

國立嘉義大學 99 學年度  
應用化學系碩士班 (乙組) 招生考試試題

科目：生物化學

I. Single Choice (60%)

- In a mixture of the five proteins listed below, which should elute second in size-exclusion (gel-filtration) chromatography?  
(A) cytochrome *c*,  $M_r = 13,000$ ; (B) immunoglobulin G,  $M_r = 145,000$ ; (C) ribonuclease A,  $M_r = 13,700$ ; (D) RNA polymerase,  $M_r = 450,000$ ; (E) serum albumin,  $M_r = 68,500$ .
- The hydrolysis of ATP has a large negative  $\Delta G^\circ$ ; nevertheless it is stable in solution due to:  
(A) entropy stabilization; (B) ionization of the phosphates; (C) resonance stabilization; (D) the hydrolysis reaction being endergonic; (E) the hydrolysis reaction having a large activation energy.
- The standard reduction potentials ( $E^\circ$ ) for the following half reactions are given.  
$$\text{Fumarate} + 2\text{H}^+ + 2\text{e}^- \rightarrow \text{succinate} \quad E^\circ = +0.031 \text{ V}$$
$$\text{FAD} + 2\text{H}^+ + 2\text{e}^- \rightarrow \text{FADH}_2 \quad E^\circ = -0.219 \text{ V}$$

If you mixed succinate, fumarate, FAD, and FADH<sub>2</sub> together, all at 1 M concentrations and in the presence of succinate dehydrogenase, which of the following would happen *initially*?  
(A) Fumarate and succinate would become oxidized; FAD and FADH<sub>2</sub> would become reduced; (B) Fumarate would become reduced, FADH<sub>2</sub> would become oxidized; (C) No reaction would occur because all reactants and products are already at their standard concentrations; (D) Succinate would become oxidized, FAD would become reduced; (E) Succinate would become oxidized, FADH<sub>2</sub> would be unchanged because it is a cofactor.
- Glucose labeled with <sup>14</sup>C in C-1 and C-6 gives rise in glycolysis to pyruvate labeled in:  
(A) its carbonyl carbon; (B) all three carbons; (C) its carboxyl carbon; (D) A and C; (E) its methyl carbon.
- In comparing fatty acid biosynthesis with  $\beta$  oxidation of fatty acids, which of the following statements is *incorrect*?  
(A) A thioester derivative of crotonic acid (*trans*-2-butenoic acid) is an intermediate in the synthetic path, but not in the degradative path; (B) A thioester derivative of D- $\beta$ -hydroxybutyrate is an intermediate in the synthetic path, not in the degradative path; (C) Fatty acid biosynthesis uses NADPH exclusively, whereas  $\beta$  oxidation uses NAD<sup>+</sup> exclusively; (D) Fatty acid degradation is catalyzed by cytosolic enzymes; fatty acid synthesis by mitochondrial enzymes; (E) The condensation of two moles of acetyl-CoA in the presence of a crude extract is more rapid in bicarbonate buffer than in phosphate buffer at the same pH; the cleavage of acetoacetyl-CoA proceeds equally well in either buffer.
- Which of the following statements about the chemiosmotic theory is *false*?  
(A) Electron transfer in mitochondria is accompanied by an asymmetric release of protons on *one* side of the inner mitochondrial membrane; (B) Energy is conserved as a transmembrane pH gradient; (C) Oxidative phosphorylation cannot occur in membrane-free preparations; (D) The effect of uncoupling reagents is a consequence of their ability to carry protons through membrane; (E) The membrane ATPase, which plays an important role in other hypotheses for energy coupling, has no significant role in the chemiosmotic theory.
- Protein amino acid side chains can hydrogen bond in the major groove of DNA, and discriminate between each of the four possible base pairs. In which one of the following groups of amino acids can all three members potentially be used in such DNA-protein recognition?  
(A) Ala, Asn, Glu; (B) Arg, Gln, Leu; (C) Asn, Gln, Trp; (D) Asn, Glu, Lys; (E) Glu, Lys, Pro.
- Which of the following statements about regulation of the *lac* operon is true?  
(A) Glucose in the growth medium decreases the inducibility by lactose; (B) Glucose in the growth medium does not affect the inducibility by lactose; (C) Glucose in the growth medium increases the inducibility by lactose; (D) Its expression is regulated mainly at the level of translation; (E) The *lac* operon is fully induced whenever lactose is present.
- In the synthesis of phosphatidylcholine from phosphatidylethanolamine, the methyl group donor is:  
(A) a tetrahydrofolate derivative; (B) choline; (C) methanol; (D) *S*-adenosylmethionine (adoMet); (E) serine
- Which of the following is *not* true of the citric acid cycle?  
(A) All enzymes of the cycle are located in the cytoplasm, except succinate dehydrogenase, which is bound to the inner mitochondrial membrane. (B) In the presence of malonate, one would expect succinate to accumulate. (C) Oxaloacetate is used as a substrate but is not consumed in the cycle. (D) Succinate dehydrogenase channels electrons directly into the electron transfer chain. (E) The condensing enzyme is subject to allosteric regulation by ATP and NADH.
- Which of the following statements apply (applies) to the  $\beta$  oxidation of fatty acids?
  - The process takes place in the cytosol of mammalian cells.
  - Carbon atoms are removed from the acyl chain one at a time.
  - Before oxidation, fatty acids must be converted to their CoA derivatives.
  - NADP<sup>+</sup> is the electron acceptor.
  - The products of  $\beta$  oxidation can directly enter the citric acid cycle for further oxidation.(A) 1 and 3 only; (B) 1, 2, and 3; (C) 1, 2, and 5; (D) 3 and 5 only; (E) 4 only.
- The enzymatic machinery to fix atmospheric N<sub>2</sub> into NH<sub>4</sub><sup>+</sup> is:  
(A) a means of producing ATP when excess N<sub>2</sub> is available. (B) composed of two key proteins, each containing iron. (C) relatively stable when exposed to O<sub>2</sub>. (D) specific to plant cells. (E) unaffected by the supply of electrons.
- Which of the following statements concerning signal transduction by the insulin receptor is *not* correct?  
(A) Activation of the receptor protein kinase activity results in the activation of additional protein kinases. (B) Binding of insulin to the receptor activates a protein kinase. (C) Binding of insulin to the receptor results in a change in its quaternary structure. (D) The receptor protein kinase activity is specific for tyrosine residues on the substrate proteins. (E) The substrates of the receptor protein kinase activity are mainly proteins that regulate transcription.
- Which of these statements is generally true of integral membrane proteins?  
(A) A hydropathy plot reveals one or more regions with a high hydropathy index. (B) The domains that protrude on the cytoplasmic face of the plasma membrane nearly always have covalently attached oligosaccharides. (C) They are unusually susceptible to degradation by trypsin. (D) They can be removed from the membrane with high salt or mild denaturing agents. (E) They undergo constant rotational motion that moves a given domain from the outer face of a membrane to the inner face and then back to the outer.

