## 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
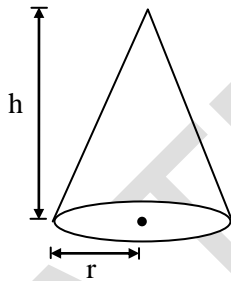
(C) defeat                    (D) defeatist

**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
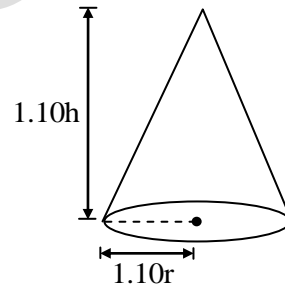
**Key: (C)**

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



Volume of circular cone,

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

Volume, $V_f = \frac{1}{3}\pi(1.1r)^2(1.1h)$

$$= \frac{1.331}{3}\pi r^2 h$$

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

**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 $x = velocity \times time$

$$x = 80t \Rightarrow t = \frac{x}{80} \qquad ...(1)$$

For y time taken = t

Distance $y = 100t \Rightarrow t = \frac{y}{100} \qquad ..(2)$

$$x + y = 540 km \qquad ...(3)$$

From (1) and (2)

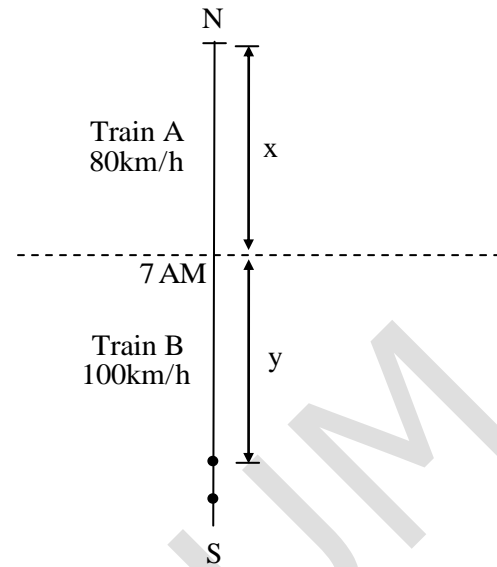$$t = \frac{x}{80} = \frac{y}{100} \Rightarrow x = 0.8y$$

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

$$1.8y = 540 \Rightarrow y = 300 km$$

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

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

```
                                    N
                                    |
                Train A        |----  ↑
                80km/h         |      x
                               |      |
            - - - - - - - - - -|-  ↓----
                7 AM           |   ↑
                               |   |
                Train B        |   y
                100km/h        |   |
                               |   ↓
                               ●
                               ●
                                    S
```

**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

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

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) Dhrupad, baani       (B) Gayaki, Vocal

(C) Baaj, institution       (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)**

**Sol:** Molar mass of oxygen =16

So for oxygen molecule its 32 g/mol

For, 1mol=32 gms

1kmol=32000 gms

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

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

**Key:** **(A)**

**Sol:** Protein sequence motifs are signatures of protein families and can often be used as tools for the prediction of protein function. The generalization and modification of already known motifs are becoming major trends in the literature, even though new motifs are still being discovered at an approximately linear rate. The emphasis of motif analysis appears to be shifting from metabolic enzymes, in which motifs are associated with catalytic functions and thus often readily recognizable, to structural and regulatory proteins, which contain more divergent motifs. The consideration of structural information increasingly contributes to the identification of motifs and their sensitivity. PROSITE's uses include identifying possible functions of newly discovered proteins and analysis of known proteins for previously undetermined activity. Properties from well-studied <u>genes</u> can be propagated to biologically related organisms, and for different or poorly known genes biochemical functions can be predicted from similarities. PROSITE offers tools for protein <u>sequence analysis</u> and motif detection

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 $=\dfrac{16+24}{2}=20$

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)**

**Sol:** HIV is a member of the genus Lentivirus, part of the family Retroviridae. Lentiviruses have many morphologies and biological properties in common. Many species are infected by lentiviruses, which are characteristically responsible for long-duration illnesses with a long incubation period. Lentiviruses are transmitted as single-stranded, positive-sense, enveloped RNA viruses. Upon entry into the target cell, the viral RNA genome is converted (reverse transcribed) into double-stranded DNA by a virally encoded enzyme, reverse transcriptase, that is transported along with the viral genome in the virus particle. The resulting viral DNA is then imported into the cell nucleus and integrated into the cellular DNA by a virally encoded enzyme, integrase, and host co-factors. Once integrated, the virus may become latent, allowing the virus and its host cell to avoid detection by the immune system, for an indiscriminate amount of time.

