

國立成功大學

113學年度碩士班招生考試試題

編 號： 252

系 所： 生物化學暨分子生物學研究所

科 目： 分子生物學

日 期： 0202

節 次： 第 2 節

備 註： 不可使用計算機

※ 考生請注意：本試題不可使用計算機。請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

一、填充題 (20分，每題1分) Complete the following statements with the appropriate terms

- | | |
|--------------------------|-----------------------------|
| A. Promoter | N. Intron |
| B. Enhancer | O. mRNA |
| C. Exon | P. DNA Polymerase |
| D. RNA Splicing | Q. Glycolysis |
| E. microRNA | R. Electron Transport Chain |
| F. Telomerase | S. DNA synthesis |
| G. Transfer RNA | T. RNA world hypothesis |
| H. Reverse Transcription | U. Ligase |
| I. Footprinting | V. shRNA |
| J. Transcriptome | W. transcript |
| K. Transcription Factor | X. ribonucleoprotein |
| L. Repressor | Y. Ribosome |
| M. Ribozyme | Z. Complement DNA |

1. The _____ is a complex molecular machine found within all living cells, which performs the translation of mRNA into proteins.
2. _____ is involved in decoding the mRNA sequence into a protein during translation.
3. The coding sequences of a gene, which are retained in the mRNA after splicing, are called _____.
4. An _____ is a DNA sequence that can increase the efficiency of transcription from a remote location, even if it's located far away from the gene it regulates.
5. The enzyme _____ adds repetitive sequences to the ends of chromosomes, thereby preventing chromosome shortening during cell division.
6. The process of _____ involves removing introns and joining exons in a pre-mRNA molecule, resulting in a mature mRNA.

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7. _____ is synthesized from an mRNA template using the enzyme reverse transcriptase.
8. Non-coding regions within a gene that are not included in the final mRNA product are known as _____.
9. A _____ is a protein that binds to DNA and represses gene transcription.
10. _____ are endogenous small RNA molecules that play a critical role in regulating gene expression by binding to and inhibiting specific mRNA molecules.
11. The technique known as DNA _____ is used to identify the specific DNA sequence to which a particular DNA-binding protein binds.
12. The _____ of a cell or tissue is the complete set of transcripts in a cell, and their quantity, for a specific developmental stage or physiological condition.
13. The conversion of RNA to DNA, a process opposite to normal transcription, is known as _____.
14. A _____ is an RNA molecule capable of acting as an enzyme, catalyzing specific biochemical reactions.
15. _____ carries genetic information from DNA to the ribosome, where it is translated into protein.
16. The _____ is a region of DNA that initiates transcription of a particular gene, serving as the binding site for RNA polymerase.
17. A _____ is a protein that binds to specific DNA sequences, controlling the rate of transcription of genetic information from DNA to mRNA.
18. The _____ suggests that early life forms may have used RNA as both genetic material and as a catalyst for biochemical reactions.
19. _____ is a structure formed by a single-stranded RNA molecule that can be used in gene silencing and RNA interference studies.
20. A complex composed of RNA and protein that has functions in various biological processes, including translation and RNA splicing, is known as _____.

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二、簡答題與問答題 (80 分，分數如題標示)

21. You suspect that a sequence upstream of a transcriptional start site is acting as an enhancer and not as a promoter.
 - a. Describe an experiment you would run to test your hypothesis. (2 points)
 - b. Predict the results based on your experimental design (3 points).

22. Please compare and describe in detail what are microRNAs and small interfering RNAs (5 points).

23. The cells use several mechanisms to guard the integrity of the mammalian genome.
 - a. What are double-strand break repair in the genome? Please describe the **mechanism(s) of double-strand break repair**. (5 points)
 - b. If a cell line culture is in the log-phase growth, please design an experiment to detect double-strand break sites' **presence and location** (5 points).

24. Replication of DNA involves three parts: initiation, elongation, and termination. It requires multiple enzymes to extend the growing DNA strands.
 - a. How do replisomes and DNA polymerases synthesize DNA strands? Please describe the **mechanistic model** and the **enzymes** synthesizing DNA strands in eukaryotic cells. (5 points)
 - b. How can cells maintain DNA replication in high fidelity? Please provide a few possible mechanisms and an example to examine experimentally. (5 points)

25. Replication of the *E. coli* circular duplex chromosome is initiated at the *Ori^C*. How does the DNA replication machinery assemble a protein complex that creates the replication forks on a double-stranded DNA molecule? Please describe the molecular **mechanism** for initiating DNA replication using the *E. coli* model. (10 points)

26. Please describe the main two protein degradation (turnover) systems in mammalian cells. (hint: what are they and how do they work) (5 points for each, total 10 points)

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27. Please name one type of protein posttranslational modification (PTM) and explain how it works (hint: enzymes that regulate this PTM and related regulations) (5 points).
28. If you are working on one protein PTM, what are potential technologies or tools you can use to understand the impact of the PTM? Please name three technologies or tools for hands-on experiments. (2 point for each, total 6 points)
29. After knocking out gene XX by CRISPR, you found the expression of protein YY is dramatically increased in multiple breast cancer cell lines (YY is not encoded by XX gene). Please write your hypothesis and what you would do next to dissect the relationship between XX and YY. (hint: please design a few experiments (at least two) to validate and dissect the relationship between XX and YY at chromatin, mRNA, or protein level) (9 points)
30. How do you track and locate a protein inside a cell? Please provide one example and explain how it works. (5 points)
31. Where and how is a plasma membrane protein generated and recycled? Please describe a general mechanism. (5 points)