GENERAL APTITUDE

1.

Items	Cost (Rs)	Profit %	Marked Price
P	5, 4000	…	5,860
Q	…	25	10,000

Details of prices of two items P and Q are presented in the above table. The ratio of cost item P to cost of item Q is 3:4. Discount is calculated as the difference between the marked price and the selling price. The profit percentage is calculated as the ratio of the difference between selling price and cost, to the cost

$$\left(\text{Profit \%} = \frac{\text{Selling price} - \text{Cost}}{\text{Cost}} \times 100\right)$$

The discount on item Q, as a percentage of its marked price, is _____

(A) 25 (B) 10 (C) 12.5 (D) 5

[2-Marks, MCQ]

Key: (B)

Sol: Given: Ratio of cost of item P to cost of item Q = 3 : 4

Cost of item P = 5400

Cost of item Q = 7200

Profit % on item Q = 25

$\therefore$ Selling price of item Q = $7200 \times \frac{125}{100} = 9000$

$\therefore$ Discount of item Q = Marked price – selling price

$= 10,000 - 9000 = 1000$

$\therefore$ Discount % = $\frac{1000}{10,000} \times 100 = 10$

2. Given below are two statements 1 and 2, and two conclusions I and **II.**

Statement 1: All bacteria are microorganisms.

Statement 2: All pathogens are microorganisms.

Conclusion I: Some pathogens are bacteria.

Conclusion II: All pathogens are not bacteria.

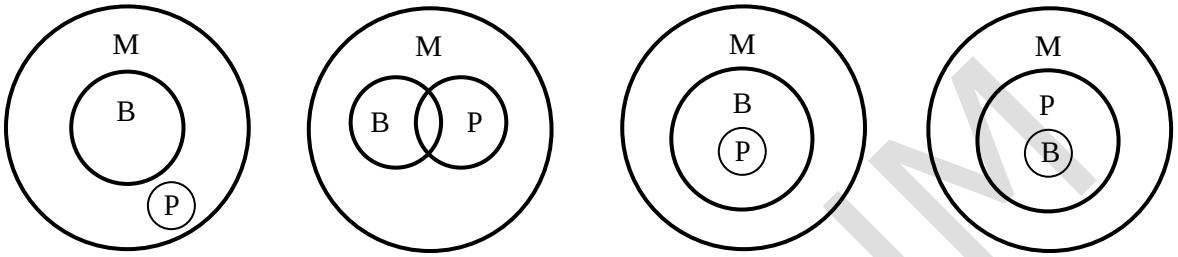
Based on the above statements and conclusions, which one of the following options is logically CORRECT?

(A) Only conclusion II is correct
(B) Either conclusion I or II is correct
(C) Neither conclusion I nor II is correct
(D) Only conclusion I is correct

[2-Marks, MCQ]

Key: (C)

Sol: Using Venn diagrams, the different possibilities are



(i) (ii) (iii) (iv)

From figure (i), conclusion I is incorrect

From figure (ii), conclusion II is incorrect

Hence, neither conclusion I nor II is correct

3. There are five bags each containing identical sets of ten distinct chocolates. One chocolate is picked from each bag.

(A) 0.6979 (B) 0.3024 (C) 0.8125 (D) 0.4235

[2-Marks, MCQ]

Key: (A)

Sol:

Total number of cases in sample space = $10\times10\times10\times10\times10=10^5$

Event A → At least two chocolates are identical

Probability of A, ie., $P\begin{pmatrix}\text{atleast two are}\\ \text{identical}\end{pmatrix}=1-P(\text{alldifferent})$

$\Rightarrow P(A)=1-\dfrac{10\times9\times8\times7\times6}{10^5}=1-0.3024=0.6976$

4. Consider the following sentences:

(i) Everybody in the class is prepared for the exam.

(ii) Babu invited Danish to his home because he enjoys playing chess.

Which of the following is the CORRECT observation about the above two sentences?

(A) (i) is grammatically incorrect and (ii) is unambiguous

(B) (i) is grammatically correct and (ii) is unambiguous

(C) (i) is grammatically correct and (ii) is ambiguous

(D) (i) is grammatically incorrect and (ii) is ambiguous

[1-Mark, MCQ]

Key: (C)

Sol: (i) is grammatically correct and

(ii) is ambiguous.

Statement 2 is ambiguous because we do not know who enjoys playing chess, Babu or Danish !!

Statement 1 is grammatically correct.

5. The ratio of boys to girls in a class is 7 to3.

Among the options below, an acceptable value for the total number of students in the class is:

(A) 21 (B) 73 (C) 37 (D) 50

[1-Mark, MCQ]

Key: (D)

Sol: Given: Ratio of boys to girls

$\therefore$ Multiples of 10 are : 10, 20, 30, 40, 50, 60, 70,.....

$\therefore$ An acceptable value for the total number of students is 50.

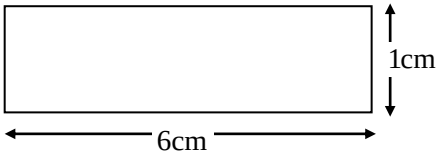
6. We have 2 rectangular sheets of paper, M and N, of dimension 6 cm × 1 cm each. Sheet M is rolled to form an open cylinder by bringing the short edges of the sheet together. Sheet N is cut into equal square patches and assembled to form the largest possible closed cube. Assuming the ends of the cylinder are closed, the ratio of the volume of the cylinder to that of the cube is _____.

(A) 3π (B) $\frac{9}{\pi}$ (C) $\frac{3}{\pi}$ (D) $\frac{\pi}{2}$

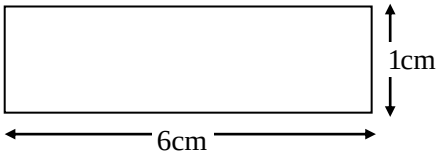
[2-Marks, MCQ]

Key: (B)

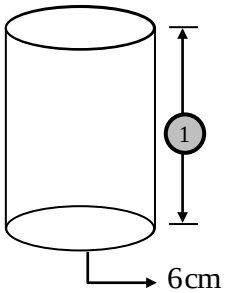
Sol: Given:

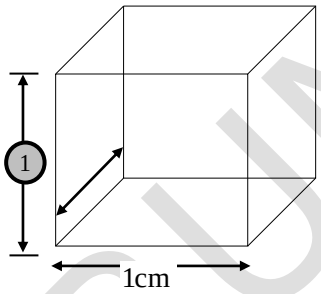


Sheet M



Sheet N





Volume of cylinder

$V = \pi r^2 h$;

where $h = 1$, r is maximum

But $2\pi r = 6\text{cm}$

$\Rightarrow r^2 = \frac{6}{2\pi} = \frac{3}{\pi}$

$\therefore V = \pi\left(\frac{3}{\pi}\right)^2 (1) \Rightarrow V = \frac{9}{\pi}\text{cm}^3$

Volume of unit cube $= 1\text{cm}$

Required ratio $= \frac{\frac{9}{\pi}}{(1)} = \frac{9}{\pi}$

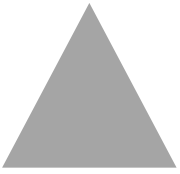
7. A polygon is convex if, for every pair of points, P and Q belonging to the polygon, the line segment PQ lies completely inside or on the polygon.

Which one of the following is NOT a convex polygon?

(A) 

(B) 

(C) 

(D) 

[1-Mark, MCQ]

Key: (B)

Sol: Here line segment does not lie inside of on the polygon.

Hence the figure in option (B) is not a convex polygon

8. _____ is to surgery as writer is to _____.

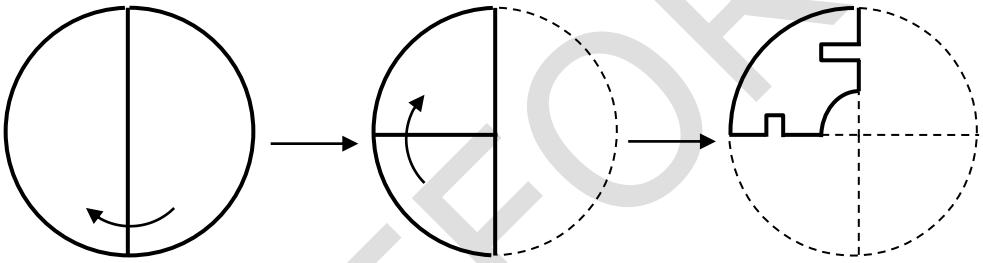
Which one of the following options maintains a similar logical relation in the above sentence?

