightarrow p = -6$

Method 2:

If  $a_{ij} = -a_{ji}$  then A is skew-symmetric.

$\therefore a_{12} = 6$

$a_{21} = p$

$\therefore p = -6 \quad [\because a_{12} = -a_{21}]$



23. Tetracycline inhibits the
- (A) Interaction between tRNA and mRNA
  - (B) Translocation of mRNA through ribosome
  - (C) Peptidyl transferase activity
  - (D) Binding of amino-acyl tRNA to ribosome

**Key: (D)**

24. The number of possible rooted trees in a phylogeny of three species is \_\_\_\_\_

**Key: (3)**

25. Which one of the following techniques can be used to compare the expression of a large number of genes in two biological samples in a single experiment?
- (A) Polymerase chain reaction
  - (B) DNA microarray
  - (C) Northern hybridization
  - (D) Southern hybridization

**Key: (B)**

**Q. No. 26 to 55 Carry Two Marks Each**

26. What is the solution of the differential equation  $\frac{dy}{dx} = \frac{x}{y}$ , with the initial condition, at  $x = 0, y = 1$ ?
- (A)  $x^2 = y^2 + 1$
  - (B)  $y^2 = x^2 + 1$
  - (C)  $y^2 = 2x^2 + 1$
  - (D)  $x^2 - y^2 = 0$

**Key: (B)**

**Sol:** Given D.E is

$$\frac{dy}{dx} = \frac{x}{y}$$

$\Rightarrow y \cdot dy = x \cdot dx \rightarrow$  variable-separate D.E

$$\Rightarrow \int x \cdot dx = \int y \cdot dy$$

$$\Rightarrow \frac{x^2}{2} = \frac{y^2}{2} + c \quad \dots(1)$$

Given  $x = 0, y = 1$

$$\therefore 0 = \frac{1}{2} + c \Rightarrow c = -\frac{1}{2}$$

$$(1) \Rightarrow \frac{x^2}{2} = \frac{y^2}{2} - \frac{1}{2}$$

$$\Rightarrow x^2 = y^2 - 1 \Rightarrow y^2 = x^2 + 1$$

27. For site-directed mutagenesis, which one of the following restriction enzymes is used to digest methylated DNA?

- (A) KpnI                      (B) DpnI                      (C) XhoI                      (D) M1uI

**Key:** (B)

28. A new game is being introduced in a casino. A player can lose Rs. 100, break even, win Rs.100 or win Rs.500. The probabilities (P(X)) of each of these outcomes (X) are given in the following table:

X (in Rs.)	-100	0	100	500
P (X)	0.25	0.5	0.2	0.05

The standard deviation ( $\sigma$ ) for the casino payout is Rs. \_\_\_\_\_ (rounded off to the nearest integer)

**Key:** (129)

**Sol:** Given table is clearly discrete probability distributions;

since  $\sum P(x) = 1$ ; where x is discrete R.V.

$$\therefore \text{Mean of } x = \sum x.p(x)$$

$$= (-100)[0.25] + (0)(0.5) + (100)(0.2) + (500)(0.05)$$

$$= -25 + 20 + 25$$

$$\Rightarrow E(x) = 20$$

$$\therefore E(x^2) = \sum x^2.P(x)$$

$$= (-100)^2 [0.25] + (0)^2 [0.5] + (100)^2 [0.2] + (500)^2 (0.05)$$

$$= \frac{1000}{4} + 10000 \times \frac{2}{10} + 250000 \times \frac{5}{100}$$

$$= 2500 + 2000 + 12500 = 17000$$

$$\therefore \text{Variance of } x = E(x^2) - [E(x)]^2$$

$$= 17000 - (20)^2$$

$$= 16,600$$

$$\therefore \text{S.D of } x = +\sqrt{\text{variance}} = \sqrt{16600} \cong 129$$

29. A UV-visible spectrophotometer has a minimum detectable absorbance of 0.02. The minimum concentration of a protein sample that can be measured reliably in this instrument with a cuvette of 1 cm path length is \_\_\_\_\_  $\mu\text{M}$ . The molar extinction coefficient of the protein is  $10,000\text{L mol}^{-1}\text{cm}^{-1}$ .

