Code No. C-15

Ph.D. Admission July 2023 Session

Ph.D. Systems and Computational Biology

HALL TICKET NUMBER

Maximum Marks: 70   Time: 2 hours

INSTRUCTIONS: Please read the instructions carefully before answering the questions

1. Answers are to be marked on the OMR answer sheet.
2. Hand over the OMR answer sheet at the end of the examination to the invigilator.
3. The question paper contains 70 questions of multiple choices, printed in 15 pages including this page. Last three blank pages (16-18) to be used for rough work.
4. OMR answer sheet provided separately.
5. All questions carry one mark each.
6. In case the candidates have equal marks, preference will be given towards the candidate who has obtained higher marks in Part-A.
7. **There is NO negative marking for wrong answers.**
8. Non-programmable scientific calculators are permitted.
9. Cells or Mobile Phones are strictly prohibited in the examination hall.

Part A

1. If x + y = 7 and xy = 10, what is the value of x?

   A. 2
   B. 4
   C. 7
   D. 8

2. Which of the following is not a characteristic of enzymes?

   A. They are proteins
   B. They lower activation energy
   C. They are consumed in the reaction
   D. They are specific to a particular substrate

3. If a DNA sequence is 30 base pairs ending with a stop codon, how many amino acids will the resulting protein contain?

   A. 9
   B. 10
   C. 27
   D. 30

4. Which of the following is not a step in the process of translation?

   A. Initiation
   B. Elongation
   C. Termination
   D. Splicing

5. What is the output of the following pseudocode?

```
i = 0
while i < 5:
  print(i)
i += 1
```

   A. 0, 2, 4
   B. 0, 1, 2, 3, 4
   C. 1, 2, 3, 4, 5
   D. 5, 4, 3, 2, 1

6. What is the output of the following pseudocode?

```
x = 10
y = 5
if x > y:
    z = x - y
print(z)
else:
    z = y - x
print(z)
```

A. -5
B. 10
C. 5
D. The program will produce an error

7. Fidelity of Human DNA Polymerase η is typically much lesser than their bacterial counterparts. If after single replication of human genome (of size 3×10^9 nucleotides) there are 3×10^6 mutations, then the fidelity of polymerase will be 1 per

A. 1000 nucleotides
B. 1,000,000 nucleotides
C. 10^{-3} nucleotides
D. 10^{-6} nucleotides

8. In a Mendelian cross between two pure parental lines with green and yellow pods, the offspring in the first generation had green pods. On selfing the F1 generation, if the number of offspring with green colored pods were 450, then the approximate number of offspring with yellow pods will be

A. 300
B. 150
C. 450
D. 600

9. Stomata are openings on the leaf surface that allow gaseous exchange when open. Considering all plants, the number of stomata average over 100 mm^2, and their mean pore area is 92 μm^2. What is the total pore area per mm^2 of leaf when the stomata are open,

A. One-ninetieth
B. One-tenth
C. One-fifth

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D. One-fiftieth

10. In a plane, the distance of point P (-6,8) from its origin is

    A. 6 units
    B. 8 units
    C. 10 units
    D. 14 units

11. $x=2, y=-1$ is a solution of the linear equation

    A. $x+2y=0$
    B. $x+2y=4$
    C. $2x+y=0$
    D. $2x+y=5$

12. If ABC is an arc of a circle and $\angle ABC=135°$, then the ratio of of arc $\overset{\frown}{ABC}$ to the circumference is:

    A. 1:4
    B. 3:4
    C. 3:8
    D. 1:2

13. If the volume and surface area of a sphere is numerically equal, then its radius is

    A. 1 unit
    B. 2 units
    C. 3 units
    D. 4 units

14. First law of thermodynamics

    A. Describes a 'thermometer'
    B. Describes conservation of energy in a reversible process
    C. Describes entropy of a system
    D. Assigns a definite value of entropy of a system at 0 Kelvin

15. Molecular vibrational modes can be best captured by which of the following experimental methods?

    A. Circular dichroism
    B. Atomic force microscopy
    C. Scanning electron microscopy
    D. Infrared spectroscopy

16. Angle between two vectors r1 ($\hat{x} + 2\hat{y} + 5\hat{z}$) and r2 ($-5\hat{x} + \hat{z}$) is _____ where $\hat{x}, \hat{y}, and\ \hat{z}$ are the unit vectors along x-, y-, and z-axis, respectively.