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

|  | **Group I** |  | **Group II** |
| --- | --- | --- | --- |
| P | Amoebiasis | 1. | Leishmania donovani |
| Q. | African sleeping sickness | 2. | Trypanosoma cruzi |
| R. | Kala azar | 3. | Entamoeba histolytica |
| S. | Chagas' disease | 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:** **(C)**

**Sol:** Amoebiasis, also known amoebic dysentery, is an infection caused by any of the amobae of the Entamoeba group.[3] Symptoms are most common during infection by Entamoeba histolytica.

African trypanosomiasis, also known as sleeping sickness, is an insect-borne parasitic disease of humans and other animals.[1] It is caused by protozoa of the species Trypanosoma brucei.[1] There are two types that infect humans, Trypanosoma brucei gambiense (TbG) and Trypanosoma brucei rhodesiense (TbR).[1] TbG causes over 98% of reported cases.[1] Both are usually transmitted by the bite of an infected tsetse fly and are most common in rural areas.

Visceral leishmaniasis (VL), also known as kala-azar[1] (UK: /ˌkɑːlə əˈzɑːr/), black fever, and Dumdum fever,[2] is the most severe form of leishmaniasis and, without proper diagnosis and treatment, is associated with high fatality.[3] Leishmaniasis is a disease caused by protozoanparasites of the genus Leishmania.

Chagas disease, also known as American trypanosomiasis, is a tropical parasitic disease caused by the protist Trypanosoma cruzi. It is spread mostly by insects known as Triatominae, or "kissing bugs". The symptoms change over the course of the infection.

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:** **(B)**

**Sol:** Mass and atoms are conserved. Moles are conserved only when there is no reaction. Volume is NOT conserved.

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…. $\to$ A.P [Common difference = 5]

Q: 9, 6, 3, 0, –3, –6, … $\to$ A.P [Common difference = 3]

R: 1, 3, 9, 27, 81… $\to$ Geometric series [common ratio = 3]

S: 4,-8,16,-32,64….. $\to$ Geometric series [common ratio = -2]

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

(A) M     (B) $G_1$     (C) S     (D) $G_0$

**Key:** **(C)**

**Sol:** In $G_1$ phase of the cell cycle, many of the DNA replication regulatory processes are initiated. In eukaryotes, the vast majority of DNA synthesis occurs during S phase of the cell cycle, and the entire genome must be unwound and duplicated to form two daughter copies. During $G_2$, any damaged DNA or replication errors are corrected. Finally, one copy of the genomes is segregated to each daughter cell at mitosis or M phase.[2] These daughter copies each contain one strand from the parental duplex DNA and one nascent antiparallel strand

9. The degree of reduction for acetic acid $\left( C_2H_4O_2 \right)$ is _____ .

**Key:** **(4)**

**Sol:** TABLE 7.4 Degree of Reduction and weight of one carbon equivalent of One Mole of some substrates and Biomass

| Compound | Molecular Formula | Degree of Reduction. $\gamma$ | Weight.m |
|---|---|---|---|
| Biomass | $CH_{1.64}N_{0.15}O_{0.52}$ $P_{0.0054}S_{0.005}$ | $4.17\left( NH_3 \right)$ $4.65\left( N_2 \right)$ $5.45\left( HNO_3 \right)$ | 24.5 |
| Methane | $CH_4$ | 8 | 16.0 |
| n-Alkane | $C_{15}H_{32}$ | 6.13 | 14.1 |
| Methanol | $CH_4O$ | 6.0 | 32.0 |
| Ethanol | $C_2H_6O$ | 6.0 | 23.0 |

| Glycerol | $C_3H_6O_3$ | 4.67 | 30.7 |
|---|---|---|---|
| Mannitol | $C_6H_{14}O_6$ | 4.33 | 30.3 |
| Acetic acid | $C_2H_4O_2$ | 4.0 | 30.0 |
| Lactic acid | $C_3H_6O_3$ | 4.0 | 30.0 |
| Glucose | $C_6H_{12}O_6$ | 4.0 | 30.0 |
| Formaldehyde | $CH_2O$ | 4.0 | 30.0 |
| Gluconic acid | $C_6H_{12}O_7$ | 3.67 | 32.7 |
| Succinic acid | $C_4H_6O_4$ | 3.50 | 29.5 |
| Citric acid | $C_6H_8O_3$ | 3.0 | 33.5 |
| Formic acid | $CH_2O_2$ | 2.0 | 46.0 |
| Oxalic acid | $C_2H_2O_4$ | 1.0 | 45.0 |