15. Which of the following statements about *E. coli* RNA polymerase (core enzyme) is *false*?  
 (A) In the absence of the  $\sigma$  subunit, core polymerase has little specificity for where initiation begins. (B) The core enzyme contains several different subunits. (C) The core enzyme has no polymerizing activity until the  $\sigma$  subunit is bound. (D) The RNA chain grows in a  $5' \rightarrow 3'$  direction. (E) The RNA product is complementary to the DNA template.
16. The diagram below represents a hypothetical operon in the bacterium *E. coli*. The operon consists of two structural genes (A and B), which code for the enzymes A-ase and B-ase, respectively, and also includes P (promoter) and O (operator) regions as shown.
- |   |   |   |   |
|---|---|---|---|
| P | O | A | B |
|   |   |   |   |
- When a certain compound (X) is added to the growth medium of *E. coli*, the separate enzymes A-ase and B-ase are both synthesized at a 50-fold higher rate than in the absence of X. (X has a molecular weight of about 200.) Which of the following statements is true of the operon described above?  
 (A) All four genes (A, B, O, and P) will be transcribed into an mRNA that will then be translated into four different proteins. (B) The 3' end of the mRNA from the operon will correspond to the left end of the operon as drawn. (C) The 5' end of the messenger from this operon will correspond to the right end of the operon as drawn. (D) The repressor for this operon binds just to the right of A. (E) When RNA polymerase makes mRNA from this operon, it begins RNA synthesis just to the left of gene A.
17. Which one of the following statements about mRNA stability is true?  
 (A) Degradation always proceeds in the  $5'$  to  $3'$  direction. (B) Degradation of mRNA by polynucleotide phosphorylase yields  $5'$ -nucleoside monophosphates. (C) In general, bacterial mRNAs have longer half-lives than do eukaryotic mRNAs. (D) Rates of mRNA degradation are always at least 10-fold slower than rates of mRNA synthesis. (E) Secondary structure in mRNA (hairpins, for example) slows the rate of degradation.
18. Which of the following statements about aromatic amino acids is correct?  
 (A) All are strongly hydrophilic. (B) Histidine's ring structure results in its being categorized as aromatic or basic, depending on pH. (C) On a molar basis, tryptophan absorbs more ultraviolet light than tyrosine. (D) The major contribution to the characteristic absorption of light at 280 nm by proteins is the phenylalanine R group. (E) The presence of a ring structure in its R group determines whether or not an amino acid is aromatic.
19. Which of the following statements about a plot of  $V_0$  vs.  $[S]$  for an enzyme that follows Michaelis-Menten kinetics is *false*?  
 (A) As  $[S]$  increases, the initial velocity of reaction  $V_0$  also increases. (B) At very high  $[S]$ , the velocity curve becomes a horizontal line that intersects the y-axis at  $K_m$ . (C)  $K_m$  is the  $[S]$  at which  $V_0 = 1/2 V_{max}$ . (D) The shape of the curve is a hyperbola. (E) The y-axis is a rate term with units of  $\mu\text{m}/\text{min}$ .
20. Which of the following is a dominant feature of the outer membrane of the cell wall of gram negative bacteria?  
 (A) Amylose; (B) Cellulose; (C) Glycoproteins; (D) Lipopolysaccharides; (E) Lipoproteins.
21. Which of the following is a palindromic sequence?  
 (A) AGGTCC    (B) CCTTCC    (C) GAATCC    (D) GGATCC    (E) GTATCC  
