

清华大学本科生考试试题专用纸 (A)

考试课程 Biochemistry II 2005 年 1 月 15 日

- 说明: 1. 第 1-40 题为选择题, 每题 2 分, 答案可能是一个或多个, 请将正确答案填在适当的横线处;
2. 第 41-44 题为问答题, 每题的分数标在了题目后面, 请将答案写在答题纸上;
3. 本卷满分为 100。

1. Which compound links glycolysis, nucleotide synthesis, and glycogen synthesis?

- A. acetyl-CoA
- B. oxaloacetate
- C. citrate
- D. glucose 6-phosphate
- E. glycerol 3-phosphate

Answer(s): D

2. You have discovered a compound that inhibits fumarase. How many moles of ATP would you expect to be generated from one mole of acetyl-CoA in the presence of this inhibitor?

- A. 5
- B. 6
- C. 6.5
- D. 7.5
- E. No ATP would form under these conditions.

Answer(s): D

3. Indicate which of the following events can occur during the processing of eukaryotic mRNA transcripts.

- A. Attachment of a poly (A) tail to the 5' end of the transcript.
- B. Methylation of all G residues.
- C. Excisions of introns.
- D. Conversion of standard bases to modified bases such as inosine.
- E. Splicing together of exons.
- F. Differential cutting and splicing to produce two different proteins.

Answer(s): CE

4. Although DNA replication has very high fidelity, mutations do occur. Which of the following types of single base-pair mutations would be most likely to be a lethal mutation?

- A. substitution
- B. insertion
- C. deletion
- D. silent
- E. B and C

Answer(s): E

5. Which of the following **correctly** describes the nitrogen cycle?

- A. Fixation of atmospheric nitrogen by nitrogen-fixing bacteria yields bioavailable

nitrate.

- B. Nitrate is reduced to ammonia in a process known as denitrification.
- C. Biological nitrogen fixation is carried out by a complex of proteins call the nitrogenase complex.
- D. A and B
- E. A, B, and C

Answer(s): C

6. Assuming the 5'→3' connection of writing nucleotide sequence, indicate which of the following mRNA codons can be recognized by the tRNA anticodon ICG.

- A. UGC
- B. CGA
- C. UGA
- D. CGU
- E. CGC

Answer(s): BDE

7. Both general recombination and transposon-type recombination:

- A. occur between homologous regions on chromosomes.
- B. are important in the repair of damaged DNA.
- C. involve RecA protein.
- D. generate genetic diversity.
- E. The two types of recombination have nothing in common.

Answer(s): D

8. Consider the mRNA sequence: (5') AAUGCAGCUUUAGCA (3'). The sequence of the coding strand of DNA is:

- A. (5') ACGATTTCGACGTAA (3')
- B. (3') TTACGTCGAAATCGT (5')
- C. (5') AATGCAGCTTTAGCA (3')
- D. (5') AAUGCAGCUUUAGCA (3')
- E. (3') AATGCAGCTTTAGCA (5')

Answer(s): C

9. The synthesis of palmitate requires:

- A. 8 acetyl-CoA.
- B. 14 NADH.
- C. 7 ATP.
- D. A and C.
- E. A, B, and C.

Answer(s): D

10. Enoyl-CoA isomerase is needed for the complete β -oxidation of

- A. unsaturated fatty acids with cis double bonds.
- B. odd-number fatty acids.
- C. saturated fatty acids.
- D. unsaturated fatty acids with trans double bonds.

Answer(s): A

11. Which of the following is a characteristic of many aminotransferase reactions?

- A. They have a large, negative ΔG° .

- B. The amino group is transferred to an α -keto acid (such as α -ketoglutarate) to form the corresponding amino acid.
C. The amino group is transferred from an ammonia molecule.
D. They are catalyzed by the same enzyme.
E. They require the cofactor *S*-adenosylmethionine.

Answer(s): B

12. If the $\Delta G'$ of the reaction $A \longrightarrow B$ is -12 kJ/mol , which of the following statements are **correct**? (Note the prime symbol means that a thermodynamic parameter is measured at pH 7.0)

- A. The reaction will proceed spontaneously from left to right at the given conditions.
B. The reaction will proceed spontaneously from right to left at standard conditions.
C. The equilibrium constant favors the formation of B over the formation of A.
D. The equilibrium constant could be calculated if the initial concentrations of A and B were known.
E. The value of $\Delta G'^{\circ}$ is also negative.