(A) Doctor, book
(B) Plan, outline
(C) Medicine, grammar
(D) Hospital, library

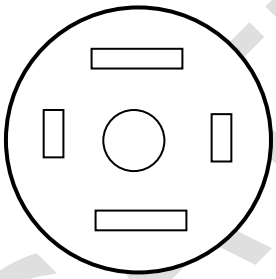
[1-Mark, MCQ]

Key: (A)

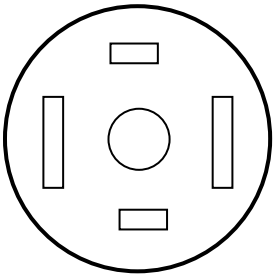
9. A circular sheet of paper is folded along the lines in the directions shown. The paper, after being punched in the final folded state as shown and unfolded in the reverse order of folding, will look like



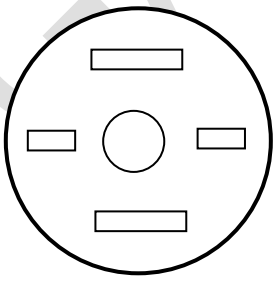
(A)



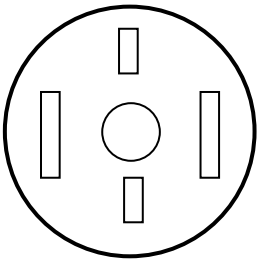
(B)



(C)



(D)



[1-Mark, MCQ]

Key: (A)

10. Some people suggest anti-obesity measures (AOM) such as displaying calorie information in restaurant menus, such measures sidestep addressing the core problem that cause obesity: poverty and income inequality.

Which one of the following statements summarizes the passage?

(A) AOM are addressing the core problems and are likely to succeed

(B) If obesity reduces, poverty will naturally reduce, since obesity causes poverty

(C) The proposed AOM addresses the core problems that cause obesity

(D) AOM are addressing the problem superficially

[2-Marks, MCQ]

Key: (D)

Sol: As AOM are not addressing the core problems, they are superficial.

Superficial: shallow, cursory mean lacking in depth or solidity. superficial implies a concern only with surface aspects or obvious features. a superficial analysis of the problem shallow is more generally derogatory in implying lack of depth in knowledge, reasoning, emotions, or character.

BIOTECHNOLOGY

1. The Cartesian coordinates (x, y) of a point A with polar coordinates $\left(4,\frac{\pi}{4}\right)$ is

(A) $\left(2,2\sqrt{3}\right)$ (B) $\left(\sqrt{3},2\sqrt{2}\right)$ (C) $\left(2\sqrt{2},2\sqrt{2}\right)$ (D) $\left(2\sqrt{2},\sqrt{3}\right)$

[1-Mark, MCQ]

Key: (C)

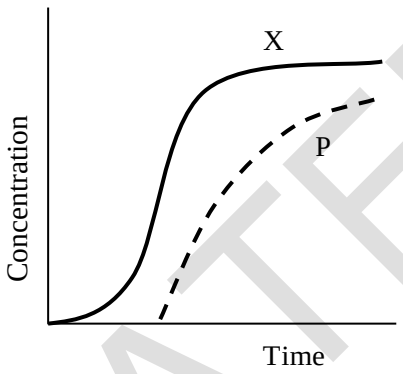
Sol: $r=4,\theta=\frac{\pi}{4}\Rightarrow x=r\cos\theta=4\times\frac{1}{\sqrt{2}}=2\sqrt{2}$

$y=r\sin\theta=4\times\frac{1}{\sqrt{2}}=2\sqrt{2}$

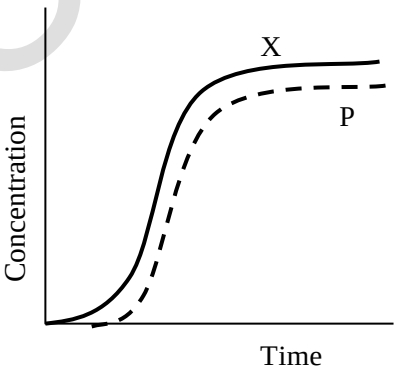
$\therefore$ Required point A is $\left(2\sqrt{2},2\sqrt{2}\right)$, option (C) is correct.

2. Which one of the following represents non-growth associated product formation kinetics in a bioprocess system? X and P denote viable cell and product concentration, respectively.

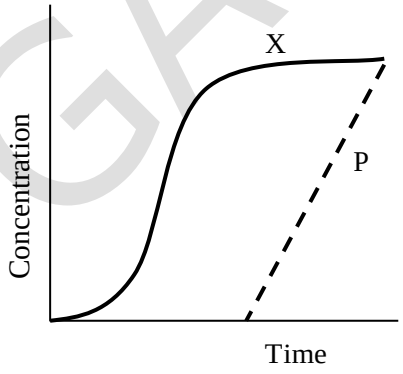
(A)



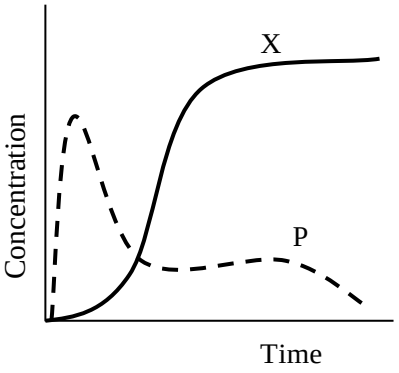
(B)



(C)

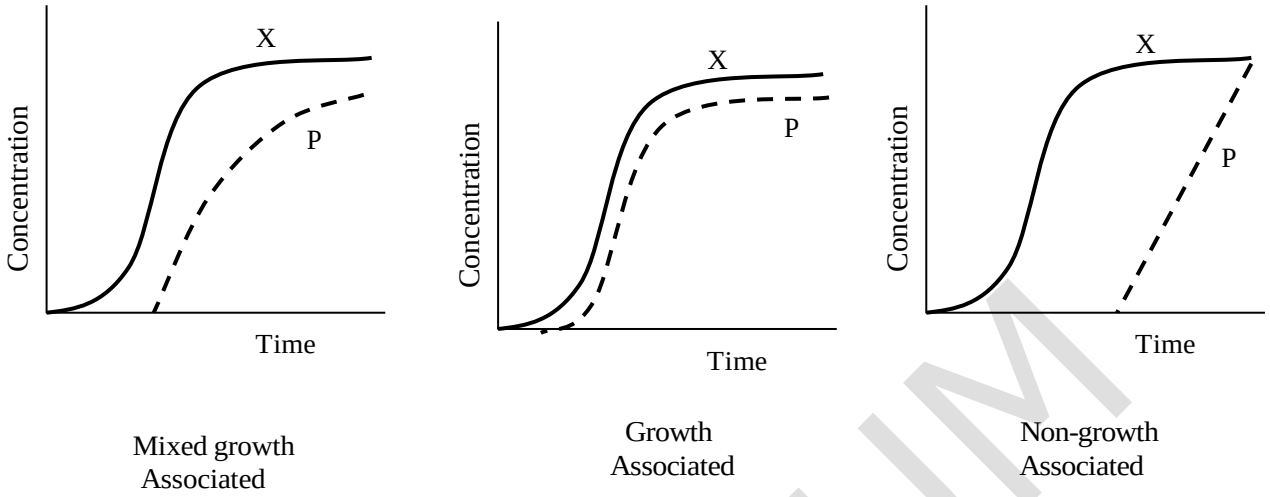


(D)



Key: (C)

Sol:



Mixed growth Associated

Growth Associated

Non-growth Associated

3. Which of the following chemical messenger(s) is/are derivative(s) of tryptophan?

(A) Melatonin
(B) Serotonin
(C) Indole acetic acid
(D) γ-amino butyric acid

[2-Marks, MSQ]

Key: (A, B, C)

Sol: Melatonin is a hormone formed by PINEAL GLAND, It is produced from tryptophan amino acid. It is involved in circadian rhythms or diurnal variations; it performs and Neurotransmitters also.

Serotonin: It is Neurotransmitter derive from tryptophan. It is formed in intestinal cells. It is a vaso-constrictor, and it controls behavior patterns sleep, blood pressure and body temperature.

Indole Acetic acid: It is a phytohormone.

Derived from tryptophan.