       TCCAGG    GCAAGG    CTTAGG    CCTAGG    CATAGG
22. Which of the following is *not* involved in signal transduction by the  $\beta$ -adrenergic receptor pathway?  
 (A) ATP; (B) Cyclic AMP; (C) Cyclic GMP; (D) GTP; (E) All of the above are involved.
23. Sphingosine is *not* a component of:  
 (A) cardiolipin; (B) ceramide; (C) cerebroside; (D) ganglioside; (E) sphingomyelin.
24. Which of the following statements about membrane lipids is true?  
 (A) Glycerophospholipids are found only in the membranes of plant cells. (B) Glycerophospholipids contain fatty acids linked to glycerol through amide bonds. (C) Lecithin (phosphatidylcholine), which is used as an emulsifier in margarine and chocolate, is a sphingolipid. (D) Some sphingolipids include oligosaccharides in their structure. (E) Triacylglycerols are the principal components of erythrocyte membranes.
25. In the Watson-Crick model of DNA structure:  
 (A) both strands run in the same direction,  $3' \rightarrow 5'$ ; 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 the sugar backbone of the two strands is just large enough to accommodate either two purines or two pyrimidines. (E) the distance between two adjacent bases in one strand is about 3.4 Å.
26. Which of the following statements about the synthesis of rRNA and tRNA in *E. coli* is true?  
 (A) Both rRNA and some tRNAs are part of the same primary transcript. (B) Each rRNA sequence (16S, 23S, 5S) is transcribed into a separate primary transcript. (C) Primary tRNA transcripts undergo methylation, but rRNA sequences are not methylated. (D) The tRNA sequences all lie at the 3' end of the rRNA transcripts; (E) There is a single copy of the rRNA genes.
27. Which one of the following types of eukaryotic regulatory proteins interact with enhancers?  
 (A) Basal transcription factors; (B) Coactivators; (C) Repressors; (D) TATA-binding proteins; (E) Transactivators.
28. A nonapeptide was determined to have the following amino acid composition:  $(\text{Lys})_2$ ,  $(\text{Gly})_2$ ,  $(\text{Phe})_2$ , His, Leu, Met. The native peptide was incubated with 1-fluoro-2,4-dinitrobenzene (FDNB) and then hydrolyzed; 2,4-dinitrophenylhistidine was identified by HPLC. When the native peptide was exposed to cyanogen bromide (CNBr), an octapeptide and free glycine were recovered. Incubation of the active peptide with trypsin gave a pentapeptide, a tripeptide, and free Lys. 2,4-Dinitrophenyl-histidine was recovered from the pentapeptide, and 2,4-dinitrophenylphenylalanine was recovered from the tripeptide. Digestion with the enzyme pepsin produced a dipeptide, a tripeptide, and a tetrapeptide. The tetrapeptide was composed of  $(\text{Lys})_2$ , Phe, and Gly. The native sequence was determined to be:  
 (A) Gly-Phe-Lys-Lys-Gly-Leu-Met-Phe-His  
 (B) His-Leu-Gly-Lys-Lys-Phe-Phe-Gly-Met  
 (C) His-Leu-Phe-Gly-Lys-Lys-Phe-Met-Gly  
 (D) His-Phe-Leu-Gly-Lys-Lys-Phe-Met-Gly  
 (E) Met-Leu-Phe-Lys-Phe-Gly-Gly-Lys-His
29. The phosphodiester bonds that link adjacent nucleotides in both RNA and DNA:  
 (A) always link A with T and G with C. (B) are susceptible to alkaline hydrolysis. (C) are uncharged at neutral pH. (D) form between the planar rings of adjacent bases. (E) join the  $3'$  hydroxyl of one nucleotide to the  $5'$  hydroxyl of the next.
30. 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 catalyzes the attack of the carboxyl group of the incoming amino acid on an ester linkage in the nascent polypeptide. (E) Peptidyl transferase is a ribozyme.

