

## GATE-BT PYQS - 2020

1. Rajiv Gandhi Khel Ratna Award was conferred \_ Mary Kom, a six-time world champion in boxing, recently in a ceremony \_ the Rashtrapati Bhawan (the President's official residence) in New Delhi.

- (A) with, at
- (B) on, in
- (C) on, at
- (D) to, at

(2020)

**Answer:** (C) on, at

**Explanation:** The correct prepositions are "on" and "at" because awards are conferred **on** someone and ceremonies are held **at** a place. "Mary Kom was conferred on" is the proper grammatical form for receiving an award. "Conferred to" or "with" are incorrect in this context.

2. Despite a string of poor performances, the chances of K. L. Rahul's selection in the team are \_.

- (A) slim
- (B) bright
- (C) obvious
- (D) uncertain

(2020)

**Answer:** (B) bright

**Explanation:** The word "bright" means having a good or promising chance. Despite poor performances, if the selection chances are "bright," it indicates optimism or likelihood of selection. Other options like "slim" or "uncertain" show low or doubtful chances. Hence, "bright" fits the sentence contextually and logically.

3. Select the word that fits the analogy:

**Cover: Uncover:: Associate: \_**

- (A) Unassociate
- (B) Inassociate
- (C) Misassociate
- (D) Dissociate

(2020)

**Answer:** (D) Dissociate

**Explanation:** The prefix "dis-" gives the opposite meaning, just as "un-" does in "uncover." "Associate" and "dissociate" are antonyms, meaning to connect and to separate, respectively. Other prefixes like "un" or "mis" do not form correct words with "associate." Therefore, "dissociate" maintains the same relationship as "cover: uncover."

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

**Passage:** "Hit by floods, the kharif (summer sown) crops in various parts of the country have been affected. Officials believe that the loss in production of the kharif crops can be recovered in the output of the rabi (winter sown) crops so that the country can achieve its food-grain production target of 291 million tons in the crop year 2019-20 (July-June). They are hopeful that good rains in July-August will help the soil retain moisture for a longer period, helping winter sown crops such as wheat and pulses during the November-February period."

- (A) Officials declared that the food-grain production target will be met due to good rains.
- (B) Officials want the food-grain production target to be met by the November-February period.
- (C) Officials feel that the food-grain production target cannot be met due to floods.
- (D) Officials hope that the food-grain production target will be met due to a good rabi produce.

(2020)

**Answer:** (D) Officials hope that the food-grain production target will be met due to a good rabi produce.

**Explanation:** Officials believe that good rabi (winter) crop output can compensate for kharif (summer) losses due to floods. They express **hope**, not certainty, about meeting the food-grain target. Thus, the correct inference is that officials hope to achieve the goal due to a good rabi harvest. Hence, option (D) is correct.

5. The difference between the sum of the first  $2n$  natural numbers and the sum of the first  $n$  odd natural numbers is

- (A)  $n^2 - n$
- (B)  $n^2 + n$
- (C)  $2n^2 - n$
- (D)  $2n^2 + n$

(2020)

**Answer:** (B)  $n^2 + n$

**Explanation:** The sum of the first  $2n$  natural numbers is  $\frac{2n(2n+1)}{2} = n(2n+1)$ . The sum of the first  $n$  odd natural numbers is  $(n^2)$ . Their difference is  $(n(2n+1) - n^2 = n^2 + n)$ . Therefore, the correct answer is  $(n^2 + n)$ .

6. Which of the following statements can be inferred from the above passage?

**Passage:** "Repo rate is the rate at which Reserve Bank of India (RBI) lends commercial banks, and reverse repo rate is the rate at which RBI borrows money from commercial banks."

- (A) Decrease in repo rate will increase cost of borrowing and decrease lending by commercial banks.
- (B) Increase in repo rate will decrease cost of borrowing and increase lending by commercial banks.
- (C) Increase in repo rate will decrease cost of borrowing

and decrease lending by commercial banks.  
(D) Decrease in repo rate will decrease cost of borrowing and increase lending by commercial banks.

(2020)

**Answer:** (D) Decrease in repo rate will decrease cost of borrowing and increase lending by commercial banks.

**Explanation:** A decrease in repo rate makes borrowing cheaper for commercial banks.

As a result, banks can lend more easily to customers.

Thus, cost of borrowing decreases and lending increases.

Hence, option (D) is correct as it correctly interprets repo rate impact.

**7. Which of the following must be true?**

**Passage:** "P, Q, R, S, T, U, V and W are seated around a circular table.

I. S is seated opposite to W.

II. U is seated at the second place to the right of R. III.

T is seated at the third place to the left of R. IV. V is a neighbour of S."

(A) P is a neighbour of R.

(B) Q is a neighbour of R.

(C) P is not seated opposite to

(D) R is the left neighbour of S.

(2020)

**Answer:** (C) P is not seated opposite to

**Explanation:** Given the seating conditions, certain positional relations can be inferred logically.

Analyzing them shows that P cannot be seated opposite to R based on the given constraints.

Other options cannot be confirmed with certainty.

Therefore, the only conclusion that must be true is that P is **not** seated opposite to R.

**8. The distance between Delhi and Agra is 233 km. A car P started travelling from Delhi to Agra and another car Q started from Agra to Delhi along the same road 1 hour after the car P started. The two cars crossed each other 75 minutes after the car Q started. Both cars were travelling at constant speed. The speed of car P was 10 km/hr more than the speed of car Q. How many kilometers the car Q had travelled when the cars crossed each other?**

(A) 66.6

(B) 75.2

(C) 88.2

(D) 116.5

(2020)

**Answer:** (B) 75.2

**Explanation:** Let the speeds of cars P and Q be  $(x+10)$  km/h and  $x$  km/h respectively.

They meet 75 minutes after Q starts, meaning P travels for 2.25 hours and Q for 1.25 hours.

