

Test Booklet Series



Test Booklet
(Biotechnology)

Test Booklet No.

Name of Applicant

Answer Sheet No.

Applicant ID/Roll No. :

Signature of Applicant :

Date of Examination :

Signature of the Invigilator(s)

Time of Examination :

1.

2.

Duration : 2 Hour]

[Maximum Marks : 100

IMPORTANT INSTRUCTIONS

- (i) The question paper is in the form of Test-Booklet containing **100 (Hundred)** questions. All questions are compulsory. Each question carries four answers marked (A), (B), (C) and (D), out of which only one is correct. Choose the correct option or the most appropriate option.
- (ii) On receipt of the Test-Booklet (Question Paper), the candidate should immediately check it and ensure that it contains all the pages, i.e., **100** questions. Discrepancy, if any, should be reported by the candidate to the invigilator immediately after receiving the Test-Booklet.
- (iii) A separate Answer-Sheet is provided with the Test-Booklet/Question Paper. On this sheet there are **100** rows containing four circles each. One row pertains to one question.
- (iv) The candidate should write his/her Application ID/Roll number at the places provided on the cover page of the Test-Booklet/Question Paper and on the Answer-Sheet and NOWHERE ELSE.
- (v) No second Test-Booklet/Question Paper and Answer-Sheet will be given to a candidate. The candidates are advised to be careful in handling it and writing the answer on the Answer-Sheet.
- (vi) For every correct answer of the question **One (1) mark will be awarded**.
- (vii) Marking shall be done only on the basis of answers responded on the Answer-Sheet.
- (viii) To mark the answer on the Answer-Sheet, candidate should darken the appropriate circle in the row of each question with Blue or Black pen.
- (ix) For each question only **one** circle should be **darkened** as a mark of the answer adopted by the candidate. If more than one circle for the question are found darkened or with one black circle any other circle carries any mark, the answer will be treated as incorrect.
- (x) The candidates should not remove any paper from the Test-Booklet/Question Paper. Attempting to remove any paper shall be liable to be punished for use of unfair means.
- (xi) Rough work may be done on the blank space provided in the Test-Booklet/Question Paper only.
- (xii) *Mobile phones (even in Switch-off mode) and such other communication/programmable devices are not allowed inside the examination hall.*
- (xiii) No candidate shall be permitted to leave the examination hall before the expiry of the time.

DO NOT OPEN THIS QUESTION BOOKLET UNTIL ASKED TO DO SO.

PART-A
(Research Methodology)

1. The main objective of fundamental/basic research is:
(A) To solve an immediate practical problem
(B) To discover new facts and develop theories
(C) To evaluate existing social programs
(D) To study historical events

2. The scientific method of research is characterized by:
(A) Subjectivity and intuition
(B) Empiricism, objectivity, and replicability
(C) Relying solely on authority
(D) Lack of logical reasoning

3. While selecting a research topic, which of the following is the LEAST important consideration?
(A) Feasibility of the study
(B) Researcher's interest
(C) Availability of funds and time
(D) Personal biases of the researcher

4. The ethical principle of "Informed Consent" implies that:
(A) Participants must be forced to participate for the greater good
(B) Participants must be fully aware of the research procedures and agree voluntarily
(C) Researchers can hide the true purpose of the study to avoid bias
(D) Data can be shared publicly without participant knowledge

5. Fabrication, falsification, and plagiarism in research are collectively known as:
(A) Research misconduct
(B) Sampling error
(C) Ethical compliance
(D) Research methodology

6. Which research design is primarily concerned with describing the characteristics of a population or phenomenon?
(A) Exploratory research design
(B) Descriptive research design
(C) Experimental research design
(D) Diagnostic research design

7. In an experimental research design, the variable that is intentionally manipulated by the researcher is the:
(A) Dependent variable
(B) Extraneous variable
(C) Independent variable
(D) Control variable