With permission, form B. Atkinson and F. Mavituna, Biochemical Enginnering and Biotechnology hand book, macmillan. Inc., New York. 1983

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)**

**Sol:** Most of the commercially available culture media include phenol red as a pH indicator, which allows constant monitoring of pH [24]. During the cell growth, the medium changes color as pH is changed due to the metabolites released by the cells. At low pH levels, phenol red turns the medium yellow, while at higher pH levels it turns the medium purple. Medium is bright red for pH 7.4, the optimum pH value for cell culture

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)**

**Sol:** Examples of nonspecific defenses include physical barriers, protein defenses, cellular defenses, inflammation, and fever. Physical barriers such as the skin and mucous membranes mechanically regulate what enters the body. Secretions provide protection at the barrier as well. Mucus, for example, can trap potential invaders. Also, skin secretions are slightly acidic, inhibiting bacterial growth. Many body secretions (such as mucus, tears, and saliva) contain an enzyme called lysozyme that destroys bacteria. Some immune cells and cells that are infected with viruses produce another set of proteins called interferons. Interferons send a warning to nearby cells. They help prevent infection by stimulating the production of antiviral proteins. Interferons also stimulate natural killer cells and macrophages.

12. The solution of $\lim\limits_{x \to 8}\left(\dfrac{x^2 - 64}{x - 8}\right)$ is _____

**Key:** **(16)**

**Sol:** $\lim\limits_{x\to 8}\left(\dfrac{x^2-64}{x-8}\right)=\lim\limits_{x\to 8}\dfrac{(x-8)(x+6)}{(x-8)}=\lim\limits_{x\to 8}(x+8)=8+8=16$

13. Which one of the following is the unit of heat transfer coefficient?

   (A) $W\,m^2K^{-1}$      (B) $W\,m^{-2}K$      (C) $W\,m^{-2}K^{-1}$      (D) $W\,m^2K$

**Key:** **(C)**

**Sol:** unit of heat transfer coefficient, $W/(m2\bullet K)$ .

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:** **(B)**

**Sol:** A <u>nonsense</u> mutation is also a change in one DNA base pair. Instead of substituting one amino acid for another, however, the altered DNA sequence prematurely signals the cell to stop building a protein. This type of mutation results in a shortened protein that may function improperly or not at all

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:** **(D)**

**Sol:** enzymes do not change the equilibrium state of a biochemical reaction. $\Delta G0$ and Keq remain the same. Instead, the enzyme reduces the activation energy needed for the reaction to proceed, and thus increase the rate of reaction. Enzymes work by stabilizing reaction intermediates. And as such, they catalyze reactions i*n either direction*! Enzymes enhance rates. They don't change free energy differences nor do the affect equilibrium constants.

16. Protein concentration of a crude enzyme preparation was $10mg\,mL^{-1}$. $10\mu L$ 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:** **(50)**

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:** **(A)**

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)**

**Sol:** *Bacillus thuringiensis* (*Bt*) crops are plants genetically engineered (modified) to contain the endospore (or crystal) toxins of the bacterium, *Bt* to be resistant to certain insect pests. In 1995, the Environmental Protection Agency (EPA) in USA approved the commercial production and distribution of the *Bt* crops: corn, cotton, potato, and tobacco. Currently, the most common *Bt* crops are corn and cotton. The crystal, referred to as Cry toxins, is proteins formed during sporulation of some *Bt* strains and aggregate to form crystals.

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

**Key:** **(B)**

**Sol:** Clearly, $\dfrac{\partial^2 u}{\partial t^2} = c^2 \dfrac{\partial^2 u}{\partial x^2}$ 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:** **(B)**

**Sol:** Rapid reproduction which increases the rate of mutation; recombination via conjugation, transduction, and transformation.

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.