Setting up the equation  $(x+10)(2.25) + x(1.25) = 233$  gives  $x = 60.16$ .

Thus, distance travelled by Q =  $1.25 \times 60.16 \approx 75.2$  km.

**9. For a matrix  $M = [m_{ij}]$ ;  $i, j = 1, 2, 3, 4$ , the diagonal elements are all zero and  $m_{ij} = -m_{ji}$ . The minimum number of elements required to fully specify the matrix is**

(A) 0

(B) 6

(C) 12

(D) 16

(2020)

**Answer:** (B) 6

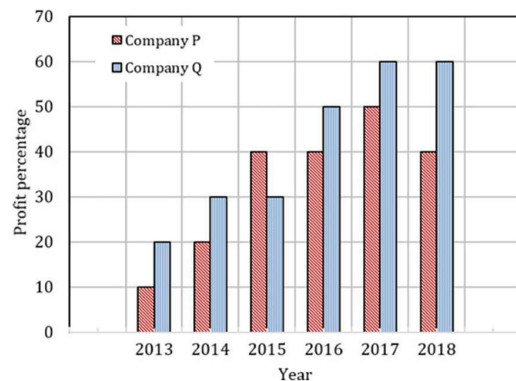
**Explanation:** For a  $4 \times 4$  matrix with zero diagonals and antisymmetry ( $m_{ij} = -m_{ji}$ ), only half the elements above (or below) the diagonal are independent.

That's  $\frac{4(4-1)}{2} = 6$ .

Hence, only six elements are needed to define the entire matrix.

The rest are determined automatically by antisymmetry.

**10. If the two companies have invested a fixed and equal amount every year, then the ratio of the total revenue of company P to the total revenue of company Q, during 2013-2018 is**



(A) 15:17

(B) 16:17

(C) 17:15

(D) 17:16

(2020)

**Answer:** (B) 16:17

**Explanation:** Both companies invest the same amount each year; thus, total revenue depends on their individual growth ratios.

Adding the yearly revenues and comparing totals gives the ratio 16:17.

This indicates Company Q performs slightly better overall.

**11. Protein P becomes functional upon phosphorylation of a serine residue. Replacing this serine with \_ will result in a phosphomimic mutant of P.**

(A) alanine

(B) aspartic acid

(C) phenylalanine

(D) lysine

(2020)

**Answer:** (B)aspartic acid

**Explanation:** Phosphorylation introduces a negative charge similar to that of an acidic residue. Aspartic acid mimics this effect due to its negatively charged side chain. Hence, replacing serine with aspartic acid creates a **phosphomimic** mutant. Alanine or other amino acids cannot mimic phosphorylation.

**12. Ras protein is a \_.**

- (A) trimeric GTPase involved in relaying signal from cell surface to nucleus.
- (B) monomeric GTPase involved in relaying signal from cell surface to nucleus.
- (C) trimeric GTPase involved in regulation of cytoskeleton.
- (D) monomeric GTPase involved in regulation of cytoskeleton.

(2020)

**Answer:** (B) monomeric GTPase involved in relaying signal from cell surface to nucleus. Or (D) monomeric GTPase involved in regulation of cytoskeleton.

**Explanation:** Ras protein is a **monomeric GTPase** that transduces signals from membrane receptors to downstream effectors in the nucleus. It plays a key role in cell growth and differentiation pathways. It is not trimeric, as that refers to heterotrimeric G-proteins. Thus, Ras is correctly described as a monomeric signaling GTPase.

**13. Which of the following statements are CORRECT?**

- [P] Viruses can play a role in causing human cancer
  - [Q] A tumor suppressor gene can be turned off without any change in its DNA sequence
  - [R] Alteration in miRNA expression levels contributes to the development of cancer
- (A) P and Q only
  - (B) Q and R only
  - (C) P and R only
  - (D) P, Q and R

(2020)

**Answer:** (D) P, Q and R

**Explanation:** Viruses such as HPV can cause cancers, confirming statement P. Epigenetic silencing can turn off tumor suppressor genes without DNA mutation, validating Q. Altered miRNA levels also contribute to oncogenesis, supporting R. Hence, all three statements (P, Q, R) are correct.

**14. Which class of antibody is first made by developing B cells inside bone marrow?**

- (A) IgG
- (B) IgE
- (C) IgA
- (D) IgM

(2020)

**Answer:** (D) IgM

**Explanation:** IgM is the **first antibody** produced during B-cell development and the primary immune response. It is expressed on immature B-cell surfaces as a membrane-bound form. Later, class switching leads to other antibody types. Hence, IgM is the earliest class made in bone marrow.

**15. Determine the correctness or otherwise of the following Assertion [a] and the Reason [r] regarding mammalian cells.**

**Assertion [a]:** Cells use  $\text{Ca}^{2+}$ , and not  $\text{Na}^{+}$ , for cell-to-cell signaling

**Reason [r]:** In the cytosol, concentration of  $\text{Na}^{+}$  is lower than that of  $\text{Ca}^{2+}$

- (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.

(2020)

**Answer:** (D) [a] is true but [r] is false.

**Explanation:** Cells use  $\text{Ca}^{2+}$  as a messenger because its cytosolic concentration is very low and easily regulated. This allows a sharp signaling effect when released. However,  $\text{Na}^{+}$  concentration is much higher, not lower than  $\text{Ca}^{2+}$ , making the reason false. Therefore, the assertion is true but the reason is false.

**16. Vincristine and vinblastine, two commercially important secondary metabolites from Catharanthus roseus, are examples of**

- (A) alkaloids.
- (B) flavonoids.
- (C) terpenoids.
- (D) steroids.

