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MIDTERM EXAM II
August 1, 2011
Biochemistry II
BI/CH422S

I. _____/42

II. _____/18

III. _____/20

TOTAL /80

I. **MULTIPLE CHOICE** (42 points; 3 pts #1-10 and 2 pts #11-16)
Choose the best answer as requested in each question by circling the approporitate letter(s).

1. Which of the following conversions requires more than one step? 17/8

   1. alanine ⟶ pyruvate
   2. glutamate ⟶ α-ketoglutarate
   3. aspartate ⟶ oxaloacetate
   4. proline ⟶ glutamate
   5. phenylalanine ⟶ succinate

   A. 1, 2, and 4
   B. 1, 3, and 5
   C. 2, 4, and 5
   D. 1 and 4
   E. 4 and 5

2. A new compound is isolated from mitochondria and a claim is made that it represents a previously unrecognized carrier in the electron transfer chain, and it is given the name coenzyme Z. Which line of evidence do you feel is the *least* conclusive in assigning this compound a position in the electron transfer chain? 18/5

   A. When added to a mitochondrial suspension, coenzyme Z very rapidly and specifically is taken up by the mitochondria.
   B. Removal of coenzyme Z from the mitochondria results in a decreased rate of oxygen consumption.
   C. Alternate oxidation and reduction of the mitochondrion-bound coenzyme Z can be readily demonstrated.
   D. The rate of oxidation and reduction of mitochondrion-bound coenzyme is of the same order of magnitude as the overall rate of electron transfer in mitochondria as measured by oxygen consumption.

3. Which of the following statements is *false* in reference to the mammalian synthesis of urea? 17/17

   A. Krebs was a major contributor to the elucidation of the pathway involved.
   B. The precursor to one of the nitrogens of urea is aspartate.
   C. The process of urea production is an energy-yielding series of reactions.
   D. The amino acid arginine is the immediate precursor to urea.

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4. In the light-independent ("dark") reactions of photosynthesis, the biosynthesis of 1 mole of hexose from 6 moles of carbon dioxide requires: 19/18

A. 18 moles of NADPH and 18 moles of ATP.
B. 18 moles of NADPH and 12 moles of ATP.
C. 12 moles of NADPH and 18 moles of ATP.
D. 12 moles of NADPH and 12 moles of ATP.
E. no NADPH and 12 moles of ATP.

5. Free fatty acids in the bloodstream are: 16/1

A. bound to hemoglobin.
B. present at levels that are independent of epinephrine.
C. carried by the protein serum albumin.
D. freely soluble in the aqueous phase of the blood.
E. nonexistent; the blood does not contain free fatty acids.

6. Which of these amino acids is (are) *both* ketogenic *and* glucogenic? 17/23

1. isoleucine
2. valine
3. histidine
4. arginine
5. tyrosine

A. 1 and 5
B. 2 and 4
C. 2, 3, and 4
D. 1, 3, and 5
E. 2, 4, and 5

7. The compound that <u>condenses</u> with CO_2 in the first reaction of carbon dioxide fixation is: 19/21

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

8. Which of the following statements about the light reactions in photosynthetic plants is *false*? 18/17

A. There are two distinct photosystems, linked together by an electron transfer chain.
B. A membrane-bound ATPase couples ATP synthesis to electron transfer.
C. The ultimate source of electrons for the process is H_2O.
D. The ultimate electron acceptor is O_2.
E. No CO_2 is fixed in the light reactions.

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9. Which of the following statements about the chemiosmotic theory is correct? 18/14

A. Electron transfer in mitochondria is accompanied by an asymmetric release of protons on *one* side of the inner mitochondrial membrane.
B. The effect of uncoupling reagents is a consequence of their ability to carry electrons through membranes.
C. Although the energy transductions in mitochondria and in chloroplasts are superficially similar, they have fundamentally different mechanisms.
D. The membrane ATPase, which plays an important role in other hypotheses for energy coupling, has no significant role in the chemiosmotic theory.
E. All of the above statements are correct.