It regulates growth in plants. It is responsible for cell division and elongation process.

γ -amino butyric Acid:

It is inhibitory neurotransmitter.

It is deriving from glutamate amino acid not truptophan amino acid.

4. Which one the following techniques/tools is NOT used for inserting a foreign gene into a cell?

(A) Electroporation
(B) DNA microarray
(C) Microinjection
(D) Gene gun

[1-Mark, MCQ]

Key: (B)

Sol: A **microarray** is a tool used to detect the expression of thousand of genes or it is used to check the gene expression of thousand genes at a time. It is a Nucleic acid hybridization based method to detect expression of genes.

Electroporation with the help of electric current temporary pores are formed DNA insert into the cells.

Gene Gun: DNA coated on Gold or Tungsten particle and transfer into plant cells.

Microinjection: It deliver foreign DNA into living cells through glass micropipette.

5. In a chemostat with a dilution rate of 0.8 h^{-1}, the steady state biomass concentration and the specific product formation rate are 8 mol m^{-3} and 0.2 (mol product) (mole biomass)$^{-1}h^{-1}$, respectively. The steady state product concentration in mol m^{-3} is _____.

[2-Marks, NAT]

Key: (2)

Sol: Given, $D = \mu = 0.8h^{-1}$ for chemostat, D = dilution, μ = Specific rate of biomass production.

$x = 8\,mol/m^3$

$Q_p = \frac{1}{X}\frac{dP}{dT} = 0.2\,h^{-1}$, Q_p = Specific product formation rate constant

$$Y_{P/X} = \frac{dP}{dX} = \frac{Q_P}{\mu} = \frac{\frac{1}{X}\frac{dP}{dt}}{\frac{1}{X}\frac{dX}{dt}} = \frac{0.2}{0.8} = 0.25$$, Yp/x= Product yield (g of prod/ g of biomass)

Product Concentration

$P = Y_{P/X} \times x = 0.25 \times 8 = \boxed{2\,mol\,m^3}$

6. A system consists of two reactors, connected by a valve. The first reactor (R1) contains an ideal gas A of volume 5L and the second reactor (R2) has an ideal gas B of volume 10 L. Initially, the valve is closed and pressure P in R1 and R2 are 9 and 6 atm, respectively. Later, when the valve is opened, the system reaches equilibrium. If the temperature T of both the reactors is maintained constant, the final equilibrium pressure in atm of the system is _____.

[1-Mark, NAT]

Key: (7)

Sol: Given a system with two reactor

R_1 having ideal gas A–5L at 9 atm

R_2 having ideal gas B–10L at 6 atm

After removal of valve – the environmental condition is same then

$V_{total} = V_1 + V_2 = 5 + 10 = 15$

$n_{total} = n_1 + n_2$

For ideal gas $PV = nRT$

P = pressure, V = volume, R = gas constant, T = temperature

n = number of moles

For n_1 and n_2, $P_1 = 9$ atm, $P_2 = 6$ atm

$V_1 = 5L, V_2 = 10L$

$n_1 = \frac{P_1 V_1}{RT}$, $n_2 = \frac{P_2 V_2}{RT}$

Let temperature T = 303K (constant), and value of R== 0.08205 $L.atm.mol^{-1}.k^{-1}$

$n_1 = 1.81, n_2 = 2.41$

$n = (n_1 + n_2) = 1.81 + 2.41 = 4.22$

So for the two gas system

$\frac{P^* V^*}{RT} = n, \qquad P^* = \frac{4.22 \times 0.08205 \times 303}{15L} \simeq 7$ atm

7. Which one of the following tools is used to compare all the possible six-open reading frames of a given nucleotide query sequence with all the available six open reading frames of the nucleotide sequence database?

(A) TBLASTN (B) TBLASTX (C) BLASTN (D) BLASTX

[2-Marks, MCQ]

Key: (B)

Sol: Variants of BLAST

- BLASTN: Compares a DNA query to a DNA database. Searches both strands automatically. It is optimized for speed, rather than sensitivity.
- BLASTP: Compares a protein query to protein database.
- BLASTX: Compares a DNA query to a protein database, by translating the query sequence in the 6 possible frames and comparing each against the database (3 reading frames from each strand of the DNA) searching.
- TBLASTN: Compares a protein query to a DNA database, in the 6 possible frames of the database.
- TBLASTX: Compares the protein encoded in DNA database, in the 6*6 possible frames of both query and database sequences (Note that all the combinations of frames may have different scores).
- BLAST 2: Also called advanced BLAST. It can perform gapped alignments.

8. The sum of infinite geometric series $1+\frac{1}{3}+\frac{1}{3^2}+\frac{1}{3^3}+...$ (rounded off to one decimal place) is _____.

[1-Mark, NAT]

Key: (1.5)

Sol: $1+\frac{1}{3}+\frac{1}{3^2}+\frac{1}{3^3}+...$, is infinite geometric series with common ratio, $r=\frac{1}{3}\left(\text{i.e., } -1<r<1\right)$ and first term, a = 1

$\therefore$ Required sum is $\frac{a}{1-r}=\frac{1}{1-\frac{1}{3}}=\frac{3}{2}=1.5$

9. In Neurospora crassa, a mutation in the poky gene results in a slow growth phenotype (poky). The results of four crosses are given below.

1. wild-type ♀ × wild-type ♂ → All progeny are wild-type

2. wild-type ♀ × poky ♂ → All progeny are wild-type

3. poky ♀ × wild-type ♂ → All progeny are poky

4. poky ♀ × poky ♂ → All progeny are poky

Which one of the following explains the inheritance mode of poky?

(A) Episomal inheritance
(B) X-linked inheritance
(C) Mendelian inheritance
(D) Mitochondrial inheritance

[2-Marks, MCQ]

Key: (D)

Sol:

♀ poky → progency poky

♀ wild type → progency wild type

Mitochondrial inheritance

10. Match enzymes in Group-I with their corresponding industrial application in Group-II.

Group-I	Group-II
P. Amylase	**1.** Laundry detergent
Q. Invertase	**2.** Fruit juice clarification
R. Pectinase	**3.** Liquefaction of sucrose
S. Xylanase	**4.** Pulp and paper processing

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

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

[2-Marks, MCQ]

Key: (D)

Sol: **Amylases:** are the enzyme used in detergent formulation to improve the detergency. It is used to digest the starch grains.

Xylanases: It is used in paper and pulp industry, it act as bio bleaching agent, increase the pulp fibrillation and water retention. It reduce the beating time in virgin pulps.

Pectinases: It is involved in fruit juice clarification. This enzyme used to breakdown pectin polymer into monomeric form galacturonic acid.

Invertase: It catalyze the hydrolusis of sucrose into glucose and fructose, it is responsible for liquefaction of sucrose.

11. In a random mating population, Y and y are dominant and recessive alleles, respectively. If the frequency of Y allele in both sperm and egg is 0.70, then the frequency of Y/y heterozygotes (rounded off to two decimal places) is _____.

[2-Marks, NAT]

Key: (0.42)

Sol: Y = dominant

y = recessive

Y = 0.70, y = 0.30 (1–0.70 = y)

Heterozygotes = 2pq = 2 × 0.70 × 0.30 = 0.14 × 0.3 = 0.42

12. The process by which intracellular macromolecules are supplied for lysosomal degradation during nutrient starvation is

(A) pinocytosis (B) apoptosis (C) autophagy (D) phagocytosis

[1-Mark, MCQ]

Key: (C)

Sol: During starvation autophagy occurs it remove damage protein and organelles to prevent cell damage and intracellular molecules are digested to provide the nutrients of cell needs.

Apoptosis is a programmed cell death process catalyzed by Fas, FasL, caspases lead to cell death.

Phagocytosis is the entrapment and engulfment of antigen; it is done by phagocytic cell known as macrophage.

Pinocytosis: It is a process by which liquid droplets are injected by living cells.

13. Which of the following layer(s) is/are formed from the inner cell mass of the blastocyst?

(A) Ectoderm (B) Mesoderm (C) Endoderm (D) Trophectoderm

[1-Mark, MSQ]

Key: (A,B,C)

Sol: Gastrulation is the formation of the three layers of the embryo: ectoderm, endoderm, and mesoderm. The endoderm gives rise to the lining of the digestive system and respiratory system. The ectoderm gives rise to the nervous system and epidermis. The mesoderm gives rise to the muscle and skeletal systems.

