

MIZORAM PUBLIC SERVICE COMMISSION
TECHNICAL COMPETITIVE EXAMINATIONS FOR ENTOMOLOGIST
UNDER HEALTH & FAMILY WELFARE DEPARTMENT,
GOVERNMENT OF MIZORAM, FEBRUARY-2024

PAPER-V
(TECHNICAL PAPER)

Time Allowed : 3 hours

FM : 200

SECTION - A (Multiple Choice questions) (100 Marks)

All questions carry equal mark of 2 each. Attempt all questions.

*This Section should be answered only on the **OMR Response Sheet** provided.*

1. The measure of central tendency that is most affected by extreme outliers is _____
 - (a) Median
 - (b) Mode
 - (c) Mean
 - (d) Standard deviation
2. What does 'p-value' represent in hypothesis testing?
 - (a) The probability of rejecting the null hypothesis
 - (b) The confidence interval of the estimated parameter
 - (c) The strength of the relationship between variables
 - (d) The probability of observing the data, given that the null hypothesis is true
3. The coefficient of variation (CV), used to compare the variability of two datasets, is calculated as:
 - (a) Median / Interquartile Range (IQR)
 - (b) Standard Deviation / Mean
 - (c) Range/Median
 - (d) Mean/Variance
4. Select the correct statement from the following options-
 - (a) The relationship between the standard error and the standard deviation depends on the sample size.
 - (b) The standard error is always larger than the standard deviation.
 - (c) The standard error and the standard deviation are always equal
 - (d) The standard error is always smaller than the standard deviation.
5. Stratified sampling is a technique that involves:
 - (a) Formation of cluster or group of people from the population set.
 - (b) Choosing participants randomly without any specific criteria
 - (c) Dividing the population into subgroups and sampling from each subgroup
 - (d) Forming of sample that involves the individuals to represent the population based on specific traits or qualities.
6. The measures used to calculate the variation present among the observations relative to their average is called
 - (a) Relative measures of dispersion
 - (b) Coefficient of kurtosis
 - (c) Absolute measures of dispersion
 - (d) Quartile deviation

7. The frequency distribution according to individual variate values is called:
 - (a) Cumulative frequency distribution
 - (b) Discrete frequency distribution
 - (c) Percentage frequency distribution
 - (d) Continuous frequency distribution
8. Which statistical test is used to determine the association between two categorical variables?
 - (a) Correlation coefficient
 - (b) Chi-square test
 - (c) Regression analysis
 - (d) Analysis of variance (ANOVA)
9. In experimental design, the method of having more than one independent variable, or factor is known as -
 - (a) Factorial design
 - (b) Random assignment
 - (c) Matched pairs design
 - (d) Blocking
10. For a particular study, subjects are randomly assigned to one of three groups: control, Group A, or Group B. The mean scores for all three groups are to be compared post treatment. The appropriate statistical test for comparing these means is:
 - (a) correlation coefficient
 - (b) chi square
 - (c) the t-test
 - (d) analysis of variance
11. The coefficient of correlation
 - (a) is the square of the coefficient of determination
 - (b) is the square root of the coefficient of determination
 - (c) is the same as r-square
 - (d) can never be negative
12. What is the function of a post-test in ANOVA?
 - (a) Describe those groups that have reliable differences between group means.
 - (b) Determine if any statistically significant group differences have occurred.
 - (c) Set the critical value for the F test (or chi-square).
 - (d) Both (b) & (c)
13. Which of the following is not a critical component of fluorescence microscope?
 - (a) Filter cube
 - (b) Dichroic mirror
 - (c) Collimator
 - (d) Blocking filter
14. Select the correct statement regarding Phase contrast microscopes.
 - (a) Uses circular filters in the condenser and objective to give contrast to parts of the cell with different refractive indices.
 - (b) Continuously changes the phase of the incident light from the condenser to improve contrast in the specimen.
 - (c) Uses special lenses to distinguish between solid and liquid phases of the cell.
 - (d) Uses special lenses to change the colour of light passing through them.
15. In Transmission electron microscope, the degree of scattering of electrons is a function of _____
 - (a) wavelength of electron beam used
 - (b) number of atoms that lie in the electron path
 - (c) number and mass of atoms that lie in the electron path
 - (d) mass of atoms that lie in the electron path