    A. 0^0
    B. 45^0
    C. 90^0
    D. 60^0

17. Which of the following properties of a protein is likely to be least affected by changes in pH?

    A. Primary structure
    B. Secondary structure
    C. Tertiary structure
    D. Quaternary structure

18. Albumin is a large protein which circulates freely in human plasma. Another type of protein, called aquaporins, act as a channel for water to enter and exit a cell, and are located within the lipid bilayer of a cell's plasma membrane. Based on their physiological locations, how would the tertiary structure of these two proteins most likely compare?

    A. Albumin has a more nonpolar core with a polar outer layer, while aquaporins have a more polar core with a nonpolar outer layer
    B. Albumin has a more nonpolar core with a nonpolar outer layer, while aquaporins have a more polar core with a polar outer layer
    C. Albumin has a more polar core with a polar outer layer, while aquaporins have a more nonpolar core with a nonpolar outer layer
    D. Albumin has a more polar core with a nonpolar outer layer, while aquaporins have a more nonpolar core with a polar outer layer

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19. Center of the circle $x^2 + y^2 - 12x + 8y - 72 = 0$ is at

A. (0,-6)
B. (-6,-4)
C. (0,4)
D. (6,-4)

20. One of the eigenvalues of the matrix A is

A. 3
B. 7
C. -1
D. -3

$$A = \begin{pmatrix} 1 & 2 & 3 \\ 1 & -1 & 4 \\ -2 & -4 & 1 \end{pmatrix}$$

21. The domain (D) and range (R) of the function $y = 2sinx - 1$ are
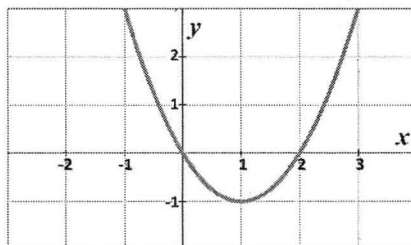
A. D and R the sets of real numbers
B. D is a set of real numbers and R ={-1, +1}
C. D is a set of real numbers and R ={-3, +1}
D. D and R both are = {-1, +1}

22. The inverse of a square matrix A does not exist when its determinant value is ___

A. 0
B. 1
C. -1
D. -2

23. Which of the following functions best describes the following graph?

A. $y = 2x + 3$
B. $y = x^2 + x - 1$
C. $y = x^2 - 2x$
D. $y = sinx + 2$

24. "e" (Euler number= 2.7183) is the value of "a" in the exponential function $f(x) = a^x$ such that the gradient (slope) of the $f(x)$ is equal to

A. 1
B. 2
C. 0
D. -1

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25. The $\lim\limits_{x \to 0} \frac{(cosx-1)}{x}$ = ?

    A. 0
    B. -1
    C. +1
    D. cannot be determined

26. The minimum of the function $y = 3x^2 + 10x$ lies at $x =$?

    A. -3/5
    B. +5/3
    C. ½
    D. -5/3

27. Where would the helical region be if the Ramachandran Map were to be redrawn for D-Alanine amino acid?

    A. I quadrant
    B. II quadrant
    C. III quadrant
    D. IV quadrant

28. At the neutral pH, the total charge on the peptide RRGAADD is __

    A. 0.0
    B. -1.0
    C. -2.0
    D. 2.0

29. If a bag contains Rs. 63, with number of coins of one Rupee and fifty paise in a ratio of 2:3, then how many 50 paisa coins the bag contains?

    A. 48
    B. 32
    C. 36
    D. 54

30. A man can row with a speed of 6 km/hr in a river that flows with a speed of 2 km/hr in the direction of the flow. If it takes additional 3 hours to row against the direction of flow, what would be the distance being covered?