14. Which of the following nucleus/nuclei is/are NMR active?

(A) ^{32}S (B) ^{13}C (C) ^{16}O (D) ^{1}H

[2-Marks, MSQ]

Key: (B,D)

Sol: Except ^{1}H all other elements needs to be present in stable isotope form in order to be NMR active (the element which changes its spin position when placed in a magnetic field.

Example: ^{12}C and ^{16}O are not NMR active.

15. Number of unrooted trees in phylogeny of five sequences is

(A) 105 (B) 15 (C) 3 (D) 945

[1-Mark, MCQ]

Key: (B)

Sol: Formula for unrooted tree in phylogeny

$= \frac{(2n-5)!}{2^{n-3}(n-3)!}$ where n is number of taxas

$\Rightarrow$ For 5 sequences,

$$\frac{(2\times5-5)!}{2^{5-3}(5-3)!} = \frac{5!}{2^2 2!} = \frac{5\times4\times3\times2!}{4\times2!} = 15$$

16. A DNA solution of $50\,\mu gmL^{-1}$ concentration gives an absorbance of 1.0 at 260nm. An aliquot of $20\,\mu L$ from a $50\ \mu L$ purified plasmid solution is diluted with distilled water to a total volume of $1000\ \mu L$. The diluted plasmid solution gives an absorbance of 0.550 at 260nm. The concentration of the purified plasmid in $\mu g\,\mu L^{-1}$ (rounded off to two decimal places) is _____.

[2-Marks, NAT]

Key: (1.37)

Sol: Given, $50\,\mu g/m\ell$ - 1 OD and $20\,\mu\ell$ from $50\mu\ell$ of purified plasmid mixed with $980\,\mu\ell$ of distilled water

$\frac{1000}{20} = 1:50$ dillution

We know from Beer-Lambert Law, C=Concentration

$OD = \varepsilon.C.\ell$ $\quad$ $\varepsilon = \text{cons tan t}$

$I = \varepsilon.\ell \times 50\,\mu g/m$ $\quad$ $\ell = \text{path length}$

$\frac{1}{50} = \varepsilon.\ell$ $\quad$ $C = \text{core}$

So, for 0.55 OD

$0.55 = \frac{1}{5} \times C_2, \qquad C_2 = 27.5\,\mu g/m\ell$

Now, $\frac{27.5}{1000} \times \text{Dilution factor} = \frac{27.5 \times 50}{1000} = 1.37\,\mu g/\mu\ell$

17. Calculate the following integral

$$\int_0^{\pi^2/4} \sin\sqrt{x}\ dx = \_\_\_\_\_.$$

[2-Marks, NAT]

Key: (2)

Sol: Put $x = t^2 \Rightarrow dx = 2tdt$

And $x = 0 \Rightarrow t = 0$

$x = \frac{\pi^2}{4} \Rightarrow t = \frac{\pi}{2}$

$\therefore$ Given integral becomes $\int_0^{\pi/2} \sin t \times 2tdt$

$= 2\left[(t)(-\cos t) - (1)(-\sin t)\right]_0^{\pi/2}$ ($\because$ Integration by parts)

$= 2\left[(0-0) + (1-0)\right] = 2$

18. Which of the following statement (s) is/are CORRECT about Agrobacterium tumefaciens?

(A) It causes crown gall disease in dicotyledonous plants

(B) It is Gram-positive soil bacterium

(C) It is used in generating transgenic plants

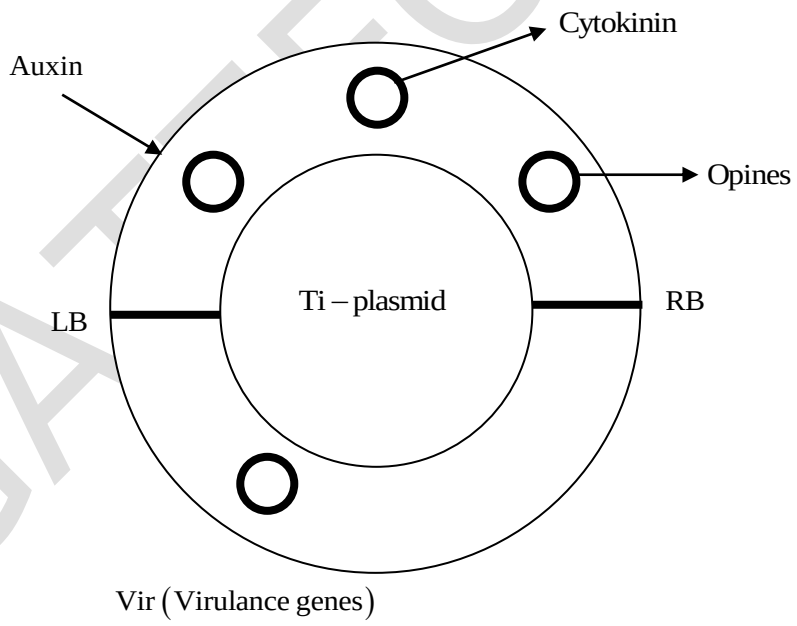
(D) It contains tumor inducing plasmid

[2-Marks, MSQ]

Key: (A,C,D)

Sol: Agrobacterium tumefaciens is a

- Gram Negative Bacteria
- Rod shaped bacterial
- Present in soil
- It infects dicots plants.
- It has Ti-plasmid.
- It is responsible for crown gall Tumor in bacteria.
- The T-DNA (Transfer DNA) is entering to plant cause Tumor in plants.
- The T-DNA contains Auxin, cytokinin and opines genes.



19. The specific growth rate of a mold during exponential phase of its growth in a batch cultivations is 0.15 h^{-1}. If the cell concentration at 30h is 33 gL^{-1}, the cell concentration in gL^{-1} (rounded off to the nearest integer) at 24 h is _____.

[2-Marks, NAT]

Key: (13.43)

Sol: Given, exponential growth rate $= 0.15h^{-1}$

Cell concentration at 30hr is $33gL^{-1}$

Cell concentration at 24h is _____.

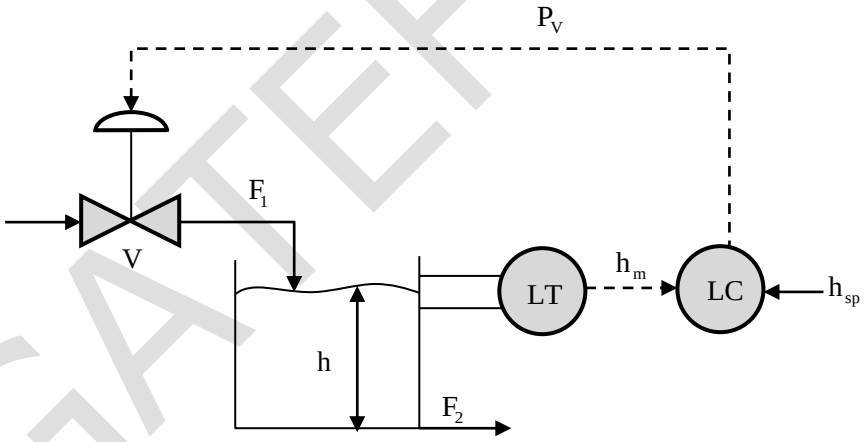
We know, $X_t = X_0 e^{ut}$

$$33 = X_0 e^{0.15\times 30}$$

$$X_0 = 0.367\ g/L$$

X_t at 24h, $X_t = 0.367 \times e^{0.15\times 24} = \boxed{13.43\,g/L}$

20. The process and instrumentation diagram for a feedback control strategy to maintain the level (h) of a liquid by regulating a valve (V) in a tank is shown below. F_1 is inlet liquid flow rate, F_2 is outlet liquid flow rate, LT is the liquid level transmitter, LC is the liquid level controller, h_{sp} is the setpoint value of the liquid level, h_m is the measured value of the liquid level and P_V is the valve pressure.



