

系所組別： 生命科學系甲組

考試科目： 生物化學

考試日期： 0226，節次： 2

## 選擇題第一部分 (10 分，每題 1 分)

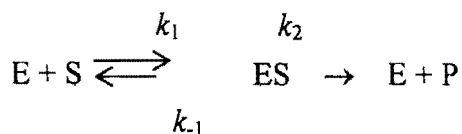
- Which of the following statements about aromatic amino acids is correct?
    - All are strongly hydrophilic.
    - Histidine's ring structure results in its being categorized as aromatic or basic, depending on pH.
    - On a molar basis, tryptophan absorbs more ultraviolet light than tyrosine.
    - The major contribution to the characteristic absorption of light at 280 nm by proteins is the phenylalanine R group.
    - The presence of a ring structure in its R group determines whether or not an amino acid is aromatic.
  - The uncommon amino acid selenocysteine has an R group with the structure  $\text{—CH}_2\text{—SeH}$  ( $\text{pK}_a \approx 5$ ). In an aqueous solution,  $\text{pH} = 7.0$ , selenocysteine would:
    - be a fully ionized zwitterion with no net charge.
    - be found in proteins as D-selenocysteine.
    - never be found in a protein.
    - be nonionic.
    - not be optically active.
  - Thr and/or Leu residues tend to disrupt an  $\alpha$  helix when they occur next to each other in a protein because:
    - an amino acid like Thr is highly hydrophobic.
    - covalent interactions may occur between the Thr side chains.
    - electrostatic repulsion occurs between the Thr side chains.
    - steric hindrance occurs between the bulky Thr side chains.
    - the R group of Thr can form a hydrogen bond.
  - Analysis of x-ray diffraction data yields a(n) \_\_; analysis of 2D NMR data yields a(n)\_\_.
    - electron density map; count of hydrogen atoms in the molecule
    - shadow of protein's outline; estimate of protein's molecular volume
    - table of interatomic distances; electron density map
    - electronic density map; table of interatomic distances
    - 3-d protein structure; 2-d protein structure
  - Experiments on denaturation and renaturation after the reduction and reoxidation of the  $\text{—S—S—}$  bonds in the enzyme ribonuclease (RNase) have shown that:
    - folding of denatured RNase into the native, active conformation requires the input of energy in the form of heat.
    - native ribonuclease does not have a unique secondary and tertiary structure.
    - the completely unfolded enzyme, with all  $\text{—S—S—}$  bonds broken, is still enzymatically active.
    - the enzyme, dissolved in water, is thermodynamically stable relative to the mixture of amino acids whose residues are contained in RNase.
    - the primary sequence of RNase is sufficient to determine its specific secondary and tertiary structure.
- (背面仍有題目,請繼續作答)

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6. A prosthetic group of a protein is a non-protein structure that is:
- a ligand of the protein.
  - a part of the secondary structure of the protein.
  - a substrate of the protein.
  - permanently associated with the protein.
  - transiently bound to the protein.
7. The amino acid substitution of Val for Glu in Hemoglobin S results in aggregation of the protein because of \_\_\_\_\_ interactions between molecules.
- covalent
  - disulfide
  - hydrogen bonding
  - hydrophobic
  - ionic
8. A monoclonal antibody differs from a polyclonal antibody in that monoclonal antibodies:
- are labeled with chemicals that can be visualized.
  - are produced by cells from the same organism that produced the antigen.
  - are synthesized by a population of identical, or "cloned," cells.
  - are synthesized only in living organisms.
  - have only a single polypeptide chain that can recognize an antigen.
9. Michaelis and Menten assumed that the overall reaction for an enzyme-catalyzed reaction could be written as



Using this reaction, the rate of breakdown of the enzyme-substrate complex can be described by the expression:

- $k_1 [E] + k_2 [ES]$ .
  - $k_1 ([E] - [ES])[S]$ .
  - $k_2 [ES]$ .
  - $k_1 ([E] - [ES])$ .
  - $k_1 [ES]$ .
10. The Lineweaver-Burk plot is used to:
- determine the equilibrium constant for an enzymatic reaction.
  - extrapolate for the value of reaction rate at infinite enzyme concentration.
  - illustrate the effect of temperature on an enzymatic reaction.
  - solve, graphically, for the rate of an enzymatic reaction at infinite substrate concentration.
  - solve, graphically, for the ratio of products to reactants for any starting substrate concentration.

