清华大学本科生考试试题专用纸 (B)

考试课程 Biochemistry II 2008 年 1 月 20 日

考场纪律：

一、学生应试时必须携带学生证，以备查对，学生必须按照监考教师指定的座位就坐。

二、除答卷必须用的笔、橡皮及教师指定的考试用具外，不得携带任何书籍、笔记、草稿纸等。

三、答卷时不准互借文具（包括计算器）。题纸上如有字迹不清等问题，学生应举手请监考老师解决。

四、学生应独立答卷，严禁左顾右盼、交头接耳、抄袭或看别人答卷等各种形式的作弊行为，如有违反，当场取消其考试资格，答卷作废。

五、在规定的时间内答卷，不得拖延。交卷时间到，学生须在原座位安静地等候监考教师收卷后，方可离开考场。

系别_____ 班号_____ 学号_____ 姓名_____ 成绩_____
阅卷教师_____

题号	一	二	三	四	五	六	七	八	九	十	总分
成绩											

试题说明：

1. 选择题单选题的正确答案只有一个，每题 1 分；多选题的正确答案可能是两个或多个，每题 1.5 分，请将正确答案填在适当的横线处；
2. 问答题的分数标在题目后面，请将答案写在所提供的答题纸上；
3. 本卷满分为 100。

I. Multiple choice questions with only one correct answer (单选题):

1. Carbon fixation involves a condensation reaction between CO_2 and:
A. 3-phosphoglycerate.
B. phosphoglycolate.
C. ribulose 1, 5-bisphosphate.
D. fructose 6-phosphate.
E. ribose 5-phosphate.
Answer C

2. The oxidation of 3 mol of glucose by the pentose phosphate pathway may result in the production of:
A. 2 mol of pentose, 4 mol of NADPH, and 8 mol of CO_2.
B. 3 mol of pentose, 4 mol of NADPH, and 3 mol of CO_2.
C. 3 mol of pentose, 6 mol of NADPH, and 3 mol of CO_2.
D. 4 mol of pentose, 3 mol of NADPH, and 3 mol of CO_2.
E. 4 mol of pentose, 6 mol of NADPH, and 6 mol of CO_2.
Answer C

3. Purine nucleotide biosynthesis can be inhibited by which of the following?
A. GTP
B. UMP
C. AMP
D. ATP
E. IDP
Answer C

4. Antimycin A blocks electron transfer between cytochromes *b* and c_1. If intact mitochondria were incubated with antimycin A, excess NADH, and an adequate supply of O_2, which of the following would be found in the oxidized state?
A. Coenzyme Q
B. Cytochrome a_3
C. Cytochrome *b*
D. Cytochrome *e*
E. Cytochrome *f*
Answer B

5. Which of the following apolipoproteins is synthesized in the liver as part of the coat of very-low-density lipoproteins (VLDLs)?
A. A-I
B. B-48
C. C-II
D. B-100
E. E
Answer C

6. Insulin has many direct effects on various cell types from such tissues as muscle, fat, liver, and skin. Which of the following cellular activities is decreased following exposure to physiological concentrations of insulin?
A. Plasma membrane transfer of glucose
B. Glucose oxidation
C. Gluconeogenesis
D. Lipogenesis
E. Formation of ATP, DNA, and RNA
Answer C

7. Which of the following statements correctly describes metabolism?
A. Fatty acids can be precursors of glucose.
B. High energy levels turn on glycolysis.
C. Synthesis and degradation of a substance do not occur at the same time.
D. Phosphorylation activates enzymes that store fat and glycogen.
E. Guanosine triphosphate (GTP) is the major donor for enzyme phosphorylation.
Answer C

8. The reactions of the urea cycle occur
A. In the cytosol
B. In the mitochondrial matrix
C. In the mitochondrial matrix and the cytosol
D. In the lysosomes

E. In peroxisomes

Answer C

9. During fatty acid metabolism in humans, coenzyme A (CoA) is different from acyl carrier protein (ACP) in which one of the following ways?
A. Binding of malonic acid with a phosphopantetheine
B. Binding of fatty acids
C. Function in fatty acid oxidation
D. Function in the cytosol
E. Function in fatty acid synthesis

Answer C

10. Which one of the following contributes nitrogen to both purine and pyrimidine rings?
A. Aspartate
B. Carbamoyl phosphate
C. Carbon dioxide
D. Glutamine
E. Tetrahydrofolate

Answer A

11. If a completely radioactive double-stranded DNA molecule undergoes two rounds of replication in a solution free of radioactive label, what is the radioactivity status of the resulting four double-stranded DNA molecules?
A. Half should contain no radioactivity
B. All should contain radioactivity
C. Half should contain radioactivity in both strands
D. One should contain radioactivity in both strands
E. None should contain no radioactivity

Answer A

12. In bacteria the elongation stage of protein synthesis does not involve:
A. aminoacyl-tRNAs.
B. EF-Tu.
C. GTP.
D. IF-2.
E. peptidyl transferase.

Answer D

13. Which of the following statements correctly describes ketone bodies?
A. They accumulate in the children with fatty acid oxidation disorders.
B. They accumulate in diabetes mellitus after insulin therapy
C. They are produced by muscle but not liver
D. They include β-hydroxybutyrate and acetone
E. They are found in blood but not in urine

Answer D

14. Citrate has a positive allosteric effect on which of the following enzymes?
A. Pyruvate kinase
B. Acetyl CoA carboxylase
C. Phosphofructokinase

D. Fatty acid synthetase
E. Enolase
Answer B

15. Which one of the following tissues can metabolize glucose, fatty acid and ketone bodies for ATP production?
A. Liver
B. Muscle
C. Hepatocytes
D. Brain
E. Red blood cells
Answer B

16. Which of the following is/are **true** of glycogen metabolism?
A. Cyclic AMP-activated protein kinase stimulates glycogen synthase.
B. Phosphorylase kinase is activated by phosphorylation.
C. Phosphorylase b is inactivated by phosphorylation.
D. Cyclic AMP levels are lowered by epinephrine and glucagon stimulation of adenylate cyclase.
E. Glycogen synthesis is stimulated by glucagon.
Answer B

17. The conversion of pyruvate to oxaloacetate is likely to require which of the following coenzyme?
A. Biotin
B. Vitamin B_{12}
C. Thiamine pyrophosphate
D. Flavin adenine dinucleotide
E. Pyridoxal phosphate
Answer A

18. Attenuation in the *trp* operon of *E. coli*:
A. is a mechanism for increasing the transcription of the structural genes when Trp is present in the growth medium
B. serves to fine-tune the transcription of the operon in response to small changes in Trp availability
C. results from the binding of the Trp repressor to the operator
D. results from the presence of short leader peptides at the amino-terminal (5') end of each structural gene
E. is a mechanism for inhibiting translation of existing (complete) trp mRNA
Answer B

19. The entry point into the citric acid cycle for odd-number fatty acid is
A. Fumarate
B. Pyruvate
C. Oxaloacetate
D. Citrate
E. Succinyl CoA
Answer E

20. Guanosine triphosphate (GTP) is required by which of the following steps in protein synthesis?
A. Aminoacyl-tRNA synthetase activation of amino acids
B. Attachment of ribosomes to endoplasmic reticulum
C. Translocation of tRNA-nascent protein complex from A to P sites
D. Attachment of mRNA to ribosomes
E. Attachment of signal recognition protein to ribosomes
Answer C

21. In the classical model of transcriptional control described by Jacob and Monod, a repressor protein binds to
A. an enhancer
B. an UAG sequence
C. an operator
D. a ribosomal-binding site
E. a TATA box
Answer C

22. 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 C

23. Ames Test is used to investigate whether a chemical reagent is:
A. oxidative.
B. reductive.
C. mutagenic.
D. enzymatic.
Answer C

24. What does it mean when the genetic code is described as “degenerate”?
A. It means that the translation machinery is prone to making errors.
B. It means that there are fewer codons than amino acids.
C. It means that two or more anticodons can base pair with the same codon.
D. It means that more than one codon can specify the same amino acid.
Answer D

25. An *E. coli* strain lacking DNA polymerase I would be deficient in DNA
A. transcription
B. methylation
C. splicing
D. degradation
E. repair
Answer E

26. 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 C

27. 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 D

28. The steps of glycolysis between glyceraldehyde 3-phosphate and 3-phosphoglycerate involve all of the following **except**
A. ATP synthesis
B. Utilization of P_i
C. Oxidation of NADH to NAD^+
D. Formation of 1.3-bisphosphoglycerate
E. Catalysis by phosphoglycerate kinase
Answer C

29. If the $\Delta G'$ of the reaction A⟶B is –12 kJ/mol, which of the following statements is **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 A over the formation of B.
D. The equilibrium constant could be calculated if the initial concentrations of A and B were known.
E. The value of $\Delta G'^{o}$ is also negative.
Answer A

30. Which of the following occurs in the degradation pathway of AMP?
A. Adenine is converted to hypoxanthine.
B. The end product is urea.
C. AMP is converted to adenosine.
D. Adenosine is converted to adenine.
Answer A

31. 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 B

32. The AAUAAA sequence on a RNA molecule marks
A. The site where ribosomes bind to initiate polypeptide synthesis.
B. The site where transcription stops.
C. The site near which the primary transcript is cleaved and a poly (A) sequence is added.
D. The site where the release factor will bind to end polypeptide synthesis.
E. The site where polyribonucleotide phosphorylase will add a stretch of random sequences.
Answer C

33. Which of the following compounds serves as a primary link between the citric acid and the urea cycle?
A. Malate
B. Succinate
C. Isocitrate
D. Citrate
E. Fumarate
Answer E

34. What does the term "essential" mean in terms of amino acids in the human diet?
A. Necessary for all the protein synthesis
B. Only available in animal protein
C. Cannot be synthesized by humans
D. Cannot be coded for by DNA
E. Cannot be degraded in the liver
Answer C

35. 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 A

36. Indicate whether each of the following statements about phosphofructokinase-1 (PFK-1) is true (T) or false (F). (***5 points***)
A. It is activated by AMP. T **Answer**_____
B. It is inhibited by citrate. T **Answer** _____
C. It is inhibited by fructose 2,6-bisphosphate. F **Answer** _____
D. It is inactivated by insulin. F **Answer** _____
E. ATP increases its $K_{0.5}$ for fructose-6-phosphate. T **Answer** _____

37. Match the description to the appropriate enzyme from the list below. (**5 *points***)
A. Citrate synthase 5 **Answer**_____
B. Succinate dehydrogenase 1 **Answer** _____
C. Pyruvate dehydrogenase 4 **Answer** _____
D. Succinyl-CoA synthetase 2 **Answer** _____

E. Malate dehydrogenase 3 **Answer** _____

(1). The only membrane-bound enzyme in the citric acid cycle.
(2). Catalyzes the substrate-level phosphorylation of ADP or GDP.
(3). Catalyzes the last reaction of the citric acid cycle.
(4). Regulated by reversible phosphorylation.
(5). Catalyzes the commitment step in the citric acid cycle.

II. Multiple choice questions with two or more correct answers (多选题):

1. 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.
Answers CE

2. Which of the following statements about the pentose phosphate pathway are true?
A. It generates NADH for reductive biosyntheses.
B. The reaction occurs in the cytosol.
C. It is more active in muscle cells than in fat-storage cells.
D. It interconverts trioses, tetroses, pentoses, hexoses, and haptoses.
E. Through this pathway, excess ribose 5-phosphate can be completely converted into glycolytic intermediates.
Answers BDE

3. Which of the following would describe fatty acid transport into the mitochondrial matrix?
A. It is not 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.
Answers BCD

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. Silent
D. Deletion
Answers BD

5. 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
Answers BDE

6. 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. CO_2.
F. N^5, N^{10}-methylenetetrahydrofolate.
G. N^{10}-formyltetrahydrofolate.
H. NH_4^+.
Answers BFH

7. The synthesis of palmitate requires:
A. 8 acetyl-CoA.
B. 14 NADH.
C. 7 ATP.
D. 8 ATP
E. 16 NADH.
Answers AC

8. Biosynthetic pathways that require NADPH include which of the following?)
A. Gluconeogenesis.
B. Fatty acid biosynthesis.
C. Ketone body formation.
D. Cholesterol biosynthesis.
E. Deoxyribonucleotide biosynthesis.
Answers BDE

9. Which of the following are **not** true of cholesterol synthesis?
A. Reduction of HMG-CoA to mevalonate is the commitment step.
B. Acetyl-CoA is the ultimate source of all 27 carbon atoms of cholesterol.
C. It is inhibited by elevated levels of intracellular cholesterol.
D. It is hormonally activated by glucagon and inactivated by insulin.
E. It occurs in the mitochondrial matrix.
Answers DE

10. Which of the following processes occur in the mitochondria of mammalian cells?
A. fatty acid biosynthesis
B. protein synthesis
C. DNA synthesis
D. β-oxidation of fatty acids
E. the citric acid cycle
Answers BCDE

III. Short-answer questions (简答题): (18 points)

1. Please explain briefly why gluconeogenesis does not occur in muscle or brain cells. (**2 points**)
Answer:
No glucose-6-phosphatase in muscle or brain cells.

2. What effect would an inhibitor of acetyl-CoA carboxylase have on fatty acid synthesis and fatty acid oxidation? (**4 points**)
Increase oxidation, but decrease synthesis.

3. When the bacteria growth medium contains both lactose and glucose, what proteins will be bound to the *lac* operon regulatory region? If only lactose is in the growth medium, what proteins will be bound to the *lac* operon regulatory region? (**6 points**)
Answer: When both glucose and lactose are present, neither Lac repressor nor CRP will be bound. If only lactose is present, CRP will be bound.

4. Why is the catabolism of isoleucine said to be both glucogenic and ketogenic? (**6 points**)

The catabolic pathway for isoleucine leads to the formation of acetyl CoA and propionyl CoA. Acetyl CoA can be utilized for the net synthesis of fatty acids or ketone bodies, but it cannot be used for the net synthesis of glucose; thus, it is said to be ketogenic. In contrast to acetyl CoA, propionyl CoA is converted to succinyl CoA, which can be utilized through part of the citric acid cycle and the gluconeogenic pathway to give the net formation of glucose. The distinction between the two types of substrates is somewhat arbitrary, however. For example, succinyl CoA can also be converted via pyruvate and

IV. Comprehensive questions (综合题): (22 points)

1. Explain **fully** the regulatory role of fructose 2,6-bisphosphate in gluconeogenesis and glycolysis, and the mechanism by which it affects fructose 1,6-bisphosphatase-1 and phosphofructokinase-1. How is the concentration of fructose 2,6-bisphosphate regulated by hormones? (**10 points**)
Answer:
Fructose-2,6-bisphosphate activates glycolysis by activating PFK-1 and inhibits gluconeogenesis by inhibiting FBPase-1. **(4 points)**
F-2,6-bisphosphate is synthesized from (and degraded to) fructose 6-phosphate in a reaction catalyzed by phosphofructokinase-2 (PFK-2) (and fructose-2,6-bisphosphatase (FBPase-2)). **(2 points)**
Glucagon stimulates the phosphorylation of PFK-2/FBPase-2, which inhibits the PFK-2 activity, but activates the FBPase-2 activity, thus inhibiting the glycolysis, but stimulating the gluconeogenesis. **(2 points)**
Insulin has the opposite effect. **(2 points)**

2. 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? Explain briefly how the enzyme polynucleotide phosphorylase was used for the elucidation of the genetic codes.(**12 points**)

Answer: these enzymes have at least four properties in common. **(6 points)**

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 (NTP or dNTP) 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 (NDP), which are added with the release of phosphate as a product. **(4 points)**

This enzyme was used to synthesize RNA polymers of different sequences and frequencies of bases for the elucidation of the genetic codes. **(2 points)**