本科目不得使用計算機　　　　　本科目試題共 3 頁

Part I Single choice (60 points, 3 points for each)

1. Which is NOT the correct statement about tree?

   (A) Tree is one kind of data structure (B) Tree can has cycle

   (C) Only one path exists in any two nodes (D) Tree do not be linked fully if remove any edge

2. Which is the interpreting language?

   (A) BASIC (B) FORTRAN (C) PASCAL (D) JAVA

3. Which technology needs the Certificate Management Center support?

   (A) CRC verification (B) DES encryption (C) symmetric encryption (D) asymmetric encryption

4. IP(v4) has A, B, C, D, and E classes, which class is 195.128.1.5 belongs to?

   (A) A (B) B (C) C (D) D

5. What times is the worst case by using binary search in 10,000 data

   (A) 10 (B) 12 (C) 14 (D) 16

6. Which is NOT the correct statement about relational database?

   (A) Record is the basic unit (B) Each table at least has one primary key

   (C) primary key is unique (D) index can speed up for searching

7. The BASIC instruction Y=2*3+9MOD5, what is the result of Y?

   (A) 7 (B) 8 (C) 10 (D) 14

8. In the Linux command line, which of the following commands is used to return working directory name? A. cp B. cd C. echo D. ls E. pwd

9. In the Linux command line, which of the following commands is used to list directory contents? A. df B. cd C. dd D. ls E. rm

10. In the Linux command line, which of the following commands is used to copy files ? A. cp B. cd C. id D. ls E. df

11. In the Linux command line, which of the following commands is used to execute a command as another user ? A. kill B. sudo C. link D. pwd E. rmdir

12. In the Linux command line, which of the following commands can be used to read files sequentially then write them to the standard output? A. ls B. cd C. dd D. df E. cat

13. In the Linux command line, which of the following commands is used to change current working directory? A. mv B. ln C. cd D. ls E. df

14. A computer has 32 GB (gigabytes) of memory. How many bits are needed to address any single byte in memory?

   (A) 15 (B) 25 (C) 35 (D) 45

15. What is Docker?

(A) A database management system (B) A version control system (C) A programming language

(D) None of the above

16. Use the XOR operator on the bit patterns 10011001 and 00101110. What is the solution?

(A) 10110111 (B) 10111111 (C) 01100111 (D) 00001000

17. What is returned from an output device when it retrieves the bit string 00101001 stored in the memory as an unsigned integer?

(A) 41 (B) 42 (C) 43 (D) 44

18. Which of the following is a client-side script language?

(A) Python (B) JavaScript (C) PHP (D) ASP

19. What SQL keyword is used to eliminate duplicate rows from the result set?

(A) UNIQUE (B) DISTINCT (C) NO DUPLICATES (D) None of the above

20. Which is NOT wireless IoT technology?

(A) WiFi (B) Bluetooth (C) LPWAN (D) Optical fiber

Part Ⅱ (40 points)

1. (15 points)

(A) What is neural network? (5 points)

(B) Please design a neural network model for predicting protein secondary structures from a sequence (10 points)

(PS: 1. A protein sequence has many residues.

　　2. A residue has 20 kinds of amino acids

　　3. Secondary structure has helix, sheet, and coil three types)

2. (10 points)

What are the four major components of a computer? Please also describe their functions.

3. (15 points)

A university has decided to assign a unique bit pattern to each employee. If the university has 2000 employees, what is the minimum number of bits needed to create this system of representation? How many patterns are unassigned? If the university hires another 50 employees, should it increase the number of bits? Please explain your answer.

一、選擇題：(請於答案卷上作答 ，共 54 分)

1. 根據 SARS-CoV-2 疫苗的儲存及運送條件，請問下何者巨分子的熱穩定性最差 (A) DNA，(B) RNA，(C) protein，(D)以上皆相同。

2. 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：(A) 凡德瓦爾力，(B)氫鍵的方向性，(C)氫鍵的數目，(D) 含氮鹼基的大小。

3. DNA 為雙股螺旋結構，請問下列何者是維持 DNA 骨架的主要力量？(A) 氫鍵，(B) 共價鍵，(C) 凡德瓦爾力，(D) 疏水作用力。

4. DNA 複製是 (A) 半保守的：每條 DNA 鏈含有一半的親本鍊和一半的合成鏈，(B) 所有生物體皆從染色體(DNA)的單一個特定部位開始複製，(C)雙向：從複制起點雙向進行，(D) 以上皆是。

5. 生物體中的巨分子生合成的過程中有校正(proofreading)的機制的是(A) DNA，(B) RNA，(C) protein，(D) polysaccharide。

6. 2018 年中國生物學家賀建奎披露其主導的全球首兩名基因編輯(CRIPR)嬰兒誕生，他針對 CCR5 進行編輯，以抵禦何種病毒入侵？(A) HBV，(B) HIV，(C) HPV，(D) EV。

