

科目 生物化學 科目代碼 2902 共 6 頁第 1 頁 *請在試卷【答案卷】內作答

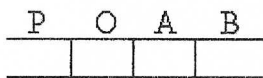
一、Essay (60%):

1. Compare the regulation of the synthesis of polysaccharides and polypeptides. Explain why polysaccharides do not have constant molecular weight and the latter has. What are the main difference on the regulation of initiation and termination for the synthesis of glycans and proteins? (10%)
2. Both epinephrine and glucagon can increase blood glucose concentration, however their actions in hepatocytes and myocytes are different. Compare the signal transduction pathways that lead to the increase of glucose in hepatocytes and myocytes. Some are the same, but some are different in both cells. You have to point all of them out. (10%)
3. Compare the reactions catalyzed by following enzymes (you can use example to support your argument): (10%)
 - a. Synthetase vs Synthase
 - b. Ligase vs Lyase
 - c. Phosphorylase vs Phosphatase
 - d. Isomerase vs Epimerase
 - e. Oxidase vs Oxygenase
4. (a) Briefly explain why there is a lag in cell growth when bacteria are switched from a medium containing glucose to one containing lactose. (b) When the growth medium contains both lactose and glucose, what proteins will be bound to the *lac* operon regulatory region? (c) If only lactose is in the growth medium, what proteins will be bound to the *lac* operon regulatory region? (10%)
5. The SOS response in *E. coli* is triggered by extensive damage to the cell's DNA and increases the capacity for repairing such DNA. Describe the molecular events that bring about expression of the SOS genes. (10%)
6. What are RFLPs and how are they used in forensic DNA fingerprinting technology? (10%)

二、Multiple choice (40%): (單選，每題二分，答錯倒扣 0.5 分) (務必使用電腦答案卡作答，否則不與計分)

- In the laboratory, recombinant plasmids are commonly introduced into bacterial cells by:
 - microinjection.
 - transformation—temperature shock of the cells incubated with plasmid DNA in the presence of CaCl_2 .
 - infection with a bacteriophage that carries the plasmid.
 - mixing plasmids with an extract of broken cells.
 - None of the above is correct.
- The *E. coli* recombinant plasmid pBR322 has been widely utilized in genetic engineering experiments. pBR322 has all of the following features *except*:
 - a replication origin, which permits it to replicate autonomously.
 - resistance to two different antibiotics, which permits rapid screening for recombinant plasmids containing foreign DNA.
 - a number of conveniently located recognition sites for restriction enzymes.
 - a number of palindromic sequences near the *EcoRI* site, which permit the plasmid to assume a conformation that protects newly inserted DNA from nuclease degradation.
- In genetic engineering, *in vitro* packaging is used to:
 - ensure that genetically engineered bacteria are not accidentally released into the environment.
 - splice a desired gene into a plasmid.
 - place an antibiotic resistance gene in a plasmid.
 - incorporate recombinant DNA into infectious bacteriophage particles.
 - cut a desired region out of the host bacterium's chromosome.
- The Ti plasmid in the bacterium *Agrobacterium tumefaciens* is useful in genetic engineering because:
 - cultures of this bacterium containing a cloned gene on the Ti plasmid produce large quantities of the gene product.
 - it provides a means to introduce foreign DNA into plant cells and integrates it into the plant chromosome.
 - plasmids composed of titanium are exceptionally stable.
 - these bacteria infect mice, creating transgenic mice.
 - None of the above reasons is correct.

5. "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). What is the primary mechanism responsible for variations in the level of constitutive enzymes?
- All constitutive enzymes are synthesized at exactly the same rate, but some are degraded faster than others.
 - Different genes have slightly different promoters, with different affinities for RNA polymerase holoenzyme.
 - The same number of mRNA copies are made from each gene, but these mRNAs are translated at different rates.
 - Some constitutively expressed genes are more inducible than others.
 - Some constitutively expressed genes are more repressible than others.
6. 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.

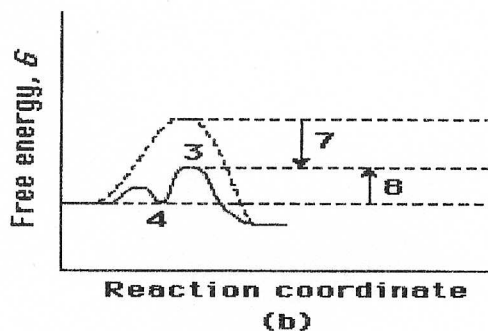
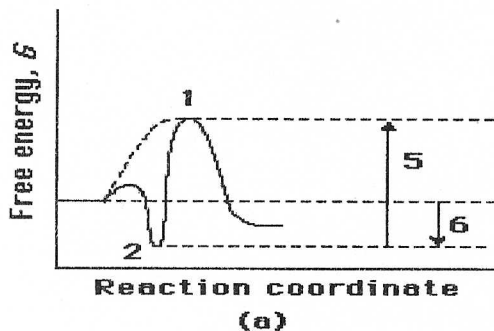


When a certain compound (X) is added to the growth medium of *E. coli*, the separate enzymes A-ase and B-ase are both synthesized at a 50-fold higher rate than in the absence of X. (X has a molecular weight of about 200.) Which of the following statements is true of the operon described above?

- When RNA polymerase makes mRNA from this operon, it begins RNA synthesis just to the left of gene A.
 - The repressor for this operon binds just to the right of A.
 - All four genes (A, B, O, and P) will be transcribed into an mRNA that will then be translated into 4 different proteins.
 - The 5' end of the messenger from this operon will correspond to the right end of the operon as drawn.
 - The 3' end of the mRNA from the operon will correspond to the left end of the operon as drawn.
7. The tryptophan operon of *E. coli* is repressed by tryptophan added to the growth medium. The tryptophan repressor probably:
- is a DNA sequence.
 - binds to the *his* operator in the absence of tryptophan.
 - binds to the *his* operator in the presence of tryptophan.
 - binds to RNA polymerase when tryptophan is present.
 - is an attenuator.

