

國立成功大學

112學年度碩士班招生考試試題

編 號： 58

系 所： 生命科學系

科 目： 生物化學

日 期： 0207

節 次： 第 3 節

備 註： 不可使用計算機

※ 考生請注意：本試題不可使用計算機。請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

1. About 25 of the 92 natural elements are known to be essential to life. Which 4 of these 25 elements make up approximately 96% of living matter? Answer the element symbols like "Au". (3 points x 4)
2. Answer whether the following statements about water are true or false (answer with T or F). (3 points x 5)
 - a. In a single molecule of water, two hydrogen atoms are bonded to a single oxygen atom by hydrogen bonds.
 - b. The partial negative charge in a molecule of water occurs because the oxygen atom has two pairs of electrons in its valence shell that are not neutralized by hydrogen atoms.
 - c. Water molecules can form hydrogen bonds with chloride ions.
 - d. Liquid water has a heat of vaporization higher than that of most other substances.
 - e. Ice floats in liquid water because the high surface tension of liquid water keeps the ice on top.
3. (4 points x 3)
 - a. Calculate the water potential (solute potential) of 0.1 M sucrose solution with the following formula:
$$\Psi = -MiRT$$

(M: Molar concentration, i: van 't Hoff factor, R: gas constant, T: absolute temperature)
 $i = 1$ (sucrose), $R = 8.31 \times 10^{-3} \text{ MPa} \cdot \text{L}/(\text{K} \cdot \text{mol})$, $T = 285 \text{ K}$
 - b. The value for Ψ in root cells in a certain plant was found to be -0.15 MPa . If you take the root tissue and place it in a 0.1 M solution of sucrose, the net water flow would _____.
 - A) be from the tissue into the sucrose solution
 - B) be from the sucrose solution into the tissue
 - C) be in both directions, and the concentration of water would remain equal
 - D) be impossible to determine from the values given here
 - c. When an animal cell is placed in a hypotonic solution and water enters the cell via osmosis, the volume of the cell increases until it bursts. This does not happen to plant cells, because _____.
 - A) they have large central vacuoles, which provide abundant space for storage of incoming water
 - B) they have cell walls, which prevent the entry of water by osmosis
 - C) they have cell walls, which provide pressure to counteract the pressure of the incoming water
 - D) certain gated channel proteins embedded in their plasma membranes open as osmotic pressure decreases, allowing excess water to leave the cell
4. When you performed electrophoresis experiments with DNA fragments, they migrated towards the positively charged electrode. Explain the reason why, mentioning the structure of DNA. (5 points)
5. When you performed Western blotting experiments, protein samples migrated towards the positively charged electrode. Explain the reason why, mentioning the procedures of this analysis. (6 points)

6. Soy sauce is prepared by fermenting a salted mixture of soybeans and wheat with several microorganisms, including yeast, over a period of 8 to 12 months. The resulting sauce (after solids are removed) is rich in lactate and ethanol. How are these two compounds produced? To prevent the soy sauce from having a strong vinegary taste (vinegar is diluted acetic acid), oxygen must be kept out of the fermentation tank. Why? (10 points)
7. Between your evening meal and breakfast, your blood glucose drops and your liver becomes a net producer rather than consumer of glucose. Describe the hormonal basis for this switch, and explain how the hormonal change triggers glucose production by the liver. (10 points)
8. The chemical mechanisms used to avoid errors in protein synthesis are different from those used during DNA replication. DNA polymerases use a 3'→5' exonuclease proofreading activity to remove mis-paired nucleotides incorrectly inserted into a growing DNA strand. There is no analogous proofreading function on ribosomes and, in fact, the identity of an amino acid attached to an incoming tRNA and added to the growing polypeptide is never checked. A proofreading step that hydrolyzed the previously formed peptide bond after an incorrect amino acid had been inserted into a growing polypeptide (analogous to the proofreading step of DNA polymerases) would be impractical. Why? (10 points)
9. *E. coli* cells are growing in a medium containing lactose but no glucose. Indicate whether each of the following changes or conditions would increase, decrease, or not change the expression of the *lac* operon. It may be helpful to draw a model depicting what is happening in each situation. (10 points)
- Addition of a high concentration of glucose
 - A mutation that prevents dissociation of the Lac repressor from the operator
 - A mutation that completely inactivates β galactosidase
 - A mutation that completely inactivates galactoside permease
 - A mutation that prevents binding of CRP to its binding site near the *lac* promoter
10. A new RNA polymerase activity is discovered in crude extracts of cells derived from an exotic fungus. The RNA polymerase initiates transcription only from a single, highly specialized promoter. As the polymerase is purified its activity declines, and the purified enzyme is completely inactive unless crude extract is added to the reaction mixture. Suggest an explanation for these observations. (10 points)