The manipulating variable(s) is/are

(A) F_2 only

(B) h_{sp} and P_V only

(C) h_m and P_V only

(D) F_1 only

[1-Mark, MCQ]

Key: (D)

Sol: The measured variable for a feedback control strategy is the tank height. Which input variable is manipulated depends on what is happening in the 2 processes (process 1 and process 2). Let us consider

two different processes- process 1 and process 2.Assume that the process 2 regulates the flow-rate F2 and process 1 controls flow rate F1. This could happen, only, if process 2 is a steam generation system and process 1 is a deionization process. Process 2varies the flow rate of water (F2) depending on the steam demand. As far as the tank process is concerned, F2 is a "wild" (disturbance) stream because the regulation of F2 is determined by another system. In this case, the F1 would be used as the manipulated variable; that is, F1 is adjusted to maintain a desired tank height. Notice that the level transmitter (LT) sends the measured height liquid in the tank (hm) to the level controller (LC). The LC compares the measured level with the desired level (hsp, the height setpoint) and sends a pressure signal (Pv) to the valve. This valve top pressure moves the valve stem up and down, changing the flow rate through the valve (F1). If the controller is designed properly, the flow rate changes to bring the tank height close to the desired setpoint. In this process and instrumentation diagram dashed lines are used to indicate signals between different parts of instrumentation.

21. Match separation methods in Group-I with associated properties in Group-II.

Group-I	Group-II
P. Centrifugation	**1.** Density
Q. Dialysis	**2.** Diffusivity
R. Solvent extraction	**3.** Size
S. Ultrafiltration	**4.** Solubility

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

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

[2-Marks, MCQ]

Key: (B)

Sol: Centrifugation is a technique used for the separation of particles from a solution according to their size, shape, density, viscosity of the medium and rotor speed. The particles are suspended in a liquid medium and placed in a centrifugal tube. The tube is then placed in a rotor and spun at a defined speed.

Ultra-Filtration (UF) is a pressure-driven barrier to suspended solids, bacteria, viruses, entotoxins and other pathogens to produce water with very high purity and low silt density. Ultra Filtration (UF) is a variety of membrane filtration in which hydrostatic pressure forces a liquid against a semi permeable membrane.

22. The cellular process which utilizes RNA-induced silencing complex to block gene expression is

(A) RNA interference (B) RNA polyadenylation

(C) RNA splicing (D) RNA editing

[1-Mark, MCQ]

Key: (A)

Sol: RNA interference is a biological process where RNA molecule inhibits gene expression or translation, mi-RNA, si-RNA play a important role, double stranded RNA molecule form cleaved by DICER enzyme, that leads to RNA induced silencing complex (RISC) formation.

RNA poly-adenylation: Where 50-250 adenine residues bind to 3 end of mRNA catalyze by Pdy-Adenylate Polymerase (PAP).

RNA Splicing: It removes introns and join the exons which is coding region.

RNA editing: RNA molecules are edit by Guide RNA, by addition and deletion in RNA leads to truncated protein formation.

23. The enzyme that transcribes the eukaryotic genes encoding precursor ribosomal RNAs (pre-rRNAs) of 28S, 18S and 5.85S rRNAs is

(A) RNA polymerase IV
(B) RNA polymerase III
(C) RNA polymerase I
(D) RNA polymerase II

[1-Mark, MCQ]

Key: (C)

Sol: To eukaryotes RNA pol I catalyze the formation of r-RNA such as 28S, 18S and 5.8S rRNA exception SS rRNA is catalyzed by RNA pol III.

RNA pol II catalyzes mRNA formation and other regulatory RNA formation.

RNA pol III catalyzes transfer RNA formation and 5S rRNA formation.

r-RNA is responsible for ribosome formation, which is involved in protein synthesis.

24. Which of the following antimicrobial agent (s) is/are growth factor analog(s)?

(A) Isoniazid (B) 5-Fluorouracil (C) Tetracycline (D) Sulfanilamide

[2-Marks, MSQ]

Key: (A,B,D)

Sol: Option A B D is correct, because they are growth factor analogue, they inhibit PABA and stop purine synthesis. But tetracycline is an antibiotic which inhibits protein synthesis by blocking A site of Ribosome....therefore tetracycline drug is protein synthesis inhibitor not growth factor analogue.

25. Which one of the following is CORRECT about microbial growth medium?

(A) Luria-Bertani broth is a synthetic medium
(B) Nutrient broth is a defined medium
(C) Sabouraud dextrose agar is a differential medium
(D) Trypticase soy agar is a complex medium

[1-Mark, MCQ]

Key: (D)

Sol: Trypticase soy agar is a complex media to grow many types of bacteria, it grows certain pathogenic bacteria which have high nutritional requirements.

Sabouraud Dextrose Agar (SDA) is a selective media for the isolation of Dermatophytes such as fungi and yeast.

LB and N.B is a complex media because nutrient not defined, it contains beef extract and peptone where exact chemical composition is unknown.

26. Decimal reduction time of a bacterial strain is 20 min. Specific death rate constant in $\min^{-1}$ (rounded off to two decimal places) is _____.

[1-Mark, NAT]

Key: (0.11-0.12)

Sol: $\ell n\left(\frac{x_t}{x_o}\right) = -k_d t$

$\ell n\left(\frac{0.1}{1}\right) = -k_d (20)$

$k_d = 0.115 \min^{-1} = 0.12 \min^{-1}$

27. A bacterium produces acetic from ethanol as per the following reaction

$2CH_3CH_2OH + 2O_2 \rightarrow 2CH_3COOH + 2H_2O$

The thermodynamic maximum yield of acetic acid from ethanol in gg^{-1} (round off to two decimal places) is _____.

[2-Marks, NAT]

Key: (1.95)

Sol: $2CH_3CH_2OH + 2O_2 \rightarrow 2CH_3COOH + 2H_2O$

To find maximum yield of acetic acid $= Y_{P/S}$ max

Ethanol $\rightarrow C_2H_6O \rightarrow 46$

Acetic acid $\rightarrow C_2H_4O_2 \rightarrow 60$

$r_s = \frac{4\times2+6-2}{2} = 6,\ r_p = \frac{4\times2+4-2\times2}{2} = 4$

Maximum number of moles

We know, $f_{max} = \frac{\omega r_s}{j r_p} = \frac{2\times6}{2\times4} = 1.5$ mole

Maximum yield $y_{PS} = \frac{1.5\times \text{MW of product}}{\text{MW of substrate}} = \frac{1.5\times60}{46} = 1.95\ g/g$

28. Match the autoimmune diseases in Group-I with the corresponding primarily affected organ in Group-II.

Group-I	Group-II
P. Hashimoto's disease	**1.** Brain
Q. Juvenile diabetes	**2.** Pancreas
R. Multiple sclerosis	**3.** Skeletal muscle
S. Myasthenia gravis	**4.** Thyroid

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

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

[2-Marks, MCQ]

Key: (B)

Sol: Myasthenia gravis is a rare autoimmune disease at the neuromuscular junction of skeletal muscle. Auto-anti bodies block the acetylcholine receptors.

Diabetes it affects the pancreatic beta cells which forms insulin, and the insulin formation defective result in hyperglycemia.

Multiple sclerosis, it affects brain which matter, Th1, Tc and autoantibodies damages the brain white matter.

Hashimoto's diseases: Thyroid protein and cells are damaged by TDTH and autoantibodies.

29. Under standard temperature (T) and pressure (P) conditions, 128g of an ideal gas molecule A occupies a volume of 1L. The gas molecule A obeys the relationship RT = 0.25PV. R and V are universal gas constant and ideal gas volume, respectively. The molecule A is

(A) CO_2 (B) O_2 (C) N_2 (D) H_2

[1-Mark, MCQ]

Key: (B)

Sol: Given, RT = 0.25 PV

We know that, RT = nPV

Where n = number of moles

And $n = \frac{m}{M}$ (m = given mass in g and M is molar mass in g)

$$\Rightarrow 0.25 = \frac{128}{M}$$

$$\Rightarrow M = \frac{128}{0.25} = 512\ g$$

So, A is O_2 as $\frac{512}{32} = 16$

30. $\frac{d}{dx}\left[\ell n(2x)\right]$ is equal to

(A) x (B) $\frac{1}{2}$ (C) $\frac{1}{x}$ (D) $\frac{1}{2x}$

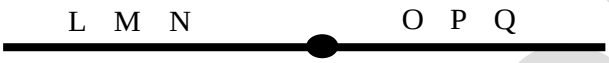
[1-Mark, MCQ]

Key: (C)

Sol: $\frac{d}{dx}\left(\ell n(2x)\right)=\frac{1}{2x}\times\frac{d}{dx}(2x)=\frac{1}{2x}\times 2=\frac{1}{x}$

31. The order of genes present in a chromosome is as follows

Which one of the following rearrangements represents a paracentric inversion?