**Key:** ()



35. Group I lists spectroscopic methods and Group II lists bimolecular applications of these methods. Match the methods in Group I with the applications in Group II

Group I		Group II	
P	Infrared	1.	Identification of functional groups
Q.	Circular Dichroism	2.	Determination of secondary structure
R.	Nuclear Magnetic Resonance	3.	Estimation of molecular weight
		4.	Determination of 3-D structure
(A)	P-4, Q-3, R-1	(B)	P-2, Q-1, R-3
(C)	P-1, Q-2, R-4	(D)	P-3, Q-2, R-4

**Key:** (C)

36. In a cross-flow filtration process, the pressure drop ( $\Delta P$ ) driving the fluid flow is 2 atm, inlet feed pressure ( $P_i$ ) is 3 atm and filtrate pressure ( $P_f$ ) is equal to atmospheric pressure. The average transmembrane pressure drop ( $\Delta P_m$ ) is \_\_\_\_\_ atm.

**Key:** ()

37. Which one of the following amino acid residues will destabilize an  $\alpha$ -helix when inserted in the middle of the helix?

(A) Pro                      (B) Val                      (C) Ile                      (D) Leu

**Key:** (D)

38. The Laplace transform of the function  $f(t) = t^2 + 2t + 1$  is

(A)  $\frac{1}{s^3} + \frac{3}{s^2} + \frac{1}{s}$       (B)  $\frac{4}{s^3} + \frac{4}{s^2} + \frac{1}{s}$       (C)  $\frac{1}{s^3} + \frac{2}{s^2} + \frac{1}{s}$       (D)  $\frac{2}{s^3} + \frac{2}{s^2} + \frac{1}{s}$

**Key:** (D)

**Sol:**  $f(t) = t^2 + 2t + 1$

$$\begin{aligned} \Rightarrow L[f(t)] &= L[t^2 + 2t + 1] \\ &= L[t^2] + 2L[t] + L[1]; \text{ Using linearity property} \\ &= \frac{2!}{s^3} + \frac{2}{s^2} + \frac{1}{s}; \text{ since } L[t^n] = \frac{n!}{s^{n+1}} \end{aligned}$$

$$\Rightarrow L[t(t)] = \frac{2}{s^3} + \frac{2}{s^2} + \frac{1}{s}$$

39. In pea plants, purple color of flowers is determined by the dominant allele while white color is determined by the recessive allele. A genetic cross between two purple flower-bearing plants results in an offspring with white flowers. The probability that the third offspring from these parents will have purple flowers is \_\_\_\_\_ (rounded off to 2 decimal places)

**Key:** (0.25)



43. The hexapeptide P has an isoelectric point (pI) of 6.9. Hexapeptide Q is a variant of P that contains valine instead of glutamate at position 3. The two peptides are analyzed by polyacrylamide gel electrophoresis at pH 8.0. Which one of the following statements is CORRECT?
- (A) P will migrate faster than Q towards the anode  
 (B) P will migrate faster than Q towards the cathode  
 (C) Both P and Q will migrate together  
 (D) Q will migrate faster than P towards the anode

**Key:** (D)

44. Which one of the following statements is CORRECT about proportional controllers?
- (A) The initial change in control output signal is relatively slow  
 (B) The initial corrective action is greater for larger error  
 (C) They have no offset  
 (D) There is no corrective action if the error is a constant

**Key:** (C)

45. In general, which one of the following statements is NOT CORRECT?
- (A) Hydrogen bonds result from electrostatic interactions  
 (B) Hydrogen bonds contribute to the folding energy of proteins  
 (C) Hydrogen bonds are weaker than van der Waals interactions  
 (D) Hydrogen bonds are directional

**Key:** (C)

46. Phenolic wastewater discharged from an industry was treated with *Pseudomonas* sp, in an aerobic bioreactor. The influent and effluent concentration of phenol were 10,000 and 10 ppm, respectively. The inlet feed rate of wastewater was  $80 \text{ L h}^{-1}$ . The kinetic properties of the organism are as follows:

