注意：I. 請於答案卷內所附的選擇題作答區內作答
II.~IX. 請依序作答，並應註明作答之題號

I. Single-choice problems (40%)

1. Which of the following properties of water protects aquatic organisms during a long, cold winter? (A) cohesion (B) solvent properties (C) temperature-stabilizing (D) none of the above.
2. White blood cells use_____to devour disease agents invading your body. (A) diffusion (B) bulk flow (C) osmosis (D) phagocytosis.
3. Which of the following is not an example of an active transport mechanism? (A) calcium pump (B) glucose transporter (C) sodium-potassium pump (D) all of the above are examples of active transport.
4. An important principle of the second law of thermodynamics states that_____. (A) energy can be transformed into matter, and because of this, we can get something for nothing (B) energy can only be destroyed during nuclear reactions, such as those that occur inside the sun (C) if energy is gained by one region of the universe, another region must also gain energy in order to maintain the balance of nature (D) matter tends to become increasingly more disorganized.
5. An allosteric enzyme_____. (A) has an active site where substrate molecules bind and another site that binds with intermediate or end-product molecules (B) is an important energy-carrying nucleotide (C) carries out either oxidation reactions or reduction reactions but not both (D) raises the activation energy of the chemical reaction it catalyzes.
6. The electrons that are passed to NADPH during the noncyclic pathway of photosynthesis were obtained from_____. (A) water (B) CO_2 (C) glucose (D) sunlight.
7. The two products of the light-dependent reactions that are required for the light-independent chemistry are _____and_____. (A) CO_2; H_2O (B) O_2; NADPH (C) O_2; ATP (D) ATP; NADPH.
8. The ultimate electron acceptor in aerobic respiration is_____. (A) NADH (B) carbon dioxide (CO_2) (C) oxygen (1/2 O_2) (D) ATP.
9. During the fermentation pathways, a net yield of two ATPs is produced from_____; the NAD^+ necessary for _____is regenerated during the fermentation reactions. (A) the Krebs cycle; glycolysis (B) glycolysis; electron transport phosphorylation (C) the Krebs cycle; electron transport phosphorylation (D) glycolysis; glycolysis.
10. Franklin's research contribution was essential in_____. (A) establishing the principle of base pairing (B) establishing most of the principal structural features of DNA (C) both A and B (D) neither A nor B.
11. Rosalind Franklin's data indicated that the DNA molecule had to be long and thin with a width (diameter) of 2 nanometers along its length. Watson and Crick

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declared that _____ ensured that width of the DNA molecule must be uniform. (A) the antiparallel nature of DNA (B) semiconservative replication processes (C) hydrogen bonding of the sugar-phosphate backbones (D) complementary base-pairing processes that match purine with pyrimidine.

12. The cause of sickle-cell anemia has been traced to _____. (A) a mosquito-transmitted virus (B) two DNA mutations that result in two incorrect amino acids in a hemoglobin chain (C) three DNA mutations that result in three incorrect amino acids in a hemoglobin chain (D) one DNA mutation that results in one incorrect amino acid in a hemoglobin chain.
13. One type of gene control discovered in female mammals is _____. (A) a conflict in maternal and paternal alleles (B) slow embryo development (C) X chromosome inactivation (D) operon.
14. A knockout cell is _____. (A) a fertilized egg that can lead to an exceptionally attractive person (B) a cell in which a particular gene sequence has been excised (C) any cell that has been removed from an organism (D) any cell that has been genetically engineered.
15. The resting membrane potential _____. (A) exists as long as a voltage difference sufficient to do work exists across a membrane (B) occurs because there are more potassium ions outside the neuronal membrane than there are inside (C) occurs because of the unique distribution of receptor proteins located on the dendrite exterior (D) is brought about by a local change in membrane permeability caused by a greater-than-threshold stimulus.
16. The markers for every cell in the human body are referred to by the letters _____. (A) HIV (B) MBC (C) RNA (D) DNA (E) MHC.
17. Whenever the body is re-exposed to a specific sensitizing agent, IgE antibodies cause _____. (A) prostaglandins and histamine to be produced (B) clonal cells to be produced (C) histamine to be released (D) the immune response to be suppressed (E) none of the above.
18. The element needed by humans for blood clotting, never impulse transmission, and bone and tooth formation is _____. (A) magnesium (B) iron (C) calcium (D) iodine (E) zinc.
19. Which of the following is *not* found in bile? (A) lecithin (B) salts (C) digestive enzyme (D) cholesterol (E) pigments.
20. Oxyhemoglobin_____. (A) releases oxygen more readily in metabolically active tissues (B) tends to release oxygen in places where the temperature is lower (C) tends to hold onto oxygen when the pH of the blood drops (D) tends to give up oxygen in regions where partial pressure of oxygen exceeds that in the lungs (E) all of the above.