(A)


(B)

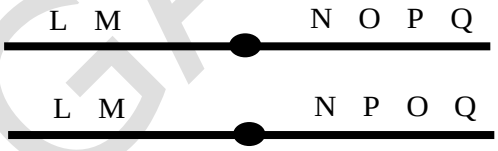

(C)


(D)


[1-Mark, MCQ]

Key: (C)

Sol:



Because paracentric inversion do not involve centromere.

It occurs within a single arm of chromosome.

32. A 0.1 mL aliquot of a bacteriophage stock having a concentration of 4×10^9 phages mL^{-1} is added to 0.5 mL of E.coli culture having a concentration of 2×10^8 cells mL^{-1}. The multiplicity of infection is _____.

[2-Marks, NAT]

Key: (4)

Sol: Multiplicity of infection $= \dfrac{4\times10^9 \text{ cells m}\ell^{-1}\times0.1\text{m}\ell}{2\times10^8 \text{ cells m}\ell^{-1}\times0.5\text{m}\ell} = 4 \text{ (Ans)}$

33. Match hypersensitivity types in Group-I with their corresponding condition in Group-II.

Group-I	Group-II
P. Type-I	**1.** Erythroblastosis fetalis
Q. Type-II	**2.** Host reaction to bee venom
R. Type III	**3.** Systemic lupus erythematosus
S. Type IV	**4.** Tuberculin reaction

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

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

[2-Marks, MCQ]

Key: (B)

Sol: Type I: 19E mediated hypersensitivity 19E Ab binds to mast cells release Histamine that leads to systemic and localized anaphylaxis.

Type II: 19G mediated hypersensitivity, it includes erythroblastosis fetalis, Autoimmune hemolytic anemia.

Type III: Immune complex mediated, in includes systemic lupus erythema matosus, Arthritis and glomerulonephritis.

Type IV: Cell mediated hypersensitivity TDTH cell mediated, it includes tubercular lesion contact dermatitis and graft rejection.

34. Which of the following combinations of plant hormones and their associated Function are CORRECT?

Hormone	Function
P. Abscisic acid	Breaks seed dormancy
Q. Auxin	Induces cell division
R. Ethylene	Stimulates ripening of fruits
S. Gibberellin	Promotes seed dormancy

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

[2-Marks, MCQ]

Key: (B)

Sol: Auxin promote cell elongation, inhibits growth of lateral buds, it induces cell division, cell expansion and cell differentiation.

Ethylene act as plant growth regulator it stimulates senescence, ripening and abscission. It plays an important role in ripening of fruits.

Gibberellins, it is responsible for seed germination, stem elongation, leaf expansion, pollen maturation and induction of flowering.

Abscisic acid is a growth inhibitor hormone in plants. It acts as antagonist to gibberellic acid. It is responsible for stress tolerance in plants.

35. If the values of two random variables (X, Y) are (121, 360), (242, 364) and (363, 362), the value of correlation coefficient between X and Y (rounded off to one decimal place) is _____.

[2-Marks, NAT]

Key: (0.5)

Sol:

$$n = 3;\ \begin{array}{l|l} x_1 = 121 & y_1 = 363 \\ x_2 = 242 & y_2 = 364 \\ x_3 = 363 & y_3 = 362 \end{array}$$

$$\bar{x} = \frac{1}{3}[121 + 242 + 363] = 242$$

$$\bar{y} = \frac{1}{3}[360 + 364 + 362] = 362$$

$$\sigma_x = \sqrt{\frac{1}{n}\sum (x_i - \bar{x})^2} = \sqrt{\frac{1}{3}(-121)^2 + (0)^2 + (121)^2} = \sqrt{\frac{2}{3}} \times 121 = 98.796$$

$$\sigma_y = \sqrt{\frac{1}{n}\sum (y_i - \bar{y})^2} = \sqrt{\frac{1}{3}\left((-2)^2 + 2^2 + 0^2\right)} = \sqrt{\frac{8}{3}} \approx 1.632$$

$$\text{Cov}(x, y) = \frac{1}{n}\sum x_i y_i - \bar{x}\,\bar{y} = \frac{1}{3}[121 \times 360 + 242 \times 364 + 363 \times 362] - 242 \times 362$$

$$= \frac{121}{3}[360 + 728 + 1086] - 242 \times 362$$

$$= 87684.6667 - 87604 = 80.667$$

$$\therefore r = \frac{\text{cov}(x, y)}{\sigma_x \sigma_y} = \frac{80.6667}{(98.796) \times (1.632)} = 0.5$$

36. In a Mendel's dihybrid experiment, a homozygous pea plant with round yellow seeds was crossed with a homozygous plant with wrinkled green seeds. F_1 intercross produced 560 F_2 progeny. The number of F_2 progeny having both dominant traits (round and yellow) is _____.

[2-Marks, NAT]

Key: (315)

Sol: RRYY (round yellow) × r r y y (wrinkled green)

↓

RrYy ——— F1

	RY	Ry	rY	ry
RY	RRYY	RRYy	RrYY	RrYy
Ry	RRYy	RRyy	RrYy	Rryy
rY	RrYY	RrYY	r rYY	r rYy
ry	RrYy	Rryy	r rYy	r ryy

Both dominant trait $= \frac{9}{16}$

Number of pea plant $= \frac{9}{16} \times 560 = 315$

37. If the area of a triangle with the vertices (k, 0), (2, 0) and (0, –2) is 2 square units, the value of k is _____.

[2-Marks, NAT]

Key: (0 or 4)

Sol: Area of triangle with the vertices $A(x_1, y_1)$, $B(x_2, y_2)$ and $C(x_3, y_3)$ is $\left|\frac{1}{2}\begin{vmatrix} 1 & x_1 & y_1 \\ 1 & x_2 & y_2 \\ 1 & x_3 & y_3 \end{vmatrix}\right| = 2$

$$\Rightarrow \left|\frac{1}{2}\begin{vmatrix} 1 & k & 0 \\ 1 & 2 & 0 \\ 1 & 0 & -2 \end{vmatrix}\right| = 2 \Rightarrow \left|\frac{1}{2}\{-2(2-k)\}\right| = 2 \Rightarrow |k-2| = 2 \Rightarrow k-2 = \pm 2$$

$\therefore k = 0$ or 4 (both correct)

38. Which one of the following methods is used to test the significance of a predicted phylogeny?

(A) Minimum evolution
(B) Maximum likelihood
(C) Maximum parsimony
(D) Bootstrap

[1-Mark, MCQ]

Key: (D)

Sol: Boot's strapping is on method which provides confidence of the phylogenetic tree created showing the number of times a branch will be observed while constructing the tree.

39. CRISPR-Cas system is associated with

(A) adaptive immunity in eukaryotes
(B) innate immunity in eukaryotes
(C) adaptive immunity in prokaryotes
(D) innate immunity in prokaryotes

[1-Mark, MCQ]

Key: (C)

Sol: This system was discovered from prokaryotic organism showing resistance to phages and viruses whose guide sequence is already present in the palindromic repeat sequence.

Hence is called an adaptive immunity and not innate.

40. A protein without its prosthetic group is known as

(A) lipoprotein (B) apoprotein (C) holoprotein (D) hemoprotein

[1-Mark, MCQ]

Key: (B)

Sol: Apoprotein means protein part of an enzyme. It lacks prosthetic group which may be metal ions or vitamin B complex such as NAD^+, FAD, Biotin, TPP etc.

Lipoprotein: It is a lipid protein complex and involve in lipid transport such an HDL, LDL, ULDL etc.

Hemoprotein: It contains Heme such as Hemoglobin and its transport oxygen to body.

Halo protein: It is a combination of protein and Non protein part of enzyme.

Holoenzyme: Apoprotein + Prosthetic group.

41. The enzyme which adds phosphate group to the free $5'$ terminus of a DNA sequence is

(A) polynucleotide kinase
(B) adenosine kinase
(C) terminal deoxynucleotidyl transferase
(D) alkaline phosphatase

[1-Mark, MCQ]

Key: (A)

Sol: Polynucleotide kinase add 5' terminal phosphate to DNA. The kinases enzyme responsible for the Transfer of phosphate.

Alkaline phosphates remove phosphate from 5' terminal phosphate of DNA molecule.

Tdt enzyme odd nucleotides to 3' end of the DNA molecule. It makes DNA sticky.