16. The intensity of secondary electrons in Scanning electron microscope depends upon which of these factors -

- I. chemical composition of the irradiated object
- II. number of electrons ejected
- III. size and chemical composition of the irradiated object, number of electrons ejected and on the number of electrons reabsorbed by surrounding

Select the correct statement/s:

- (a) ii and iii
- (b) i and ii only
- (c) i only
- (d) iii only

17 Which of the following statements about Transmission Electron Microscopy is not true.

- (a) The beam is focused by electromagnetic lenses
- (b) The specimen must be stained with osmium or other heavy metal.
- (c) The specimens are placed in a high vacuum for viewing
- (d) The specimens must be sliced very thin, 20-100 nm in thickness.

18. Which of the following spectroscopy techniques is associated with molecular emission?

- (a) UV-Visible spectroscopy
- (b) IR spectroscopy
- (c) Fluorescence spectroscopy
- (d) X-ray diffraction

19. In electrophoresis, when voltage V is applied across a pair of electrodes (cathode and anode), a potential gradient 'E' is created between the electrodes. The value of 'E' can be calculated as

- (a) $E=V/d$
- (b) $E=(1/V) \times q$
- (c) $E=(Vd)/q$
- (d) $E=V+d$

20. What is the purpose of adding β -mercaptoethanol in SDS-PAGE?

- (a) give negative charges to amino acids in the proteins
- (b) oxidation of disulfide bonds in the proteins
- (c) reduction of disulfide bonds in the proteins
- (d) breaking hydrogen bonds in the proteins

21. Consider the electrophoresis of two proteins namely, histones ($pI = 8.5$) and myoglobin ($pI = 5.5$) under non-denaturing conditions ($pH = 7.0$). The result of the electrophoresis would be -

- (a) histones migrate to the cathode (-); myoglobin migrates to the anode (+).
- (b) histones migrate to the anode (+); myoglobin migrates to the cathode (-).
- (c) both proteins migrate to the anode (+).
- (d) both proteins migrate to the cathode (-).

22. Which of these techniques would be a preferred method for purification of monoclonal antibodies?

- (a) 2-dimensional electrophoresis
- (b) Ion exchange chromatography
- (c) HPLC
- (d) Isoelectric focussing

23. In a PCR experiment, how many DNA duplexes will result from a DNA duplex after four cycles of the reaction?

- (a) 4
- (b) 8
- (c) 16
- (d) 32

24. Select the statement that is not a characteristic of Taq DNA polymerase-

- (a) It is a highly thermostable DNA polymerase from the bacterium *Thermus aquaticus*
- (b) It catalyzes $5' \rightarrow 3'$ synthesis of DNA
- (c) It can generate DNA products with $3'$ -dT overhangs
- (d) It possesses a $5'$ to $3'$ exonuclease activity

