Name Key

Biochemistry 5700
Fall, 2007
Final Exam
December 14, 2007

INSTRUCTIONS:

Do not begin until 9:30 AM. The exam must be turned in by 11:20 AM. This exam contains two sections: the "new material" section and the "comprehensive" section.
Answer the questions by marking on the scantron sheet using a #2 pencil. Turn in the scantron when you are finished. Good Luck!!

Equations: $\Delta G = \Delta G^{\circ\prime} + RT\ln Q$ $\Delta E = \Delta E^{\circ\prime} - \frac{RT}{nF}\ln Q$ $\Delta G' = -nFE'$

$\mathrm{pH} = \mathrm{p}K_a + \log\frac{[A^-]}{[HA]}$ $v = \frac{V_{max}\cdot[S]}{K_m + [S]}$

Constants: F = 96.5 kJ/V•mol R = 8.3144 J/mol•K

table 5–1

Properties and Conventions Associated with the Standard Amino Acids

Amino acid	Abbreviated names	M_r	pK_a values		
			pK_1 (—COOH)	pK_2 (—NH_3^+)	pK_R (R group)
Glycine		75	2.34	9.60	
Alanine		89	2.34	9.69	
Valine		117	2.32	9.62	
Leucine		131	2.36	9.60	
Isoleucine		131	2.36	9.68	
Methionine		149	2.28	9.21	
Phenylalanine		165	1.83	9.13	
Tyrosine		181	2.20	9.11	10.07
Tryptophan		204	2.38	9.39	
Serine		105	2.21	9.15	
Proline		115	1.99	10.96	
Threonine		119	2.11	9.62	
Cysteine		121	1.96	10.28	8.18
Asparagine		132	2.02	8.80	
Glutamine		146	2.17	9.13	
Lysine		146	2.18	8.95	10.53
Histidine		155	1.82	9.17	6.00
Arginine		174	2.17	9.04	12.48
Aspartate		133	1.88	9.60	3.65
Glutamate		147	2.19	9.67	4.25

TABLE 13–7 Standard Reduction Potentials of Some Biologically Important Half-Reactions, at pH 7.0 and 25 °C (298 K)

Half-reaction	E'° (V)
$\frac{1}{2}O_2 + 2H^+ + 2e^- \longrightarrow H_2O$	0.816
$Fe^{3+} + e^- \longrightarrow Fe^{2+}$	0.771
$NO_3^- + 2H^+ + 2e^- \longrightarrow NO_2^- + H_2O$	0.421
Cytochrome *f* (Fe^{3+}) + e^- ⟶ cytochrome *f* (Fe^{2+})	0.365
$Fe(CN)_6^{3-}$ (ferricyanide) + e^- ⟶ $Fe(CN)_6^{4-}$	0.36
Cytochrome a_3 (Fe^{3+}) + e^- ⟶ cytochrome a_3 (Fe^{2+})	0.35
$O_2 + 2H^+ + 2e^- \longrightarrow H_2O_2$	0.295
Cytochrome *a* (Fe^{3+}) + e^- ⟶ cytochrome *a* (Fe^{2+})	0.29
Cytochrome *c* (Fe^{3+}) + e^- ⟶ cytochrome *c* (Fe^{2+})	0.254
Cytochrome c_1 (Fe^{3+}) + e^- ⟶ cytochrome c_1 (Fe^{2+})	0.22
Cytochrome *b* (Fe^{3+}) + e^- ⟶ cytochrome *b* (Fe^{2+})	0.077
Ubiquinone + $2H^+$ + $2e^-$ ⟶ ubiquinol	0.045
Fumarate^{2-} + $2H^+$ + $2e^-$ ⟶ succinate^{2-}	0.031
$2H^+ + 2e^- \longrightarrow H_2$ (at standard conditions, pH 0)	0.000
Crotonyl-CoA + $2H^+$ + $2e^-$ ⟶ butyryl-CoA	−0.015
Oxaloacetate^{2-} + $2H^+$ + $2e^-$ ⟶ malate^{2-}	−0.166
Pyruvate$^-$ + $2H^+$ + $2e^-$ ⟶ lactate$^-$	−0.185
Acetaldehyde + $2H^+$ + $2e^-$ ⟶ ethanol	−0.197
FAD + $2H^+$ + $2e^-$ ⟶ $FADH_2$	−0.219*
Glutathione + $2H^+$ + $2e^-$ ⟶ 2 reduced glutathione	−0.23
$S + 2H^+ + 2e^- \longrightarrow H_2S$	−0.243
Lipoic acid + $2H^+$ + $2e^-$ ⟶ dihydrolipoic acid	−0.29
$NAD^+ + H^+ + 2e^-$ ⟶ NADH	−0.320
$NADP^+ + H^+ + 2e^-$ ⟶ NADPH	−0.324
Acetoacetate + $2H^+$ + $2e^-$ ⟶ β-hydroxybutyrate	−0.346
α-Ketoglutarate + CO_2 + $2H^+$ + $2e^-$ ⟶ isocitrate	−0.38
$2H^+ + 2e^- \longrightarrow H_2$ (at pH 7)	−0.414
Ferredoxin (Fe^{3+}) + e^- ⟶ ferredoxin (Fe^{2+})	−0.432