## II. Short Questions (40%)

**II-1** Draw the Haworth perspective structures for disaccharides containing two glucose molecules:  
**(6%)** (A) in a  $(\beta 1 \rightarrow 4)$  linkage; (B) in an  $(\alpha 1 \rightarrow 6)$  linkage.

**II-2** An enzyme-catalyzed reaction was carried out with the substrate concentration initially a thousand times greater than the  $K_m$  for that substrate. After 9 minutes, 1% of the substrate had been converted to product, and the amount of product formed in the reaction mixture was 12  $\mu\text{mol}$ . If, in a separate experiment, one-third as much enzyme and twice as much substrate had been combined, how long would it take for the same amount (12  $\mu\text{mol}$ ) of product to be formed?

**II-3** (A) Tyr-Lys-Met (B) Gly-Pro-Arg (C) Asp-Trp-Tyr (D) Asp-His-Glu (E) Leu-Val-Phe  
**(10%)**

Which one of the above tripeptides:

\_\_\_\_(a) is most negatively charged at pH 7?

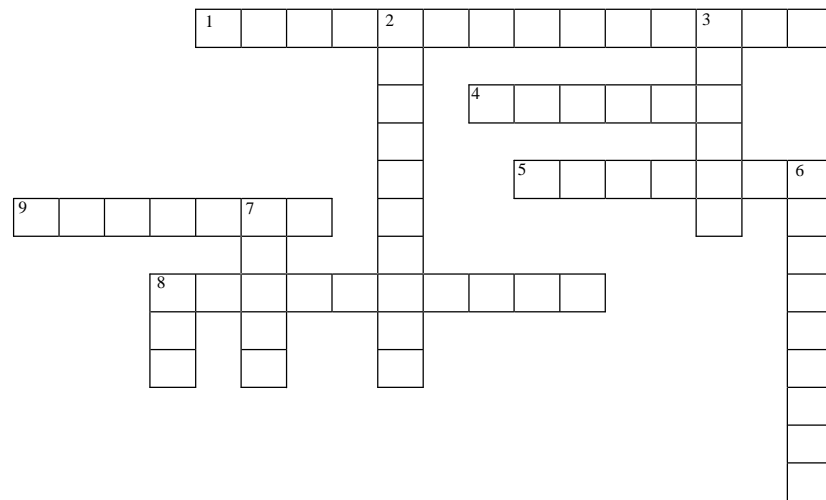
\_\_\_\_(b) will yield DNP-tyrosine when reacted with 1-fluoro-2,4-dinitrobenzene and hydrolyzed in acid?

\_\_\_\_(c) contains the largest number of nonpolar R groups?

\_\_\_\_(d) contains sulfur?

\_\_\_\_(e) will have the greatest light absorbance at 280 nm?

**II-4** Terms for DNA Clone technology (注意複數)  
**(20%)**



### Across

1. Vectors of choice for medium-size DNA fragments.
4. The new, improved *product* of two fused genes is a \_\_\_\_\_ protein.
5. Small, circular, extrachromosomal DNA molecule.
8. Synthetic DNA fragment with recognition sequences for several restriction endonucleases.
9. Viral \_\_\_\_\_ are often modified retroviruses.

### Down

2. A self-replicating DNA plasmid that contains an inducible promoter and a polylinker is called a(n) \_\_\_\_\_ vector.
3. Contains all the genetic information to make an organism.
6. It joins DNA strands; molecular “glue” (2 words)
7. Difference in lengths and sequences of DNA fragments produced by random cutting of genomic DNA by restriction enzymes; vary from one individual to another.(縮寫名稱)
8. Gene amplification technique that relies on the activity of a heat-stable polymerase(*Taq1*) isolated from hot-spring bacteria.