

## Part I

1. Please answer the following questions about the twenty fundamental amino acids for comprising of proteins. For example: if you think that the answer is glycine, you must write down your answer as Glycine, Gly, and G to get the full score.
  - (a) The amino acids have two chiral carbons. (2%)
  - (b) Which amino acid contains an indole ring? (1%)
  - (c) Which amino acid contains a pyrrolidine ring? (1%)
2. Please answer the following questions about the  $\alpha$ -helix.
  - (a) In average, how many amino acid residues consist of one turn of  $\alpha$ -helix? (1%)
  - (b) In the  $\alpha$ -helix, how many atoms are involved in the formation of a hydrogen bond? (1%)
  - (c) In the  $\alpha$ -helix, all C=O groups, N-H groups and R groups in the peptide bonds point toward which direction? (3%)
3. Please briefly explain the following biochemical terms.
  - (a) Domain (2%)
  - (b) Zymogen (2%)
  - (c) Isozyme (2%)
  - (d)  $k_{cat}/K_m$  (2%)
4. Please answer the following questions about hemoglobin.
  - (a) Where is the binding site of 2,3-BPG located in hemoglobin? (2%)
  - (b) Why fetal hemoglobin has a higher affinity for  $O_2$  than adult hemoglobin? (2%)
5. What are the major conclusions of the RNase A renaturation experiment demonstrated by Christian B. Anfinsen? (4%)
6. Please describe the property of the intrinsically unstructured (disordered) proteins. (4%)
7. Please list the six major classes of enzyme nomenclature proposed by the International Union of Biochemistry. (6%)
8. Please describe the double-displacement (ping-pong) catalytic mechanism for two-substrate enzymatic reaction. (2%)
9. Please draw the catalytic triad at the active site of serine proteases. (3%)
10. The citric acid cycle – also known as the TCA cycle (tricarboxylic acid cycle) or the Krebs cycle – is a series of biochemical reactions used by all aerobic organisms to release stored energy through the oxidation of acetyl-CoA derived from carbohydrates and other metabolites. Please draw a complete TCA cycle filled with all the metabolites and coenzymes (you don't need to write down the enzymes which are involved in each specific reactions). (10%)

見背面

## Part II 單選題，每題兩分

11. A protein binds to the DNA sequence AAAAA with a dissociation constant of 10-nM. The same protein binds to the RNA sequence AUAAUA with a dissociation constant of 15-nM. And this protein binds to a lipid with a dissociation constant of 10-mM. Which of the following statements is true:
- The protein binds to RNA and DNA with high affinity than lipids, but low specificity.
  - The protein has high specificity for lipids over RNA and DNA.
  - The protein binds with low affinity for RNA and DNA, but high specificity.
  - The protein binds with low affinity and low specificity, for all three targets.
12. To which amino acid residues in glycoproteins are the sugars commonly linked?
- Tyrosine only
  - Only Serine and threonine
  - Serine, threonine, and asparagine
  - Lysine and arginine
  - Serine, tyrosine, and cysteine
13. The phosphodiester bonds that link adjacent nucleotides in both RNA and DNA:
- always link A with T and G with C.
  - are susceptible to alkaline hydrolysis.
  - are uncharged at neutral pH.
  - form between the planar rings of adjacent bases.
  - join the 3' hydroxyl of one nucleotide to the 5' hydroxyl of the next
14. Chargaff's rules state that in typical DNA:
- A = G.
  - A = C.
  - A = U.
  - A + T = G + C.
  - A + G = T + C.
15. Which of the following is an epimeric pair?
- D-glucose and D-glucosamine
  - D-glucose and D-mannose
  - D-glucose and L-glucose
  - D-lactose and D-sucrose
  - L-mannose and L-fructose
16. Which of the following best describes the cholesterol molecule?
- Amphipathic
  - Nonpolar, charged
  - Nonpolar, uncharged
  - Polar, charged
  - Polar, uncharged

17. Which of these statements about the composition of biological membranes is false?
- In a given eukaryotic cell type (e.g., a hepatocyte), all intracellular membranes have essentially the same lipids and proteins.
  - The carbohydrate found in membranes is virtually all part of either glycolipids or glycoproteins.
  - The plasma membranes of the cells of vertebrate animals contain more cholesterol than the mitochondrial membranes.
  - The ratio of lipid to protein varies widely among cell types in a single organism.
  - Triacylglycerols are not commonly found in membranes
18. In the plant signaling pathways employing receptor-like kinases (RLKs), which one of the following does not occur?
- Activation of a MAPK cascade
  - Autophosphorylation of receptor
  - Dimerization of receptor
  - Ligand binding to receptor
  - Phosphorylation of key proteins on His residues
19. The reaction  $A + B \rightarrow C$  has a  $\Delta G^\circ$  of  $-20 \text{ kJ/mol}$  at  $25^\circ \text{C}$ . Starting under standard conditions, one can predict that:
- at equilibrium, the concentration of B will exceed the concentration of A.
  - at equilibrium, the concentration of C will be less than the concentration of A.
  - at equilibrium, the concentration of C will be much greater than the concentration of A or B.
  - C will rapidly break down to A + B.
  - when A and B are mixed, the reaction will proceed rapidly toward formation of C.
20. What is the correct order of function of the following enzymes of  $\beta$ -oxidation?
- $\beta$ -Hydroxyacyl-CoA dehydrogenase
  - Thiolase
  - Enoyl-CoA hydratase
  - Acyl-CoA dehydrogenase
- 1, 2, 3, 4
  - 3, 1, 4, 2
  - 4, 3, 1, 2
  - 1, 4, 3, 2
  - 4, 2, 3, 1

Part III 問答題，分數標示於各題

21. What is the effect of increasing concentration of each of the following on the "rate of glycogen degradation in the liver". Please explain these effects by describing their biochemical mechanisms (10 points)
- cytosolic  $\text{Ca}^{2+}$
  - plasma glucagon
  - blood glucose
22. Formation and stability of biomolecules, protein, DNA, starch, lipid bilayer, are governed by non-covalent bonds. Please describe how these molecules are stabilized. And discuss what are in common, and what are unique? (10 points)
23. Please draw the chemical structures of the two common DNA base pairs and explain how the major groove and minor groove are formed. (5 points).
24. Please describe how the oligosaccharide chains in glycoproteins modify the protein structure and functions. And also, how oligosaccharides contribute to the structural diversity by the chemical/structural properties of oligosaccharides. (5 points).