

ROYAL CIVIL SERVICE COMMISSION
BHUTAN CIVIL SERVICE EXAMINATION (BCSE) 2024
EXAMINATION CATEGORY: TECHNICAL

PAPER III: SUBJECT SPECIALISATION PAPER FOR BIOTECHNOLOGY

Date	: October 5, 2023
Total Marks	: 100
Writing Time	: 150 minutes (2.5 hours)
Reading Time	: 15 Minutes (prior to writing time)

GENERAL INSTRUCTIONS:

1. Write your Registration Number clearly and correctly on the Answer Booklet.
2. The first 15 minutes is to check the number of pages of Question Paper, printing errors, clarify doubts and to read the instructions. You are NOT permitted to write during this time.
3. This paper consists of **TWO SECTIONS**, namely SECTION A & SECTION B:
 - **SECTION A** has two parts: Part I - 30 Multiple Choice Questions
Part II - 4 Short Answer Questions
All questions under SECTION A are **COMPULSORY**.
 - **SECTION B** consists of two Case Studies. Choose only **ONE** case study and answer the questions of your choice.
4. All answers should be written on the Answer Booklet provided to you. Candidates are not allowed to write anything on the question paper. If required, ask for additional Answer Booklet.
5. All answers should be written with correct numbering of Section, Part and Question Number in the Answer Booklet provided to you. Note that any answer written without indicating the Section, Part and Question Number will NOT be evaluated and no marks will be awarded.
6. Begin each Section and Part in a fresh page of the Answer Booklet.
7. You are not permitted to tear off any sheet(s) of the Answer Booklet as well as the Question Paper.
8. Use of any other paper including paper for rough work is not permitted.
9. **You must hand over the Answer Booklet to the Invigilator before leaving the examination hall.**
10. This paper has **7 printed pages**, including this instruction page.

GOOD LUCK

SECTION A

PART I

Multiple Choice Questions [30 marks]

Choose the correct answer and write down the letter of your chosen answer in the Answer Booklet against the question number e.g. 31 (d). Each question carries ONE mark. Any double writing, smudgy answers or writing more than one choice shall not be evaluated.

1. Which of the following structures is not found in all types of cells?
 - a) Nucleus
 - b) Ribosomes
 - c) DNA
 - d) Cell membrane

2. Enzymes are primarily composed of
 - a) Carbohydrates
 - b) Lipids
 - c) Proteins
 - d) Nucleic acids

3. Which of the following is an example of a selectable marker used in cloning vectors?
 - a) Green Fluorescent Protein
 - b) Ampicillin Resistant Gene
 - c) LacZ gene
 - d) Restriction sites

4. The purpose of a genomic library in rDNA technology is to:
 - a) Store mRNA molecules for reuse
 - b) Store all DNA sequences of an organism
 - c) Store Protein
 - d) All of the above

5. Which of the following statements about cDNA is true?
 - a) cDNA is synthesized directly from genomic DNA
 - b) cDNA contains only exons, with no introns
 - c) cDNA is typically double stranded when first synthesized
 - d) cDNA can be used to study the regulatory sequence of genes

6. Fill in the blank with the appropriate answer from the choices given. EcoRI restriction enzyme recognizes and cuts.....sequences.
 - a) GAATTC
 - b) AAGCTT
 - c) GGATCC
 - d) CTGCAC

7. DNA Profiling is best described as the process of:
 - a. Determining the sequence of the entire genome
 - b. Cloning and expressing genes in bacteria
 - c. Analyzing specific regions of DNA to identify genetic differences
 - d. Editing genes using CRISPR-Cas9 technology

8. A shuttle vector is
 - a) A vector used to shuttle DNA between bacteria and viruses
 - b) A vector used exclusively in eukaryotic cells
 - c) A vector used for high through-put sequencing
 - d) A vector that can replicate in multiple host species

9. The origin of replication in a plasmid is essential for:
 - a) Insertion of foreign DNA
 - b) DNA repair
 - c) Replication of plasmid within a host cell
 - d) Initiation of Transcription

10. Which of the following loci is commonly used in forensic DNA typing?.
 - a) Short Tandem Repeats
 - b) MHC loci
 - c) Single Nucleotide Polymorphism
 - d) Variable Number Tandem Repeats

11. In which part of the cell does transcription occur in eukaryotes?
 - a) Cytoplasm
 - b) Endoplasmic reticulum
 - c) Mitochondria
 - d) Nucleus

12. Fill in the blank with the appropriate answer from the choices given. _____ is a method used to separate proteins based on their size and charge.
 - a) PCR
 - b) Western Blotting
 - c) Gel Electrophoresis
 - d) Chromatography

13. Which of the following is the main advantage of using monoclonal antibodies in therapeutics?
 - a) They are less expensive to produce than polyclonal antibodies
 - b) They can recognize multiple antigens
 - c) They have high specificity for a single antigen
 - d) They are more stable than polyclonal antibodies

14. Which process is essential for production of insulin using recombinant DNA technology?
 - a) Cloning the insulin gene
 - b) Isolating mRNA from pancreatic cells
 - c) Using CRISPR-Cas9 to edit bacterial DNA
 - d) Extracting insulin from animal pancreas