$\therefore \quad a_{12} = 6$

$\quad a_{21} = P$

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

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)**

**Sol:** Tetracyclines are inhibitors of growth (bacteriostatic) rather than killers of the infectious agent (bacteriocidal) and are only effective against multiplying microorganisms.[1] They are short-acting and passively diffuse through porin channels in the bacterial membrane. They inhibit protein synthesis by binding reversibly to the bacterial 30S ribosomal subunit and preventing the aminoacyl tRNA from binding to the A site of the ribosome. They also bind to some extent the bacterial 50S ribosomal subunit and may alter the cytoplasmic membrane causing intracellular components to leak from bacterial cells.

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

**Key: (3)**

**Sol:**

| Number of Taxa | Number of unrooted tress | Number of rooted trees |
| --- | --- | --- |
| 3 | 1 | 3 |
| 4 | 3 | 15 |
| 5 | 15 | 105 |
| 6 | 105 | 945 |
| 7 | 945 | 10395 |
| 8 | 10395 | 135135 |
| 9 | 135135 | 2027025 |
| 10 | 2027025 | 34459425 |

**GATEFORUM**
Engineering Success

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)**

**Sol:** A DNA microarray (also commonly known as DNA chip or biochip) is a collection of microscopic DNA spots attached to a solid surface. Scientists use DNA microarrays to measure the expression levels of large numbers of genes simultaneously or to genotype multiple regions of a genome. Each DNA spot contains picomoles ($10-12$ moles) of a specific DNA sequence, known as probes (or reporters or oligos). These can be a short section of a gene or other DNA element that are used to hybridize a cDNA or cRNA (also called anti-sense RNA) sample (called target) under high-stringency conditions.

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

26. What is the solution of the differential equation $\dfrac{dy}{dx} = \dfrac{x}{y}$, 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

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

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

$$\Rightarrow \int x - dx = \int y.dy$$

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

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)**

**Sol:** Important part of site-directed mutagenesis is eliminating the template with a methylation-recognizing-nuclease, as DpnI. Although digestion of DpnI can eliminate fully methylated parental DNA, around 20–30% of hemimethylated molecules (parental strand combined with PCR-generated strand) could not be removed due to hemimethylated DNA, and the PCR product would be more resistant to DpnI.

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

$\therefore$ Mean of $x = \Sigma x.p(x)$

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

$\qquad = -25 + 20 + 25$

$\Rightarrow E(x) = 20$

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

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

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

$\qquad = 2500 + 2000 + 12500 = 17000$

$\therefore \quad$ Variance of $x = E(x^2) - \left[E(x)\right]^2$

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

$\qquad = 16,600$

$\therefore$ 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 _____ $\mu M$ . The molar extinction coefficient of the protein is $10,000 L\,mol^{-1}cm^{-1}$.

**Key: (2)**

30. The molecular mass of a protein is 22 kDA. The size of the cDNA (excluding the untranslated regions) that codes for this protein is _____ kb (rounded off to 1 decimal place).

**Key:** **(0.6)**

31. Yeast biomass $(C_6H_{10}O_3N)$ grown on glucose is described by the stoichiometric equation given below:

$$C_6H_{12}O_6 + 0.48\,NH_3 + 3O_2 \rightarrow 0.48\,C_6H_{10}O_3N + 3.12\,CO_2 + 4.32\,H_2O$$
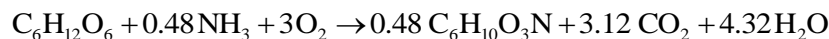
The amount of glucose needed for the production of $50\,gL^{-1}$ of yeast biomass in a batch reactor with a working volume of 100000 L is _____ kg (rounded of to the nearest integer).

**Key:** **(12500 to 14500)**

32. Match the instruments in Group I with their corresponding measurements in Group II.

| | **Group I** | | | **Group II** |
|---|---|---|---|---|
| P | Manometer | | 1. | Agitator speed |
| Q. | Rotameter | | 2. | Pressure difference |
| R. | Tachometer | | 3. | Cell number |
| S. | Haemocytometer | | 4. | Air flow rate |

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

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

**Key:** **(C)**

33. Which one of the following is coded by the ABO blood group locus in the human genome?

(A) Acyl transferase      (B) Galactosyltransferase

(C) Transposase      (D) $\beta$ – Galactosidase

**Key:** **(B)**

**Sol:** A manometer is a device for measuring fluid pressure consisting of a bent tube containing one or more liquids of different densities. A known pressure (which may be atmospheric) is applied to one end of the manometer tube and the unknown pressure (to be determined) is applied to the other end

The rotameter is an industrial flowmeter used to measure the flowrate of liquids and gases. The rotameter consists of a tube and float.

