

Code No. E-23

ENTRANCE EXAMINATION - 2025

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 13 pages (last three pages to be used for rough work), including this page.
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 answer.**
8. Non-programmable scientific calculators are only permitted.
9. Cell, Mobile Phones are strictly prohibited in the examination hall.

PART A

1. Methane has ____ Carbon atom(s) and is (are) in ____ geometry.
 - A. 2, tetrahedral
 - B. 1, trigonal
 - C. 2, trigonal
 - D. 1, tetrahedral
2. Hydrogen bonds are ____ and, essentially, ____ interactions.
 - A. weak, electrostatic
 - B. strong, electrostatic
 - C. weak, covalent
 - D. strong, covalent
3. A bacterial genome is 50% GC-rich. The probability of finding a subsequence GTTTGC anywhere in the genome is _____. (Note: ^ means 'to the power of')
 - A. 6×0.25
 - B. 6×0.5
 - C. $(0.25)^6$
 - D. $(0.5)^6$
4. A newly formulated Blood Pressure (BP) lowering medicine was tested on 36 volunteers randomly selected from a population. The BP values were measured after medication, and their mean value was found to be 110 with a variance of 25. At a 5% significance level, a test statistic was computed and compared with its critical value. Since the test statistic was greater than the critical value, it was concluded that the BP-lowering medicine is effective, given the data. The test statistic that should be computed is _____.
 - A. Student's t
 - B. Z
 - C. χ^2
 - D. F
5. In a standard Normal distribution, the highest probability value is for $z =$ ____ value.
 - A. -3
 - B. -1
 - C. 0
 - D. +3
6. The units of distances used typically for describing the separation of atoms and the separation of astronomical bodies, such as stars, are ____ and ____, respectively.
 - A. Nanometers and light years
 - B. Meters and kilometers
 - C. Light years and nanometers
 - D. Nanometers and kilometers

7. Two trains proceeding towards each other from 300 km apart, cross each other at 180 km from one of the stations. What is the ratio of their speeds?
- A. 10:9
 - B. 15:4
 - C. 18:12
 - D. 20:12
8. A solution contains water and alcohol in a 3:4 ratio. If 3 liters of water are added to the solution, the ratio becomes 5:4. What is the quantity of alcohol in the solution?
- A. 6
 - B. 9
 - C. 4
 - D. 12
9. The mean of a distribution is 12, and the variance is 9. What is the coefficient of variation?
- A. 20%
 - B. 25%
 - C. 30 %
 - D. 35%
10. If 10 men out of 200 men and 20 women out of 500 women are deaf, then find the total probability of deaf people in a population with an equal number of men and women.
- A. 0.45
 - B. 0.045
 - C. 0.05
 - D. 0.5
11. Which distribution has the properties of $E(X) = \mu$ and $V(X) = \sigma^2$?
- A. Bernoulli's
 - B. Binomial
 - C. Poisson's
 - D. Normal
12. If the coefficient of x^3 in the expansion of $(1+x)^n$ is 84, what is n?
- A. 7
 - B. 8
 - C. 9
 - D. 10
13. _____ is the spontaneous thermodynamic process
- A. Moving car
 - B. Falling fruit
 - C. Liquification of nitrogen gas
 - D. Melting of iron

14. What is a major ethical concern at the intersection of patient-related data and Artificial Intelligence (AI)?
- A. AI has no impact on disease and data privacy
 - B. The potential misuse of data, leading to privacy violations and discrimination
 - C. AI can only be used for medical advancements without ethical risks
 - D. Patient data is not considered personal information and does not require protection
15. The expectation value of a discrete random variable x with probability function $f(x)$ is given by
- A. $\sum x \cdot f(x^2)$
 - B. $\sum x^2 \cdot f(x)$
 - C. $\sum x$
 - D. $\sum x \cdot f(x)$
16. The entropy of a system is a measure of
- A. It's a disorder or a number of microscopic configurations
 - B. Its volume at a constant pressure
 - C. The number of particles in the system
 - D. Its total energy
17. Which tool would be most appropriate to compare gene expression between cancerous and normal tissues?
- A. DNA fingerprinting
 - B. CRISPR
 - C. Microarray
 - D. Karyotyping
18. You are studying a gene involved in diabetes. Which primary database would help you find information about known mutations in this gene?
- A. CATH
 - B. OMIM
 - C. BLAST
 - D. PDB
19. Which of the following best describes the term "genome annotation"?
- A. Designing gene therapies
 - B. Identifying gene locations and functions in a DNA sequence
 - C. Synthesizing new genes
 - D. Amplifying DNA sequences