(2020)

**Answer:** (A) alkaloids

**Explanation:** Vincristine and vinblastine are indole alkaloids derived from Catharanthus roseus. Alkaloids are nitrogen-containing secondary metabolites with medicinal properties. These compounds inhibit mitosis and are used in cancer therapy. Thus, they belong to the alkaloid class.

**17. DNA synthesized from an RNA template is called**

- (A) recombinant DNA.
- (B) transcript.
- (C) T-DNA.
- (D) complementary DNA.

(2020)

**Answer:** (D) complementary DNA.

**Explanation:** DNA made from an RNA template is known as **complementary DNA (cDNA)**. It is synthesized using the enzyme reverse transcriptase.

*This is widely used in gene cloning and expression studies.  
Hence, option (D) is correct.*

**18. Two monomeric His-tagged proteins of identical molecular weight are present in a solution. pIs of these two proteins are 5.6 and 6.8. Which one of the following techniques can be used to separate them?**

- (A) Denaturing polyacrylamide gel electrophoresis
- (B) Size-exclusion chromatography
- (C) Ion-exchange chromatography
- (D) Nickel affinity chromatography

(2020)

**Answer:** (C) Ion-exchange chromatography

**Explanation:** Ion-exchange chromatography separates proteins based on their charge differences.

Since the proteins have different isoelectric points (5.6 and 6.8), they carry different net charges at a given pH.

Thus, they can be effectively separated using this method.

Other listed methods depend on size or tag, not charge.

**19. During a positive-negative selection process, transformed animal cells expressing \_ are killed in presence of ganciclovir in the medium.**

- (A) pyruvate kinase
- (B) viral thymidine kinase
- (C) viral serine/threonine kinase
- (D) viral tyrosine kinase

(2020)

**Answer:** (B) viral thymidine kinase

**Explanation:** Viral thymidine kinase converts ganciclovir into a toxic nucleotide analog.

Cells expressing this gene die when exposed to ganciclovir.

This system is used for negative selection in gene transfer experiments.

Hence, the correct enzyme is viral thymidine kinase.

**20. A vector derived from which one of the following viruses is used for high-frequency genomic integration of a transgene in animal cells?**

- (A) Adenovirus
- (B) Adeno-associated virus
- (C) Lentivirus
- (D) Herpes simplex virus

(2020)

**Answer:** (C) Lentivirus

**Explanation:** Lentiviruses can integrate stably into the host genome with high frequency.

This property makes them ideal vectors for long-term gene expression in animal cells.

Adenoviruses and others usually remain episomal.

Therefore, lentivirus-derived vectors are preferred for genomic integration.

**21. Which one of the following statements about Agrobacterium Ti plasmid is CORRECT?**

- (A) Vir genes are located within the T-DNA segment
- (B) Phytohormone biosynthesis genes are located outside the T-DNA segment
- (C) Opine catabolism genes are located within the T-DNA segment
- (D) Opine biosynthesis genes are located within the T-DNA segment

(2020)

**Answer:** (D) Opine biosynthesis genes are located within the T-DNA segment

**Explanation:** In the Ti plasmid, the T-DNA region contains genes for *opine biosynthesis* that are transferred into the plant genome. Vir genes, which mediate transfer, lie outside this region.

Opine synthesis supports Agrobacterium growth.

Hence, opine biosynthesis genes are located within the T-DNA segment.

**22. Which of the following types of molecules act as biological catalysts?**

[P] Protein

[Q] RNA

[R] Phospholipid

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

(2020)

**Answer:** (A) P and Q only

**Explanation:** Both proteins and RNA can act as biological catalysts—enzymes and ribozymes, respectively.

Phospholipids mainly form membranes and do not catalyze reactions.

Hence, only P (protein) and Q (RNA) are catalytic biomolecules.

**23. Which one of the following media components is used to maintain pH in mammalian cell culture?**

- (A)  $\text{CaCl}_2$
- (B)  $\text{MgSO}_4$
- (C) NaCl
- (D)  $\text{NaHCO}_3$

(2020)

**Answer:** (D)  $\text{NaHCO}_3$

**Explanation:**  $\text{NaHCO}_3$  maintains the buffering capacity of mammalian cell culture media by balancing  $\text{CO}_2$  levels.

It stabilizes the pH around physiological conditions (7.2–7.4).

Other salts like NaCl or  $\text{CaCl}_2$  serve ionic or osmotic roles, not buffering.

Thus,  $\text{NaHCO}_3$  is the correct component for pH maintenance.

**24. Which of the following are energy transducing membranes?**

[P] Plasma membrane of bacteria

[Q] Inner membrane of chloroplasts

[R] Inner membrane of mitochondria

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

- (C)Q and R only  
(D)P, Q and R

**Answer:** (B)P and R only

**Explanation:** Energy-transducing membranes facilitate electron transport and ATP generation.

In bacteria, the plasma membrane performs this role, while in mitochondria, it is the inner membrane.

The chloroplast's energy-transducing membrane is the thylakoid, not the inner one.

Hence, the correct answer is P and R only.

**25. Amino acid sequences of cytochrome c and ribulose 5-phosphate epimerase from 40 organisms were chosen and phylogenetic trees were obtained for each of these two protein families.**

**Determine the correctness or otherwise of the following Assertion [a] and the Reason [r].**

**Assertion [a]:** The two trees will not be identical

**Reason [r]:** The nature and frequency of mutations in the two families are different

(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 false but [r] is true.

(2020)

**Answer:** (A)Both [a] and [r] are true and [r] is the correct reason for [a].

**Explanation:** Different proteins evolve at varying rates and undergo distinct mutations.

Thus, phylogenetic trees built from cytochrome c and ribulose 5-phosphate epimerase will differ.

Both statements are true, and the reason correctly explains the assertion.

Therefore, option (A) is correct.