8. Research conducted to find out the causes of an event that has already happened, without manipulating variables, is known as:
- (A) Action research (B) Ex-post facto research
(C) Applied research (D) Pure research
9. The "Control Group" in an experimental design is used to:
- (A) Introduce the experimental treatment
(B) Serve as a baseline for comparison with the experimental group
(C) Eliminate the dependent variable
(D) Increase the sample size
10. Deductive reasoning in the scientific method moves from:
- (A) Specific observations to general theories
(B) General theories to specific hypotheses
(C) Empirical data to conceptualization
(D) Null hypothesis to alternative hypothesis
11. Internal validity in an experimental design refers to:
- (A) The generalizability of the findings to the real world
(B) The certainty that the independent variable caused the changes in the dependent variable
(C) The consistency of the measuring instrument
(D) The representativeness of the sample
12. If every member of the population has an equal and independent chance of being selected, the sampling technique is called:
- (A) Purposive sampling (B) Convenience sampling
(C) Simple random sampling (D) Quota sampling
13. When the population is heterogeneous with distinct subgroups (strata), the most appropriate probability sampling technique is:
- (A) Simple random sampling (B) Stratified random sampling
(C) Cluster sampling (D) Snowball sampling

- 14.** In cluster sampling, the sampling units selected are:
- (A) Individual elements
 - (B) Natural groupings or categories (e.g., districts, schools)
 - (C) Homogeneous subgroups
 - (D) Volunteers
- 15.** Snowball sampling is specifically used when:
- (A) The population size is very large
 - (B) The sampling frame is readily available
 - (C) The population is hidden, rare, or difficult to access
 - (D) The researcher needs a perfectly representative sample
- 16.** The difference between a sample statistic and the true population parameter is termed as:
- (A) Systematic error
 - (B) Sampling error
 - (C) Measurement error
 - (D) Non-sampling error
- 17.** Which measurement scale classifies data into mutually exclusive categories without any order or ranking?
- (A) Ordinal scale
 - (B) Interval scale
 - (C) Nominal scale
 - (D) Ratio scale
- 18.** A Likert scale (Strongly Disagree to Strongly Agree) is technically an example of:
- (A) Nominal scale
 - (B) Ordinal scale
 - (C) Interval scale
 - (D) Ratio scale
- 19.** Which scaling technique asks respondents to rate an object on a series of bipolar adjectives (e.g., Good-Bad, Fast-Slow)?
- (A) Likert scale
 - (B) Guttman scale
 - (C) Semantic Differential scale
 - (D) Thurstone scale

- 20.** The key difference between a questionnaire and a schedule is:
- (A) A questionnaire is filled by the enumerator, a schedule is filled by the respondent
 - (B) A questionnaire is filled by the respondent, a schedule is filled by the enumerator/interviewer
 - (C) A schedule is mailed, a questionnaire is given face-to-face
 - (D) There is no difference between them
- 21.** Data collected by the researcher themselves for the specific purpose of the current study is called:
- (A) Secondary data
 - (B) Primary data
 - (C) Official data
 - (D) Documentary data
- 22.** The process of checking the raw data to ensure completeness, accuracy, and consistency before analysis is called:
- (A) Coding
 - (B) Editing
 - (C) Tabulation
 - (D) Classification
- 23.** Assigning numerical values or symbols to the responses for computational purposes is known as:
- (A) Editing
 - (B) Coding
 - (C) Transcription
 - (D) Tabulation
- 24.** A histogram is used to graphically represent the distribution of:
- (A) Discrete/categorical data
 - (B) Continuous data grouped into class intervals
 - (C) Qualitative characteristics
 - (D) Proportions of a whole
- 25.** A pie chart is most effective for representing:
- (A) Trends over time
 - (B) The relationship between two continuous variables
 - (C) The percentage breakdown of a whole
 - (D) Frequency distribution of continuous data

26. A hypothesis that states there is no significant difference or relationship is called:
- (A) Directional hypothesis
 - (B) Non-directional hypothesis
 - (C) Null hypothesis
 - (D) Alternative hypothesis
27. "Students who study using method A will score significantly higher than those who study using method B." This is an example of:
- (A) Null hypothesis
 - (B) Directional alternative hypothesis
 - (C) Non-directional alternative hypothesis
 - (D) Ex-post facto hypothesis
28. A Type I error in hypothesis testing occurs when:
- (A) We fail to reject a true null hypothesis
 - (B) We reject a true null hypothesis
 - (C) We fail to reject a false null hypothesis
 - (D) We reject a false null hypothesis
29. The probability of committing a Type I error is denoted by:
- (A) Beta (β)
 - (B) Alpha (α)
 - (C) P-value
 - (D) Standard error
30. A statistical test that makes assumptions about the population parameters (like normal distribution, homogeneity of variance) is called:
- (A) Non-parametric test
 - (B) Parametric test
 - (C) Chi-square test
 - (D) Distribution-free test
31. The Chi-square (χ^2) test is primarily used to test:
- (A) The difference between means of two groups
 - (B) The association between two categorical variables
 - (C) The significance of regression coefficients
 - (D) The variance within a single group