Mixer and agitator users today find the need for precise mixer speed monitoring and validation, particularly with cGMP sanitary agitators. Measuring and monitoring and validating exact mixer speed is done by a mixer tachometer.

The hemocytometer (or haemocytometer) is a counting-chamber device originally designed and usually used for counting blood cells.

34. Which one of the following covalent linkages exists between 7-Methyl guanosine $(m^7G)$ and mRNAs?

(A) $2'-3'$ triphosphate
(B) $3'-5'$ triphosphate

(C) $5'-5'$ triphosphate
(D) $2'-5'$ triphosphate

**Key: (C)**

**Sol:** The 7-methylguanosine cap is joined to the first transcribed nucleotide via the 5′ hydroxyl group, through a triphosphate linkage, to produce m7G(5′)ppp(5′)X, where m7G is 7-methylguanosine, p is a phosphate group and X is the first transcribed nucleotide. This 5′–5′ linkage is in contrast with the 3′–5′ phosphodiester bond, which links nucleotides in transcribed RNA.

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)**

**Sol:** IR (infrared) spectroscopy is useful in organic chemistry because it enables you to identify different functional groups. This is because each functional group contains certain bonds, and these bonds always show up in the same places in the IR spectrum

Circular dichroism (CD) spectroscopy is widely used for protein secondary structure analysis. However, quantitative estimation for β-sheet–containing proteins is problematic due to the huge morphological and spectral diversity of β-structures.

Nuclear magnetic resonance spectroscopy of proteins (usually abbreviated protein NMR) is a field of structural biology in which NMR spectroscopy is used to obtain information about the structure and dynamics of proteins, and also nucleic acids, and their complexes.

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: (1)**

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: (A)**

**Sol:** Prolines in alpha helices after the first turn (4th residue) cause a kink in the helix. This kink is caused by proline being unable to complete the H-bonding chain of the helix and steric or rotamer effects that keep proline from adapting the prefered helical geometry.

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

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

**Key: (D)**

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

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

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

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: (0.75)**

**Sol:** Purple flowers genotypes: PP, Pp

White flowers genotype: pp

As one of the offspring is white flower the cross should be between heterozygous purple flower and homozygous white flower

So,

Pp*Pp----- two purple flowers crossing

We get four off springs

PP, Pp, Pp, pp----four off springs

Third offspring to be purple flower possibility 1 in 4 off springs $1/4 = 0.25$

40. Which of the following statements are CORRECT when a protein sequence database is searched using the BLAST algorithm?

P. A larger E-value indicates higher sequence similarity

Q. E-value $\angle 10^{-10}$ indicates sequence homology

R. A higher BLAST score indicates higher sequence similarity

S. E-value $> 10^{10}$ indicates sequence homology

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

(C) P, R and S only          (D) P and S only

**Key: (B)**

**Sol:** E < 0.05: probably related (homologous)

E < 1 : may be related

E >= 1 : no statistical significance, but may be biologically significant anyway

From the above interpretations:

Statement p and s are false and q is correct;

Statement r is true: The BLAST nucleotide sequence identity suggested 75-98% relationship or similarity,

41. Which of the following statements are CORRECT about the function of fetal bovine serum in animal cell culture?

P. It stimulates cell growth

Q. It enhances cell attachment

R. It provides hormones and minerals

S. It maintains pH at 7.4

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

**Key:** **(C)**

**Sol:** It is rich in natural growth-factors required to stimulate cell growth, cell proliferation, differentiation & also for regulation of cellular activity.

Because of its high quantity of hormones, carrier proteins and macromolecular proteins, fetal bovine serum is frequently present in culture medium used in in vitro fertilization. In this process, embryonic stem cells are transferred into the culture medium; this results in growth of the cells.