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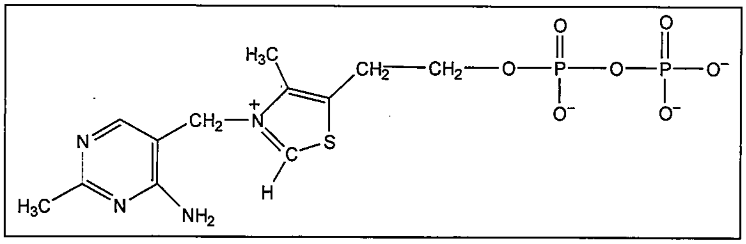

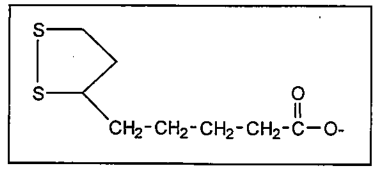

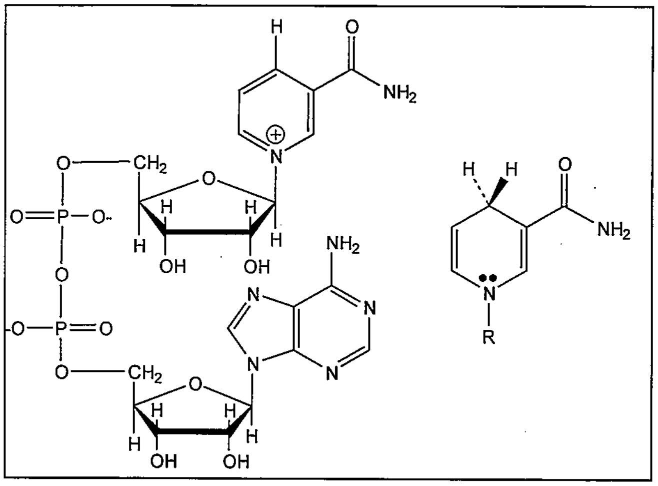

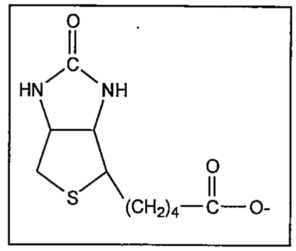

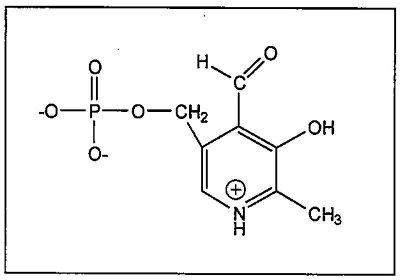

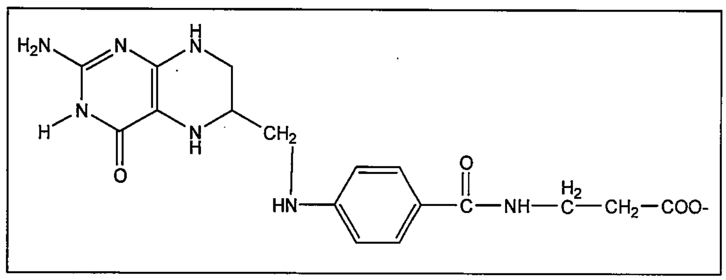

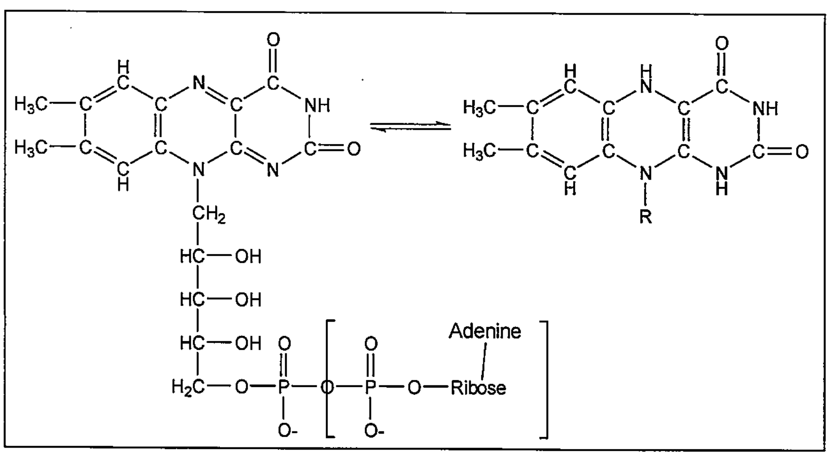

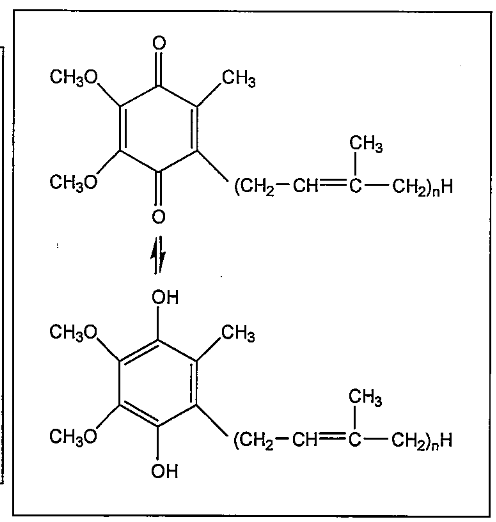

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(1) What is the correct sequence of events by which fatty acids are transported and processed from the cytosol to the mitochondrion?

(a) fatty acid → fatty acyl-AMP → fatty acyl-CoA → fatty acyl carnitine → fatty acyl-CoA
(b) fatty acid → fatty acyl-phosphate → fatty acyl carnitine → fatty acyl-CoA
(c) fatty acid → fatty acyl-CoA → fatty acyl-AMP → fatty acyl carnitine → fatty acyl-CoA
(d) fatty acid → fatty acyl-CoA → fatty acyl-AMP → fatty acyl-CoA → fatty acyl carnitine
