

國立中興大學 111 學年度碩士班招生考試試題

科目：生物化學

系所：基因體暨生物資訊學研究所

本科目不得使用計算機

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Part I. (25 分)

1. 一般來說，若是已知基因體上的 DNA 序列，則我們通常能正確推測它可能轉錄出的 RNA 序列。(a)以下這個 DNA 序列可能轉錄成的 RNA 序列：CCCGGCTAAGACGTT (b)倘若已知這是某個 tRNA 基因的一部分，同樣是要推測它的 RNA 序列，你認為可能會遇到什麼問題呢？(8 分)
2. Ciprofloxacin 是一種治療細菌感染症時常用的抗生素。研究得知它的作用機制是能有效地抑制大腸桿菌中 Topoisomerase II 的活性。請推論為什麼這樣的抑制作用能被用來殺死細菌？(5 分)
3. 在蛋白質折疊(folding)時，主要有四種非共價作用力(noncovalent interactions/forces)參與在其中，請問是哪四者？(12 分)

Part II. (25 分)

一、選擇題：(共 14 分)

1. 根據 SARS-CoV-2 疫苗的儲存及運送條件，請問下列何者巨分子的熱穩定性最差 (1) DNA · (2) RNA · (3) protein。
2. 下列何種突變技術精準度最高？(1) CRISPR · (2) 基因轉殖 · (3) 放射線誘變 · (4) 化學誘變。
3. 關於 Primary active transport 一級主動運輸何者為真？(1) 無須運輸蛋白參與 · (2) 濃度由高往低處運輸 · (3) 消耗 ATP · (4) 藉由膜電位差達成物質運送。
4. 咖啡與茶葉因為含有咖啡因及茶鹼常被充為提神飲料，咖啡因及茶鹼主要的作用是 cAMP 的類似物。請問 cAMP 在訊息傳遞中主要的功能為？(1) receptor · (2) inhibitor · (3) secondary messenger · (4) phosphate group donor。
5. DNA 為雙股螺旋結構，下列何者不是影響 DNA 鹼基配對的主要因素為：(1) 凡德瓦爾力 · (2) 氫鍵的方向性 · (3) 氫鍵的數目 · (4) 含氮鹼基的大小。

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6. 葉酸常做為懷孕婦人的營養補充品，其主要功用是提供 UTP 甲基，該轉化功用若受到抑制(或喪失)，將影響 cell cycle 中的 (1) G1 · (2) S · (3) G2 · (4) M phase 的正常運作。
7. 下列何者不是真核生物蛋白質的轉錄後修飾? (1) 剪切多餘的氨基酸 · (2) 額外添加胺基酸序列 · (3) 共價鍵修飾 · (4) 校正錯誤的胺基酸。

二、問答題：

8. 小明希望利用重組基因的技術大量生產 SARS-CoV-2 棘蛋白並藉由以鎳離子親和性管柱(nickel resin)進行純化，所以將可以表現出 SARS-CoV-2 棘蛋白的 S 基因選殖到表現載體 pET-20b(+)中使其在轉殖到 E. coli 後可以表達出 C 端與 His-tag 融合的重組 SARS-CoV-2 棘蛋白質，請問：小明在設計引子(primers)時應注意那些事項？(4 分)
9. PCR 為快速增幅 DNA 的技術，Ct 值可以反應模板的濃度(例如：COVID-19 在體內的濃度)，假設相同實驗條件下，樣品 A 的 Ct 值為 15，B 的 Ct 值為 12，請問：A 的濃度為 B 的幾倍？(3 分)
10. 請說明作為重組 DNA 所用的選殖載體(cloning vector)須具備哪些基本條件。(4 分)

Part III. (25 分)

一、選擇題：(共 22 分)

1. Which of the following scientists is now accredited with generating the X-ray diffraction photograph that played a pivotal role in the discovery of the structure of B-DNA?
 - A) James Watson
 - B) Francis Crick
 - C) Maurice Wilkins
 - D) Rosalind Franklin
 - E) all of the above

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2. The chromosomes of some viruses and bacteria are _____ and often _____.
 - A) linear; single stranded
 - B) linear; supercoiled
 - C) circular; single stranded
 - D) circular; supercoiled
 - E) none of the above

3. Which of the following would NOT result in the relaxation of supercoiled DNA?
 - A) heating the DNA to induce denaturation
 - B) nicking one strand
 - C) treatment with pancreatic DNaseI
 - D) treatment with type II topoisomerase
 - E) treatment with type I topoisomerase