32. In a Chi-square test of independence, if the calculated value of χ^2 is greater than the critical/ table value at the 0.05 level, we:
- (A) Accept the null hypothesis
 - (B) Reject the null hypothesis
 - (C) Conclude the variables are independent
 - (D) Conclude the sample is biased
33. The formula for calculating expected frequency (E) in a Chi-square contingency table cell is:
- (A) (Row Total $\times$ Column Total) / Grand Total
 - (B) (Row Total + Column Total) / Grand Total
 - (C) Grand Total / (Row Total $\times$ Column Total)
 - (D) Row Total / Column Total
34. Analysis of Variance (ANOVA) is used instead of multiple t-tests to compare the means of three or more groups because:
- (A) ANOVA is easier to calculate
 - (B) Multiple t-tests increase the risk of Type I error
 - (C) ANOVA does not require normal distribution
 - (D) ANOVA uses nominal data
35. In a one-way ANOVA, the "one way" refers to:
- (A) One dependent variable and one independent variable with multiple levels
 - (B) One independent variable and multiple dependent variables
 - (C) Only one sample being tested
 - (D) One-tailed test of significance
36. The F-ratio in One-way ANOVA is calculated as:
- (A) Within-group variance / Between-group variance
 - (B) Between-group variance / Within-group variance
 - (C) Total variance / Residual variance
 - (D) Mean square error / Mean square total
37. The degrees of freedom for "Between Groups" in a One-Way ANOVA with 'k' groups is:
- (A) $N - 1$
 - (B) $N - k$
 - (C) $k - 1$
 - (D) $(N - 1) - (k - 1)$

38. Which of the following is a non-parametric alternative to One-way ANOVA?
- (A) Kruskal-Wallis test (B) Mann-Whitney U test
(C) Wilcoxon signed-rank test (D) Chi-square goodness of fit
39. A multivariate statistical technique used to reduce a large number of interrelated variables to a smaller set of unobservable factors is:
- (A) Cluster Analysis (B) Factor Analysis
(C) Discriminant Analysis (D) Conjoint Analysis
40. In Factor Analysis, the proportion of variance in a specific variable explained by the common factors is called:
- (A) Communality (B) Eigenvalue
(C) Factor loading (D) Uniqueness
41. Which concept in Factor Analysis represents the total variance explained by a specific factor across all variables?
- (A) Communality (B) Eigenvalue
(C) Factor score (D) Rotation
42. Multiple Regression is used to:
- (A) Classify objects into groups
(B) Predict the value of a dependent variable based on two or more independent variables
(C) Reduce the number of variables
(D) Determine the association between two categorical variables
43. In Multiple Regression, the coefficient of multiple determination (R^2) represents:
- (A) The correlation between two independent variables
(B) The proportion of variance in the dependent variable explained by all independent variables
(C) The regression coefficient of the strongest predictor
(D) The standard error of the estimate
44. Pearson's correlation coefficient (r) measures:
- (A) The causal relationship between two variables
(B) The linear association between two continuous variables
(C) The association between two categorical variables
(D) The variance of a single variable

