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PD - 33

Total No. of Pages : 14

Ph.d Entrance Examination March - April, 2026
Biotechnology Engineering
Subject Code: 58838

Day and Date : Tuesday, 06-10-2026

Total Marks : 100

Time : 10.00 a.m. to 12.00 p.m.

Instructions :

- 1) All questions are compulsory.
 - 2) Each question carries 2 marks.
 - 3) Answers should be marked in the given OMR answer sheet by darkening the appropriate option.
 - 4) Use black ball point pen only for marking the circle. Do not make any stray mark on the OMR answer sheet.
 - 5) Follow the instructions given on OMR Sheet.
 - 6) Rough work shall be done on the sheet provided at the end of question paper.
 - 7) Only non-programmable calculators are allowed.
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Section-I

Research Methodology

1. Which type of research is primarily concerned with formulating a theory or contributing to general knowledge rather than immediate practical application?
 - a) Applied research
 - b) Basic research
 - c) Action research
 - d) Empirical research
2. A proposition that is accepted without proof and acts as a foundational premise for further reasoning is known as a(n):
 - a) Hypothesis
 - b) Axiom
 - c) Variable
 - d) Corollary

3. "Translational research" in biotechnology specifically focuses on:
 - a) Translating research papers into multiple languages
 - b) Translating mRNA into proteins in vitro
 - c) Moving basic laboratory findings into practical healthcare or industrial applications
 - d) Theoretical analysis of computational genome databases
4. Which type of research aims at finding an immediate solution for an urgent practical problem faced by society or industry?
 - a) Applied research
 - b) Pure research
 - c) Fundamental research
 - d) Historical research.
5. In industrial biotechnology, the progression from concept generation to a marketable product is typically described as:
 - a) Serendipity loop
 - b) Lab-to-market pipeline
 - c) Downstream-only design
 - d) Uncontrolled empirical progression
6. Which characteristic of biological systems often poses the biggest challenge to reproducibility in biotech experiments?
 - a) High molecular weight
 - b) Inherent biological variation and environmental sensitivity
 - c) Inability to be genetically sequenced
 - d) Lack of defined chemical reactions

7. Which database is the primary open-access biomedical literature search engine maintained by the NCBI?
- a) ScienceDirect
 - b) PubMed
 - c) Scopus
 - d) IEEE Xplore
8. An exploratory research design is most suitable when:
- a) The problem is well-defined and final decisions are to be taken
 - b) Little is known about the research problem and initial insights are needed
 - c) A precise cause-and-effect relationship must be verified mathematically
 - d) The commercial production line is already running
9. The closeness of agreement between independent test results obtained under stipulated conditions is defined as:
- a) Accuracy
 - b) Precision
 - c) Sensitivity
 - d) Specificity
10. A diagnostic assay's ability to correctly identify individuals who do NOT have the disease (true negative rate) is its:
- a) Specificity
 - b) Sensitivity
 - c) Accuracy
 - d) Detection limit
11. Which variable is deliberately manipulated by an investigator to observe its effect on an outcome?
- a) Dependent variable
 - b) Independent variable
 - c) Confounding variable
 - d) Extraneous variable

12. In an enzyme kinetics assay, enzyme activity is typically quantified by measuring:
- a) Rate of change in substrate or product concentration over time
 - b) Total molecular weight of the enzyme
 - c) The boiling point of the reaction buffer
 - d) The half-life of stable isotopes in the buffer
13. In sandwich EL ISA, the secondary enzyme-conjugated antibody binds directly to:
- a) The microtiter plate plastic directly
 - b) A distinct epitope on the target antigen
 - c) The primary capture antibody's variable region
 - d) The stop solution
14. An experimental artifact is defined as:
- a) An unexpected true biological phenomenon
 - b) An erroneous finding caused by technical or procedural distortions
 - c) A validated control sample
 - d) A patented lab instrument
15. Why is publishing or properly documenting negative results critical in scientific research?
- a) It fulfills legal requirements for obtaining trademarks
 - b) It prevents unnecessary duplication of failed pathways and avoids publication bias
 - c) It guarantees immediate peer-reviewed journal acceptance
 - d) It replaces the need for positive controls