Answer(s): AD

13. Which of the following is **not** a physiological role of nucleotides?

- A. allosteric regulators
B. intermediates for biosynthetic processes
C. components of many proteins
D. components of the coenzymes NAD, FAD, and CoA
E. intracellular signaling molecules

Answer(s): C

14. Indicate which of the following statements about the *lac* operon is **true**.

- A. All seven genes are transcribed into mRNA, which is then translated into five different proteins.
B. The repressor binds to the structural genes, preventing their transcription.
C. Efficient binding of RNA polymerase to DNA occurs only in the presence of CRP and cAMP.
D. cAMP acts as an inducer by binding to the Lac repressor.
E. In the absence of lactose, the repressor binds the operator.
F. A mutation in the I gene such that no gene product is made leads to constitutive expression of the Z, Y, and A genes.

Answer(s): CEF

15. Which pair correctly matches the enzyme with its allosteric activator?

- A. hexokinase; ATP
B. phosphofructokinase-1; AMP
C. pyruvate kinase; ATP
D. pyruvate dehydrogenase; NADH
E. pyruvate carboxylase; ADP

Answer(s): B

16. Which of the following describes fatty acid transport into the mitochondrial matrix?
- A. It is the rate-limiting step in fatty acid oxidation.
 - B. It is regulated by malonyl-CoA.
 - C. The cytosolic and matrix pools of CoA are distinct and separate.
 - D. Once fatty acyl groups have entered the matrix, they are committed to oxidation to acetyl-CoA.
 - E. All of the above are true.

Answer(s): E

17. In nucleotide metabolism, all of the following are true **except**:
- A. The commitment step in purine biosynthesis is the transfer of amino group to PRPP.
 - B. Both purine and pyrimidine biosynthesis are regulated by end-product inhibition.
 - C. Nucleotides can be synthesized in a single reaction via salvage pathways.
 - D. De novo pyrimidine synthesis begins with a molecule of PRPP.
 - E. Orotidylate is the common precursor in the biosynthesis of pyrimidines, and inosinate is the common precursor in the biosynthesis of the purines ATP and GTP.

Answer(s): D

18. The most **efficient** way to **turn off** glycogen degradation is to:
- A. decrease the activity of phosphorylase kinase.
 - B. increase the activity of phosphodiesterases.
 - C. increase the activity of phosphatases.
 - D. increase the activity of glycogen synthase.
 - E. decrease the intracellular levels of cAMP.

Answer(s): E

19. In some respects, the urea cycle and the citric acid cycle are analogous processes. Ornithine and citrulline have roles that are similar to those of oxaloacetate and what other citric acid cycle intermediate?

- A. acetyl-CoA
- B. malate
- C. citrate
- D. ammonia
- E. CO₂

Answer(s): C

20. Indicate which of the following statements about the mitochondrial electron transfer and oxidative phosphorylation are **true**.

- A. Synthesized ATP must be transported into the intermembrane space before it can enter the cytosol.
- B. Cytochrome c and the F₁ subunit of ATPase are peripheral membrane proteins.
- C. Complexes I, II, III and IV are all proton pumps.
- D. Ubiquinone is a hydrophilic molecule.
- E. The final electron acceptor is H₂O.

Answer(s): AB

21. Which of the following describes the activity and regulation of ribonucleotide reductase and/or its importance to the cell?

- A. Both of its activity and its substrate specificity are regulated by the binding of effector molecules.
- B. ATP increases the overall activity of the enzyme.
- C. Control of the enzyme's activity ensures a balanced pool of precursors for DNA synthesis.
- D. Balanced pools of deoxyribonucleotides are necessary in DNA synthesis, given the complementary base-pairing of nucleotides in double-stranded DNA.
- E. All of the above are true.

Answer(s): E

22. Earlier in its life, a tadpole lives in an aqueous environment and excretes much of its excess nitrogen as ammonia. Once it matures into an adult, the frog spends much time on dry land and becomes ureotelic. Which of the following enzyme activities would be most likely to increase drastically in the adult frog?