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## 選擇題第二部分 (20 分，每題 2 分)

1. The phosphodiester bonds that link adjacent nucleotides in both RNA and DNA:
  - A) join the 3' hydroxyl of one nucleotide to the 5' hydroxyl of the next.
  - B) are susceptible to alkaline hydrolysis.
  - C) are uncharged at neutral pH.
  - D) form between the planar rings of adjacent bases.
2. In the Watson-Crick structure of DNA, the:
  - A) absence of 2'-hydroxyl groups allows bases to lie perpendicular to the helical axis.
  - B) adenine content of one strand must equal the thymine content of the same strand.
  - C) nucleotides are arranged in the A-form.
  - D) purine content (fraction of bases that are purines) must be the same in both strands.
3. The most precise modern definition of a gene is a segment of genetic material that:
  - A) codes for one polypeptide.
  - B) codes for one polypeptide or RNA product.
  - C) determines one phenotype.
  - D) that codes for one protein.
4. The linking number ( $Lk$ ) of a closed-circular, double-stranded DNA molecule is changed by:
  - A) breaking a strand, then rejoining it.
  - B) breaking a strand, unwinding or rewinding the DNA, then rejoining it.
  - C) supercoiling without the breaking of any phosphodiester bonds.
  - D) underwinding without the breaking of any phosphodiester bonds.
5. At replication forks in *E. coli*:
  - A) DNA helicases make endonucleolytic cuts in DNA.
  - B) DNA primers are degraded by exonucleases.
  - C) DNA topoisomerases make endonucleolytic cuts in DNA.
  - D) RNA primers are synthesized by primase.
6. The role of the Dam methylase is to:
  - A) add a methyl group to uracil, converting it to thymine.
  - B) modify the template strand for recognition by repair systems.
  - C) remove a methyl group from thymine.
  - D) remove a mismatched nucleotide from the template strand.
7. Which of the following statements is *false*? In vitro, the strand-exchange reaction:
  - A) can include formation of a Holliday intermediate.
  - B) requires DNA polymerase.
  - C) may involve transient formation of a three- or four-stranded DNA complex.
  - D) needs RecA protein.

(背面仍有題目, 請繼續作答)

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8. Processing of a primary mRNA transcript in a eukaryotic cell does *not* normally involve:
- A) attachment of a long poly(A) sequence at the 3' end.
  - B) conversion of normal bases to modified bases, such as inosine and pseudouridine.
  - C) excision of intervening sequences (introns).
  - D) methylation of one or more guanine nucleotides at the 5' end.
9. Which one of the following statements about the elongation phase of protein synthesis is true?
- A) At least five high-energy phosphoryl groups are expended for each peptide bond formed.
  - B) During elongation, incoming aminoacylated tRNAs are first bound in the P site.
  - C) Elongation factor EF-Tu facilitates translocation.
  - D) Peptidyl transferase is a ribozyme.
10. "Housekeeping genes" in bacteria are commonly expressed constitutively, but not all of these genes are expressed at the same level (the same number of molecules per cell). The primary mechanism responsible for variations in the level of constitutive enzymes from different genes is that:
- A) all constitutive enzymes are synthesized at the same rate, but are not degraded equally.
  - B) their promoters have different affinities for RNA polymerase holoenzyme.
  - C) some constitutively expressed genes are more inducible than others.
  - D) some constitutively expressed genes are more repressible than others.

### 問答題

1. (五分) The amino acid histidine has a side chain for which the  $pK_a$  is 6.0. Calculate what fraction of the histidine side chains will carry a positive charge at pH 5.4. Be sure to show your work.
2. (五分) In two or more sentences, describe the usefulness of each of the following reagents or reactions in the analysis of protein structure: (5 points)
- (a) Edman reagent (phenylisothiocyanate)
  - (b) Sanger reagent (1-fluoro-2,4-dinitrobenzene, FDNB)
  - (c) trypsin
3. (五分) What is the difference between general acid-base catalysis and specific acid-base catalysis? (Assume that the solvent is water.)
4. (五分) Explain why most multicellular organisms use an iron-containing protein for oxygen binding rather than free  $Fe^{2+}$ . Your answer should include an explanation of (a) the role of heme and (b) the role of the protein itself.

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5. (五分) List one basic property that distinguishes RNA polymerases from DNA polymerases, and list one basic property they share.

6. (五分) Describe the sequence of events between the transcription of an mRNA for a secreted protein and the arrival of that protein in the lumen of the endoplasmic reticulum.

7. (五分) *E. coli* cells are placed in a growth medium containing lactose. Indicate how the following circumstances would affect the expression of the lactose operon (increase/decrease/no change).

- a). Addition of high levels of glucose
- b). A *lac* repressor mutation that prevents dissociation of a *lac* repressor from the operator
- c). A mutation that inactivates  $\beta$ -galactosidase
- d). A mutation that inactivates galactoside permease
- e). A mutation that prevents binding of CRP to its binding site near the *lac* promoter

8. (5 分) Define the following terms: Genomic, Transcriptome, Proteome, Metabolome

9. (15 分) For the each of the following metabolic pathways, describe where in the cell it occurs and identify the starting material and end product(s):

- a) Citric acid cycle
- b) glycolysis
- c) oxidative phosphorylation
- d) fatty acid synthesis

10. (15 分)

- a). what would be the consequences of a carnitine deficiency for fatty acid oxidation?
- b). what would be the consequences of a deficiency of vitamin B12 for fatty acid oxidation? and, what metabolic intermediates might accumulate?