7. 關於生物膜的描述，何者正確？(A) 按重量計含量最豐富的是脂質成分，(B) 跨模擴散(transverse diffusion)比橫向擴散(lateral diffusion)更快，(C) 不飽和脂質構成的生物膜比飽和脂質構成的生物膜相變(phase transition)需要更高的溫度，(D)雙層脂質膜，成分包括兩親性脂質，例如：甘油磷脂(glycerophospholipids)、鞘脂(sphingolipids)及膽固醇(cholesterol)。

8. 關於 Secondary active transport 一級主動運輸何者為真？(A) 無須運輸蛋白參與，(B) 濃度由高往低處運輸，(C) 消耗 ATP，(D) 藉由膜電位差達成物質運送。

9. 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抑制何種酵素活性？(A) GTPase，(B) Adenylyl cyclase，(C) cAMP phosophodiesterase，(D) Protein kinase A。

10. 作為一個選殖用的載體(cloning vector)，下列何者不是必要組成？(A)多重選殖位點(multiple cloning site)，(B) 篩選標誌基因(selection marker)，(C)複製起始點(origin of replication)，(D)以上皆非。

11. 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？(A)目標基因序列不會被選定的限制酶截切，(B) 限制酶切位的方向性，(C) 維持胺基酸密碼子(codon)的 in frame，(D) 以上皆是。

12. 遺傳密碼(codon)由非重疊的三核苷酸密碼子組成。(A) 三字母代碼的前兩個核苷酸通常就足夠決定代表的氨基酸，(B) 具有相似序列的密碼子指定分子量似的氨基酸，(C) 每一個密碼子均有對應的氨基酸，(D) 以上皆是。

13. 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？(A) 0.125，(B) 0.8，(C) 1.25， (D) 8。

14. 苯酮尿症(phenylketounia)是因酵素缺損，不能將_____代謝為_____造成的疾病。所列空格分別為何？
    (A) 苯丙胺酸(phenylalanine)；酪胺酸(tyrosine)
    (B) 苯丙胺酸(phenylanaline)；丙胺酸(alanine)
    (C) 麩胺醯胺(glutamine)；天門冬胺酸(aspartate)
    (D) 酪胺酸(tyrosine)；精胺酸(arginine)

15. 請問下列哪一種作用力不存在蛋白質分子結構的四級結構(quaternary structure)中？
    (A) 雙硫鍵結(disulfide bond)
    (B) 氫鍵作用力(hydrogen bond)
    (C) 靜電引力(electrostatic interaction)
    (D) 疏水性交互作用力(hydrophobic interaction)

16. 下列關於氣體進出細胞之方式，何者正確？
    (A) 二氧化碳溶於水成為 HCO_3^- 後，可行單純擴散進入細胞
    (B) 只有紅血球在氧氣不足時，可利用主動運輸將 O_2 帶入細胞
    (C) 二氧化碳進出細胞不受細胞內訊息傳遞分子的調控
    (D) 一氧化碳可透過不耗能的通道進入細胞

17. 下列對半乳糖、葡萄糖、果糖與其組合而成的雙糖之敘述，何者正確？
    (A) 半乳糖、葡萄糖與果糖之分子量皆相同
    (B) 蔗糖由葡萄糖和果糖所組成，而且其不具有旋光性
    (C) 麥芽糖是由葡萄糖與果糖所組成
    (D) 乳糖是由兩個半乳糖所組成

18. Which pair of amino acids absorbs the most UV light at 280 nm?
    (A) Threonine & Histidine
    (B) Trp & Tyrosine
    (C) Cystein & Asparagine
    (D) Phenylalnine & Proline

19. The endoplasmic reticulum bound enzyme that hydrolyzes glucose-6-phosphate to glucose in liver is:
(A) glucokinase.
(B) glucose oxidase.
(C) hexokinase.
(D) phosphoglucomutase.
(E) glucose-6-phosphatase.

20. Of the following biochemical compounds, what are ketone bodies?

①	②	③	④	⑤
$H_2N-\overset{O}{\overset{\|}{C}}-NH_2$	$H_3C-\overset{H}{\underset{OH}{\overset{\|}{C}}}-CH_2-\overset{O}{\overset{\|}{C}}-OH$	$^-O_2C-CH_2-CH_2-CH_3$	$H_3C-\overset{O}{\overset{\|}{C}}-CH_3$	$H_2N-\underset{CH_3}{CH}-\overset{O}{\overset{\|}{C}}-OH$