- A. carbamoyl phosphate synthetase I
- B. glutamine synthetase
- C. glutaminase
- D. α -ketoglutarate dehydrogenase
- E. carboxypeptidase

Answer(s): A

23. The discontinuity of eukaryotic genes was first revealed by:

- A. using footprinting techniques.
- B. DNA sequence comparison.
- C. RNA sequence analysis.
- D. electron microscopic analysis of RNA-DNA hybrid molecules.
- E. plant genetic studies.

Answer(s): D

24. Ames Test is used to investigate whether a chemical reagent is:

- A. oxidative.
- B. reductive.
- C. mutagenic.
- D. enzymatic.

Answer(s): C

25. A sample of malonyl-CoA synthesized from radioactive (^{14}C labeled) HCO_3^- and unlabeled acetyl-CoA is used in fatty acid synthesis. In which carbon(s) will the final fatty acid be labeled? (Recall that the carboxyl carbon is C-1.)

- A. every carbon
- B. every odd-numbered carbon
- C. every even-numbered carbon
- D. only the carbon farthest from C-1
- E. no part of the molecule will be labeled.

Answer(s): E

26. Not taking into account the NADH generated in the malate dehydrogenase reaction, how many high-energy phosphate bonds are used to form a molecule of urea, starting from ammonia and HCO_3^- ?

- A. 1
- B. 2
- C. 3
- D. 4
- E. 0

Answer(s): D

27. DNA polymerase I has:

- A. 3' \rightarrow 5' exonuclease activity.
- B. 5' \rightarrow 3' exonuclease activity.
- C. proofreading activity.
- D. polymerase activity.

Answer(s): ABCD

28. The proton-motive force generated by the electron transfer chain:

- A. includes a pH-gradient component.
- B. includes an electrical-potential component.
- C. is used for active transport processes.
- D. is used to synthesize ATP.
- E. has all of the above characteristics.

Answer(s): E

29. Which statement is **not** true of phosphofructokinase-1?

- A. It is inhibited by fructose 2, 6-bisphosphate.
- B. It is activated by AMP.
- C. It is inhibited by citrate.
- D. It is inhibited by ATP.
- E. ATP increases its $K_{0.5}$ for fructose 6-phosphate.

Answer(s): A

30. Some photosynthetic prokaryotes use H_2S , hydrogen sulfide, instead of water as their photosynthetic hydrogen donor. How does this change the ultimate products of photosynthesis?

- A. Carbohydrate (CH_2O) is not produced.
- B. H_2O is not produced.
- C. Oxygen is not produced.
- D. ATP is not produced.
- E. The products do not change.

Answer(s): C

31. Which of the following answers complete the sentence correctly? Surplus dietary amino acids may be converted into

- A. proteins.
- B. fats.
- C. ketone bodies.
- D. glucose.
- E. a variety of biomolecules for which they are precursors.

Answer(s): ABCDE

32. Human chromosomes are extremely large, complex structures. Which of the following statements **correctly** describes the organization of the human chromosomes?

- A. All of the genetic information of the cell is encoded in the nuclear, chromosomal DNA.
- B. Genes for histones and ribosomal RNAs are structural genes.
- C. Most of the chromosomal DNA codes for proteins.
- D. A and B.
- E. A, B, and C.

Answer(s): B

33. Methylation of GATC sequences at _____ is believed to control the replication frequencies in *E. coli* cells.

- A. *oriC*
- B. *TER*
- C. The leading strand
- D. The lagging strand

Answer(s): A

34. _____ causes **premature termination** of polypeptide synthesis by mimicking aminoacyl transfer RNA: it is able to enter the A site and accept the peptidyl group to form a peptidyl molecule, which however will dissociate from the ribosome.

- A. Tetracyclin
- B. Puromycin
- C. Chloramphenicol
- D. Streptomycin

Answer(s): B

35. Which of the following compounds **do not** directly provide atoms to form the purine ring?

- A. Aspartate.
- B. Carbamoyl phosphate.
- C. Glutamine.
- D. Glycine.
- E. CO₂.
- F. N⁵, N¹⁰-methylenetetrahydrofolate.
- G. N¹⁰-formyltetrahydrofolate.
- H. NH₄⁺.