25. In Southern blotting, after electrophoresis, DNA is transferred onto
- (a) A positively charged Nylon membrane
 - (b) A negatively charged nylon membrane
 - (c) A positively charged cellulose membrane
 - (d) A negatively charged cellulose membrane
26. In Western blotting workflow, which part of the experimental conditions may cause the signal to saturate if not tested carefully?
- (a) The amount of sample loaded onto the gel
 - (b) Transfer conditions
 - (c) Image acquisition time
 - (d) Primary antibody concentration
27. Select the incorrect statement regarding restriction enzymes used in recombinant DNA technology?
- (a) They are site-specific enzymes
 - (b) They recognize palindromic sequences
 - (c) They are ATP dependent nucleases
 - (d) They are endonucleases
28. Consider the following statements regarding DNA ligase enzymes:
- (A) They function by joining 3' -OH and 5' -PO₄ termini to form a phosphodiester bond
 - (B) DNA ligase activity entails three sequential nucleotidyl transfer steps
 - (C) DNA ligases can be ATP and NAD⁺ dependent
- Select the correct answer:
- (a) Only A is true
 - (b) Only B is true
 - (c) Only C is true
 - (d) All statements are true
29. A plasmid vector is cut in one place and a poly(G)tail is added to the 3' ends. For effective cloning, the donor DNA should have
- (a) poly(G) at the 3' ends
 - (b) poly(G) at the 5' ends
 - (c) poly(C) at the 3' ends
 - (d) poly(C) at the 5' ends
30. The characteristic that differentiates expression vectors from cloning vectors is
- (a) Origin of replication
 - (b) Control elements
 - (c) Suitable marker gene
 - (d) Restriction enzyme sites
31. Which of these statements does not hold true for Microarrays?
- (a) specific DNA sequences are either deposited or synthesized in a 2-D (or sometimes 3-D) array on a surface
 - (b) It is based on traditional gel electrophoresis principles that have been transferred to a chip format.
 - (c) DNA is covalently or non-covalently attached to the surface
 - (d) It be used to quantify an arbitrarily large number of different nucleic acid sequences in solution
32. _____ is a critical part of genetically modified mosquitoes produced to decrease wild mosquito populations.
- (a) A self-limiting gene that prevents female mosquito offspring from surviving to adulthood
 - (b) A self-limiting gene that renders female mosquito unable to lay healthy eggs
 - (c) A regulatory gene that hinders fertilization of eggs by male mosquitoes
 - (d) A regulatory gene that is passed on to the next generation of males and causes sterility
33. Dideoxynucleotides used in Chain termination method of DNA sequencing lack 'O' in
- (a) Carbons 1 and 2
 - (b) Carbons 2 and 3
 - (c) Carbons 3 and 4
 - (d) Carbons 1 and 4

34. In Next Generation Sequencing, DNA segments are modified by the addition of certain segments to aid in the sequencing process. Which of these is not a part of such sample modification?
- (a) Flow cell binding sequence (b) Sample index
(c) Sequencing primer sites (d) Reporter gene sequence
35. Which of the following statements is not a characteristic feature of BLAST?
- (A) It is a tool that finds regions of similarity between sequences.
(B) The program compares nucleotide or protein sequences and calculates the statistical significance of matches.
(C) It can be used to infer only evolutionary but not functional relationships between sequences
- Select the correct answer:
- (a) All statements are true (b) Only A and B are True
(c) Only A and C are True (d) Only B and C are True
36. Which of these is not a specialised search tool on NCBI BLAST?
- (a) CDART (b) VECSCREEN
(c) CD-SEARCH (d) GETENTRY
37. Select the bioinformatics database that is wrongly described in the following list -
- (a) UniProt: A database of protein sequences and functional information, providing curated and computationally predicted protein annotations.
(b) GenBank: A comprehensive database of DNA and RNA sequences, maintained by the National Center for Biotechnology Information (NCBI).
(c) Ensembl: The primary database mainly for experimentally determining and predicting the possible three-dimensional structures of proteins.
(d) Gene Expression Omnibus (GEO): A database for gene expression data, including microarray and RNA sequencing data from various experiments and tissues.
38. Protein-coding genes can be identified by
- (a) Transposon tagging (b) ORF scanning
(c) Zoo-blotting (d) Nuclease S1 mapping
39. Homology modelling is a computational technique used to predict the three-dimensional structure of a protein based on
- (a) The parent DNA sequence (b) The secondary structural characteristics
(c) Protein crystallography (d) Primary amino acid sequence
40. An estimate of phylogenetic relationships among the taxa is commonly represented in the form of a
- (a) Cladogram (b) Idiogram
(c) Phenogram (d) Dendrogram
41. The most useful characteristics for constructing a phylogenetic tree emphasizing evolutionary branching among several fish species would be -
- (a) Several analogous characteristics shared by all the fishes
(b) Single homologous characteristic shared by all the fishes
(c) The total degree of morphological similarity among various fish species
(d) Several characteristics thought to have evolved after different fishes diverged from one another
42. The Human Genome Project was a large international, collaborative effort that mapped and sequenced the human genome for the first time and was conducted during the years -
- (a) 1988-2003 (b) 1988-2005
(c) 1990-2003 (d) 1990-2005

