

ROYAL CIVIL SERVICE COMMISSION
BHUTAN CIVIL SERVICE EXAMINATION (BCSE) 2023
EXAMINATION CATEGORY: TECHNICAL

PAPER III: SUBJECT SPECIALISATION PAPER FOR BIOTECHNOLOGY

Date	: October 7, 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. The DNA is primarily located in _____ in the prokaryotic cell.
 - a) Nucleus
 - b) Mitochondria
 - c) Cytoplasm
 - d) All of the above.
2. What is the name of the small subunit of a ribosome that reads the mRNA during translation?
 - a) mRNA subunit
 - b) tRNA subunit
 - c) rRNA subunit
 - d) amino acid subunit
3. In genome editing using CRISPR-Cas, what is the role of Cas9 protein?
 - a) It cleaves the target DNA at a specific location
 - b) It provides energy for DNA replication
 - c) It copies the target DNA sequence
 - d) It synthesizes RNA
4. Which of the following is an example of cell differentiation in the human body?
 - a) Stem cells differentiating into neurons
 - b) Liver cells differentiating into muscle cells
 - c) Red Blood Cells differentiating into white blood cells
 - d) None of the above
5. Which of the following takes place during the post-transcriptional gene regulation?
 - a) DNA methylation
 - b) Promoter activation
 - c) RNA Polymerase binding
 - d) RNA splicing
6. What is the function of the codon in gene expression?
 - a) To signal the start of translation
 - b) To determine the type of amino acid to be incorporated into a protein
 - c) To control movement of mRNA
 - d) To activate transcription factors
7. Which metabolic pathway is responsible for the conversion of glucose into two molecules of pyruvate?
 - a) Glycolysis
 - b) Pyruvate Phosphate Pathway
 - c) Glucogenesis
 - d) All of the above

8. All of the following statements are true **EXCEPT**
- Bar gene in Bt176 eliminates herbicidal activity of glufosinate
 - Ribose is soluble in water
 - Bt176 is a genetically modified soy
 - Codon UAA do not code for amino acids
9. _____ is not a potential product of fermentation.
- Hydrogen gas
 - Oxygen
 - Vinegar
 - Kimchi
10. Electron Transport Chain take place in _____.
- Nucleus
 - Golgi apparatus
 - Endoplasmic reticulum
 - Mitochondria
11. Flow cytometry is used to
- detect antigens.
 - measure antibody levels.
 - sort and analyze cells based on their properties.
 - test for antibiotic susceptibility.
12. Which of the following is **NOT** a type of white blood cell involved in the immune response?
- T cells
 - B cells
 - Platelets
 - Natural Killer (NK) cells
13. The role of the transcription factors is
- regulate the rate of cell division.
 - maintain the pluripotency in stem cells.
 - control the expression of specific genes that determine cell identity.
 - promote apoptosis.
14. The process by which the species evolve from a common ancestor into distinct forms is termed as
- Convergent evolution
 - Divergent evolution
 - Coevolution
 - Adaptive Radiation
15. What is the concept of “survival of the fittest” in the context of natural selection?
- The strongest individuals survive and reproduce
 - The most adapted individuals survive and reproduce
 - The most intelligent individuals survive and reproduce
 - The largest individuals survive and reproduce

16. When Mendel crossed a true-breeding yellow-seeded pea plant (YY) with a true-breeding green-seeded pea plant (yy), what was the genotype of the F1 generation?
- YY
 - yy
 - Yy
 - Yg
17. Which of the following technique is used to predict the three-dimensional structure of proteins?
- Protein folding simulation
 - X-ray crystallography
 - Southern blotting
 - All of the above
18. The primary purpose of using microarrays in molecular biology research is to
- amplify DNA sequences.
 - sequence the entire genomes.
 - study protein-protein interactions.
 - measure gene expression levels.
19. Genetic drift is
- the process of selective breeding.
 - the gradual change in the frequency of alleles in a population due to random chance.
 - the process of mutations accumulating over time.
 - the movement of individuals from one habitat to another.
20. _____ is the main goal of quantitative proteomics.
- Determination of three-dimensional structure of proteins
 - Identification of all proteins in a sample
 - Measurement of changes in protein abundance between different conditions
 - Study of the protein-protein interactions
21. In a DNA molecule, which end is known as the 3' end?
- The end where adenine is found
 - The end where guanine is found Deoxyribose sugars
 - The end with a free phosphate group attached to the deoxyribose sugar
 - The end with a free hydroxyl group attached to the deoxyribose sugar
22. During binary fission, the bacterial DNA _____.
- remains unchanged
 - undergoes mitosis
 - replicates and segregates into two daughter cells
 - condenses into a single chromosome
23. All of the following statements are true **EXCEPT**
- Bacteria protect themselves from viruses by fragmenting the viral DNA with endonuclease
 - Most bacteria reproduce through budding
 - Fermentation refers to production of organic acids by microorganism
 - Generation time represents the time required for a bacterial population to double in number