4. Which of the following prokaryotic enzymes can introduce negative supercoils?
 - A) topoisomerase IA
 - B) topoisomerase III
 - C) DNA gyrase
 - D) all of the above
 - E) none of the above

5. Heat-denatured DNA exhibits _____ UV absorbance, which is called the _____.
 - A) increased; hyperchromic effect
 - B) decreased; hyperchromic effect
 - C) increased; hypochromic effect
 - D) decreased; hypochromic effect
 - E) identical; renaturation effect

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6. tRNA molecules are
- I. extensively base-paired.
 - II. stabilized by hydrogen bonds.
 - III. stabilized by stacking interactions.
 - IV. stabilized by covalent cross links.
- A) I, II
B) II, III
C) I, II, III
D) I, III
E) I, II, IV
7. Which of the following materials would be useful for a researcher seeking to purify chromosomal DNA of lysed *E. coli* cells from cellular proteins and RNA?
- A) ethidium bromide
B) hydroxyapatite
C) acridine orange
D) proflavin
E) DNA gyrase
8. The sequence-specific binding of *Bam*HI to DNA depends primarily on
- A) hydrogen bonding and allows binding to less specific sequences as well.
B) hydrogen bonding and precludes binding to any other sequence.
C) stacking interactions and could be mimicked using an intercalation molecule.
D) hydrogen bonding and could be mimicked using an intercalation molecule.
E) none of the above

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9. Histone H1 binds to ___ which allows attachment to ____.
- A) the nucleosome core particle; nucleases
 - B) linker DNA; the next nucleosome
 - C) the nucleosome core particle; the next nucleosome
 - D) linker DNA; nucleases
 - E) none of the above
10. What evidence suggests that a biological function exists for Z-DNA?
- A) Z-DNA is unique because it is made up of alternating pyrimidine and purine residues in the *anti* and *syn* conformation.
 - B) The left-handed nature of Z-DNA allows phosphate separation which is stabilizing.
 - C) X-ray structure of the protein binding Z-DNA has been identified.
 - D) A and B
 - E) A, B, and C
11. *E. coli* DNA repair enzymes act on the sequence. Which of the following will result?
- A) The underlined A will be changed to a C.
 - B) The underlined G will be changed to a T.
 - C) The underlined A will be methylated.
 - D) The underlined G will be methylated.
 - E) More than one of the above is correct

二、問答題：

12. What is central dogma of molecular biology (分子生物學之中心思想)? (3 points)

Part IV. (25 分)

一、請說明改正以下敘述錯誤之處 (共 20 分，每題 2 分)

1. Like proteins and nucleic acids, macromolecular polysaccharides are strictly linear polymers.

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2. Most naturally occurring fatty acids contain an even number of carbon atoms. If double bonds are present (unsaturation), they are usually *trans*.
3. A temperature drop has the effect of raising the of hemoglobin (i.e, lowering O₂-binding affinity), thereby facilitating greater release of O₂. The response of hemoglobin to temperature change is called the Bohr effect after Christian Bohr, who reported it in 1904.
4. Cycle threshold (Ct) is a numerical value generated during an error-prone PCR test. It refers to the number of cycles needed for a sample to amplify and cross a threshold (cut-off) to be considered detected/positive for SARS-CoV-2 virus infection.
5. Of the several possible secondary structures for polypeptides, the most frequently observed are the left-handed α -helix and the β -sheet.
6. All globular proteins have a defined inside and outside. Hydrophilic residues are packed mostly on the inside, whereas hydrophobic residues are on the surface.
7. Charge-charge interactions can occur between positively and negatively charged side chain groups. For example, a leucine side chain amino group may be placed close to the carboxyl group of some glutamic acid residue.
8. If the ΔG value for a given biochemical reaction is a relatively large, negative value, the reverse reaction is thermodynamically favorable.
9. When a macroion (polyampholyte or polyelectrolyte) is placed in an aqueous salt solution, small ions of the opposite sign tend to cluster about it, forming a counterion atmosphere; at high ionic strength, the counterion atmosphere greatly enhances the interaction between macroions.

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10. At physiological pH, most amino acids are amphipathic, meaning that they contain both a positive and negative charge.

二、請簡述說明西方墨點法 (western blotting) 的步驟與原理 (5 分)