45. If the Pearson correlation coefficient between X and Y is -0.85 , it indicates:
- (A) A weak positive relationship (B) A strong positive relationship
(C) A strong negative relationship (D) No relationship
46. Which multivariate technique is used to group objects or individuals so that objects in the same group are highly similar to each other but different from objects in other groups?
- (A) Discriminant Analysis (B) Factor Analysis
(C) Cluster Analysis (D) Conjoint Analysis
47. The main difference between Cluster Analysis and Discriminant Analysis is that:
- (A) Cluster analysis requires predefined groups, discriminant analysis does not
(B) Discriminant analysis requires predefined groups, cluster analysis does not
(C) Cluster analysis uses metric data, discriminant analysis uses non-metric
(D) Discriminant analysis is for data reduction, cluster analysis is for prediction
48. Conjoint Analysis is primarily used in marketing research to:
- (A) Determine the optimal number of clusters
(B) Measure how consumers value different features of a product by analyzing trade-offs
(C) Reduce the dimensions of product features
(D) Classify customers into predefined demographic groups
49. The standard format for writing a quantitative research report is generally known by the acronym:
- (A) IMRAD (Introduction, Method, Results, And Discussion)
(B) PEST (Political, Economic, Social, Technological)
(C) SWOT (Strengths, Weaknesses, Opportunities, Threats)
(D) APA (American Psychological Association)
50. Which section of the research report contains a brief summary of the entire study, including the problem, methodology, major findings, and conclusions?
- (A) Introduction (B) Abstract/Executive Summary
(C) Literature Review (D) Discussion

PART-B
(Biotechnology)

- 51.** Which checkpoint ensures DNA has been completely replicated before mitosis?
(A) G1 checkpoint (B) G2 checkpoint
(C) Metaphase checkpoint (D) Cytokinesis checkpoint
- 52.** A receptor activates phospholipase C after ligand binding. Which pair of second messengers is produced directly?
(A) cAMP and Ca^{2+} (B) cGMP and NO
(C) IP_3 and DAG (D) ATP and ADP
- 53.** Which of the following observations would most strongly suggest activation of the intrinsic apoptotic pathway?
(A) Release of cytochrome c from mitochondria followed by activation of caspase-9
(B) Activation of death receptors and caspase-8
(C) Activation of Bcl-2 and inhibition of cytochrome c release
(D) Activation of NF- κ B leading to cell survival
- 54.** A mammalian cell contains a mutation that prevents phosphorylation of the Retinoblastoma (Rb) protein. Which phase of the cell cycle will most likely be affected?
(A) G2 phase (B) M phase
(C) G1 to S phase transition (D) Cytokinesis
- 55.** Which tumor suppressor induces cell cycle arrest following DNA damage?
(A) Ras (B) Myc
(C) p53 (D) Akt
- 56.** During DNA replication, DNA polymerase III encounters an RNA primer synthesized on the lagging strand. Which enzyme removes this primer in *Escherichia coli*?
(A) DNA polymerase III (B) Primase
(C) DNA ligase (D) DNA polymerase I

- 57.** In eukaryotes, transcriptional initiation by RNA polymerase II requires which general transcription factor to bind directly to the TATA box?
- (A) TFIID (TBP) (B) TFIIB
(C) TFIIE (D) TFIIF
- 58.** Which DNA repair pathway primarily corrects UV-induced thymine dimers in human cells?
- (A) Nucleotide excision repair (B) Base excision repair
(C) Mismatch repair (D) Homologous recombination
- 59.** The 5' cap of eukaryotic mRNA is added by
- (A) Poly(A) polymerase (B) RNA polymerase II
(C) Sigma factor (D) Guanylyl transferase
- 60.** Which enzyme has both 5'-3' and 3-5' exonuclease activity?
- (A) DNA Polymerase I (B) DNA Polymerase II
(C) DNA Polymerase III (D) RNA Polymerase II
- 61.** A mutation changes the Shine-Dalgarno sequence of a bacterial mRNA without affecting the coding region. Which process will be primarily affected?
- (A) Transcription initiation (B) Translation initiation
(C) mRNA splicing (D) Protein folding
- 62.** A bacterial operon is negatively regulated by a repressor and positively regulated by CAP-cAMP. Under which condition will expression of the operon be maximal?
- (A) High glucose, no lactose (B) High glucose, high lactose
(C) Low glucose, high lactose (D) Low glucose, no lactose
- 63.** Which of the following would most likely increase the half-life of a eukaryotic mRNA?
- (A) Removal of the 5' cap
(B) Removal of the poly(A) tail
(C) Splicing of introns
(D) Increased binding of poly(A)-binding proteins

