

國立成功大學

115學年度碩士班招生考試試題

編 號：201

系 所：分子醫學研究所

科 目：分子生物學

日 期：0203

節 次：第 3 節

注 意：1.不可使用計算機
2.請於答案卷(卡)作答，於
試題上作答，不予計分。

1. (A) What is the key difference of the base composition between RNA and DNA (3%)? RNA is synthesized through transcription by RNA polymerases in cells. There are different types of RNA, such as rRNA, mRNA, and tRNA, in both prokaryotic and eukaryotic cells. (B) How do prokaryotic cells catalyze the synthesis of rRNA, mRNA, and tRNA (5%)? and (C) Which type of RNA polymerases do eukaryotic cells, such as human cells, use to synthesize mRNA (2%)? (D) What are the differences in termination of transcription between prokaryotic and eukaryotic cells (6%)?
2. Regarding gene transcription in eukaryotic cells, (A) What is the role of the TATA box in gene transcription (6%)? (B) If a gene does not have the TATA box, what are the other gene elements and molecular mechanisms that can assist gene transcription (6%)?
3. Regarding DNA replication, (A) what is semi-conservative replication (2%)? (B) What are Okazaki fragments (3%)? (C) In eukaryotic cells, what is the end-replication problem of chromosomes (3%)? (D) What is the molecular mechanism that solves the end-replication problem of chromosomes (2%)?
4. Our cells are continuously exposed to various DNA damaging agents that can affect health and cause diseases without proper repair. (A) In addition to base modifications and DNA strand breaks, please list the other types of DNA damage (6%). (B) Describe the DNA repair pathways that repair DNA double strand breaks (6%).
5. Regarding the protein translation, (A) What is the typical start codon and what is the amino acid encoded by the start codon in eukaryotes (2%)? (B) Please explain why there are only 45 tRNAs matching with 61 mRNA codons in protein translation (4%). (C) Please describe the cap-dependent translation initiation process in eukaryotes (4%).
6. To dissect gene function at different regulatory levels, multiple gene perturbation strategies can be employed. (A) Please explain the molecular mechanisms of siRNA-mediated gene silencing and CRISPR/Cas9-mediated gene knockout, including the key molecular components involved in each approach (6%) and (B) the level at which gene expression is perturbed (DNA or RNA) (2%). (C) Compare siRNA and short hairpin RNA with respect to their mode of expression and the stability or duration of gene silencing (2%). Finally, (D) describe appropriate experimental methods used to evaluate the efficiency of gene knockdown or knockout at the RNA and protein levels (4%).
7. In 2024, the Nobel Prize in Chemistry was awarded to the developers of AlphaFold, which predicts protein structure from the primary amino acid sequence. (A) Please describe the four levels of protein structure and give one example for each level (8%). You need to describe which covalent bond stabilizes primary protein structure and 4 physical forces that stabilize high-level structure. (B) Define post-translational modification (PTM) and describe two types of PTMs, including the amino acid residues modified and their potential functional roles (4%). Finally, (C) list two methods used to experimentally determine protein structure and state one advantage of each method (4%).
8. From a molecular and cellular biology perspective, explain why ageing increases cancer risk. (A) Please describe two ageing-associated molecular or cellular changes (4%), and (B) explain how each creates a tumor-permissive cellular or tissue environment that facilitates tumor initiation or progression (4%). Answers should focus on cell-intrinsic

mechanisms, rather than epidemiological or lifestyle factors such as diet or smoking. Finally, (C) name one method used to determine biological age and briefly state its principle (2%).