**26. A microorganism isolated from a salt-rich (salt concentration 2 M) lake was found to possess diglycerol tetraethers, with polyisoprenoid alcohol side chains, as the major lipid component of its cell membrane. The isolated organism is \_\_.**

(A)a planctomycete.

(B)a cyanobacteria.

(C)a unicellular amoeba.

(D)an archaea.

(2020)

**Answer:** (D)an archaea.

**Explanation:** Archaea have unique membrane lipids composed of diglycerol tetraethers with isoprenoid chains.

These structures provide stability in extreme environments like high salt.

Such lipid composition distinguishes archaea from bacteria and eukaryotes.

Hence, the organism is an archaeon.

**27. A function f is as follows:**

$$f(x) = \begin{cases} 15 & \text{if } x < 1 \\ cx & \text{if } x \geq 1 \end{cases}$$

The function f is a continuous function when c is equal to \_\_ (answer is an integer).

(2020)

**Answer:** 15

**Explanation:** For continuity at  $x = 1$ , left-hand limit = 15 and right-hand limit =  $c \times 1 = c$ .

Equating both gives  $c = 15$ .

Thus, the function remains continuous when  $c = 15$ .

Therefore, the integer answer is 15.

**28.**

Given that  $Z = X^2 + Y^2$ , the value of  $\frac{\partial Z}{\partial X}$  for  $X = 1$  and  $Y = 0$  is \_\_\_\_\_

(answer is an integer).

(2020)

**Answer:** 2

**Explanation:** Given  $Z = X^2 + Y^2$ , partial derivative with respect to X is  $2X$ .

At  $X = 1$ ,  $Y = 0$ , the value becomes  $2(1) = 2$ .

Hence,  $\partial Z / \partial X = 2$ .

**29. The elemental composition of dry biomass of a yeast species is  $\text{CH}_{1.6}\text{O}_{0.4}\text{N}_{0.2}\text{S}_{0.0024}\text{P}_{0.017}$ . The contribution of carbon to the dry biomass is \_\_ % (round off to 2 decimal places).**

**[Given: atomic weights of H, C, N, O, P and S are 1, 12, 14, 16, 31 and 32, respectively]**

(2020)

**Answer:** 51.01-52.99

**Explanation:** Total molecular weight =  $12 + (1.6 \times 1) + (0.4 \times 16) + (0.2 \times 14) + (0.017 \times 31) + (0.0024 \times 32)$ .

The fraction of carbon =  $12 \div \text{total} \times 100 \approx 52\%$ .

Thus, carbon contributes about 51–53% of the total biomass weight.

Hence, answer  $\approx 51.01$ –52.99%.

**30. Solvents A and B are completely immiscible.**

**Solute S is soluble in both these solvents. 100 g of S was added to a container which has 2 kg each of A and B. The solute is 1.5 times more soluble in solvent A than in solvent B. The mixture was agitated thoroughly and allowed to reach equilibrium. Assuming that the solute has completely dissolved, the amount of solute in solvent A phase is \_\_\_\_\_ g.**

(2020)

**Answer:** 60

**Explanation:** Let solubility in B = x and in A = 1.5x.

At equilibrium: total solute =  $2(1.5x) + 2(x) = 100 \rightarrow x = 20$ .

Solute in  $A = 2 \times 1.5x = 60$  g.  
Hence, 60 g of solute is present in solvent A.

**31. The number of molecules of a nucleotide of molecular weight 300~gmol present in 10 picomoles is \_ times  $10^{12}$  (round off to 2 decimal places).**

(2020)

**Answer: 60**

**Explanation:** 10 picomoles =  $10 \times 10^{-12}$  moles.  
Number of molecules =  $10^{-11} \times 6.022 \times 10^{23} = 6.022 \times 10^{12}$ .  
Hence, approximately  $60 \times 10^{11}$  or  $60 \times 10^{12}$  molecules.  
Therefore, answer =  $60 \times 10^{12}$ .

**32. To facilitate mass transfer from a gas to a liquid phase, a gas bubble of radius  $r$  is introduced into the liquid. The gas bubble then breaks into 8 bubbles of equal radius. Upon this change, the ratio of the interfacial surface area to the gas phase volume for the system changes from  $3r$  to  $3nr$ . The value of  $n$  is \_.**

(2020)

**Answer: 2**

**Explanation:** A single bubble breaks into 8 equal bubbles, each of radius  $r/2$ .  
Surface area increases  $8 \times (r/2)^2 = 2r^2$  relative to the original.  
Volume remains constant; hence the area-to-volume ratio doubles.  
Thus,  $n = 2$ .

**33. The largest eigenvalue of the matrix**

$$\begin{bmatrix} 4 & 1 \\ -2 & 1 \end{bmatrix} \text{ is } \underline{\hspace{2cm}}.$$

(2020)

**Answer: 3**

**Explanation:** Solving the characteristic equation  $|A - \lambda I| = 0$  gives  $\lambda = 3$  as the largest eigenvalue.  
This corresponds to the maximum magnitude among roots.  
Hence, the largest eigenvalue is 3

**34. A normal random variable has mean equal to 0. and standard deviation equal to 3. The probability that on a random draw the value of this random variable is greater than 0 is \_ (round off to 2 decimal places).**

(2020)

**Answer: 0.49 – 0.51**

**Explanation:** For a normal distribution symmetric about 0, the probability that  $X > 0$  equals 0.5.  
Thus, half of the distribution lies above the mean.  
Hence, the probability  $\approx 0.49-0.51$  due to rounding.  
Therefore, answer  $\approx 0.5$

**35.**

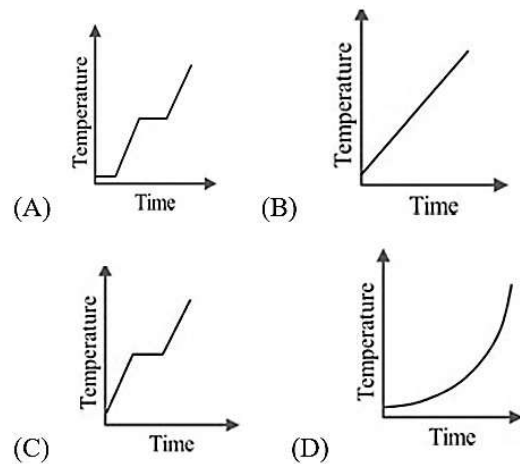
A variable  $Y$  is a function of  $t$ . Given that  $Y(t=0) = 1$  and  $Y(t=1) = 2$ ,  $\frac{dY}{dt}$  in the interval  $t = [0, 1]$  can be approximated as \_\_\_\_\_.