10. Pyridoxal phosphate is a cofactor in this class of reactions: 17/4

A. methylation.
B. acetylation.
C. reduction.
D. desulfuration.
E. transamination.

11. In the reoxidation of $CoQH_2$ by purified ubiquinone-cytochrome *c* reductase (Complex III), the overall stoichiometry of the reaction requires 2 moles of cytochrome *c* per mole of $CoQH_2$ because: 18/7

A. cytochrome *c* is a 2-electron acceptor, whereas $CoQH_2$ is a 1-electron donor.
B. cytochrome *c* is a 1-electron acceptor, whereas $CoQH_2$ is a 2-electron donor.
C. two molecules of cytochrome *c* must first combine physically before they are catalytically active.
D. heart muscle has a high rate of oxidative metabolism, and therefore requires twice as much cytochrome *c* as $CoQH_2$ for electron transfer to proceed normally.

12. In amino acid catabolism, the first reaction for many amino acids is a(n): 17/24

A. decarboxylation requiring thiamine pyrophosphate.
B. reduction requiring pyridoxal phosphate.
C. transamination requiring pyridoxal phosphate.
D. hydroxylation requiring NADPH and O_2.
E. oxidative deamination requiring NAD^+.

13. The role of hormone-sensitive triacylglycerol lipase is to: 16/3

A. hydrolyze lipids stored in the liver.
B. hydrolyze triacylglycerols stored in adipose tissue.
C. hydrolyze membrane phospholipids in hormone-producing cells.
D. synthesize triacylglycerols in the liver.
E. synthesize lipids in adipose tissue.

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14. If a person's urine contains unusually high concentrations of urea, which of the following diets has he or she probably been eating recently? 17/16

A. very high carbohydrate, very low protein
B. very low carbohydrate, very high protein
C. very high fat, very low protein
D. very high fat, high carbohydrate, no protein

15. A fatty acid with an odd number of carbons will enter the citric acid cycle as acetyl-CoA and: 16/21

A. α-ketoglutarate.
B. malate.
C. succinyl-CoA.
D. citrate.
E. butyrate.

16. 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? 18/6

A. cytochrome a_3
B. cytochrome *f*
C. cytochrome *b*
D. cytochrome *e*
E. coenzyme Q

II. **SHORT ANSWER & PROBLEMS**. (18 points)

17. Ala, Cys, Gly, Ser, and Thr are amino acids whose degradation yields pyruvate. Which, if any, of the remaining 15 amino acids also do so? Explain. [NOTE: the pathway for Thr was not covered in class] (2 pts) 17/53

18. There are 3 steps of branched-chain amino acid degradation and of β oxidation that chemically resemble three successive steps of the citric acid cycle. Which steps are these? (3 pts) 16/49

19. *Helicobacter pylori*, the bacterium responsible for gastric ulcers, can survive in the stomach (where the pH is a slow as 1.5) in part because it synthesizes large amounts of the enzyme urease. (a) write the reaction for urea hydrolysis by urease. (b) Explain why the reaction could help establish a more hospitable environment for *H. pylori*, which tolerates acid but prefers to grow near-neutral pH. (2 pts) 17/52

