第一部分 (34 points total)

Match (16%)

1. Pyruvate kinase
2. Phosphohexose isomerase
3. Biotin
4. Glucokinase
5. α-Ketoglutarate
6. Glucose 6-phosphatase
7. Glycogen synthase
8. Transaminase
9. Phosphofructokinase-1
10. Isocitrate dehydrogenase
11. Frutokinase
12. Cobalamin
13. Phosphofructokinase-2
14. Carnitine acyl-transferase I
15. Fructose 2,6-bisphosphate
16. Succnyl-CoA synthetase
17. Succinate
18. Glycogen phosphorylase
19. Pyridoxal 5'-phosphate
20. Glucose 6-phosphate dehydrogenase
21. Fructose 2,6-bisphosphatase
22. Fumarate
23. Fructose 1,6-bisphosphatase
24. PEP carboxykinase
25. Malate dehydrogenase
26. Protein phosphatase
27. Thiamin pyrophosphate
28. Pyruvate carboxylase
29. Protein kinase
30. ATP

A. Which family of the enzyme that is responsible for amino acid metabolism
B. Which of the enzymes involve in the irreversible steps of gluconeogenesis
C. Which of the enzymes involve in the first step of pantose phosphate pathway
D. Which enzyme participate the rate-limiting step in glycolysis?
E. The only five-carbon substrate in TCA cycle
F. Which of the enzyme involves in the irreversible step of fatty acid oxidation?
G. A family of the enzymes which phosphorylate the protein substrate
H. A family of the enzymes which dephosphorylate the protein substrate
I. Which of the enzymes involve in the control of glycogen breakdown
J. Which of the coenzyme involves in the catalytic reaction of pyruvate carboxylase
K. The major coenzyme for amino acid metabolism?
L. Which of the enzyme is the isoenzyme of hexokinase
M. Which of the enzymes involve the substrate-level phosphorylation in TCA cycle

Short answer question (7%)

1. For the binding of a ligand to a protein, what is the relationship between the $K_a$ (association constant), the $K_d$ (dissociation constant), and the affinity of the protein for the ligand? (2%)

第 1 頁
背面有題，請繼續作答。
2. Simply describes the catalytic mechanism of chymotrypsin including:
   (1) Which amino acid residues involve the catalytic triad (3%) and
   (2) What kind of catalysis involves in the catalytic mechanism (2%)

Filling the blank and answer the following question (11%)
1. Could enzyme reduce the activation energy (yes or no)?
2. Could enzyme increase the rate constants of direct or reverse reaction (yes or no)?
3. Does the enzyme change the equilibrium (yes or no)?
4. The oxygen binding curve of Myoglobin is followed a ________ kinetic curve.
5. The oxygen binding curve of hemoglobin is followed a ________ kinetic curve.
6. __________ is an allosteric inhibitor of hemoglobin
7. The prosthetic group of hemoglobin is ________.
8. A biochemist obtains the following set of data for an enzyme that is known to follow Michaelis-Menten kinetics.

<table>
<thead>
<tr>
<th>Substrate concentration (µM)</th>
<th>Initial velocity (µmol/min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>49</td>
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<tr>
<td>2</td>
<td>96</td>
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<tr>
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<tr>
<td>5,000</td>
<td>1001</td>
</tr>
</tbody>
</table>

   (A) $V_{max}$ for the enzyme is ________.
   (B) Explain in one sentence how you determined $V_{max}$.
   (C) $K_m$ for the enzyme is ________.
   (D) Explain in one sentence how you determined $K_m$.

第二部分 (33 points total)

Short answer questions: (33 points)
1. Why do living cells usually produce only one chiral form of biomolecules? (3 points)
2. Please define the term "specific activity" of an enzyme. (3 points)
3. For each of these methods of separating proteins, describe the principle of the method, and tell what property of proteins allows their separation by this technique. (3 points)
   (a) ion-exchange chromatography
   (b) size-exclusion (gel filtration) chromatography
   (c) affinity chromatography.

4. Please draw the structure of the peptide Asp-Ala-Cys, and show the ionizable groups in the form they have at pH 7. (3 points)

5. Please describe the principle of electrophoresis. (3 points)

6. What is Ramachandran plot? (3 points)

7. Why do proline and glycine residues occur infrequently in α-helices? (2 points)

8. Name four factors (bonds or other forces) that contribute to stabilizing the native structure of a protein, and describe one condition or reagent that interferes with each type of stabilizing force. (4 points)

9. How do “chaperone” proteins assist in the correct folding of polypeptides? (3 points)

10. Please describe the application of SDS gel electrophoresis. (3 points)

11. How does adenosine triphosphate (ATP) act as the major carrier of chemical energy in all cells? (3 points)

第三部分 (33 points total)

Part I: Multiple Choice: (Choose ONE answer for each question and write A, B, C, D, or E on your answering sheet. 每题 1 分 15%)

1. A major component of RNA but not of DNA is:
   A) adenine.
   B) cytosine.
   C) guanine.
   D) thymine.
   E) uracil.