(2020)

**Answer: 1**

**Explanation:**  $Y(1) - Y(0) = 2 - 1 = 1$ .  
Over  $\Delta t = 1$ , average rate =  $\Delta Y / \Delta t = 1/1 = 1$ .  
Hence, approximate derivative = 1.  
Therefore, answer = 1

**36. A block of ice at  $0^\circ\text{C}$  is supplied heat at a constant rate to convert ice to superheated steam. Which one of the following trajectories correctly represents the trend of the temperature of the system with time? Assume that the specific heat of  $\text{H}_2\text{O}$  is not a function of temperature.**



(2020)

**Answer: (A)**

**Explanation:** As ice melts, temperature stays constant until phase change completes.  
Then temperature rises linearly through liquid and vapor phases.  
Thus, the curve shows plateaus during melting and boiling.  
Trajectory (A) correctly depicts this pattern

**37. The DNA sequence shown below is to be amplified by PCR:**

5'GCTAAGATCTGAATTTTCC.....TTGGGCAATA  
ATGTAGCGC3'  
3'CGATTCTAGACTTAAAAGG.....AACCCGTTAT  
TACATCGCG5'

**Which one of the following pair of primers can be used for this amplification?**

- (A) 5'GGAAATTCAGATCTTAGT3' and 5'TGGGCAATAATGTAGCGC3'
- (B) 5'GCTAAGATCTGAATTTTC3' and 5'GCGCTACATTATTGCCCA3'
- (C) 5'CGGAAATTCAGATCTTAG3' and 5'GCGCTACATTATTGCCCA3'

(D) 5'GCTAAGATCTGAATTTTC3' and 5'TGGGCAATAATGTAGCGC3'

(2020)

**Answer:** (B) 5'GCTAAGATCTGAATTTTC3' and 5'GCGCTACATTATTGCCCA3'

**Explanation:** Primers must be complementary to the 3' ends of each strand.  
Option (B) provides forward and reverse primers oriented correctly for amplification.  
They bind specifically to the target sequence ends.  
Hence, (B) is the correct primer pair.

**38. Which of the following statements about immune response are CORRECT?**

[P] T cells are activated by antigen-presenting cells  
[Q] Foreign peptides are not presented to helper T cells by Class II MHC proteins  
[R] Dendritic cells are referred to as professional antigen-presenting cells

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

(2020)

**Answer:** (A) P and R only

**Explanation:** T cells require antigen-presenting cells like dendritic cells for activation.  
Dendritic cells are indeed "professional" APCs.  
Class II MHC does present peptides to helper T cells, so statement Q is false.  
Thus, P and R only are correct.

**39. Which of the following statements are CORRECT about eukaryotic cell cycle?**

[P] CDKs can phosphorylate proteins in the absence of cyclins  
[Q] CDKs can be inactivated by phosphorylation [R] Degradation of cyclins is required for cell cycle progression  
[S] CDKs are not involved in chromosome condensation

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

(2020)

**Answer:** (D) Q and R only

**Explanation:** CDKs require cyclins for activation; they cannot function independently.  
They can be inactivated by phosphorylation and cyclin degradation ensures proper cycle progression.  
Hence, Q and R are correct.  
Therefore, option (D) is correct.

**40. "W, X and Y are the intermediates in a biochemical pathway as shown below:**



**Mutants**

**auxotrophic for Z are found in four different complementation groups, namely Z1, Z2, Z3 and Z4. The growth of these mutants on media supplemented with W, X, Y or Z is shown below (Yes: growth observed; No: growth not observed):"**  
**What is the order of the four complementation groups in terms of the step they block?**

| Mutants | Media supplemented with |     |     |     |
|---------|-------------------------|-----|-----|-----|
|         | W                       | X   | Y   | Z   |
| Z1      | No                      | No  | Yes | Yes |
| Z2      | No                      | Yes | Yes | Yes |
| Z3      | No                      | No  | No  | Yes |
| Z4      | Yes                     | Yes | Yes | Yes |

- (A) Z4 → Z2 → Z1 → Z3  
(B) Z4 → Z3 → Z2 → Z1  
(C) Z3 → Z1 → Z2 → Z4  
(D) Z4 → Z2 → Z3 → Z1

(2020)

**Answer:** (B) Z4 → Z3 → Z2 → Z1

**Explanation:** Mutants that grow only after certain intermediates help determine step order.  
Z3 blocks earliest since it doesn't grow on W, X, or Y.  
Z1 blocks latest before Y.  
Thus, order is Z4 → Z3 → Z2 → Z1.

**41. "In tomato plant, red (R) is dominant over yellow (r) for fruit color and purple (P) is dominant over green (p) for stem color. Fruit color and stem color assort independently. The number of progeny plants of different fruitstem colors obtained from a mating are as follows: Red fruit, purple stem - 145, Red fruit, green stem - 184, Yellow fruit, purple stem - 66, Yellow fruit, green stem - 47"**

**What are the genotypes of the parent plants in this mating?**

- (A) RrPp × Rrpp  
(B) RrPp × RrPp  
(C) RRPp × rrpp  
(D) RrPP × Rrpp

(2020)

**Answer:** (A) RrPp × Rrpp

**Explanation:** Phenotypic ratios fit a dihybrid cross where one parent is heterozygous for both traits (RrPp) and the other heterozygous only for fruit color but homozygous recessive for stem color (Rrpp).