Physical and Chemical analysis: Appearance : Amber liquid pH : 6.8 - 8.2 Osmolality : 280 – 340 mOsm/KgH2 O

42. $\int_{-1}^{1} f(x)dx$ Calculated using trapezoidal rule for the values given in the table is _____ (rounded off to 2 decimal places)

| X | −1 | $-2/3$ | $-1/3$ | 0 | $1/3$ | $2/3$ | 1 |
|---|---|---|---|---|---|---|---|
| f(x) | 0.37 | 0.51 | 0.71 | 1.0 | 1.40 | 1.95 | 2.71 |

**Key:** **(2.37)**

**Sol:** Using trapezoid rule, we have

$$\int_{a}^{b} f(x)dx \approx \frac{h}{2}\left[(y_0 + y_n) + 2(y_1 + y_2 + ... + y_{n-1})\right]$$

Given $y_0 = 0.37$, $y_1 = 0.51$, $y_2 = 0.71$, $y_3 = 1.0$, $y_4 = 1.40$, $y_5 = 1.95$, $y_6 = 2.71$ & $h = \frac{1}{3}$

$$\therefore \text{From (1);} \int_{-1}^{1} f(x)dx \approx \frac{\left(\dfrac{1}{3}\right)}{2}\left[(0.37+2.71)+2[0.51+0.71+1.0+1.40+1.95]\right] \approx \frac{1}{6}\left[3.08+2(5.57)\right]$$

$$\Rightarrow \int_{-1}^{1} f(x)dx \approx 2.37$$

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: (A)**

**Sol:** Glutamate has acidic side chains so it move towards cathode, where as valine has aliphatic side chain so it move towards anode. This satisfies first statement.

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: (B)**

**Sol:** Proportional Control

It is a major step forward to let the magnitude of the corrective action depend on the magnitude of the error. This has the effect that a small error will lead to only a small adjustment, whereas a larger error will result in a greater corrective action.

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)**

**Sol:** As a result of Hydrogen bonding, a H-atom links the two electronegative atoms simultaneously, one by a covalent bond and the other by a hydrogen bond. Hence it is said to form a hydrogen bridge. Hydrogen bond is a weak bond, but it isstronger than van-der Waals forces. So statement C is not correct.

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 $80L\ h^{-1}$. The kinetic properties of the organism are as follows:

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

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

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

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

**Key:** **(970 to 1010)**

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_____cal mol$^{-1}$ (rounded off to the nearest integer). (R = 1.987 cal mol$^{-1}$ K$^{-1}$, T = 37 °C)

**Key:** **(280 to 295)**

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:** **(30)**

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:** **(D)**

**Sol:** The fidelity of DNA synthesis is known to be affected by a variety of factors including polymerase structure, $3'{\rightarrow}5'$ exonuclease activity, dNTP and divalent cation concentrations, and pH. So mg+2 and pH only correct.

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)**

**Sol:** Lysosomes act in digesting intracellular components such as worn out organelles (autophagy) or by fusing with phagosomes to break down phagocytosed material. Their abundance is greatest in phagocytes, such as macrophages, but almost all cells contain some lysosomes.

The smooth endoplasmic reticulum lacks ribosomes and functions in lipid synthesis but not metabolism, the production of steroid hormones, and detoxification.

Molecules of rRNA are synthesized in a specialized region of the cell nucleus called the nucleolus, which appears as a dense area within the nucleus and contains the genes that encode rRNA. The encoded rRNAs differ in size, being distinguished as either large or small.

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)**

**Sol:** Microorganisms growing in chemostats usually reach a steady state because of a negative feedback between growth rate and nutrient consumption: if a low number of cells are present in the bioreactor, the cells can grow at growth rates higher than the dilution rate as they consume little nutrient so growth is less limited by the addition of limiting nutrient with the inflowing fresh medium.

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: (B)**

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 $mL^{-1}$. The desired probability of contamination after sterilization is $10^{-3}$. The death rate of spores at $121^oC$ is $4\,min^{-1}$. 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: (9 to 10)**

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)**

**Sol:** A type of white blood cell, the B cell, produces antibodies that bind to the injected antigen. These newly produced antibodies are then harvested from the mouse. These isolated B cells are in turn fused with immortal B cell cancer cells, a myeloma,[clarification needed] to produce a hybrid cell line called a hybridoma, which has both the antibody-producing ability of the B-cell and the exaggerated longevity and reproductivity of the myeloma.

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: (D)**

**Sol:** factors that can influence the lag phase of a microbial culture in a batch fermentor are inoculums age, inoculums size and media composition