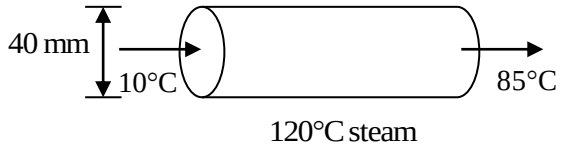
Adenosine kinase add phosphate group to Adenosine nitrogenous base.

42. Milk flowing through a stainless steel inner tube (40 mm inner diameter) of double tube-type heater is to be heated from 10°C to 85°C by saturated steam condensing at 120°C on the outer surface of the inner tube. Total heat transferred (Q) is 146200 kcal h^{-1} and the overall heat transfer coefficient is 750 kcal $h^{-1}m^{-2^{\circ}}C^{-1}$. The total length of the heating tube in m (rounded off to one decimal place) is _____.

[2-Marks, NAT]

Key: (23.69)

Sol: Given,



We know,

Overall heat transfer across heat exchanger

$Q = U \times A_{overall} \Delta T_{LMTD}$

U = overall heat transfer coefficient

A = Area

LMTD = Log mean temperature difference

$A_{overall} = 2\pi r.L = 2 \times \pi \times 20 \times 10^{-3}.L = 0.1256L$

$LMTD = \Delta T_1 = (120 - 10) = 110°C$

$\Delta T_2 = (120 - 85) = 35°c$

$$LMTD = \frac{\Delta T_1 - \Delta T_2}{\ell n\left(\frac{\Delta T_1}{\Delta T_2}\right)} = \frac{110 - 35}{\ell n\left(\frac{110}{35}\right)} = 65.5°C$$

Given,

$U = 750 \text{ kcal } h^{-1}.m^{-2}.°C$

$Q = 146200 \text{ kW } h^{-1}$

$Q = U \times A_{overall} \times LMTD$

$146200 = 750 \times 0.1256.L \times 65.5$

$$\frac{146200}{750 \times 0.1256 \times 65.5} = L = \boxed{23.69m}$$

43. Three balls, colored in blue, green and red, are successively transferred from box A to box B in the order BLUE-GREEN-RED. The probability of a reverse transfer of the balls to the box A in the same order (rounded off to two decimal places) is _____.

[1-Mark, NAT]

Key: (0.17)

Sol: The probability that three balls (red, green, blue, respectively) successively, transferred from box A to box B is $\frac{1}{3}\times\frac{1}{2}\times\frac{1}{1}=\frac{1}{6}=0.1666\approx 0.17$

i.e., no change in both directions.

44. The value of $\lim\limits_{x\to 0}\left[\frac{x-\sin 2x}{x-\sin 5x}\right]$ (rounded off to two decimal places) is _____.

[1-Mark, NAT]

Key: (0.25)

Sol: $\lim\limits_{x\to 0}\left(\frac{x\left(1-\frac{\sin 2x}{x}\right)}{x\left(1-\frac{\sin 5x}{5}\right)}\right)=\lim\limits_{x\to 0}\left(\frac{1-\frac{\sin 2x}{x}}{1-\frac{\sin 5x}{5}}\right)=\frac{1-2}{1-5}=0.25 \quad \left(\because \lim\limits_{x\to 0}\frac{\sin ax}{x}=a\right)$

45. Which one of the following cell organelle(s) is/are surrounded by a single phospholipid membrane?

(A) Nucleus (B) Mitochondria (C) Lysosome (D) Golgi apparatus

[1-Mark, MSQ]

Key: (C,D)

Sol: Vacuole, lysosome, Golgi apparatus Endoplasmic reticulum are single membrane bound organelles present only in eukaryotic cell.

Nucleus, mitochondria and chloroplast are double membrane bound organelles present only in eukaryotic cells.

So therefore, lysosome and Golgi apparatus are correct.

46. A batch cultivation of E.coli follows zeroth order Mono's growth kinetics. The cell growth is terminated when the residual dissolved oxygen concentration attains 10% of its saturation value and oxygen mass transfer coefficient $\left(k_L a\right)$ reaches its maximum value $\left(80\,h^{-1}\right)$. The saturation value of dissolved oxygen concentration is 0.007 $kg\,m^{-3}$. If the maximum specific growth rate and yield coefficient

$\left(Y_{X/O_2}\right)$ are 0.2 h^{-1} and $1.5(\text{kg cells})(\text{kg } O_2)^{-1}$, respectively, then the final cell concentration in kg m^{-3} (rounded off to two decimal places) at the end of the batch cultivation is _____.

[2-Marks, NAT]

Key: (3.78)

Sol: Given the cell growth will terminate at 10% saturated oxygen concentration

$k_{LA} = 80h^{-1}, \mu = 0.2h^{-1}, Y_{X/O_2} = 1.5\,\text{kg.cells/kg of } O_2$

. $C^* = 0.007\ \text{kg.m}^{-3}, C = C^* \times 10\%$

We know for man transfer,

$$Xq_{O_2} = k_{L_a}\left(C^* - C\right) \approx \text{constant}$$

This formula will follow at equilibrium or at no growth

So, in the case at 10% saturation

We know, q_{O_2} = oxygen up take rate constant.

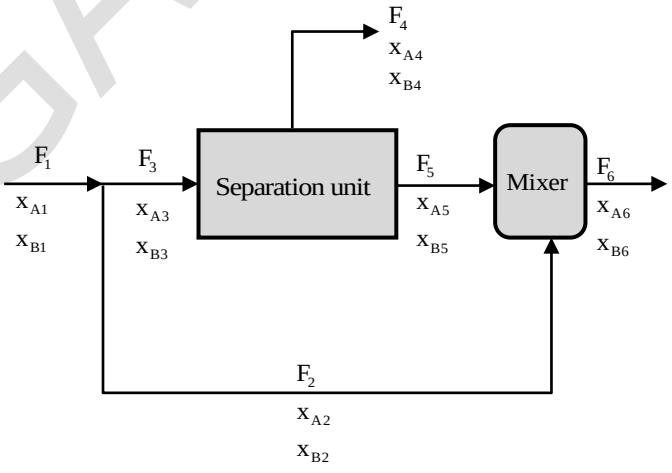
$$= \frac{1}{X} \times \frac{dC_{O_2}}{dt} = \frac{1}{X}\frac{dX}{dt} \times \frac{dC_{O_2}}{dX}$$

$$= \frac{\mu}{Y_{X/O_2}} = \frac{0.2}{1.5} = 0.133$$

So $X.0.133 = 80(0.007 - 0.0007)$

$$X = \frac{80(0.007 - 0.0007)}{0.133} = 3.789$$

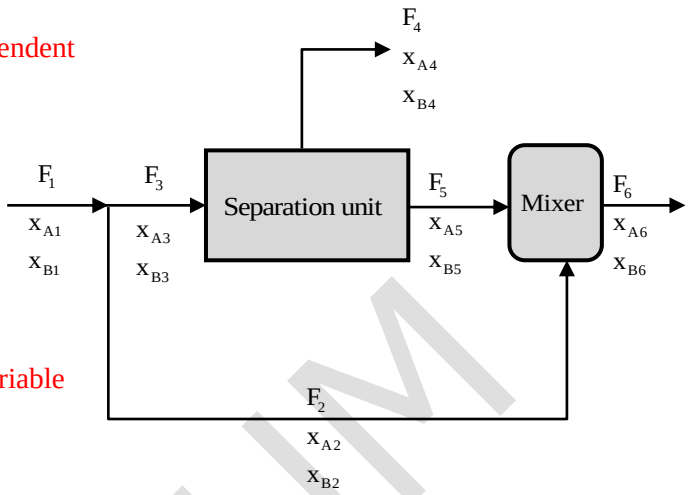
47. A feed stream (F_1) containing components A and B is processed in a system comprising of separation unit and a mixer as shown below in the schematic diagram. The mole fractions of the components A and B are x_A and x_B, respectively. If $F_1 + F_2 = 100\ \text{kg h}^{-1}$, the degrees of freedom of the system is _____.