43. In radial immunodiffusion, the size of the precipitin rings depends on-

- (A) Antigen concentration in the sample well
- (B) Antibody concentration in the agarose gel

Considering the statements, A and B, select the correct answer

- (a) Only A
- (b) Only B
- (c) Both A and B
- (d) Neither A nor B

44. Which of the following is not an established technique of ELISA?

- (a) Direct ELISA
- (b) Indirect ELISA
- (c) Sandwich ELISA
- (d) Dual ELISA

45. In ELISA, the chromogen p-Nitrophenyl Phosphate is a substrate for the enzyme/s

- (a) Alkaline phosphatase
- (b) Horseradish peroxidase
- (c) Both Alkaline phosphatase and horseradish peroxidase
- (d) Neither Alkaline phosphatase and horseradish peroxidase

46. Which of these statements is true for counter immune-electrophoresis technique?

- (a) Electrophoresis will drive the antibody and antigen parallel to each other
- (b) Electrophoresis will drive the antibody and antigen towards each other
- (c) Electrophoresis will cause the antibody to migrate to the anode
- (d) Electrophoresis will cause the antigen to migrate to the cathode

47. Consider the following statements regarding Chimeric Antigen Receptor T-Cell Therapy

- (A) They are recombinant receptors for antigens which redirect the specificity and function of T lymphocytes
- (B) They can be replicated rapidly and homogeneously, and are programmed to target CD4+ expressing cells

Select the correct answer:

- (a) Both A and B are true
- (b) Neither A nor B are true
- (c) Only A is true
- (d) Only B is true

48. mRNA vaccines were first authorized and used for which disease?

- (a) Hepatitis B
- (b) Rabies
- (c) Spanish flu
- (d) Covid-19

49. Which of these statements best describes the principle of DNA vaccines?

- (a) A vaccine that is administered as DNA; the DNA is then expressed to produce a protein, which stimulates an immune response.
- (b) A DNA molecule that is recognized by an antibody
- (c) A vaccine that works by stimulating the immune system to recognize pathogen DNA sequences
- (d) None of the above

50. What is the main difference between Rapid Antigen Test (RAgT) and RT-PCR test for Covid 19?

- (a) RAgT tests for viral genetic material while RT-PCR tests for viral envelope proteins
- (b) RAgT tests for viral spike protein while RT-PCR tests for viral genetic material
- (c) RAgT tests for viral enzyme while RT-PCR tests for viral spike protein
- (d) RAgT tests for viral nuclear membrane protein while RT-PCR tests for viral enzyme

SECTION - B (Short answer type question) (100 Marks)

Marks for each question is indicated against it.

This Section should be answered only on the Answer Sheet provided.

1. What is meant by Sampling? What are the desired characteristics of a Sample? Also write notes on Probability Sampling and Non-Probability Sampling Techniques. (1+2+5=8)
2. What are measures of dispersion and name the different types? Elaborate on Variance and standard deviation. (3+5=8)
3. Write notes on Chi-square test and t-test, along with their applications. (5+5=10)
4. What is the principle behind isoelectric focussing? Why is it important in two-dimensional electrophoresis? Also describe the procedure and components required for SDS-PAGE? (3+2+5=10)
5. What are electron microscopes? Discuss the applications and differences between scanning and transmission electron microscopes. (2+8=10)
6. What are PCR primers? Write notes on the types, significance and designing method of PCR primers? (3+7=10)
7. Describe the various applications of DNA sequencing. Also explain the Sanger's method of DNA Sequencing. (3+7=10)
8. What are genetically modified organisms? Citing the example of transgenic mosquitos, explain the significance and implications of using such organisms. (2+4=6)
9. What are primary databases? Give an example and elaborate on the characteristics and uses of one such database. (2+5=7)
10. What is BLAST? Write notes on the different functions that can be performed on this tool. (2+5=7)
11. Elaborate on the principle and method of ELISA. Give one important application in the medical field. (5+2=7)
12. Explain in detail how recombinant vaccines are produced, citing at least one example. (6+1=7)

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