64. A researcher deletes the gene encoding eIF2 in yeast. Which cellular process will be most directly impaired?
- (A) DNA replication (B) RNA processing
(C) Initiation of protein synthesis (D) Protein degradation
65. Enhancers are DNA sequences that
- (A) Inhibit translation (B) Increase transcription
(C) Terminate transcription (D) Replicate DNA
66. A patient with defective nucleotide excision repair is expected to be highly susceptible to
- (A) Xeroderma pigmentosum (B) Down syndrome
(C) Sickle-cell anemia (D) Phenylketonuria
67. A newly discovered mutagen predominantly causes insertion of a single nucleotide into coding sequences. Which mutation is most likely to result?
- (A) Silent mutation (B) Missense mutation
(C) Frameshift mutation (D) Neutral mutation
68. Which experimental observation provides the strongest evidence that a phenotype is caused by epigenetic modification rather than DNA sequence mutation?
- (A) The mutation is inherited through meiosis.
(B) A chromosome deletion is detected by karyotyping.
(C) DNA sequencing reveals a base substitution.
(D) Treatment with a DNA demethylating agent restores the normal phenotype.
69. A population is in Hardy-Weinberg equilibrium with allele frequencies $p = 0.7$ and $q = 0.3$. What is the expected frequency of heterozygotes?
- (A) 0.09 (B) 0.21
(C) 0.42 (D) 0.49

70. DNA methylation usually results in
- (A) Gene silencing
 - (B) Increased expression
 - (C) Chromatin relaxation
 - (D) Histone degradation
71. A bacterial culture growing in a glucose-rich medium is shifted to a lactose-containing medium. Growth temporarily ceases before resuming. This phenomenon is known as
- (A) Catabolite repression
 - (B) Balanced growth
 - (C) Synchronous growth
 - (D) Diauxic growth
72. An auxotrophic mutant differs from its wild-type counterpart because it
- (A) Cannot replicate DNA.
 - (B) Has a defective ribosome.
 - (C) Requires an additional nutrient that the wild type can synthesize.
 - (D) Cannot perform glycolysis
73. Which environmental condition is expected to produce the highest ATP yield during glucose metabolism in *Escherichia coli*?
- (A) Anaerobic fermentation
 - (B) Nitrate respiration
 - (C) Aerobic respiration
 - (D) Lactic acid fermentation
74. A bacterial strain doubles every 30 minutes. Assuming unlimited nutrients, how many cells will be present after 3 hours if the initial population is 1×10^6 cells?
- (A) 8×10^6
 - (B) 16×10^6
 - (C) 32×10^6
 - (D) 64×10^6
75. During lag phase, cells mainly
- (A) Divide rapidly
 - (B) Adapt to new environment
 - (C) Sporulate
 - (D) Die
76. Which parameter is most likely to decrease first if oxygen transfer becomes limiting in an aerobic fermenter?
- (A) Culture volume
 - (B) Biomass productivity
 - (C) pH
 - (D) Agitation speed

77. A plasmid vector contains the lacZ α gene with a multiple cloning site (MCS). White colonies on X-gal/IPTG plates most likely indicate:
- (A) Plasmids without inserts
 - (B) Successful insertion of foreign DNA
 - (C) Cells lacking plasmids
 - (D) Loss of antibiotic resistance
78. Secondary metabolites are generally produced during:
- (A) Stationary phase
 - (B) Lag phase
 - (C) Exponential phase
 - (D) Death phase
79. A chemostat maintains microbial growth under
- (A) Batch conditions
 - (B) Continuous culture
 - (C) Anaerobic conditions
 - (D) Static conditions
80. During industrial production of penicillin, glucose is supplied gradually rather than at high concentration because excess glucose:
- (A) Increases contamination.
 - (B) Prevents oxygen transfer.
 - (C) Denatures enzymes.
 - (D) Suppresses secondary metabolite synthesis through catabolite repression.
81. Which bioreactor is commonly used for animal cell culture?
- (A) Packed-bed reactor
 - (B) Trickling filter
 - (C) Airlift bioreactor
 - (D) Rotating drum
82. Agitation in a bioreactor primarily improves:
- (A) Mixing and oxygen transfer
 - (B) DNA synthesis
 - (C) Sporulation
 - (D) Mutation frequency
83. Sterilization of bioreactors is usually done by
- (A) UV light
 - (B) Alcohol
 - (C) Formaldehyde
 - (D) Steam