[2-Marks, NAT]

Key: (6)

Sol: Consider F_1 as independent variable and F_2 as dependent



$F_1 + F_2 = 100\ \text{kgh}^{-1}$

$\boxed{F_2 = 100 - F_1} \rightarrow (F_2 \rightarrow \text{dependent})$

$F_1 - F_2 = F_3$

$F_3 = F_1 - (100 - F_1)$

$\boxed{F_3 = 2F_1 - 100} (F_3 \rightarrow \text{dependent})$

Between F_4 and F_5, consider F_4 as independent variable

Also, $F_3 - F_4 = F_5$

$\boxed{F_5 = 2F_1 - 100 - F_4} (F_5 - \text{dependent})$

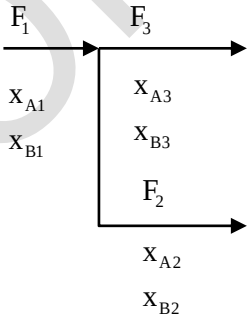
$F_6 \rightarrow F_5 + F_2$

$\boxed{F_6 = 2F_1 - 100 - F_4 + 100 - F_1} (F_6 - \text{dependent})$

Hence, $\boxed{F_1 \text{ and } F_4}$ are independent variables

Given, Mole fraction of $A \rightarrow x_A$

Mole fraction of $B \rightarrow x_B$



Now, $\dfrac{x_{A1} + x_{B1} = 1}{\boxed{x_{B1} = 1 - x_{A1}}}$

Hence $\dfrac{x_{A1}\text{independent}}{x_{B1}\ \text{dependent}}$

Division in flow, does not result in change in concentration.

Hence, $x_{A1} = x_{A3}$ and $x_{B1} = x_{B3}$

Similarly, $x_{A2} = x_{A1}$ and $x_{B2} = x_{B1} = 1 - x_{A1}$

Hence, $x_{A3}, x_{B3}, x_{A2}, x_{B2}$ are dependent variables.

In separation unit, flow divides concentration changes

Hence $\boxed{x_{A4} + x_{B4} = 1}$

Considering x_{A4} independent

$x_{B4} = 1 - x_{A4}$

$x_{A4} \rightarrow$ independent, x_{B4} dependent

Similarly, x_{A5} independent

x_{B5} dependent

In mixer, mole fraction again changes

$x_{A6} + x_{B6} = 1$

$x_{A6} \rightarrow$ independent

$x_{B6} \rightarrow$ dependent

Number of independent variables = Degree of freedom = 6

$[F_1, F_4, x_{A1}, x_{A4}, x_{A5}, x_{A6}]$.

48. It is desired to scale-up a fermentation from 1L to 1000L vessel by maintaining a constant power-to-volume ratio. The small fermenter is operated at an agitator speed of 300 rotations per minute (rpm). If the value of scale up factor is 10, agitator speed in rpm (rounded off to the nearest integer) for the large fermenter is _____.

[2-Marks, NAT]

Key: (64.5)

Sol: Given, 1L to 1000 L

Scale up factor -10

$N_1 = 300$ rpm, $\frac{D_1}{D_2} = \frac{1}{10}$

$N_2 = ?$

For power to volume ratio $\frac{P}{V} \propto N^3 D_i^2$

So, $N_1^3 D_1^r = N_2^3 D_2^2$

$$(300)^3 \left(\frac{D_1}{D_2}\right)^2 = N_2^3$$

$$\sqrt[3]{\frac{27 \times 10^6}{10^2}} = N_2 = 64.63$$

Answer is 64 to 65.

49. The possible number of SalI restriction sites in a 9 kb double-standard DNA, with all four bases occurring in equal proportion (rounded off to the nearest integer) is _____.

[2-Marks, NAT]

Key: (2)

Sol: Sal I restriction size = 6 base power frequency of sal I restriction size $= 4^6 = 4096$

The possible number of restriction size in 9kb double – stranded DNA is

$$\frac{9 \times 10^3}{4^6} = \frac{9000}{4096} = 2.19 \simeq 2$$

50. Coronavirus genome consists of

(A) positive-sense single-stranded RNA
(B) double-stranded RNA
(C) negative-sense single-stranded RNA
(D) double-stranded DNA

[1-Mark, MCQ]

Key: (A)

Sol: Coronaviruses are enveloped virus with positive-sense SS RNA genome and a nucleocapsid of helical symmetry.

Genome size –26 to 32 kbp. They cause respiratory tract infections. SARS, MERS and COVID-19 are lethal.

Coronavirus can cause pneumonia viral or bacterial and bronchitis than may be lethal to humans.

51. The enzyme α-amylase used in starch hydrolysis has an affinity constant (K_m) value of 0.005M. To achieve one-fourth of the maximum rate of hydrolysis, the required starch concentration in mM (rounded off to two decimal places) is _____.

[1-Mark, NAT]

Key: (1.67)

Sol: Given $k_m = 0.005\ M$ and $\mu = \frac{\mu_m}{4}$

So, $\frac{\mu_m}{4} = \frac{\mu_m s}{k_m + s}$, (Using MM kinetics)

$\frac{\mu_m}{4} = \frac{\mu_m s}{0.005 + s} \Rightarrow 0.005 + s = 4s$

$\Rightarrow \frac{0.005}{3} = s$

$\Rightarrow 1.67\ mM$

52. Tertiary structure of a protein consisting of α-helices and β-strands can be determined by

(A) nuclear magnetic resonance spectroscopy
(B) circular dichroism spectroscopy
(C) UV spectroscopy
(D) mass spectrometry

[2-Marks, MCQ]

Key: (A)

Sol: Several methods are currently used to determine the structure of a protein, including X-ray crystallography, NMR spectroscopy, and electron microscopy. Each method has advantages and disadvantages. In each of these methods, the scientist uses many pieces of information to create the final atomic model.

53. Which one of the following statements is INCORRECT about hybridoma production?

(A) Polyethylene glycol is used to fuse myeloma cells to B-cells

(B) Hybridoma cells can use hypoxanthine and thymidine

(C) Hybridoma cells are made to produce polyclonal antibodies

(D) DNA synthesis in myeloma cells is blocked by aminopterin

[1-Mark, MCQ]

Key: (C)

Sol: Hybridoma technology used to form monoclonal antibodies not poly clonal antibodies, which binds to single epitope of an antigen.

PEG is used to fuse myeloma cells to B-cell. It acts as Fusogen.

Aminopterin block de novo synthesis of purine formation, so therefore DNA replication is stop.

Hybridoma cells use hypoxanthine and Thymidine due to presence of enzyme hypoxanthine guanine phosphoribosyl transfer rase (HGPRT) Thymidine kinases (TKs).

54. A sedimentation tank of height 100 cm is used in a conventional activated sludge process to separate a suspension of spherical shaped granular sludge biomass of 0.5 mm diameter. The viscosity of the liquid is 1 cP. The difference in density between the suspended biomass and the liquid is 0.1 gcm^{-3}. If the biomass reach their terminal velocity instantaneously, the biomass settling time in min(rounded off to two decimal places) is _____.

[2-Marks, NAT]

Key: (1.22)

Sol: Given,

Sedimentation of Biomass

Diameter = $0.5\text{mm} = \frac{0.5}{10} = 0.05\text{cm}$

ρ_P = Particle density, ρ = solvent density

$(\rho_P - \rho) = 0.1\,\text{gcm}^{-3}$

μ = viscosity = $1C_P = 0.01\,\text{g/cm.s}$

$g = 9.8\,\text{m/s} = 980\,\text{cm/s}$

So we know

Velocity of sedimentation exposed by Stokes equation.

$$V_S = \frac{g(\rho_P - \rho)D_P^2}{18\mu} = \frac{980 \times 0.1 \times (0.05)^2}{18 \times 0.01} = 1.36\,\text{cm/s}$$

Now time, $\frac{100\text{cm}}{V_S} = \frac{100}{1.36} \times \frac{1}{60}\text{min} = 1.22\text{ min}$

55. The determinant of matrix $A = \begin{pmatrix} 1 & 1 & 1 & 1 \\ -1 & 1 & 1 & 1 \\ -1 & -1 & 1 & 1 \\ 1 & 1 & 1 & 3 \end{pmatrix}$ is _____.

[2-Marks, NAT]

Key: (8)

Sol: $\begin{vmatrix} 1 & 1 & 1 & 1 \\ -1 & 1 & 1 & 1 \\ -1 & -1 & 1 & 1 \\ 1 & 1 & 1 & 3 \end{vmatrix}$

(Applying $R_2 + R_1; R_3 + R_1; R_4 - R_1$)

$= \begin{vmatrix} 1 & 1 & 1 & 1 \\ 0 & 2 & 2 & 2 \\ 0 & 0 & 2 & 2 \\ 0 & 0 & 0 & 2 \end{vmatrix}$ is determinant of upper triangular matrix.

$= 1 \times 2 \times 2 \times 2 = 8$