16. Which measure of central tendency is least sensitive to extreme outliers?
- a) Arithmetic mean
 - b) Geometric mean
 - c) Median
 - d) Mid-range
17. The standard deviation of the sampling distribution of a statistic is formally called the:
- a) Variance
 - b) Standard error
 - c) Coefficient of variation
 - d) Mean deviation
18. Which probability distribution is characterized by an equal mean and variance ($\mu = \sigma^2$)?
- a) Binomial distribution
 - b) Normal distribution
 - c) Poisson distribution
 - d) Uniform distribution
19. In a standard normal distribution, approximately what percentage of data falls within ± 2 standard deviations of the mean?
- a) 68.2%
 - b) 90.0%
 - c) 95.4%
 - d) 99.7%
20. Pearson's correlation coefficient (r) ranges between:
- a) 0 and 1
 - b) -1 and +1
 - c) $-\infty$ and $+\infty$
 - d) -0.5 and +0.5
21. Analysis of Variance (ANOVA) is primarily used to:
- a) Compare means among three or more groups simultaneously
 - b) Test the dependency between two categorical variables
 - c) Replace linear regression completely
 - d) Determine the sample mode

22. Rejecting a true null hypothesis (H_0) constitutes a:
- a) Type I error (α)
 - b) Type II error (β)
 - c) Standard deviation error
 - d) Power failure
23. Which statistical test is most appropriate to evaluate differences in proportions between categorical variables?
- a) Student's t-test
 - b) Pearson's Chi-square test
 - c) Paired t-test
 - d) Mann-Whitney U test
24. In linear regression analysis ($y = mx + c$), the slope 'm' indicates:
- a) The value of y when $x = 0$
 - b) The predicted change in y for a one-unit change in x
 - c) The coefficient of determination
 - d) The total experimental error
25. A p-value less than 0.05 in a hypothesis test indicates that:
- a) The null hypothesis is completely proven true
 - b) There is less than a 5% probability that the observed result occurred by random chance under H_0
 - c) 95% of the data gathered is invalid
 - d) The experimental design was fundamentally flawed

Section-II

BIOTECHNOLOGY ENGINEERING CORE

26. In Michaelis-Menten enzyme kinetics, the constant K_m represents the substrate concentration at which:
- a) Reaction rate is zero
 - b) Reaction rate reaches V_{max}
 - c) Reaction velocity is half of V_{max}
 - d) The enzyme undergoes irreversible denaturation
27. During the eukaryotic cell cycle, DNA replication occurs exclusively during the:
- a) G_1 phase
 - b) S phase
 - c) G_2 phase
 - d) M phase
28. Which analytical spectroscopy technique relies on vibrations of molecular bonds to yield structural fingerprints?
- a) UV-Visible spectroscopy
 - b) FTIR spectroscopy
 - c) Atomic absorption spectroscopy
 - d) Flow cytometry
29. In size-exclusion (gel filtration) chromatography, molecules elute in what order?
- a) Smallest molecules first
 - b) Largest molecules first
 - c) Positively charged molecules first
 - d) Hydrophobic molecules first
30. Which antibody class is secreted as a pentamer and acts as the primary antibody during initial antigen exposure?
- a) IgG
 - b) IgE
 - c) IgM
 - d) IgA

31. Major Histocompatibility Complex class I (MHC-I) molecules present endogenous peptides directly to:
- a) CD4+ Helper T cells
 - b) CD8+ Cytotoxic T cells
 - c) B cell receptors
 - d) Natural killer cell receptors exclusively
32. The BLAST algorithm is widely employed in bioinformatics to:
- a) Model 3D protein folding from scratch
 - b) Perform local sequence alignment and similarity searches
 - c) Predict thermodynamic stability of membrane liposomes
 - d) Automate Sanger sequencing chromatograms
33. Which scoring matrix is best suited for identifying sequence similarity between highly divergent protein sequences?
- a) BLOSUM80
 - b) BLOSUM62
 - c) BLOSUM45
 - d) PAM30
34. Type II restriction endonucleases are preferred in genetic engineering because they:
- a) Cleave non-specifically at random distances from their binding site
 - b) Cleave at defined positions within or directly adjacent to specific palindromic sequences
 - c) Require both ATP and S-adenosylmethionine to catalyze cuts
 - d) Only digest single-stranded RNA targets