    A. 20 km
    B. 30 km
    C. 38 km
    D. 24 km

31. In the box plot below, the dots shown above the upper whisker are referred to as ___ and are identified as those whose values are _____ , where Q1, Q3 are first and third quartiles and IQR=Q3-Q1

    A. Outliers, $< Q1-1.5$ (IQR)
    B. Inliers, $> Q1 + 1.5$ (IQR)
    C. Outliers, $> Q3 + 1.5$ (IQR)
    D. Outliers, $< Q3 - 1.5$ (IQR)
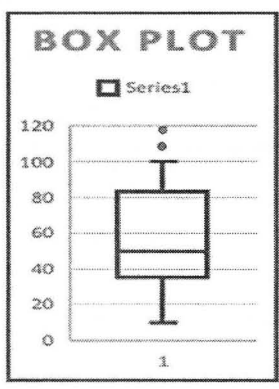
32. Comparison of two variances done by using following distributions

    A. T – Distribution
    B. F – Distribution
    C. Normal Distribution
    D. Poisson Distribution

33. The variance of random variables A and B are 0.2 and 0.5 respectively. Let $Z = 5A-2B$. The variance of Z is?

    A. 3
    B. 4
    C. 5
    D. 7

34. If 5 out of 100 men and 10 out of 250 women are deaf. What is the total probability of deaf people when men and women are in equal numbers?

    A. 0.45
    B. 0.045
    C. 0.05
    D. 0.5

35. For a gamma distribution with shape parameter α and the rate parameter λ, the mean and the variance are _____

    A. $E(X) = 1/\lambda$, $Var(X) = \alpha/\lambda^2$
    B. $E(X) = \alpha/\lambda$, $Var(X) = 1/\lambda^2$
    C. $E(X) = \alpha/\lambda$, $Var(X) = \alpha/\lambda^2$
   D. $E(X) = \alpha\lambda$, $Var(X) = \alpha\lambda^2$

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Part B

36. Which small RNA pathway is responsible for post-transcriptional gene silencing?

    A. miRNA
    B. siRNA
    C. piRNA
    D. All of the above

37. Which of the following sequencing technologies produces the longest read lengths?

    A. Illumina
    B. PacBio
    C. Ion Torrent
    D. Oxford Nanopore

38. Which of the following network properties is associated with resilience to targeted attacks on the network?

    A. Small-worldness
    B. Modularity
    C. Degree centrality
    D. Heterogeneity

39. Which of the following algorithms is commonly used for global sequence alignment?

    A. Needleman-Wunsch
    B. Smith-Waterman
    C. Dayhoff
    D. Gilbert

40. Which of the following measures of support is commonly used to assess the robustness of a phylogenetic tree?

    A. Branch length
    B. Bootstrap value
    C. Clade size
    D. Outgroup comparison

41. Which of the following databases contains information about genetic variation in humans?

    A. GenBank
    B. Brenda
    C. dbSNP
    D. PDB

42. Inheritance of continuous (quantitative) traits is generally under the control of

    A. single gene
    B. multiple genes
    C. environmental factors
    D. multiple genes plus environmental factors

43. In an eukaryotic cell, DNA molecule is found in

    A. Mitochondria
    B. Golgi apparatus
    C. Vacuole
    D. Lysosomes

44. Expression of genes typically happens in which type of chromatin?

    A. Euchromatic region
    B. Heterochromatic region
    C. Monochromatic region
    D. Every region of the genome

45. Microarray is a technique for

    A. Quantifying the amount of micronutrients
    B. Genome wide gene expression profiling
    C. High-throughput sequencing
    D. Profiling the metabolome

46. If the codons were composed of just two nucleotides, then how many amino acids would it encode (consider the ideal case of no redundancy among codons)?