2. The difference between a ribonucleotide and a deoxyribonucleotide is:
   A) a deoxyribonucleotide has α configuration; ribonucleotide has the β configuration at C-1.
   B) a deoxyribonucleotide has an —H instead of an —OH at C-2.
   C) a ribonucleotide has an extra —OH at C-4.
   D) a ribonucleotide has more structural flexibility than deoxyribonucleotide.
   E) a ribonucleotide is a pyranose, deoxyribonucleotide is a furanose.
3. In the Watson-Crick model of DNA structure:
   A) both strands run in the same direction, 3' → 5'; they are parallel.
   B) phosphate groups project toward the middle of the helix, where they are protected from interaction with water.
   C) T can form three hydrogen bonds with either G or C in the opposite strand.
   D) the distance between two adjacent bases in one strand is about 3.4 Å.
   E) the distance between the sugar backbone of the two strands is just large enough to accommodate either two purines or two pyrimidines.

4. In the Watson-Crick model of DNA structure (now called B-form DNA):
   A) a purine in one strand always hydrogen bonds with a purine in the other strand.
   B) A−T pairs share three hydrogen bonds.
   C) G−C pairs share two hydrogen bonds.
   D) the 5' ends of both strands are at one end of the helix.
   E) the bases occupy the interior of the helix.

5. The Meselson-Stahl experiment established that:
   A) DNA polymerase has a crucial role in DNA synthesis.
   B) DNA synthesis in E. coli proceeds by a conservative mechanism.
   C) DNA synthesis in E. coli proceeds by a semi-conservative mechanism.
   D) DNA synthesis requires dATP, dCTP, dGTP, and dTTP.
   E) newly synthesized DNA in E. coli has a different base composition than the preexisting DNA.

6. An Okazaki fragment is a:
   A) fragment of DNA resulting from endonuclease action.
   B) fragment of RNA that is a subunit of the 30S ribosome.
   C) segment of DNA that is an intermediate in the synthesis of the lagging strand.
   D) segment of mRNA synthesized by RNA polymerase.
   E) piece of DNA that is synthesized in the 3' → 5' direction.

7. The 5' → 3' exonuclease activity of E. coli DNA polymerase I is involved in:
   A) formation of a nick at the DNA replication origin.
   B) formation of Okazaki fragments.
   C) proofreading of the replication process.
   D) removal of RNA primers by nick translation.
   E) sealing of nicks by ligase action.

8. The operator region normally can be bound by:
   A) suppressor tRNA.
   B) repressor.
   C) attenuator.
   D) inducer.
   E) mRNA.

9. A regulon is:
   A) a group of related triplet codons.
   B) an operon that is subject to regulation.
   C) a protein that regulates gene expression.
   D) a network of operons with a common regulator.
   E) a ribosomal protein that regulates translation.
10. The tryptophan operon of *E. coli* is repressed by tryptophan added to the growth medium. The tryptophan repressor probably:

A) is a DNA sequence.
B) is an attenuator.
C) binds to RNA polymerase when tryptophan is present.
D) binds to the *trp* operator in the absence of tryptophan.
E) binds to the *trp* operator in the presence of tryptophan.

11. Which of the following is a palindromic sequence?

A) AGGTCC  
   TCCAGG
B) CCTTCC  
   GCAAGG
C) GAATCC  
   CT TAGG
D) GGATCC  
   CCTAGG
E) GTATCC  
   CATAGG

12. In living cells, nucleotides and their derivatives can serve as:

A) carriers of metabolic energy.
B) enzyme cofactors.
C) intracellular signals.
D) precursors for nucleic acid synthesis.
E) all of the above.

13. In bacteria the elongation stage of protein synthesis does *not* involve:

A) aminoacyl-tRNAs.
B) EF-Tu.
C) GTP.
D) IF-2.
E) peptidyl transferase.

14. The large structure consisting of an mRNA molecule being translated by multiple copies of the macromolecular complexes that carry out protein synthesis is called a:

A) proteosome.
B) ribosome.
C) synthosome.
D) polysome.
E) lysosome.

15. The reverse transcriptase of an animal RNA virus catalyzes:

A) degradation of the RNA strand in a DNA-RNA hybrid.
B) insertion of the viral genome into a chromosome of the host (animal) cell.
C) RNA formation in the 3′ → 5′ direction.
D) RNA synthesis, but not DNA synthesis.
E) synthesis of an antisense RNA transcript.
Part II: 請將左邊的酵素與右側的功能進行一對一配對 18 %（每題 2 分； for the best fit）

(1) RecA (a) oriC binding
(2) UvrC (b) Holliday junction resolution
(3) DNA polymerase III (c) supercoiling release
(4) DNA polymerase I (d) strand invasion
(5) DnaA (e) mismatch repair
(6) RuvC (f) excinuclease
(7) RecBCD (g) base-excision repair
(8) DNA polymerase IV/V (h) branch migration
(9) DNA gyrase (i) SOS repair