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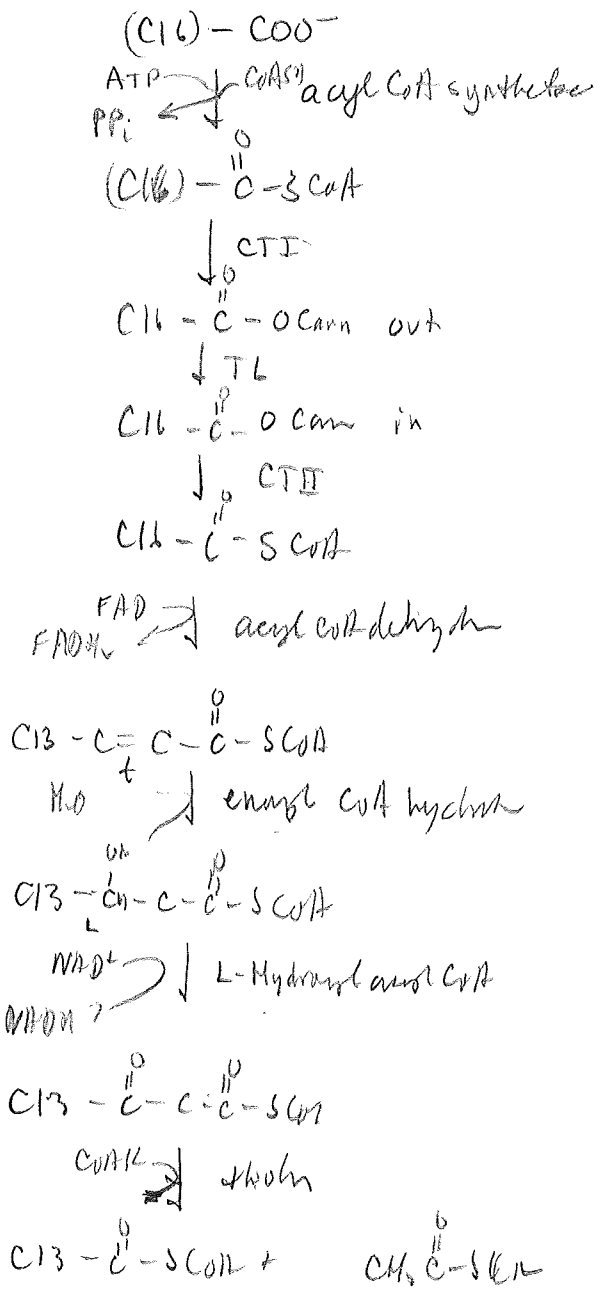
III. **PATHWAYS**. (20 points)
Write out the eight steps in β oxidation from palmitate to myristyl-CoA (C14) plus acetyl-CoA, which includes three steps needed for transport. For each step give the name of the enzyme that catalyzes the reaction (no abbreviations), any cofactors required (abbreviations OK), the name of each intermediate and their structures (including palmitate, myristyl-CoA, and acetyl-CoA; you can abbreviate phosphate and/or phosphoryl by a circled "P" and Coenzyme A as "CoA").

24. (20 pts) 29/105



Same as 2010

Answer Key for Test "Exam1_2011S", 07/14/11

No. in Q-Bank	No. on Test	Correct Answer
13	1	D
13	2	D
15	3	C
15	22	4 B
10	25	5 B

$\Delta G = RT\ln([K^+(in)]/[K^+(out)]) + z\mathfrak{F}\Delta\Psi$
$\Delta G = (8.3)(310)\ln(150/4) + (1)(97000)(-0.06)$
$\Delta G = (2.57)kJ/mol(3.6) + (-5.8)kJ/mol$
$\Delta G = (9.3)kJ/mol - (5.8)kJ/mol$
$\Delta G = +3.5$ kJ/mol, or about 4

14	20	6	B
10	23	7	C
13	18	8	B
14	16	9	C
13	6	10	C
13	3	11	C
15	21	12	B
14	42	13	D
10	28	14	C
15	8	15	B
14	87	16	G; P; G+P; G; G

+P +P
or or → G+P

15	32	17	C; B; A, D; E
13	35	18	(a) Co^+; (b) glucose; (c) Fe^{2+}; (d) acetate; (e) ethanol (f) acetaldehyde.
14	59	19	The glycolytic pathway is so central to all of cellular metabolism that mutations in glycolytic enzymes are lethal; embryos with such mutations do not develop.

13 24 20
$\Delta G°'$ is a physical constant, characteristic of each chemical reaction. ΔG is a variable that depends on $\Delta G°'$, the temperature, and the concentrations of all reactants and products:

$$\Delta G = \Delta G°' + RT \ln \frac{[\text{product}]}{[\text{reactant}]}$$

15	52	21	Succinate acts "catalytically" as an intermediate in the citric acid cycle; it is not consumed but is regenerated by the operation of the cycle. Its addition to an extract depleted in citric acid cycle intermediates allows the cycle to resume operating, oxidizing acetyl-CoA to CO_2.