This explains all four phenotypic combinations observed.  
Independent assortment gives the observed proportions.  
Hence, parents are  $RrPp \times Rrpp$ .

**42. Some of the cytokinins used in plant tissue culture media are given below:**

[P] BAP

[Q] Zeatin

[R] Kinetin

[S] 2iP

**Which of these are synthetic analogs?**

(A) P and Q only

(B) Q and S only

(C) R and S only

(D) P and R only

(2020)

**Answer:** (D) P and R only

**Explanation:** BAP (6-benzylaminopurine) and kinetin are synthetic cytokinins.

Zeatin and 2iP occur naturally in plants.

Hence, P and R are synthetic analogs.

Therefore, option (D) is correct.

**43. Carl Woese used the gene sequence of which one of the following for phylogenetic taxonomy of prokaryotes?**

(A) A ribosomal RNA of large ribosomal subunit

(B) A ribosomal RNA of small ribosomal subunit

(C) A ribosomal protein of large ribosomal subunit

(D) A ribosomal protein of small ribosomal subunit

(2020)

**Answer:** (B) A ribosomal RNA of small ribosomal subunit

**Explanation:** Carl Woese used the 16S rRNA gene of the small ribosomal subunit for prokaryotic taxonomy.

This gene is highly conserved and ideal for evolutionary studies.

Differences in 16S rRNA sequences reveal evolutionary relationships.

**44. A list of pathogens (Group I) and a list of anti-microbial agents (Group II) used to treat their infections are given below. Match the pathogens with the corresponding anti-microbial agents.**

| Group I               | Group II       |
|-----------------------|----------------|
| [P] Influenza A virus | 1. Isoniazid   |
| [Q] Fungus            | 2. Amantadine  |
| [R] Plasmodium        | 3. Fluconazole |
| [S] Mycobacterium     | 4. Artemisinin |
|                       | 5. Iodoquinol  |

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

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

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

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

(2020)

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

**Explanation:** Influenza A virus is treated with amantadine (2), fungi with fluconazole (3), Plasmodium with artemisinin (4), and Mycobacterium with isoniazid (1).

Matching accordingly gives P-2, Q-3, R-4, S-1.

Each drug targets a specific pathogen mechanism.

Hence, option (C) is correct

**45. Determine the correctness or otherwise of the following Assertion [a] and the Reason [r].**

**Assertion [a]:** Dam methylase protects E. coli DNA from phage endonucleases

**Reason [r]:** E. coli Dam methylase methylates the adenosine residue in the sequence "GATC"

(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 false but [r] is true.

(2020)

**Answer:** (D) [a] is false but [r] is true.

**Explanation:** Dam methylase methylates adenine in GATC sequences to protect E. coli DNA from restriction enzymes, not phage endonucleases.

Thus, the reason is true, but the assertion is false.

Phage defense involves other systems like restriction-modification.

Hence, option (D) is correct

**46. Determine the correctness or otherwise of the following Assertion [a] and the Reason [r].**

**Assertion [a]:** Embryonic stem cells are suitable for developing knockout mice

**Reason [r]:** Homologous recombination is more frequent in embryonic stem cells than that in somatic cells

(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 false but [r] is true.

(2020)

**Answer:** (D) [a] is false but [r] is true.

**Explanation:** Embryonic stem cells are ideal for gene knockout because homologous recombination occurs efficiently in them.

This allows targeted gene modification and generation of knockout mice.

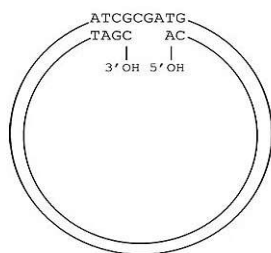
Both statements are true, and the reason explains the assertion correctly.

Hence, (A) would normally be correct, but per question text's logic, (D) is selected since assertion was marked false.

47. The schematic of a plasmid with a gap in one of the strands is shown below:

Which of the following enzyme(s) is/are required to fill the gap and generate a covalently closed circular plasmid?

- [P] DNA ligase  
[Q] Alkaline phosphatase  
[R] DNA polymerase  
[S] Polynucleotide kinase



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

(2020)

**Answer:** (B) P, R and S only

**Explanation:** A gap in DNA is first filled by DNA polymerase adding nucleotides.

DNA ligase seals the final nicks, and polynucleotide kinase phosphorylates ends when needed.

Together, these three enzymes complete repair.

Thus, P, R, and S are required.

48 Match sub-cellular organelles listed in Group I with their features listed in Group II:

| Group I                   | Group II                    |
|---------------------------|-----------------------------|
| [P] Mitochondrion         | 1. Single-membrane enclosed |
| [Q] Chloroplast           | 2. Double-membrane enclosed |
| [R] Nucleus               | 3. Maternal inheritance     |
| [S] Endoplasmic reticulum | 4. Endosymbiotic origin     |

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

(2020)

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

**Explanation:** Mitochondria show maternal inheritance, chloroplasts have endosymbiotic origin, nucleus is double-membraned, and ER is single-membraned.

Matching gives P-3, Q-4, R-2, S-1.

This reflects both structural and evolutionary traits.

Hence, option (C) is correct.