20. A researcher wants to knock out a gene in mice to study its function. Which method should be used?
- A. PCR
 - B. Northern blot
 - C. CRISPR-Cas9
 - D. Gel electrophoresis
21. In a microarray gene expression analysis, which statistical method is commonly used to correct for multiple testing?
- A. Logistic regression
 - B. Principal component analysis
 - C. Bonferroni or Benjamini-Hochberg correction
 - D. Kaplan-Meier estimator
22. What does a p-value of 0.03 indicate in a hypothesis test?
- A. There is a 3% chance the null hypothesis is true.
 - B. There is a 97% chance the alternative hypothesis is true.
 - C. The null hypothesis is definitely false.
 - D. There is a 3% chance of observing this result if the null hypothesis is true.
23. In PCA, the first principal component (PC1):
- A. Captures the least amount of variance
 - B. Is orthogonal to the data
 - C. Represents the direction of greatest variance in the data
 - D. Is the component with the smallest eigenvalue.
24. Which data structure is best suited to store a list of gene names with functions?
- A. Vector
 - B. Dictionary/Hash
 - C. Matrix
 - D. List
25. What does a *for* loop do in most programming languages?
- A. Repeats a block of code a fixed number of times
 - B. Defines a new function
 - C. Accepts user input
 - D. Prints the output to the screen
26. A die is rolled. What is the probability of getting a number greater than 4?
- A. $1/2$
 - B. $1/3$
 - C. $2/3$
 - D. $1/6$

27. The average mark of 30 students is 72. If the marks of one student were incorrectly recorded as 92 instead of 69, what is the correct average?
 - A. 71.1
 - B. 71.3
 - C. 71.9
 - D. 72.5
28. A PCR reaction doubles the amount of DNA every cycle. How many copies will be produced after 10 cycles starting from a single copy?
 - A. 512
 - B. 1024
 - C. 2048
 - D. 1000
29. If 1 out of every 5000 base pairs mutates during replication, how many mutations would occur in a genome of 3 million base pairs?
 - A. 60
 - B. 300
 - C. 600
 - D. 1200
30. In a population study, the mean heart rate is 72 beats per minute (bpm) with a standard deviation of 8 bpm. Assuming normal distribution, what percentage of individuals fall between 64 and 80 bpm?
 - A. 50%
 - B. 68%
 - C. 95%
 - D. 99%
31. In a population of 1,000 individuals, 360 show a recessive phenotype (aa). Assuming Hardy-Weinberg equilibrium, what is the frequency of the dominant allele (A)?
 - A. 0.4
 - B. 0.6
 - C. 0.8
 - D. 0.5
32. Which of the following is used to define a function in Python?
 - A. `def myfunc():`
 - B. `function myfunc():`
 - C. `func myfunc():`
 - D. `define myfunc():`

33. What is a "tensor" in TensorFlow?
- A. A type of layer in a neural network
 - B. A special data type used only in hardware acceleration
 - C. A data pipeline object
 - D. A multi-dimensional array
34. In proteins, a salt-bridge interaction is formed between ____ and ____ amino acid residues
- A. A, A
 - B. E, K
 - C. E, D
 - D. K, R
35. The "Disallowed region" in the Ramachandran map is the region of ϕ and ψ angles that describe conformations of polypeptide chains having _____ among their non-bonded atoms
- A. no clashes
 - B. electrostatic interactions
 - C. clashes
 - D. hydrogen bonding interactions