14 64 22
Anaerobic metabolism of glucose (fermentation to lactate) produces 2 ATP per glucose; based on the assumption, aerobic metabolism (oxidation to CO_2) yields 36 ATP per glucose. For yeast to produce about the same amount of ATP, 18 times more glucose will be consumed anaerobically relative to aerobic consumption.

14 82 23
Phosphofructokinase-1 is inhibited allosterically by ATP and citrate, and is activated by AMP, ADP, and fructose-2,6-bisphosphate.

10 51 24
The graph does not indicate the involvement of a transport protein, since the rate does not saturate at hign [X]. You could verify this you could increase the [X] further (perhaps you are only seeing the very first part of curve OR - use inhibitor.

25 → names & substrates 1/2 (5.5), structures 1/2 (6.5), enzyme name 1.0 (10), NAD^+ (1), P_i (1), H_2O (1), ATP 1/4 (1) = (25)

Answer Key for Test "Exam2_2011S", 07/31/11

No. in Q-Bank	No. on Test	Correct Answer
17	8	1 E
18	5	2 A
17	17	3 C
19	18	4 C
16	1	5 C
17	23	6 A
19	21	7 B
18	17	8 D
18	14	9 A
17	4	10 E
18	7	11 B
17	24	12 C
16	3	13 B
17	16	14 B
16	21	15 C
18	6	16 A
17	53	17 Tryptophan can be considered a member of this group since its alpha amino acid and beta carbons result in the formation of Ala, which goes to pyruvate via transamination.
16	49	18 1. **Succinate dehydrogenase** ($HOOC-CH_2-CH_2-COOH$ --> $HOOC-HC=CH-COOH$ (*trans*)), using FAD 2. **Fumarase** ($HOOC-HC=CH-COOH$ (*trans*) --> $HOOCCHOH-CH_2-COOH$) 3. **Malate dehydrogenase** ($HOOCCHOH-CH_2-COOH$ --> $HOOC-C=O-CH_2-COOH$), using NAD^+
17	52	19 (a) $H_2N-C=O-NH_2$ (urea) + H_2O ----> 2 NH_3 + CO_2 (b) The NH_3 produced by the action of urease can combine with protons in gastric fluid to form NH_4^+. This could reduce the concentration of protons and therefore increase the pH.
18	55	20 An ATP Synthase with more *c* subuints requires more proton translocation events to drive one complete rotation of the c ring. Consequently, more substrate oxidation (O_2 consumption) is required to synthesize the 3 ATP molecules per rotation. An F_o with 9 *c* subuints would require 9 protons translocated per 3 ATP, and one with 12 would require 12 protons translocated per 3 ATP. If NADH oxidation to O_2 pumps 10-12 protons and F_o with 10 c subunits has a P/O ratio of 2.5, then an F_o with 9 *c* subunits would only require 9 protons/rotation or 10/9 (=1.1) the P/O ratio of one with 10 c subunits, or a P/O ratio of 1.1x2.5 = **2.8**; and an F_o with 12 *c* subunits would have a P/O ratio of (10/12 = 08.3x2.5 =) **2.1**.
18	56	21 The label appears as $^{18}O_2$: $H_2{}^{18}O + CO_2 + light$ ----> $(CH_2O) + {}^{18}O_2$
18	23	22 $UQH_2 \rightarrow$ cyt *b* $\rightarrow$ cyt c_1 $\rightarrow$ cyt *c* $\rightarrow$ cyt ($a + a_3$) $\rightarrow O_2$ E_o' for O_2 must be the larger positive value (+0.82), because electron flow occurs spontaneously to the electron acceptor with the more positive E_o'.
16	50	23 Six cycles are required C2 (acetyl-CoA) = 3 C3 (propionyl-CoA) = 3 C4 (methylpropionyl (isobutryl)-CoA) = 1
29	105	24 names of enzymes (8), names of substrates (4.5), structures of substrates (4.5), cosubstrates for synthetase (1), carnitine & CoA (1), other cofactors (1)