科目 生物化學 科目代碼 2902 共 6 頁第 4 頁 *請在電腦答案卡作答

8. How does transcriptionally active chromatin differ from chromatin that is *not* being transcribed?
- The DNA in regions of active transcription is more sensitive to degradation by nucleases.
 - Methylated cytosine residues are less common in regions being actively transcribed.
 - Nucleosomes are absent in regions with very high transcriptional activity.
 - All of the above are correct.
 - None of the above (A, B, or C) is correct.
9. Which of the following statements about tRNA molecules is *false*?
- There is at least one tRNA for each of the 20 amino acids.
 - The amino acid attachment is always to an A nucleotide at the 3' end of the molecule.
 - Any given tRNA will only accept one specific amino acid.
 - A, C, G, and U are the only bases present in the molecule.
 - Although composed of a single strand of RNA, each molecule contains several short, double-helical regions.
10. It is possible to convert the Cys that is a part of Cys-tRNA^{Cys} to Ala by a catalytic reduction. If the resulting Ala-tRNA^{Cys} were added to a mixture of (1) ribosomes, (2) all the other tRNAs and amino acids, (3) all of the cofactors and enzymes needed to make protein *in vitro*, and (4) mRNA for hemoglobin, where in the newly synthesized hemoglobin would the Ala from Ala-tRNA^{Cys} be incorporated?
- wherever Ala normally occurs
 - wherever Cys normally occurs
 - wherever either Ala or Cys normally occurs
 - wherever the dipeptide Ala-Cys normally occurs
 - nowhere; this is the equivalent of a nonsense mutation
11. Compare the two reaction coordinate diagrams below and select the answer that correctly describes their relationship. In each case the single intermediate is the ES complex.



- The ES complex is given by #2 in (a) and #3 in (b).
- The activation energy for the *catalyzed* reaction is #5 in (a) and is #7 in (b).
- (a) describes a strict "lock and key" model whereas (b) describes a transition-state complementarity model.
- The activation energy for the *uncatalyzed* reaction is given by #5 + #6 in (a) and by #7 + #4 in (b).
- The contribution of binding energy is given by #5 in (a) and by #7 in (b).

12. The benefit of measuring the *initial* rate of a reaction, V_0 , is that at the beginning of a reaction:
- A) changes in $[S]$ are negligible, so $[S]$ can be treated as a constant.
 - B) $[ES]$ can be measured accurately.
 - C) $V_0 = V_{\max}$.
 - D) changes in K_m are negligible, so K_m can be treated as a constant.
 - E) varying $[S]$ has no effect on V_0 .
13. An enzyme-catalyzed reaction was carried out with the substrate concentration initially 1,000 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 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 mol) of product to be formed?
- A) 1.5 min
 - B) 3 min
 - C) 6 min
 - D) 13.5 min
 - E) 27 min
14. In glycoproteins, the carbohydrate moiety is always attached through the amino acid residues:
- A) tryptophan, aspartate, or cysteine.
 - B) asparagine, serine, or threonine.
 - C) glycine, alanine, or aspartate.
 - D) aspartate or glutamate.
 - E) glutamine or arginine.
15. The Cori cycle is:
- A) the interconversion between glycogen and glucose 1-phosphate.
 - B) the synthesis of alanine from pyruvate in skeletal muscle and the synthesis of pyruvate from alanine in liver.
 - C) the synthesis of urea in liver and degradation of urea to carbon dioxide and ammonia by bacteria in the gut.
 - D) the production of lactate from glucose in peripheral tissues with the resynthesis of glucose from lactate in liver.
 - E) none of the above.
16. An α helix would be destabilized most by:
- A) the presence of an Arg^+ residue near the carboxyl terminus of the α helix.
 - B) the transmission of the electric dipole of several peptide bonds throughout the α helix.
 - C) the presence of two Lys^+ residues near the amino terminus of the α helix.
 - D) interactions between neighboring Asp^- and Arg^+ residues.
 - E) interactions between two adjacent hydrophobic Val residues.

17. For the reaction $A \rightarrow B$, the K_{eq} ' is 10^4 . If a reaction mixture originally contains 1 mmol of A and no B, which of the following is true?
- A) At equilibrium, there will be far more A than B.
 - B) The reaction will definitely proceed toward B at a very high rate.
 - C) ΔG° for the reaction will be large and positive.
 - D) The rate of the reaction may be immeasurably small.
18. In glycolysis, fructose 1,6-bisphosphate is converted to two products with a standard free-energy change (ΔG°) of 23.8 kJ/mol. Under what conditions encountered in a normal cell will the free-energy change (ΔG) be negative, enabling the reaction to proceed spontaneously to the right?
- A) Under standard conditions, enough energy is released to drive the reaction to the right.
 - B) The reaction will not go to the right spontaneously under any conditions because the ΔG° is positive.
 - C) The reaction will proceed spontaneously to the right if there is a high concentration of products relative to the concentration of fructose 1,6-bisphosphate.
 - D) The reaction will proceed spontaneously to the right if there is a high concentration of fructose 1,6-bisphosphate relative to the concentration of products.
 - E) None of the above conditions is sufficient.
19. An example of an eicosanoid hormone is:
- A) testosterone.
 - B) epinephrine.
 - C) thyroxine.
 - D) thromboxane.
 - E) retinoic acid.
20. Erythrose 4-phosphate is a precursor of:
- A) phenylalanine.
 - B) aspartate.
 - C) threonine.
 - D) serine.
 - E) cysteine.