15. The purpose of the ADME studies in drug development is to:
- Assess the drug's efficacy in large population
 - Evaluate the absorption, distribution, metabolism and excretion of a drug
 - Determine the molecular structure of a drug
 - Test the drug's toxicity in animal model
16. Fill in the blank with the appropriate answers from the choices given. _____ is a gram-positive bacterium.
- Salmonella typhi*
 - E. coli*
 - Pseudomonas aeruginosa*
 - Staphylococcus aureus*
17. Which of the following process involves the engulfing of large particles or cells by a cell?
- Exocytosis
 - Endocytosis
 - Phagocytosis
 - Pinocytosis
18. What is “in silico” screening?
- Drug testing on animal model
 - Computer based simulation and modelling used to predict drug activity
 - Screening drugs with high-throughput robotics
 - Clinical trials conducted in humans
19. The Fluid Mosaic Model is :
- A model that describes the structure of the DNA double helix
 - A theory that explains cell division
 - A concept that describes protein synthesis
 - A model that explains the structure and function of the plasma membrane
20. Fill in the blank with the appropriate answers from the choices given. _____ phase of the cell cycle is characterized by the replication of DNA
- G1
 - S
 - G2
 - M
21. Which model organism is commonly used for studying vertebrate development due to its transparent embryos?
- Drosophila melanogaster*
 - Caenorhabditis elegans*
 - Danio rerio*
 - Mus musculus*

22. What is the main function of morphogens in developmental biology?
- To replicate DNA
 - To synthesize proteins
 - To produce ATP
 - To determine the fate of cells based on their concentration gradients
23. The role of the stem cell in developmental biology is to:
- Serve as the building blocks for all cells and tissues
 - Provide energy for cellular activities
 - Produce antibodies
 - Transport oxygen
24. Which of the following animal is commonly used in the production of monoclonal antibodies?
- Dolly Sheep
 - Mice
 - Cow
 - Guinea Pig
25. The role of lysosomes in the cell is to:
- Energy Production
 - Breakdown of waste materials and cellular debris
 - Lipid synthesis
 - Protein synthesis
26. Fill in the blank with the appropriate answers from the choices given. _____ cells are fused with myeloma cells to produce hybridomas.
- T cells
 - Macrophages
 - B cells
 - Neutrophils
27. The flow cytometry is used to:
- Amplify DNA sequences
 - Separate the proteins by size
 - Analyze the physical and chemical characteristics of cells
 - Visualize the structure of antibodies
28. The role of an adjuvant in vaccine formulation is to:
- Preserve the vaccine
 - Inactivate the pathogen
 - Label the antigen
 - Enhance the immune response
29. Which of the following best describes pharmacogenomics?
- Study of effects of drugs on gene expression
 - Analysis of drug metabolites in the body
 - Development of new drug delivery systems
 - Study of genetic variations that influence individual responses to drugs

30. A cellular mechanism to inactivate gene expression post-transcriptionally is termed as:
- RNA capping
 - RNA Interference
 - Degradation
 - RNA priming

**SECTION A
PART II**

Short Answer Questions [20 marks]

This part has 4 Short Answer Questions. Answer ALL the questions. Each question carries 5 marks.

1. What is the significance of Bt crops in agriculture and how important is the marker genes in Bt crops? **(5 marks)**
2. Explain the principle of Mendelian inheritance. **(5 marks)**
3. Discuss the role of gene mutation in development of genetic diseases with examples. **(5 Marks)**
4. What role does oxygen transfer play in bioreactor operation, and how can it be optimized? **(5 marks)**

SECTION B

Case Study [50 marks]

Choose either CASE I OR CASE II from this section. Each case study carries 50 marks. Mark for each sub-question is indicated in the brackets.

CASE I

"Modern biotechnology plays a pivotal role in improving the lives of people by offering innovative solutions in healthcare, agriculture, and environmental sustainability." In this context, answer the following questions.

1. What emerging biotechnological trends and innovations could shape healthcare in the coming decades? What challenges and ethical considerations might arise with these advancements? **(10 marks)**
2. Discuss specific biotechnological applications that address environmental challenges such as pollution, resource depletion, and climate change. How effective are these applications in promoting a sustainable environment? **(10 marks)**
3. Discuss the challenges and opportunities in integrating traditional biotechnology practices with modern biotechnological innovations. How can a synergistic approach enhance the benefits of biotechnology in various fields? **(10 marks)**

4. Define and briefly explain the following terms/processes: **(5x3=15 marks)**
 - a) **Synthetic Biology**
 - b) **Gene Expression**
 - c) **Codon**
 - d) **Anabolism**
 - e) **Biochemical Pathway**
5. Examine how policy and regulatory frameworks influence the advancement and implementation of cutting-edge biotechnologies. **(5 marks)**

CASE II

Biotechnology involves using natural organisms or their components, such as enzymes, to create products and processes that benefit humans, such as fermenting beer, making bread, and breeding plants and animals. In this context, answer the following questions.

1. Explain how genetic engineering techniques enhance enzyme production in biotechnology? **(10 marks)**.
2. How does lactic acid fermentation contribute to the preservation and enhancement of food flavors and textures? **(10 marks)**
3. Examine the role of genetic diversity in plant breeding and why is maintaining genetic diversity important for the success of breeding programs? **(10 marks)**
4. Define the following: **(5x3=15 marks)**
 - **Genetic Recombination**
 - **Structural Bioinformatics**
 - **Metabolite**
 - **Catabolism**
 - **Electron Transport Chain**
5. In what ways do regulations affect the research, commercialization, and societal acceptance of biotechnological innovations? **(5 marks)**

TASHI DELEK