

系所組別 生命科學系甲組

考試科目：生物化學

考試日期：0307，節次：2

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請勿在本試題紙上作答，否則不予計分

Part I (total 30 points)

Multiple Choice Questions (1.5 point/question)

- Of the 20 standard amino acids, only _____ is not optically active. The reason is that its side chain is _____.
 - alanine; is a simple methyl group
 - glycine; is a hydrogen atom
 - glycine; is unbranched
 - lysine; contains only nitrogen
 - proline; forms a covalent bond with the amino group
- Which of the following is correct with respect to the amino acid composition of proteins?
 - Larger proteins have a more uniform distribution of amino acids than smaller proteins.
 - Proteins contain at least one each of the 20 different standard amino acids.
 - Proteins with different functions usually differ significantly in their amino acid composition.
 - Proteins with the same molecular weight have the same amino acid composition.
 - The average molecular weight of an amino acid in a protein increases with the size of the protein.
- Which of the following pairs of bonds within a peptide backbone show free rotation around both bonds?
 - C—C and N—C
 - C=O and N—C
 - C—O and N—C
 - N—C and C—C
 - N—C and N—C
- Amino acid residues commonly found in the middle of β turn are:
 - Ala and Gly.
 - hydrophobic.
 - Pro and Gly.
 - those with ionized R-groups.
 - two Cys.
- An allosteric interaction between a ligand and a protein is one in which:
 - binding of a molecule to a binding site affects binding of additional molecules to the same site.
 - binding of a molecule to a binding site affects binding properties of another site on the protein.
 - binding of the ligand to the protein is covalent.
 - multiple molecules of the same ligand can bind to the same binding site.
 - two different ligands can bind to the same binding site.
- Which one of the following statements is true of enzyme catalysts?
 - They bind to substrates, but are never covalently attached to substrate or product.
 - They increase the equilibrium constant for a reaction, thus favoring product formation.
 - They increase the stability of the product of a desired reaction by allowing ionizations, resonance, and isomerizations not normally available to substrates.
 - They lower the activation energy for the conversion of substrate to product.
 - To be effective they must be present at the same concentration as their substrates.
- Which of the following statements about a plot of V_0 vs. $[S]$ for an enzyme that follows Michaelis-Menten kinetics is false?
 - As $[S]$ increases, the initial velocity of reaction V_0 also increases.
 - At very high $[S]$, the velocity curve becomes a horizontal line that intersects the y-axis at K_m .
 - K_m is the $[S]$ at which $V_0 = 1/2 V_{max}$.
 - The shape of the curve is a hyperbola.
 - The y-axis is a rate term with units of $\mu\text{M}/\text{min}$.

Short Questions

- (4.5 points) In one or two sentences, describe the usefulness of each of the following reagents or reactions in the analysis of protein structure:
 - Edman reagent (phenylisothiocyanate)
 - Sanger reagent (1-fluoro-2,4-dinitrobenzene, FDNB)
 - trypsin
- (5 points) Once a protein has been denatured, how can it be renatured? If renaturation does not occur, what might be the explanation?

(背面仍有題目,請繼續作答)

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3. (5 points) Explain how the effects of sickle cell disease demonstrate that hemoglobin undergoes a conformational change upon releasing oxygen.
4. (5 points) Why is the Lineweaver-Burk (double reciprocal) plot more useful than the standard V vs. $[S]$ plot in determining kinetic constants for an enzyme? (Your answer should probably show typical plots.)