24. During which stage of drug production are drugs tested on animals to evaluate safety and efficacy?
- Drug discovery
 - Clinical trials
 - Drug Formulation
 - Preclinical testing
25. Which of the following amino acids contain a sulfur atom in its side chain?
- Aspartate
 - Methionine
 - Tyrosine
 - Glutamine
26. The process by which a molecule gains an electron and become negatively charged is called
- Oxidation
 - Endothermic
 - Reduction
 - Combustion
27. The human genome project was launched in the year _____.
- 1990
 - 1972
 - 1980
 - 1989
28. Restriction enzymes are discovered by
- Berg
 - Gellert and Lehman
 - Hamilton Smith and Nathans
 - Hoffmann-Berling
29. Huntington's Disease is caused by mutation in
- RNA
 - DNA
 - cDNA
 - mRNA
30. Which of the following bacterial structures play a role in the attachment of bacteria to surfaces during biofilm formation?
- Capsule
 - Plasmid
 - Flagella
 - Spores

PART II – Short Answer Questions [20 marks]

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

1. How has biotechnology revolutionized agriculture? (5 marks)
2. What are the differences between reverse transcription and reverse transcriptase PCR (RT-PCR), and when are each of these techniques used? (5 marks)
3. Discuss the significance of microbial diversity in biotechnology. How can the exploration of unique microbial strains lead to the development of novel biotechnological applications and products? (5 Marks)
4. Explore the challenges and opportunities of using extremophiles (microorganisms thriving in extreme environments) in biotechnology. (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

"Biotechnology is transforming modern agriculture by offering innovative solutions. Through genetic engineering, precision breeding techniques, and advancements in biotech tools, agriculture is evolving to meet the growing global demand for sustainable and resilient food production systems." In this context, answer the following questions.

1. How can biotechnology help address emerging food safety issues, such as the impact of climate change on food production and distribution? (10 marks)
2. What are the potential risks associated with genetically modified foods, and how are they assessed and managed? (10 marks)
3. How are biotechnological techniques, such as DNA testing and sequencing, used to trace and identify sources of foodborne illnesses? (10 marks)
4. Define and briefly explain the following terms/processes: (5x3=15 marks)
 - a) Bioprocessing
 - b) Biosafety
 - c) Marker-Assisted Selection (MAS)
 - d) Selective Breeding
 - e) Genetic Diversity
5. Are there any successful examples of commercially available genetically modified animals, and what are their applications? (5 marks)

CASE II

“Biotechnology is a multidisciplinary science that draws upon knowledge and techniques from various fields of biology, chemistry, genetics, engineering, and more. This multidisciplinary nature is a fundamental characteristic of biotechnology and is essential for its success and versatility”. In this context, answer the following questions.

1. Explain the concept of bioprocessing and its role in the production of biopharmaceuticals and other biotechnology products (5 Marks).
2. How is Biotechnology different from traditional breeding methods in agriculture? (5 marks)
3. What is Single Cell Protein (SCP), and how is it different from conventional protein sources? (5 marks)
4. Define the following: (5x3 marks=15 marks)
 - a) Morphogenesis
 - b) Horizontal Gene Transfer
 - c) Precursor Metabolite
 - d) Selectable Marker
 - e) BLAST
5. How can biotechnology be utilized to address the challenges of soil degradation and nutrient depletion in agriculture? (10 marks)
6. What is site-directed mutagenesis, and how is it used to modify specific genes for functional studies or protein engineering? (10 marks)

TASHI DELEK