- 84.** During scale-up of an aerobic fermentation from a 5-L laboratory fermenter to a 5000-L industrial fermenter, which parameter is generally the most difficult to maintain?
- (A) Temperature (B) pH
(C) Oxygen transfer coefficient (kLa) (D) Culture volume
- 85.** In an aerobic stirred-tank bioreactor, increasing agitation speed primarily results in:
- (A) Reduced oxygen transfer
(B) Increased oxygen transfer but higher shear stress
(C) Lower power consumption
(D) Lower mixing efficiency
- 86.** During fermentation, the dissolved oxygen (DO) suddenly decreases while pH and temperature remain constant. The most likely explanation is:
- (A) Increased microbial respiration due to rapid cell growth
(B) Culture contamination by bacteriophage
(C) Failure of the pH probe
(D) Nutrient depletion
- 87.** Which parameter is most appropriate for evaluating the efficiency of oxygen transfer in an industrial fermenter?
- (A) Reynolds number
(B) Biomass concentration
(C) Michaelis constant (K_m)
(D) Volumetric oxygen transfer coefficient (kLa)
- 88.** Which strategy is most appropriate for increasing antibiotic production in an industrial microbial strain?
- (A) Random mutagenesis followed by screening for overproducing mutants
(B) Reducing aeration
(C) Increasing mutation rate without selection
(D) Continuous cultivation without monitoring

- 89.** A recombinant protein has an isoelectric point (pI) of 9.2. At pH 7.0, the protein will:
- (A) Carry a net negative charge and bind to an anion exchanger.
 - (B) Carry a net positive charge and bind to a cation exchanger.
 - (C) Have no net charge.
 - (D) Be denatured.
- 90.** A researcher wants to separate proteins solely based on molecular size while preserving their native structure. Which technique is most appropriate?
- (A) SDS-PAGE
 - (B) Ion-exchange chromatography
 - (C) Size-exclusion (gel filtration) chromatography
 - (D) Affinity chromatography
- 91.** A protein specifically binds to immobilized Protein A during purification. This method is an example of:
- (A) Ion-exchange chromatography
 - (B) Hydrophobic interaction chromatography
 - (C) Reverse-phase chromatography
 - (D) Affinity chromatography
- 92.** A researcher performs PCR using a high-fidelity DNA polymerase instead of Taq polymerase. The primary advantage is:
- (A) Lower mutation rate due to 3' → 5' exonuclease proofreading activity
 - (B) Faster amplification
 - (C) Ability to amplify RNA directly
 - (D) Higher primer specificity due to helicase activity
- 93.** Sanger sequencing uses:
- (A) rNTPs
 - (B) dNTPs
 - (C) ddNTPs
 - (D) ATPs

- 94.** DNA ligase catalyzes the formation of:
- (A) Hydrogen bonds
 - (B) Glycosidic bonds
 - (C) Peptide bonds
 - (D) Phosphodiester bonds
- 95.** Which cloning vector can accommodate the largest DNA insert?
- (A) BACs
 - (B) pUC19
 - (C) λ Phage
 - (D) pBR322
- 96.** Which cytokine is primarily responsible for clonal expansion of activated T lymphocytes?
- (A) IL-4
 - (B) IL-2
 - (C) IFN- γ
 - (D) TNF- α
- 97.** Which statement best distinguishes innate immunity from adaptive immunity?
- (A) Innate immunity responds rapidly using germline-encoded receptors, whereas adaptive immunity generates highly specific responses with memory.
 - (B) Innate immunity exhibits immunological memory.
 - (C) Adaptive immunity is antigen-independent.
 - (D) Adaptive immunity functions without antigen presentation.
- 98.** The antigen-binding site is present in the:
- (A) Fc region
 - (B) Fab region
 - (C) Constant region
 - (D) Hinge region
- 99.** Which immunoglobulin crosses the placenta?
- (A) IgA
 - (B) IgM
 - (C) IgE
 - (D) IgG
- 100.** Toll-like receptors are involved in:
- (A) Innate immune recognition
 - (B) Adaptive immunity only
 - (C) Antibody secretion
 - (D) Complement inhibition

ROUGH WORK

ROUGH WORK