Part II (total 30 points)**Multiple Choice Questions (2 points each)**

1. In the Watson-Crick model for the DNA double helix (B form), the A-T and G-C base pairs share which one of the following properties?
- The distance between the two glycosidic (base-sugar) bonds is the same in both base pairs, within a few tenths of an angstrom.
 - The molecular weights of the two base pairs are identical.
 - The number of hydrogen bonds formed between the two bases of the base pair is the same.
 - The plane of neither base pair is perpendicular to the axis of the helix.
 - The proton-binding groups in both base pairs are in their charged or ionized form.
2. The proofreading function of DNA polymerase involves all of the following *except*:
- a 3' → 5' exonuclease.
 - base pairing.
 - detection of mismatched base pairs.
 - phosphodiester bond hydrolysis.
 - reversal of the polymerization reaction.
3. After binding by *E. coli* RNA polymerase, the correct order of events for transcription initiation is:
- closed complex formation, open complex formation, promoter clearance, start of RNA synthesis.
 - closed complex formation, open complex formation, start of RNA synthesis, promoter clearance.
 - open complex formation, closed complex formation, start of RNA synthesis, promoter clearance.
 - start of RNA synthesis, closed complex formation, open complex formation, promoter clearance.
 - start of RNA synthesis, open complex formation, closed complex formation, promoter clearance.
4. Which one of the following statements about mRNA stability is true?
- Degradation always proceeds in the 5' to 3' direction.
 - Degradation of mRNA by polynucleotide phosphorylase yields 5'-nucleoside monophosphates.
 - In general, bacterial mRNAs have longer half-lives than do eukaryotic mRNAs.
 - Rates of mRNA degradation are always at least ten-fold slower than rates of mRNA synthesis.
 - Secondary structure in mRNA (hairpins, for example) slows the rate of degradation.
5. Which of the following are features of the "wobble" hypothesis?
- A naturally occurring tRNA exists in yeast that can read both arginine and lysine codons.
 - A tRNA can recognize only one codon.
 - Some tRNAs can recognize codons that specify two different amino acids, if both are nonpolar.
 - The "wobble" occurs only in the first base of the anticodon.
 - The third base in a codon always forms a normal Watson-Crick base pair.
6. Which of the following statements about aminoacyl-tRNA synthetases is *false*?
- Some of the enzymes have an editing/proofreading capability.
 - The enzyme attaches an amino acid to the 3' end of a tRNA.
 - The enzyme splits ATP to AMP + PP_i.
 - The enzyme will use any tRNA species, but is highly specific for a given amino acid.
 - There is a different synthetase for every amino acid.
7. Which of the following is true about the sorting pathway for proteins destined for incorporation into lysosomes or the plasma membrane of eukaryotic cells?
- Binding of SRP to the signal peptide and the ribosome temporarily accelerates protein synthesis.
 - The newly synthesized polypeptides include a signal peptide at their carboxyl termini.
 - The signal peptide is cleaved off inside the mitochondria by signal peptidase.

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- D) The signal recognition particle (SRP) binds to the signal peptide soon after it appears outside the ribosome.
 E) The signal sequence is added to the polypeptide in a posttranslational modification reaction.
8. Glycosylation of proteins inside the endoplasmic reticulum does *not* involve:
- A) a His residue on the protein.
 B) an Asn residue on the protein.
 C) dolichol phosphate.
 D) glucose.
 E) *N*-acetylglucosamine.

Short Answer Questions

1. (5 points) During translation, cells use two different mechanisms to ensure the overall fidelity. The process of charging tRNAs with their cognate amino acids involves multiple proofreading steps to increase the overall fidelity. Briefly describe these steps.

2. (5 points) Describe the regulation of the *lac* operon. Describe what happens to transcription from *lac* operon when 1) both glucose and lactose are high in the medium. 2) Glucose is high and lactose is low in the growth medium. 3) Glucose is low and lactose is high in the growth medium. 4) There is no glucose or lactose in the medium.

3. (4 points) Name four general types of postsynthetic processing reactions that are observed in RNA. Briefly (one sentence or less) point out an example of each type. In your example, identify the type of RNA molecule involved (tRNA, mRNA, rRNA, etc.), the type of "processing" involved, and whether the example is characteristic of eukaryotes or prokaryotes, or both. Do not describe specific genes, sequences, complicated structures, or enzymes.

Part III (total 40 points)

1. (5 points) About 30% of glucose oxidation in the liver occurs via the pentose phosphate pathway, whereas in muscle cells, most glucose is oxidized by glycolysis. Briefly give a rationale for this observation.
2. (5 pts) Catabolism is primarily an oxidative process. Write the glycolytic reaction that represents a metabolic oxidation. Name the enzyme that catalyzes this reaction, draw the relevant structures, and identify the oxidizing agent of this reaction.
3. (5 points) What is meant by the term anaplerotic reaction? Give two examples of anaplerotic reactions.
4. (3 points) Summarize the path of electron transfer among Complexes I, II, III, and IV, cytochrome *c*, and Coenzyme Q.
5. (2 points) What is the net result of the successive reactions catalyzed by superoxide dismutase and catalase?
- A) Conversion of the free radical O_2^- to H_2O_2 , which is converted to water and O_2 .
 B) Conversion of the free radical O_2^- to H_2O_2 , which is converted to water and GSSG.
 C) Conversion of the free radical O_2^- to peroxide, which is converted to CO_2 .
 D) Conversion of the free radical O_2^- to carbon dioxide and water.
6. (5 points) Why is HMG-CoA reductase a target of drug therapy? Provide an example of such a drug.
7. (5 points) In the movie Jurassic Park, the scientists "engineer" the dinosaurs with a faulty gene so that they cannot synthesize lysine and are dependent on tablet supplements. Why is this silly?
8. (10 pts) Describe the pathway of hormone-activated phospholipase C and IP3 in mammalia cells.