    A. 20
    B. 8
    C. 16
    D. 4

47. At very high substrate concentrations, the rate of enzymatic reaction

    A. Approaches K_m (Michaelis–Menten constant)
    B. Approaches maximal reaction rate (V_{max})
    C. Will be same as at lower or any concentration
    D. Will be zero

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48. In sexually reproducing organisms, genetic exchange of chromosomal regions between the pair of homologous chromosomes takes place during

    A. Gamete formation
    B. Transition from zygote to embryo
    C. Cellular differentiation
    D. Mitosis

49. Which of the following plots represent electrostatic potential energy, V(x), between two charged particles separated by a distance 'x'?
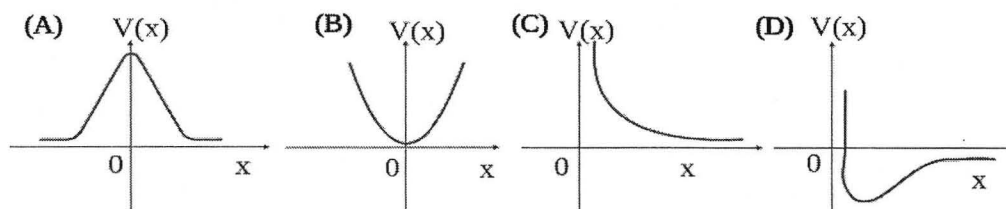
50. Let us consider two systems A and B with number of molecules, temperature, pressure, and volume being (NA, TA, PA, VA) and (NB, TB, PB, VB), respectively. These systems will reach mechanical equilibrium when

    A. PA = PB
    B. TA = TB
    C. NA = NB
    D. VA = VB

51. Energy fluctuation is given by $\Delta E = E - <E>$ where, $<E>$ is the mean or average value of E. Find the value of $< (\Delta E)^2 >$

    A. $<E^2> - <E>^2$
    B. $E^2 - <E>^2$
    C. $E^2 - 2E<E> + <E>^2$
    D. $E^2 - <E>$

52. Steepest descent, Conjugate gradient, and Newton Raphson methods are generally used for

    A. Finding probability distribution function
    B. Network analysis
    C. Generating random numbers
    D. Minimizing the potential energy of a system of particles

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53. Consider the below table for a scatter plot with x as independent and y as dependent variable, respectively. The slope (m) of a linear regression plot through these points is given by the following formula where summation is over $i = 1, n$ with 'n' being the total number of data points. What is the value of 'm' that will best fit these data points?

X	1	2.1	2.9	2.9	4
Y	2.55	4.98	7.1	7.5	9.7

$$m = \frac{n \Sigma x_i y_i - \Sigma x_i \Sigma y_i}{n \Sigma x_i^2 - \left(\Sigma x_i\right)^2}$$

A. 3.73
B. 2.43
C. 3.63
D. 2.51

54. A molecular dynamics simulation is performed for a system containing water as solvent and a protein which has at its surface, among other groups, an isoleucine residue (containing a - $CH(CH_3)CH_2CH_3$ side chain) and a lysine residue (containing a -$CH_2CH_2CH_2CH_2NH_3^+$ side chain). Which of the following statements is correct?

A. The water molecules will tend to approach the isoleucine residues more strongly due to the hydrophobic interactions.
B. Hydrogen-bonding will lead to frequent observations of short N-O distances between the N atom in the distal NH_3^+ group and the O atoms of water molecules.
C. The charged group of the lysine residue will tend to 'bury' itself in the surface of the protein, to avoid contact with water molecules.
D. Isoleucine is an amino acid, and amino acids are soluble in water, so the simulation will show that this residue detaches itself from the protein and moves into the solvent.

55. Clustering coefficient of the node B in the following graph is __
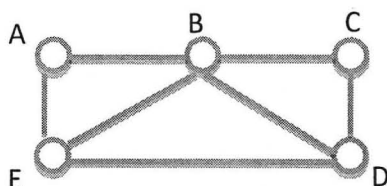
A. 1.00
B. 0.75
C. 0.50
D. 0.25

56. Proteins function only when they form dimer complexes are referred to as___

   A. Permanent Non-obligate
   B. Permanent Obligate
   C. Transient non-obligate
   D. Transient obligate

57. Date hubs are those proteins which form ____ with their interacting partners.

   A. A large number of interactions and not having correlated expression pattern
   B. Very few interactions and also not having correlated expression pattern
   C. A large number of interactions and having correlated expression pattern
   D. Very few interactions and also having correlated expression pattern