35. The vir genes responsible for transferring T-DNA into plant nuclear genomes are located on the:
- a) Host plant nuclear chromosome
 - b) Agrobacterium Ti plasmid
 - c) Bacterial main chromosome
 - d) Tobacco mosaic virus RNA
36. In plant tissue culture, a high ratio of cytokinin to auxin in the growth media promotes:
- a) Root development (rhizogenesis)
 - b) Shoot regeneration (caulogenesis)
 - c) Induction of plant dormancy
 - d) Immediate cell apoptosis
37. Hybridoma technology developed by Köhler and Milstein is used for the commercial synthesis of:
- a) Recombinant human insulin
 - b) Polyclonal antiserum
 - c) Monoclonal antibodies
 - d) Attenuated viral vaccines
38. The primary engineering goal of the upstream bioprocess phase is to:
- a) Purify proteins via fractional precipitation
 - b) Optimize host growth, medium composition, and target product synthesis in bioreactors
 - c) Lyse and clarify cell debris
 - d) Crystallize final therapeutic APIs
39. For Newtonian fluids, shear stress is directly proportional to:
- a) Square of fluid velocity
 - b) Shear rate (velocity gradient)
 - c) Fluid density squared
 - d) Reynolds number

40. Flow through a smooth circular pipe is considered fully laminar when the Reynolds number (Re) is:
- a) Less than 2,100
 - b) Between 4,000 and 10,000
 - c) Greater than 10,000
 - d) Exactly 300,000
41. The Hagen-Poiseuille equation calculates pressure drop for:
- a) Fully developed turbulent flow in packed columns
 - b) Steady laminar flow of an incompressible Newtonian fluid through a horizontal pipe
 - c) Compressible gas dynamics in fluidized beds
 - d) Centrifugal fluid distribution across microfilters
42. Which filtration membrane mechanism primarily separates proteins based strictly on molecular size cutoffs (MWCO)?
- a) Microfiltration
 - b) Ultrafiltration
 - c) Reverse osmosis
 - d) Coarse clarification
43. According to Fick's First Law, diffusive mass flux (1) is directly proportional to the:
- a) Absolute system pressure
 - b) Concentration gradient (dC/dx)
 - c) Viscosity of the solute squared
 - d) Surface tension of the interface
44. A thermodynamic process during which no heat enters or leaves the system ($Q = 0$) is defined as:
- a) Isothermal
 - b) Isobaric
 - c) Adiabatic
 - d) Isochoric

45. Which of the following thermodynamic state variables is an intensive property?
- a) Mass
 - b) Volume
 - c) Temperature
 - d) Total Enthalpy
46. In an ideal continuous stirred-tank reactor (CSTR) operating at steady state, conditions within the vessel are:
- a) Varying continuously along the reactor length
 - b) Completely uniform and identical to the exit stream
 - c) Subject to progressive dead-zone accumulation
 - d) Rapidly oscillating in substrate concentration
47. When the effectiveness factor (η) of an immobilized biocatalytic particle is much less than 1 ($\eta, \ll 1$), the reaction rate is:
- a) Limited by internal pore diffusion resistances
 - b) Limited strictly by intrinsic chemical kinetic turnover
 - c) Independent of particle diameter
 - d) Operating at infinite velocity
48. In biological nuclear magnetic resonance (NMR) spectroscopy, which atomic nucleus is NOT NMR-active?
- a) ^1H
 - b) ^{13}C
 - c) ^{12}C
 - d) ^{31}P
49. Differential Scanning Calorimetry (DSC) is applied in biophysics to monitor:
- a) Electrophoretic mobility of polynucleotides
 - b) Heat capacity changes and thermal denaturation temperatures of biomolecules
 - c) Radiolytic degradation pathways in nucleic acids
 - d) Light absorption in the far-UV spectrum

50. In isoelectric focusing (IEF), proteins migrate until they reach a pH region where their:

- a) Net electrical charge is zero
- b) Molecular weight reaches minimum resistance
- c) Hydrophobic patches are completely exposed
- d) Disulfide bonds are fully reduced



- Rough Work -

- Rough Work -