＊ 下列題目請在試卷內的「非選擇題作答區」作答。

II. (A) Tropomyosin, a 70-kd muscle protein, is a two-stranded α-helical coiled coil. Estimate the length of the molecule? (B) Suppose that a 40-residue segment of a protein folds into a two-stranded antiparallel β structure with a

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4-residue hairpin turn. What is the longest dimension of this motif? (4%)

III. Suppose that you wish to synthesize a pool of RNA molecules that contain all four bases at each of 40 positions. How much RNA must you have in grams if the pool is to have at least a single molecule of each sequence? The average molecular weight of a nucleotide is 330 g mol^{-1}. (2%)

IV. The kinetics of an enzyme are measured as a function of substrate concentration in the presence and in the absence of 2 mM inhibitor (I). (20%)

	Velocity (μmol/minute)	
[S] (μM)	No inhibitor	Inhibitor
3	10.4	4.1
5	14.5	6.4
10	22.5	11.3
30	33.8	22.6
90	40.5	33.8

(A) What are the values of V_{max} and K_M in the absence of inhibitor? In its presence?
(B) What type of inhibition is it?
(C) What is the binding constant of this inhibitor?
(D) If [S] = 10 μM and [I] = 2 mM, what fraction of the enzyme molecules have a bound substrate? A bound inhibitor?
(E) If [S] = 30 μM, what fraction of the enzyme molecules have a bound substrate in the presence and in the absence of 2 mM inhibitor? Compare this ratio with the ratio of the reaction velocities under the same conditions.

V. The specific rotations of the α and β anomers of D-glucose are +112 degrees and +18.7 degrees, respectively. Specific rotation, $[\alpha]_D$, is defined as the observed rotation of light of wavelength 589 nm (the D line of a sodium lamp) passing through 10 cm of a 1 g ml^{-1} solution of a sample. When a crystalline sample of α-D-glucopyranose is dissolved in water, the specific rotation decreases from 112 degrees to an equilibrium value of 52.7 degrees. On the basis of this result, what are the proportions of the α and β anomers at equilibrium? Assume that the concentration of the open-chain form is negligible. (4%)

VI. The fraction of open channels at 5 mV increments beginning at -45 mV and ending at +5 mV at 20 °C is 0.02, 0.04, 0.09, 0.19, 0.37, 0.59, 0.78, 0.89, 0.95, 0.98, and 0.99. (6%)

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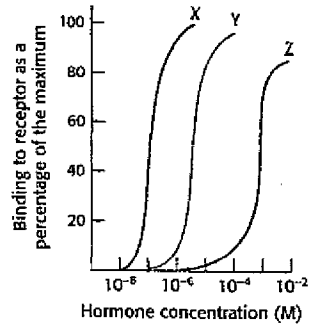
(A) At what voltage are half the channels open?
(B) What is the value of the gating charge?
(C) How much free energy is contributed by the movement of the gating charge in the transition from -45 mV to +5 mV?

VII. The lowest-energy absorption band of photosystem P870 occurs at 870 nm. (4%)
(A) Calculate the energy of an einstein of light at this wavelength.
(B) Estimate the effective standard redox potential ($E^{o\prime}$) of P870 in its first excited singlet state, given that the $E^{o\prime}$ for oxidation in the ground state is +0.45 V.

VIII. The following reagents are often used in protein chemistry: (a) CNBr (b) Performic acid (c) Phenyl isothiocyanate (d) Urea (e) Dabsyl chloride (f) Chymotrypsin (g) Mercaptoethanol (h) 6 N HCl (i) Trypsin (j) Nihydrin
Which one is the best suited for accomplishing each of the following tasks? (12%)
(A) Determination of the amino acid sequence of a small peptide.
(B) Identification of the amino-terminal residue of a peptide (of which you have less than 0.1 μg).
(C) Reversible denaturation of a protein devoid of disulfide bonds. Which additional reagent would you need if disulfide bonds were present?
(D) Hydrolysis of peptide bonds on the carboxyl side of aromatic residues.
(E) Cleavage of peptide bonds on the carboxyl side of methionines.
(F) Hydrolysis of peptide bonds on the carboxyl side to lysine and arginine residues.

IX. You wish to determine the hormone-binding specificity of a newly identified membrane receptor. Three different hormnones, X, Y, Z, were mixed with the receptor in separate experiments, and the percentage of binding capacity of the receptor was determined as a function of hormone concentration, as shown in graph A. (8%)

(A)



(A) What concentrations of each hormone yield 50% maximal binding?
(B) Which hormone shows the highest binding affinity for the receptor?