58. The degree distribution of a random network (ER network) is best described by ____ function.

   A. Power-law
   B. Gamma
   C. Poisson
   D. Harmonic

59. A graph where any pair of connected nodes belong to two different sets is referred to as

   A. Bipartite graph
   B. directed graph
   C. undirected graph
   D. monopartite graph

60. Bottlenecks, by definition, are those nodes whose ____ centrality values are high

   A. Degree
   B. Clustering coefficient
   C. Betweenness
   D. Closeness

61. The Betweenness centrality value of node "E" in the following graph is ____

   A. 3.0
   B. 1.0
   C. 2.0
   D. 0.0

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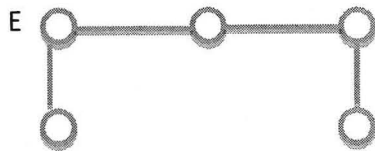
62. The Eulerian path in a graph is the one where __

    A. All the nodes are visited once but crossed some of the edges more than once
    B. All the edges are crossed only once while visiting all the nodes
    C. All the nodes are visited only once, and no need to cross all the edges
    D. A free-walk is taken in that graph without counting the number of edges and the nodes crossed

63. The unit of rate constant of a zero-order reaction is

    A. s^{-1}
    B. $mol\ L^{-1}\ s^{-1}$
    C. $L^2\ mol^{-2}\ s^{-1}$
    D. $L\ mol^{-1}\ s^{-1}$

64. The Lineweaver-Burk equation is given as

    A. $\frac{1}{V0} = \frac{km}{Vmax*S} + \frac{1}{Vmax}$
    B. $\frac{1}{Vmax} = \frac{km}{V0*S} + \frac{1}{V0}$
    C. $V0 = \frac{Vmax*S}{km+S}$
    D. $Vmax = \frac{V0*S}{km+S}$

65. What is the ratio of V_{max}/V_0 for $[S] = 5K_m$?

    A. 1/2
    B. 10/11
    C. 4/5
    D. 6/5

66. In an non-competitive enzyme inhibition kinetics, concentration of inhibitor affects the linearized plot by

    A. moving the entire curve to the right
    B. changing the y-intercept
    C. changing the x-intercept
    D. moving the entire curve to the left

67. In the Michaelis-Menten kinetics, the rate determining step of is _____

    A. The complex dissociation step to produce products
    B. The complex formation step
    C. The product formation step
    D. None of the mentioned

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68. A concentration response coefficient for a metabolic reaction is defined as _____

   A. Ratio of fractional change in metabolite concentration to fractional change in parameter
   B. Ratio of fractional change in metabolite concentration to fractional change in reaction rate
   C. Ratio of fractional change in metabolite concentration to fractional change in enzyme concentration
   D. Ratio of fractional change in reaction rate concentration to fractional change in metabolite concentration

69. The amount of heat produced by a human body that needs 2000 Kcal/day is equivalent to

   A. 182 W
   B. 58 W
   C. 97 W
   D. 0.58 W

70. The Monod kinetics models the relationship of

   A. substrate utilized with the biomass consumption
   B. specific growth rate to the substrate availability
   C. yield with the biomass utilization
   D. the biomass concentration with specific growth rate

University of Hyderabad

Entrance Examinations - 2023

School/Department/Centre: School of Life Sciences, Department of Systems and Computational Biology

Course/Subject   : **Systems and Computational Biology** *Revised key*

Q.No.	Answer	Q.No.	Answer	Q.No.	Answer
1	A	26	D	51	A
2	C	27	A	52	D
3	A	28	A	53	B
4	D	29	D	54	B
5	B	30	D	55	C
6	C	31	C	56	B,D
7	A	32	B	57	A
8	B	33	D	58	C
9	A	34	B	59	A
10	C	35	C	60	C
11	A	36	D	61	A
12	C	37	D	62	B
13	C	38	B	63	B
14	B	39	A	64	A
15	D	40	B	65	D
16	C	41	C	66	B
17	A	42	D	67	A
18	A	43	A	68	A
19	D	44	A	69	C
20	C	45	B	70	B
21	C	46	C		
22	A	47	B		
23	C	48	A		
24	A	49	C		
25	A	50	A		

Note/Remarks :

The changes have been made where necessary.

Signature

School/Department/Centre
अध्यक्ष / HEAD
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