

※ 注意：請用 2B 鉛筆作答於答案卡，並先詳閱答案卡上之「畫記說明」。

一、單選題(請作答於『答案卡』，每題 3 分，共 30 分)

1. Which of the following molecules is hydrolyzed for each elongation cycle during protein synthesis by ribosomes?
(A) GTP
(B) CTP
(C) TTP
(D) ATP
(E) dATP
2. Which of the following is **not** part of a tRNA cloverleaf structure?
(A) codon arm
(B) acceptor arm
(C) anticodon arm
(D) D arm
(E) extra arm.
3. A phage can transfer its genome or a DNA molecule to a bacterial cell. This process is called
(A) transformation.
(B) conjugation.
(C) transduction.
(D) recombination.
(E) accommodation.
4. Which of the following enzymatic activities is **not** found in natural DNA polymerases?
(A) 5' to 3' polymerase
(B) 3' to 5' polymerase
(C) 5' to 3' exonuclease
(D) 3' to 5' exonuclease
(E) strand-displacement activity
5. Which of the following statements regarding transposons is **not** correct?
(A) Transposons can move from one position to another on the genome.
(B) Transposons can propagate themselves within the genome.
(C) Insertion sequences are a type of transposons.
(D) Transposons can be transcribed into RNAs.
(E) Transposons are non-coding DNAs.
6. Which of the following statements regarding genetic code is correct?
(A) Multiple codons can encode one amino acid.
(B) Genetic code is shared by organisms from the simplest bacteria to higher animals.
(C) Scientists can reprogram the amber codon to encode unnatural amino acids.
(D) All of the above.
(E) None of the above.
7. Which of the following statements regarding DNA packaging is **not** correct?
(A) Histone phosphorylation affects chromatin structure.
(B) Heterochromatin is a tightly packed form of DNA.
(C) Insulator provides a barrier that protects against the inactivating effect from heterochromatin.
(D) Centromeric DNA is normally in a heterochromatin state.
(E) During mitosis, securin holds sister chromatids together.

見背面

8. Which of the following statements regarding telomere is **not** correct?
- (A) Telomere lies at the end of a chromosome.
 - (B) Each telomere consists of a long series of short, tandemly repeated sequences.
 - (C) Telomerase is a large ribonucleoprotein with a templating RNA and a protein with catalytic activity.
 - (D) Ectopic expression of human telomerase reverse transcriptase (hTERT) can be used to immortalize primary cells.
 - (E) hTERT is often down-regulated in rapidly dividing stem cells.
9. Which of the following statements regarding introns is **not** correct?
- (A) Introns are removed when primary transcript is processed to give mature RNA.
 - (B) Intron junctions are defined by the GU-AG rule: starts with the dinucleotide GU and ends with the dinucleotide AG.
 - (C) As genome size increases, the tendency is for exons to become large and introns remain small.
 - (D) Aptamers can be used to control intron splicing.
 - (E) Many animal micro RNA (miRNA) genes are located in introns of protein-coding genes.
10. Which of the following statements regarding p53 is **not** correct?
- (A) It is a tumor suppressor.
 - (B) It is a DNA-binding protein.
 - (C) It is a stable protein with half-life of several hours.
 - (D) Its activation can lead to cell cycle arrest.
 - (E) It can activate apoptosis.

二、簡答題(請於試卷依題號作答，共 70 分)

1. The upstream sequence near the transcription start site of a gene is usually rich in A and T (called a TATA box), and transcription initiation is facilitated when the DNA forms a negatively supercoiled structure. From the energy point of view, state why the above two features on the DNA are important for transcription initiation. (4 points)
2. In bacteria, translation is usually coupled to transcription. In other words, an mRNA can be used for translation while it is still being synthesized. However, these two reactions (transcription and translation) are well separated in eukaryotes. (a) What is the structural feature in a eukaryotic cell that separates these two reactions? (b) Describe **two** problems the cell may have if these two reactions are coupled. (6 points)
3. A ribozyme is an enzyme in which the catalytic core is formed by RNA only. As revealed by the high-resolution structures, the bacterial ribosome is considered as a ribozyme. Describe briefly how we can come up with this conclusion. (4 points)
4. Micro RNA (miRNA) and small interfering RNA (siRNA) are short RNAs produced in cells to regulate translation of target mRNA. Describe **two similar** and **two different** features between these two types of RNAs. (6 points)
5. The genes in an operon (like the *lac* operon in *E. coli*) can be turned on or off in a highly regulated manner. Describe how the regulation works (using the following terms: promoter, operator, repressor, sigma factor, and so on). (6 points)
6. DNA replication is a complex reaction involving many enzymes and factors. Briefly describe the functions of following factors in DNA replication: (a) helicase, (b) primase, (c) ligase, (d) exonuclease, (e) single-stranded DNA-binding proteins. (5 points)

7. The Sanger method has been a traditional approach for DNA sequencing. Nowadays NGS (Next Generation Sequencing) becomes a popular method for many researchers. (a) Describe briefly how the Sanger method works. (b) Describe briefly **two** advantages of NGS over the Sanger method. (6 points)
8. Molecular cloning of one or more DNA fragments into a vector is an everyday practice in research labs. (a) Briefly describe the conventional restriction enzyme based cloning (using restriction enzymes, multiple cloning sites, DNA ligase, and so on). (b) Describe **one** other DNA assembly method and **one** of its advantages over the conventional method. (8 points)
9. In 2012, the Nobel Prize in Physiology / Medicine was awarded jointly to Sir John Gurdon and Shinya Yamanaka. The “Yamanaka factors” – Sox2, Oct4, Klf4, and c-Myc – were identified in a screen. Describe how one may carry out such screen (using the following terms: transcriptional factors, mature cells, pluripotency markers, and so on). (7 points)
10. In 2014, the Nobel Prize in Chemistry was awarded jointly to Eric Betzig, Stefan Hell and William Moerner. Briefly describe how the techniques they developed have made important contributions in biological research (hint: for the traditional technique, what fundamentally limits the precision?) (6 points)
11. Endosymbiotic theory states that several key organelles of eukaryotes are formally free-living single-cell organisms that were taken up inside another cell in the course of evolution. Give **one** of such organelles and **one** evidence that supports this theory. (6 points)
12. (a) Briefly describe the difference between gene knockdown and gene knockout. (b) Define (i) morpholino, (ii) CRISPR/Cas. (6 points)

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