Answer(s): BFH

36. Which of the following is **true** of the control of gluconeogenesis?
- A. Glucagon stimulates adenylyl cyclase, causing the formation of cAMP.
 - B. Cyclic AMP stimulates the phosphorylation and thus increases the activity of FBPase-2.
 - C. FBPase-2 activity lowers the level of fructose-2, 6-bisphosphate, thus increasing the rate of gluconeogenesis.
 - D. It is reciprocally linked to the control of glycolysis.
 - E. All of the above are true.

Answer(s): E

37. Carbon fixation involves a condensation reaction between CO₂ and:

- A. 3-phosphoglycerate.
- B. phosphoglycolate.
- C. ribulose 1, 5-bisphosphate.
- D. fructose 6-phosphate.
- E. ribose 5-phosphate.

Answer(s): C

38. How do the hormones epinephrine and glucagon **differ** in their metabolism of glucose?

- A. Only epinephrine stimulates glyconeogenesis.
- B. Only glucagon stimulates glyconeogenesis.
- C. Only epinephrine acts on muscle.
- D. Only glucagon stimulates glycolysis.

Answer(s): C

39. The enzyme(s) responsible for the transcription of eukaryotic rRNA is:

- A. RNA polymerase I
- B. RNA polymerase II
- C. RNA polymerase III
- D. RNA polymerase I and III
- E. RNA polymerase II and III

Answer(s): D

40. The enzymatic process of “charging” a molecule of tRNA is similar to other enzyme catalyzed reactions you have encountered in this course. Which of the following correctly describes such similarities?

- A. Formation of an acyl-adenylate intermediate coupled to the hydrolysis of pyrophosphate is similar to reactions involved in fatty acid activation.
- B. Proofreading and correcting abilities that prevent incorporation of the wrong molecule are analogous to the action of DNA polymerase.
- C. The aminoacyl-tRNA synthetase is a relatively nonspecific enzyme (i.e. it can activate many different amino acids) and in the respect is similar to ribonucleotide reductase.
- D. A and B
- E. A and C
- F. B and C

Answer(s): D

41. Explain why skeletal muscle does not contribute glucose to the blood. (4 points)

Answer: Because it lacks the enzyme glucose 6-phosphatase.

42. Explain why untreated diabetics lose weight. (4 points)

Answer: The rate of triacylglycerol biosynthesis is affected by the action of several hormones, one of which is insulin. Insulin promotes the conversion of carbohydrates to triacylglycerols. People with severe diabetes, due to failure of insulin secretion or action, not only are unable to use glucose properly but also fail to synthesize fatty acids from carbohydrates or amino acids. Untreated diabetics have increased rate of fat oxidation and ketone body formation, as a consequence, lose weight.

43. Suppose that a bacterial mutant is found to replicate its DNA at a very low rate. Upon analysis, it is found to have entirely normal activity of DNA polymerases I and III, DNA gyrase, and DNA ligase. It also makes normal amounts and kinds of *dnaA*, *dnaB*, *dnaC*, and SSB proteins. The *oriC* region of its chromosome is found to be entirely normal with respect to nucleotide sequence. What defect might account for the abnormally low rate of DNA replication in this mutant? Explain. (4 points)

Answer: A decrease in the activity of primase would account for the low rate of DNA replication. DNA replication requires the prior synthesis of RNA primers. Decreased rates of dNTP synthesis would also slow replication.

44. Describe three properties common to the reactions catalyzed by DNA polymerase, RNA polymerase, and reverse transcriptase. How is the enzyme polynucleotide phosphorylase different from these enzymes? (8 points)

Answer: these enzymes have at least four properties in common.

1. All are template directed, synthesizing a sequence complementary to the template.
2. Synthesis occurs in a 5' to 3' direction.
3. All catalyze the addition of a nucleotide by the formation of a phosphodiester bond.
4. All use (deoxy) ribonucleoside triphosphates as substrate, and release pyrophosphate as a product.

The enzyme polynucleotide phosphorylase differs from these enzymes in points 1 and 4. It does not use a template, but rather add ribonucleotides to an RNA in a highly reversible reaction. The substrates (in the direction of synthesis) are ribonucleoside diphosphates, which are added with the release of phosphate as a product. In the cell, this enzyme probably catalyzes the reverse reaction to degrade RNAs.