Maximum specific growth rate ( $\mu_m$ ) =  $1 \text{ h}^{-1}$

Saturation constant ( $K_s$ ) =  $100 \text{ mg L}^{-1}$

Cell death rate ( $k_d$ ) =  $0.01 \text{ h}^{-1}$

Assuming that the bioreactor operates under 'chemostat' mode, the working volume required for this process is \_\_\_\_\_ L (rounded off to the nearest integer)

**Key:** (D)

47. The difference in concentrations of an uncharged solute between two compartments is 1.6-fold. The energy required for active transport of the solute across the membrane separating the two compartments is \_\_\_\_\_  $\text{cal mol}^{-1}$  (rounded off to the nearest integer). ( $R = 1.987 \text{ cal mol}^{-1} \text{ K}^{-1}$ ,  $T = 37 \text{ }^\circ\text{C}$ )

**Key:** (D)

48. The dimensions and operating condition of a lab-scale fermentor are as follows:

Volume = 1 L

Diameter = 20 cm

Agitator speed = 600 rpm

Ratio of impeller diameter to fermentor diameter = 0.3

This fermentor needs to be scaled up to 8,000 L for a large scale industrial application. If the scale-up is based on constant impeller tip speed, the speed of the agitator in the larger reactor is \_\_\_\_\_ rpm. Assume that the scale-up factor is the cube root of the ratio of fermentor volumes.

**Key:** ( )

49. Which of the following factors affect the fidelity of DNA polymerase in polymerase chain reaction?

P.  $Mg^{2+}$  concentration

Q. pH

R. Annealing temperature

(A) P and Q only

(B) P and R only

(C) Q and R only

(D) P, Q and R

**Key:** (A)

50. Match the organelles in Group I with their functions in Group II.

**Group I**

**Group II**

P Lysosome

1. Digestion of foreign substances

Q. Smooth ER

2. Protein targeting

R. Golgi apparatus

3. Lipid synthesis

S. Nucleolus

4. Protein synthesis

5. rRNA synthesis

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

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

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

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

**Key:** (A)

51. Which of the following statements is ALWAYS CORRECT about an ideal chemostat?

P. Substrate concentration inside the chemostat is equal to that in the exit stream

Q. Optimal dilution rate is lower than critical dilution rate

R. Biomass concentration increases with increase in dilution rate

S. Cell recirculation facilitates operation beyond critical dilution rate

(A) P and Q only

(B) P, R and S only

(C) P and S only

(D) P, Q and S only

**Key:** (B)

52. Determine the correctness or otherwise of the following Assertion [a] and the Reason [r]  
Assertion [a]: It is possible to regenerate a whole plant from a single plant cell.  
Reason [r]: It is easier to introduce transgenes in to plants than animals.  
(A) Both [a] and [r] are true and [r] is the correct reason for [a]  
(B) Both [a] and [r] are true but [r] is not the correct reason for [a]  
(C) Both [a] and [r] are false  
(D) [a] is true but [r] is false

**Key: (A)**

53. Ail industrial fermentor containing 10,000 L of medium needs to be sterilized. The initial spore concentration in the medium is  $10^6$  spores  $\text{mL}^{-1}$ . The desired probability of contamination after sterilization is  $10^{-3}$ . The death rate of spores at  $121^\circ\text{C}$  is  $4\text{min}^{-1}$ . Assume that there is no cell death during heating and cooling phases. The holding time of the sterilization process is \_\_\_\_\_min (rounded off to the nearest integer).

**Key: ()**

54. Antibody-producing hybridoma cells are generated by the fusion of a  
(A) T cell with a myeloma cell  
(B) B cell with a myeloma cell  
(C) Macrophage with a myeloma cell  
(D) T cell and a B cell

**Key: (B)**

55. Which of the following factors can influence the lag phase of a microbial culture in a batch fermentor?  
P. Inoculum size  
Q. Inoculum age  
R. Medium composition

(A) P and Q only      (B) Q and R only      (C) P and R only      (D) P, Q and R

**Key: (B)**