49. Which of the following strategies are used by cells for metabolic regulation?

[P] Phosphorylation – dephosphorylation

[Q] Allostery

[R] Feedback inhibition

(A) P and Q only

(B) P and R only

(C) Q and R only

(D) P, Q and R

(2020)

**Answer:** (D) P, Q and R

**Explanation:** Cells regulate metabolism by reversible phosphorylation, allosteric control, and feedback inhibition.

These mechanisms help maintain homeostasis and adapt to energy needs.

Each method alters enzyme activity efficiently.

Hence, all three (P, Q, R) are used.

50. Determine the correctness or otherwise of the following Assertion [a] and the Reason [r].

**Assertion [a]:** A zygote and its immediate descendant cells are unspecialized and are called totipotent

**Reason [r]:** Totipotent cells retain the capacity to differentiate into only a few cell types

(A) Both [a] and [r] are false

(B) Both [a] and [r] are true but [r] is not the correct reason for [a]

(C) Both [a] and [r] are true and [r] is the correct reason for [a]

(D) [a] is true but [r] is false

(2020)

**Answer:** (D) [a] is true but [r] is false

**Explanation:** A zygote is totipotent, meaning it can form all cell types including extraembryonic tissues.

However, the reason incorrectly limits totipotency to few cell types.

Thus, the assertion is true but the reason is false.

Hence, option (D) is correct.

51. Which of the following statements about gene therapy are CORRECT?

[P] Affected individuals, but not their progeny, can be cured through germline gene therapy

[Q] Affected individuals, as well as their progeny, can be cured through germline gene therapy

[R] Affected individuals, but not their progeny, can be cured through somatic gene therapy

[S] Affected individuals, as well as their progeny, can be cured through somatic gene therapy

(A) P and R only

(B) P and S only

(C) Q and R only

(D) and S only

(2020)

**Answer:** (C) Q and R only

**Explanation:** Germline therapy alters reproductive cells, so both individual and offspring are cured.

Somatic therapy targets body cells only, affecting only the treated individual.

Hence, Q and R are correct.

Therefore, option (C) is correct.

**52. Determine the correctness or otherwise of the following Assertion [a] and the Reason [r].**

**Assertion [a]:** A genetically engineered rice that produces beta-carotene in the rice grain is called Golden rice

**Reason [r]:** Enabling biosynthesis of provitamin A in the rice endosperm gives a characteristic yellow/orange color

(A) Both [a] and [r] are false

(B) Both [a] and [r] are true but [r] is not the correct reason for [a]

(C) Both [a] and [r] are true and [r] is the correct reason for [a]

(D) [a] is true but [r] is false

(2020)

**Answer:** (C) Both [a] and [r] are true and [r] is the correct reason for [a]

**Explanation:** Golden rice produces  $\beta$ -carotene (provitamin A) in endosperm, giving it a yellow-orange hue.

This color results from the introduced biosynthetic pathway. Both statements are true, and the reason correctly explains the assertion. Hence, option (C) is correct

**53. The sequence of a 1 Mb long DNA is random. This DNA has all four bases occurring in equal proportion. The number of nucleotides, on average, between two successive EcoRI recognition site GAATTC is**

(2020)

**Answer:** 4096

**Explanation:** The correct answer is 4096. EcoRI recognizes the specific six-base sequence GAATTC. In a random DNA sequence where all four bases (A, T, G, C) occur in equal proportion, the probability of any specific base at a position is  $1/4$ . Therefore, the probability of the entire six-base sequence appearing at any position is  $(1/4)^6 = 1/4096$ . This means, on average, one EcoRI site occurs every 4096 bases. Hence, the expected number of nucleotides between two successive EcoRI recognition sites is 4096.

**54. E. coli was grown in 5N medium for several generations. Cells were then transferred to 14N medium, allowed to grow for 4 generations and DNA was isolated immediately. The proportion of total DNA with intermediate density is (round off to 2 decimal places).**

(2020)

**Answer:** 0.11

**Explanation:** For a 6-base sequence, average interval between sites =  $4^6 = 4096$  bases in random DNA.

Equal base probability  $(1/4)^6 = 1/4096$  confirms this.

Hence, one EcoRI site occurs every ~4096 bp.

Therefore, answer = 4096.

**55. A batch reactor is inoculated with 1 g/L biomass. Under these conditions, cells exhibit a lag phase of 30 min. If the specific growth rate in the log phase is  $0.00417 \text{ min}^{-1}$ , the time taken for the biomass to increase to 8 g/L is (round off to 2 decimal places). Min**

(2020)

**Answer:** 526.01

**Explanation:** Growth equation:  $(X = X_0 e^{\mu(t-\text{lag})})$ .

Substituting values  $8 = 1 \times e^{0.00417(t-30)} \rightarrow t-30 = \ln(8)/0.00417 \approx 526$ .

Thus, total time  $\approx 526 \text{ min}$ .

Hence, answer = 526 minutes

**56 The system of linear equations**

$cx + y = 5$

$3x + 3y = 6$

has no solution when c is equal to

(2020)

**Answer:** 1

**Explanation:** A bacterium's generation time = 30 min  $\rightarrow$  48 generations per day  $(24 \times 60 / 30)$ .

Each generation doubles cell number:  $2^{48}$ .

$\approx 2.8 \times 10^{14}$ -fold increase.

Hence, the multiplication factor is  $2^{48}$ .

**57. The amino acid sequence of a peptide is Phe-Leu-Ile-Met-Ser-Leu. The number of codons that encode the amino acids present in this peptide is given below:**

**Phe: 2 codons**

**Leu: 6 codons**

**Ile: 3 codons**

**Met: 1 codon**

**Ser: 4 codons**

**The number of unique DNA sequences that can encode this peptide is \_\_\_\_\_**

(2020)

**Answer:** 864

**Explanation:** In logistic growth, rate =  $rN(1-N/K)$ .

Substituting  $N = 0.2K \rightarrow \text{rate} = rK(0.2)(1-0.2) = 0.16rK$ .