(A) ①④
(B) ②⑤
(C) ①③
(D) ②④
(E) ④⑤

21. This represents what biomacromolecules?

$$H_2N-\overset{H}{\underset{H}{\overset{\|}{C}}}-\overset{O}{\overset{\|}{C}}-OH$$
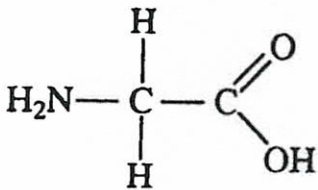
(A) Protein
(B) Lipid
(C) Carbohydrate
(D) Nucleic acid

22. The sugar in RNA is _____ , the sugar in DNA is _____
    (A)deoxyribose, ribose
    (B)ribose, deoxyribose
    (C)ribose, phosphate
    (D)ribose, uracil

23. Seven of the ten reactions of glycolysis are reversible (ΔG near zero) and can be used in reverse of glycolysis for gluconeogenesis. The three irreversible reactions are catalyzed by:
    (A) hexokinase, phosphoglycerate kinase, and pyruvate kinase.
    (B) triose phosphate isomerase, phosphoglycerate mutase, and pyruvate kinase.
    (C) enolase, phosphoglycerate kinase, and phosphofructokinase-1.
    (D) hexokinase, phosphoglucoisomerase, and glyceraldehyde-3-phosphate dehydrogenase.
    (E) hexokinase, phosphofructokinase-1, and pyruvate kinase.

24. Drinking alcohol can stimulate the synthesis of which enzyme in the liver?
    (A) Aspartate aminotransferase (AST)
    (B) Alanine aminotransferase (ALT)
    (C) Lactate dehydrogenase (LDH)
    (D) γ-Glutamyltransferase (GGT)

25. Which of the following amino acids has both Ketogenic and Glucogenic functions?
    (A) Arginine
    (B) Aspartic acid
    (C) Glutamine
    (D) Tryptophan

26. Genetic information for living things is stored in:
    (A)DNA, also known as deoxyribonucleic acid
    (B)Polysaccharides such as glycogen or amylopectin
    (C)Triacylglycerols such as glyceryl tristearate
    (D)Organelles such as lysozomes

27. What is the product of the catabolic breakdown of Alanine?
(A)Fumarate
(B)Oxaloacetate
(C)Pyruvate
(D)Malate

二、請說明改正以下敘述錯誤之處 (28 分，每題 2 分)

1. In cells, the hydrolytic release of the sulphate groups from the high energy compounds can drive an unfavorable process, such as transmission of nerve impulses and muscle contraction.

2. If DNA is mixed with a negatively charged protein, these molecules have a strong tendency to associate.

3. Glycine is the only amino acid in this group in which the side chain forms a covalent bond with the α–amino group.

4. Cellulose is a polymer made by joining thousands of molecules of galactose.

5. A decrease in blood pH results in stabilization of the deoxy state, and thereby favors greater O_2 released from hemoglobin. The cysteine residues in the hemoglobin play important roles in this mechanism.

6. Lysine absorbs light in the near-ultraviolet region of the spectrum. This characteristic is frequently used for the detection and/or quantitation of proteins, by measuring absorption at 280 nm.

7. During the study of oxygen binding for myoglobin and hemoglobin, a Ramachandran plot can distinguish cooperative ligand binding from noncooperative binding.

8. The assembly of microtubules bears resemblance to that of actin, and ATP is required.

9. Nucleic acids, proteins, polysaccharides and lipids are biopolymers (so-called macromolecules), and constitute a large fraction of the mass of any cell.

10. The Human Genome Project was a landmark global scientific effort to determining the protein sequences of the entire human genome.

11. SARS-CoV-2 is a strain of coronavirus that causes COVID-19, and it has a single-stranded DNA genome.

12. Potassium (K^+) is an important ion in the process of neurotransmitter release.

13. Most naturally occurring fatty acids contain an even number of carbon atoms. If double bonds are present (unsaturation), they are usually *trans*.

14. Ion exchange chromatography separates ions and polar molecules based on their affinity to the ion exchanger. A cation exchanger can absorb DNA and RNA.

科目： 生物化學　　　　　　　　　　　系所： 基因體暨生物資訊學研究所

三、問答題(18 分)

1. 請舉例說明真核生物 RNA 的三種轉譯後修飾(posttranscriptional modification)。(6 分)

2. 葉酸的主要功用是提供 UTP 甲基使其轉換成為 TTP，請問在細胞週期中哪一個階段最需要葉酸？(2 分)

3. 維凝膠電泳 (two-dimensional gel electrophoresis) 是分離蛋白質的有利技術。(5 分)

   1. 請簡述說明二維凝膠電泳 (two-dimensional gel electrophoresis) 的步驟。

   2. 請簡述這技術如何運用於蛋白體學的研究？

4. 請寫出以下五種縮寫單字所對應的胺基酸(5 分)
   1.W:
   2.Y:
   3.Q:
   4.N:
   5.F: