INTRODUCTORY BIOCHEMISTRY

BI 28 Second Midterm Examination April 1, 2008

Name _____ **SIS #** _____

Make sure that your name or SIS # is on **every** page. This is the only way we have of matching you with your exam after grading it. Please work independently. Read each question **carefully** before answering. Unless otherwise indicated, there is only one correct answer for each multiple choice question. Points are indicated by the question within brackets [ ]. **There are no calculators or other electronic devices needed or allowed on this exam.** Exams will be photocopied before being returned on Thursday.
Please note: All regrade requests for this exam are due by Thursday April 10th at 5pm. Regrades can lead to an overall lower score on the exam.

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Extra Credit_____/2

Exam total _____/100

1. [2 points] The free energy released from the oxidation of pyruvate by the pyruvate dehydrogenase complex is stored in what energy rich molecule(s)?

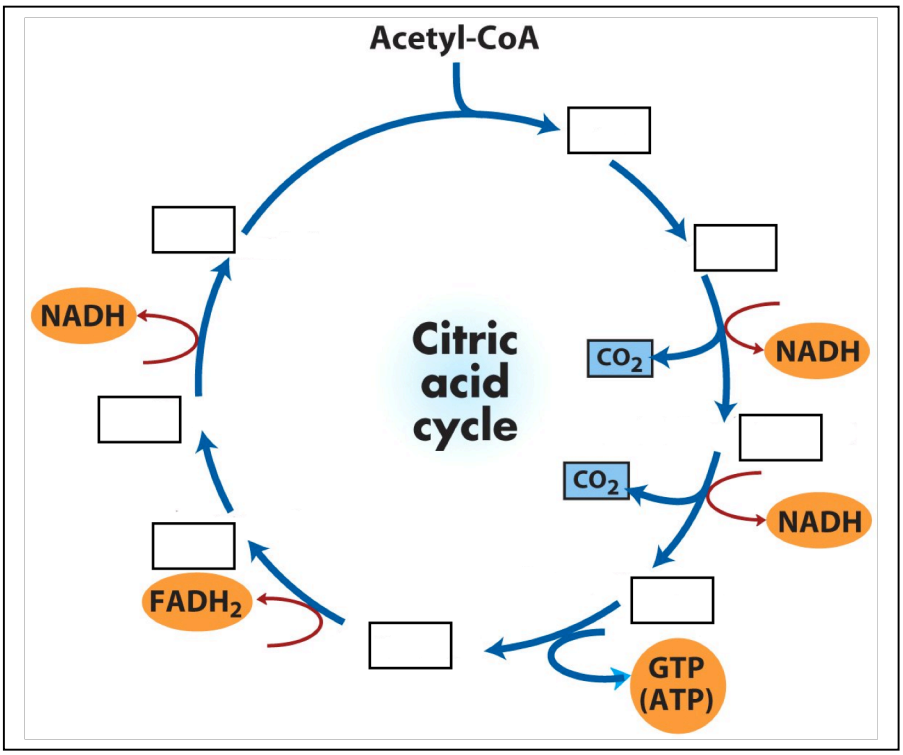
A. Acetyl-CoA
B. $FADH_2$
C. NADH and acetyl-CoA
D. thiamine pyrophosphate
Circle the correct answer

2. [2 points] Compounds like succinate, fumarate and α-ketoglutarate have a catalytic effect on the consumption of oxygen in a cell suspension. The rate of oxygen consumption is far more than that required for their own oxidation. This is evidence that _____.

A) they are intermediates in glycolysis
B) they act as enzymes to cause the oxidation of other compounds
C) they are involved in a cyclic pathway
D) they must be cofactors for enzymes that are oxidoreductases.
Circle the correct answer

3. [4 points] Enter the correct numbers corresponding to the molecules given below into the boxes in the figure to the right.

1. succinate
2. citrate
3. oxaloacetate
4. fumarate
5. succinyl-CoA
6. α-ketoglutarate
7. isocitrate
8. malate



4. [4 points] Briefly explain the function of anaplerotic reactions.

5. [2 points] Which statement is false about the glyoxylate cycle?

A) In mammals the glyoxylate cycle is used to replenish citric acid cycle intermediates.
B) It is an anabolic alternative for the metabolism of acetyl CoA
C) It can be regarded as a shunt in the citric acid cycle
D) In eukaryotes, metabolites must be transferred from the mitochondria to the cytosol to be used in the glyoxylate cycle.

Circle the correct answer

6. [2 points] Almost all of the oxygen (O_2) one consumes in breathing is converted to:

A) acetyl-CoA.
B) carbon dioxide (CO_2).
C) carbon monoxide and then to carbon dioxide.
D) none of the above.
E) water.

Circle the correct answer

7. [6 points] Briefly describe three central elements of the chemiosmotic theory for coupling oxidation to phosphorylation in mitochondria. Describe (a) the oxidation process, what is being oxidated and what the result of this oxidation is, (b) how the oxidation process is coupled to the phosphorylation process, and (c) how the phosphorylation process operates and what molecule is being phosphorylated.

8. [5 points] Indicate whether the following statements are true or false by circling T or F.

T / F Complex II participates in both the electron transport chain and the citric acid cycle.
T / F Coenzyme Q is highly hydrophilic and is dissolved within the inner membrane.
T / F Heme is a prosthetic group of cytochromes.
T / F Only one out of the 8 total α- and β-subunits of ATP synthase contains bound ADP at any given time.
T / F The F_1 complex binds ATP with extremely high affinity.

9. [2 points] Which statement is <u>not</u> true about the transport of ATP across the inner mitochondrial membrane on its way to the cytosol?

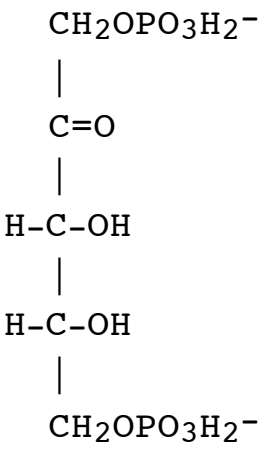
A) It is accomplished by adenine nucleotide translocase.
B) The same translocase that transports ATP also transports ADP in the opposite direction.
C) ATP is complexed with Mg^{2+} for electroneutral passive antiport.
D) The transport causes the loss of a net charge of -1 in the matrix.
Circle the correct answer

10. [7 points] Indicate the location each of the following components in the photosynthetic electron transport pathway of plants by placing the numbers corresponding to the components in the spaces provided.

H2O → _____ → _____ → _____ → _____ → _____ → _____ → _____ → $NADP^+$

1. Plastoquinone
2. Reaction center of Photosystem II
3. Ferredoxin
4. Plastocyanin
5. Cytochrome *b6f* complex
6. Reaction center of Photosystem I
7. Oxygen-evolving complex

11. [2 points] How many photons are required to drive the formation of one molecule of O_2 and the reduction of two molecules of $NADP^+$? _____



12. [2 points] What is the name of the compound pictured above?

_____

13. [1 point] Indicate with (an) asterisk(s) (*) which carbon atom(s) of the above compound react(s) with CO_2 in the CO_2-fixation step of the Calvin cycle.

14. [1 point] Name an alternative molecule that this compound reacts with. _____

15. [2 points] An intermediate found in gluconeogenesis and not in glycolysis is ___

A) 2-phosphoglycerate
B) oxaloacetate
C) phosphoenolpyruvate
D) fructose-1,6-bisphosphate
Circle the correct answer

16. [3 points] Place the enzymes listed below in the proper order to show how lactate may be used to synthesize PEP (not all enzymes may be required; be careful, wrong answers will be penalized).

_____ PEP carboxykinase
_____ pyruvate carboxylase
_____ enolase
_____ lactose synthase
_____ lactate dehydrogenase

17. [4 points] Indicate whether the following statements are true or false by circling T or F

T / F Glycogen is a polymer of (α 1→4) linked subunits of glucose that is extensively branched with (α 1→6) linkages.
T / F Glycogen synthase transfers glucose residues to a nonreducing end of a glycogen branch.
T / F Glycogen synthase uses glucose 1-phosphate as substrate for glycogen synthesis.
T / F Glycogen synthase remains covalently bound to the reducing end of the completed glycogen molecule.

18. [5 points] Name the two enzymes that are active in glycogen breakdown and briefly describe their functions.

19. [7 points] The list below includes metabolic reactions and processes for the catabolism of fatty acids. Number the items in the order in which they occur in an organism beginning with fatty acids in the cytoplasm.

Start: Fatty acid in cytoplasm
_____ thiolytic cleavage
_____ formation of acyl-carnitine
_____ dehydrogenation to a trans-Δ^2-enoyl-CoA
_____ linkage of fatty-acid to CoA
_____ hydration of double bond
_____ dehydrogenation to a β-Ketoacyl-CoA
_____ transport of fatty acid to mitochondrion

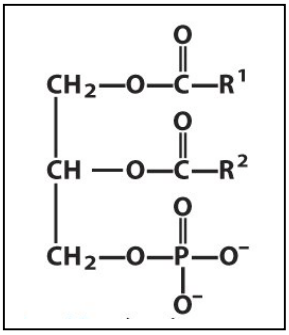
20. [2 points] What is the coenzyme associated with the enzyme acetyl-CoA carboxylase?

A) NADPH
B) biotin
C) FAD
D) heme
Circle the correct answer

21. [2 points] What type of bond best describes the linkage between acyl carrier protein (ACP) and fatty acids in fatty acid biosynthesis?

A) thioester
B) phosphoanhydride
C) ester
D) amide
Circle the correct answer

22. [3 points] What is the name of the compound given to the right? This molecule is the precursor of which compounds?



23. [2 points] Which of the following precursors is <u>not</u> involved in cholesterol biosynthesis?

A) squalene
B) acetoacetyl-CoA
C) sphinganine
D) mevalonate
E) farnesyl pyrophosphate
Circle the correct answer

24. [2 points] Nonessential amino acids:

A) are amino acids other than those required for protein synthesis.
B) are not utilized in mammalian proteins.
C) are synthesized by plants and bacteria, but not by humans.
D) can be synthesized in humans as well as in bacteria.
E) may be substituted with other amino acids in proteins.
Circle the correct answer

25. [2 points] The carbon in urea originates from _____.

A) Ornithine
B) aspartate
C) bicarbonate
D) ATP
Circle the correct answer

26. [4 points] Each of the following amino acids may be catabolized to a citric acid cycle intermediate. Identify the citric acid cycle intermediate for each.

A. glutamate _____
B. aspartate _____
C. asparagine _____
D. glutamine _____

27. [2 points] Which of the following is/are true statement(s) about glutamine?

A) It is a nitrogen donor in many biosynthetic reactions
B) It is a nitrogen source for glutamate synthase.
C) It carries nitrogen between tissues, thus avoiding high toxic levels of NH_4^+ in blood.
D) All of the above
Circle the correct answer(s)

28. [2 points] Briefly describe where the sulfur atom for the biosynthesis of cysteine is derived from in (a) mammals and (b) plants and bacteria.

29. [2 points] The biosynthesis of which amino acid requires a precursor derived from the pentose phosphate pathway?

_____

30. [2 points] The biopolymers that humans use to store potential fuel molecules are glycogen, proteins, and triacylglycerols. What is the preferred order of use?

A. Proteins > triacylglycerols > glycogen
B. Triacylglycerols > glycogen > proteins
C. Glycogen > proteins > triacylglycerols
D. Glycogen > triacylglycerols > proteins
Circle the correct answer

31. [2 points] When blood glucose is abnormally low, the pancreas releases:
A) epinephrine.
B) glucagon.
C) glucose.
D) insulin.
E) trypsin.
Circle the correct answer

32. [2 points] Identify the metabolic effects of insulin from the list below (more than one answer may be correct).
A. Stimulates glycogen synthesis
B. Decreases gluconeogenesis
C. Decreases glycogen synthesis
D. Decreases glucose transport
E. Increases gluconeogenesis
F. Increases blood glucose levels
Circle the correct answer(s)

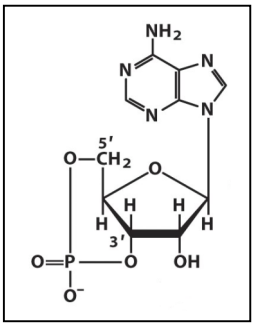
33. [2 points] The ion channel that opens in response to acetylcholine is an example of a _____ signal transduction system.
A) G protein
B) ligand-gated
C) receptor-enzyme
D) serpentine receptor
E) voltage-gated
Circle the correct answer

34. [2 points] Steroid hormones are carried on specific carrier proteins because the hormones:

A) are too unstable to survive in the blood on their own.
B) cannot dissolve readily in the blood because they are too hydrophobic.
C) cannot find their target cells without them.
D) need them in order to pass through the plasma membrane.
E) require subsequent binding to specific receptor proteins in the nucleus.

Circle the correct answer

35. [2 points] Which second messenger molecule is shown in the figure to the right?



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36. [2 points] Nitric oxide is produced from which reaction?

A) arginine to citrulline
B) glutatmate to α-ketoglutarate
C) tryptophan to acetyl-CoA
D) citrulline to argininosuccinate

Circle the correct answer

Extra credit [2 points]:
Describe the effect of cholera toxin on cellular signaling.