PART B

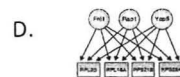
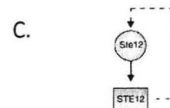
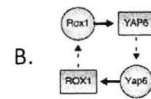
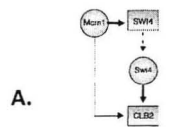
36. Which of the following statements best describes the role of cyclin-dependent kinases (CDKs) in the cell cycle?
- A. CDKs degrade damaged DNA during mitosis
 - B. CDKs activate cyclins to induce apoptosis
 - C. CDKs phosphorylate target proteins to regulate cell cycle progression
 - D. CDKs inhibit transcription factors in the G1 phase
37. Which cell organelle modifies and sorts proteins before they are sent to their destination?
- A. Nucleus
 - B. Endoplasmic reticulum
 - C. Golgi apparatus
 - D. Mitochondria
38. Which of the following is an example of a model organism in developmental biology?
- A. *Elephas maximus*
 - B. *Xenopus laevis*
 - C. *Panthera tigris*
 - D. *Canis lupus familiaris*
39. Which process converts a single-layered blastula into a multilayered structure?
- A. Fertilization
 - B. Cleavage
 - C. Gastrulation
 - D. Organogenesis
40. Which of the following correctly represents the main components of the central (CNS) and peripheral (PNS) nervous systems?
- A. Brain and spinal cord (CNS); nerves and ganglia (PNS)
 - B. Brain and nerves (CNS); spinal cord and ganglia (PNS)
 - C. Spinal cord and ganglia (CNS); brain and nerves (PNS)
 - D. Nerves and brainstem (CNS); spinal cord and ganglia (PNS)
41. Which molecule is released from mitochondria to start the process of apoptosis?
- A. ATP
 - B. Cytochrome c
 - C. DNA polymerase
 - D. Actin

42. What is the main enzyme responsible for adding new nucleotides during DNA replication?
- A. DNA ligase
 - B. RNA polymerase
 - C. DNA helicase
 - D. DNA polymerase
43. Which of the following techniques is correctly matched with the type of molecule it analyzes?
- A. Western blot – RNA
 - B. Northern blot – Protein
 - C. PCR – DNA
 - D. SDS-PAGE – RNA
44. Which class of immunoglobulin is primarily involved in mucosal immunity and is secreted in saliva, tears, and breast milk?
- A. IgG
 - B. IgA
 - C. IgE
 - D. IgM
45. During an adaptive immune response, which of the following is responsible for presenting antigens to helper T cells?
- A. Natural killer (NK) cells
 - B. B cells
 - C. Macrophages
 - D. Dendritic cells
46. What is the main role of the complement system in innate immunity?
- A. To activate T cells directly
 - B. To produce antibodies against pathogens
 - C. To neutralize cytokine signaling
 - D. To opsonize pathogens and form membrane attack complexes
47. Which of the following techniques is commonly used for sequencing DNA?
- A. Western blotting
 - B. PCR
 - C. Sanger sequencing
 - D. Gel electrophoresis

48. Which molecule carries genetic information from DNA to ribosomes?
- A. tRNA
 - B. mRNA
 - C. rRNA
 - D. DNA polymerase
49. Which of the following best describes the Boltzmann distribution?
- A. It gives the probability of a system being in a state of maximum energy.
 - B. It gives the distribution of particle speeds in a gas.
 - C. It describes the probability of a system occupying a state with energy (E) in thermal equilibrium.
 - D. It determines the quantum state of particles in a vacuum.
50. Expect (E) value in BLAST depends on _____
- A. Only on the length of the input sequence
 - B. The length of the input sequence and the size of the database that is being searched
 - C. The % identity of the local alignment between the query and the subject
 - D. Only the size of the database that is being searched
51. The rate of a biochemical reaction operating at substrate concentration below the saturation constant represents?
- A. First order kinetics
 - B. Zero order kinetics
 - C. Second order kinetics
 - D. None of the above
52. A bistable response can be generated from the network structure that has
- A. Double positive feedback loop
 - B. Ultrasensitive positive feedback loop
 - C. Double negative feedback loop
 - D. All of the above
53. What is the fractional rate (v/v_{max}) of an enzymatic reaction if $S = 3 * K_m$?
- A. 0.5
 - B. 0.75
 - C. 1
 - D. 0.25
54. A graph traces a Eulerian path when _____
- A. all the vertices are even
 - B. all the vertices are odd
 - C. there is at least one odd vertex
 - D. there are at least three odd vertices