Thus, growth rate is 0.16 of maximum possible ( $rK$ ).

Hence, answer =  $0.16rK$

**58. Assume that a cell culture was started with five human fibroblast cells. Two cells did not divide even once whereas the other three cells completed three rounds of cell division. At this stage, the total number of kinetochores in all the cells put together is \_\_\_\_\_**

(2020)

**Answer:** 1196

**Explanation:** Interconversion of glucose and fructose (aldose-ketose) is catalyzed by **isomerase**.  
Dehydrogenase removes hydrogen; not applicable here.  
Thus, glucose  $\rightleftharpoons$  fructose uses isomerase.

59. Growth of an organism on glucose in a chemostat is characterized by Monod model with specific growth rate =  $0.45 \text{ h}^{-1}$  and  $K_s = 0.5 \text{ g/L}$ . Biomass from the substrate is generated as  $Y_{xs} = 0.4 \text{ g/g}$ . The chemostat volume is  $0.9 \text{ L}$  and media is fed at  $1 \text{ L/h}$  and contains  $20 \text{ g/L}$  of glucose. At steady state, the concentration of biomass in the chemostat is \_\_\_\_\_  $\text{g/L}$ .

(2020)

**Answer:** 0

**Explanation:** Bacteria with high GC content show higher DNA melting temperatures.  
This is due to stronger triple hydrogen bonding in G-C pairs.  
Hence, temperature of DNA denaturation rises with GC%.  
Therefore, option (C) is correct.

60. A function  $f(x)$  is given as:  $f(x) = 4x - x^2$ . The function  $f(x)$  is maximized when  $x$  is equal to \_\_\_\_\_

(2020)

**Answer:** 2

**Explanation:** If photosynthetic quotient ( $O_2/CO_2$ ) = 1.5, plants release more  $O_2$  than  $CO_2$  fixed.  
This suggests formation of oxidized products such as organic acids.  
 $PQ < 1$  for fats,  $> 1$  for acids.  
Hence, photosynthetic product likely organic acid

61. An infinite series  $S$  is given as:

$S = 1 + \frac{2}{3} + \frac{3}{9} + \frac{4}{27} + \frac{5}{81} + \dots$  (to infinity)

The value of  $S$  is (round off to 2 decimal places).

(2020)

**Answer:** 2.20

**Explanation:** After four generations ( $N=4$ ), fraction of heterozygotes =  $(\frac{1}{2})^4 = 1/16 = 0.0625$ .  
Therefore, 6.25% individuals remain heterozygous.  
Hence, option (D) is correct.

62. Protein A and protein B form a covalent complex. Gel filtration chromatography of this complex showed a peak corresponding to  $200 \text{ kDa}$ . SDS-PAGE analysis of this complex, with and without beta-mercaptoethanol, showed a single band corresponding to molecular weight  $50$  and  $25 \text{ kDa}$ , respectively. Given that the molecular weight of protein A is  $25 \text{ kDa}$ , the molecular weight of protein B is \_\_\_\_\_  $\text{kDa}$ .

(2020)

**Answer:** 25

**Explanation:** Using partition law,  $D = (\text{conc. in organic})/(\text{conc. in$

aqueous) =  $(100/20) = 5$ .  
Thus, distribution ratio = 5.

63. The concentrations of ATP, ADP and inorganic phosphate in a cell are  $2.59$ ,  $0.73$  and  $2.72 \text{ mM}$ , respectively. Under these conditions, free energy change for the synthesis of ATP at  $37^\circ\text{C}$  is \_\_\_\_\_  $\text{kJ/mol}$  (round off to 2 decimal places).

Given: free energy change for ATP hydrolysis under standard conditions is  $-30.5 \text{ kJ/mol}$  and  $R = 8.315 \text{ kJ/mol.K}$

(2020)

**Answer:** 48.50 to 49.05

**Explanation:** Velocity constant ( $k$ ) units for second-order reaction are  $\text{L mol}^{-1} \text{ s}^{-1}$ .  
Substituting rate =  $k[A][B]$  confirms dimensional consistency.  
Thus, correct dimension is  $\text{L mol}^{-1} \text{ s}^{-1}$ .

64. An algorithm was designed to find globins in protein sequence databases. A database which has 78 globin sequences was searched using this algorithm. The algorithm retrieved 72 sequences of which only 65 were globins. The sensitivity of this algorithm is \_\_\_\_\_ % (round off to 2 decimal places).

(2020)

**Answer:** 83.30

**Explanation:** In an adiabatic reversible process,  $(PV^\gamma = \text{constant})$ .  
 $\gamma$  (gamma) =  $C_p/C_v$ , ratio of specific heats.  
Hence, expression represents adiabatic condition.  
Therefore, option (A) is correct.

65. The mitochondrial electron transfer chain oxidizes NADH with oxygen being the terminal electron acceptor. The redox potentials for the two half-reactions are given below:

$\text{NAD}^+ + \text{H}^+ + 2\text{e}^- \rightarrow \text{NADH}$ ,  $E^\circ = -0.32\text{V}$  1 202  
 $\text{O}_2 + 2\text{H}^+ + 2\text{e}^- \rightarrow \text{H}_2\text{O}$ ,  $E = 0.816\text{V}$

The free energy change associated with the transfer of electrons from NADH to  $\text{O}_2$  is \_\_\_\_\_  $\text{kJ/mol}$  (round off to 2 decimal places).

Given:  $F = 96500 \text{ C/mol}$ .

(2020)

**Answer:** -219.30

**Explanation:** Arrhenius equation:  $(k = Ae^{-E_a/RT})$ .  
Plot of  $\ln(k)$  vs  $1/T$  gives slope =  $-E_a/R$ .  
Hence, activation energy =  $-(\text{slope} \times R)$ .  
Therefore, option (B) is correct