55. The Needleman-Wunsch algorithm for pair-wise sequence alignment of proteins is an adaptation of ____
- A. Support Vector Machine
 - B. Dynamic Programming
 - C. Random Forest
 - D. Hidden Markov Model
56. AlphaFold is a tool primarily for the prediction of protein ____
- A. secondary structures only
 - B. families
 - C. cellular functions
 - D. tertiary (3D) structures
57. The degree distribution in a typical Random/ER graph is given by ____ function
- A. Power-law
 - B. Poisson mass
 - C. Quadratic
 - D. Exponential
58. Bottlenecks in a network are the top 20 percentile of the nodes having high ____ centrality values
- A. Degree
 - B. Clustering coefficient
 - C. Eigen vector
 - D. Betweenness
59. The degree distribution in a Clique of 5 nodes is best described by the following function
- A. $P(k) = 1.0$ for $k=4$, all other k -values $P(k) = 0.0$
 - B. $P(k) = 1.0$ for all k
 - C. $P(k) = 0.0$ for all k
 - D. $P(k) = 4.0$ for all k
60. Random model of a network fails to explain the ____ real-world networks
- A. Small-world phenomenon of
 - B. The existence of hubs and bottlenecks in
 - C. Peripheral subnetworks associated with
 - D. Robustness against random attacks in

61. Which of the following network motifs represents “Feed-forward Loop” (Image courtesy: Lee *et al* (2002))



62. A ____ is a network in which there are two categories of nodes such that no two pairs of nodes belonging to the same category are connected by an edge.

- A. Monopartite
- B. Bipartite
- C. Tripartite
- D. Quadripartite

63. Which amino acid is most likely to disrupt an α -helix if it appears in the middle of the helix?

- A. Alanine
- B. Valine
- C. Proline
- D. Isoleucine

64. In simple linear regression involving two variables x and y , the equation is usually written as _____. (where a , b , and c are constants)

- A. $y = ax^2 + bx + c$
- B. $y = ax^3 + bx^2 + cx$
- C. $y = ax + b$
- D. $y = x.y + c$

65. What does Levinthal's paradox illustrate?

- A. Proteins fold randomly into their native structure
- B. Protein folding is too fast to be random
- C. Protein folding is a slow process
- D. Folding is driven by enzyme catalysis

66. In Hidden Markov Models (HMMs), used in gene prediction, the hidden states typically represent

- A. Nucleotide frequencies
- B. Observable emissions like GC content
- C. Biological features such as exons, introns, and intergenic regions
- D. The position of sequencing reads

67. Which of the following steps is not typically involved in RNA-Seq data analysis?

- A. Alignment of reads to the reference genome
- B. Quantification of gene expression levels
- C. Differential gene expression analysis
- D. Protein structure prediction

68. In the given MSA, which sites are informative for constructing tree using maximum parsimony method?

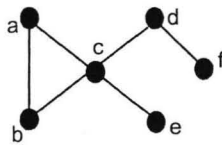
	1	2	3	4	5	6	7	8	9	10
SeqA	A	G	G	T	A	A	C	T	G	G
SeqB	A	C	G	T	T	A	T	T	A	A
SeqC	A	T	A	T	T	G	T	C	T	A
SeqD	A	A	T	T	T	G	T	C	G	G

- A. 6, 8, 10
- B. 2, 9, 10
- C. 4, 6, 9
- D. 2, 3, 6

69. 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

70. What is the diameter of the graph below?



- A. 1
- B. 2
- C. 3
- D. 4

Rough work

E-23

University of Hyderabad

Entrance Examinations - 2025

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

Course/Subject : Systems and Computational Biology

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

Note/Remarks :



Signature

School/Department/Centre

अध्यक्ष / HEAD

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