(e) fatty acid → fatty acyl-phosphate → fatty acyl-CoA → fatty acyl carnitine → fatty acyl-CoA

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(2) Match the enzyme from beta oxidation with an enzyme from the citric acid cycle that carries out the most similar chemistry

	Acyl-CoA dehydrogenase	β-hydroxyacyl-CoA dehydrogenase	Enoyl-CoA hydratase
(a)	Malate dehydrogenase	Succinate dehydrogenase	fumarase
(b)	Succinate dehydrogenase	α-ketoglutarate dehydrogenase	fumarase
(c)	Succinate dehydrogenase	Malate dehydrogenase	aconitase
(d)	Succinate dehydrogenase	Malate dehydrogenase	fumarase
(e)	Malate dehydrogenase	α-ketoglutarate dehydrogenase	aconitase

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(3) The breakdown of oleic acid (cis Δ^9-octadecenoic acid) to 9 acetyl-CoA molecules via beta oxidation will produce:

(a) 9 NADH and 9 $FADH_2$
(b) 9 NADH and 8 $FADH_2$
(c) 8 NADH and 8 $FADH_2$
(d) 8 NADH and 7 $FADH_2$
(e) 9 NADH and 7 $FADH_2$

C18 satd
↓ 8 cycles — 8 NADH
8 $FADH_2$
9C2

w/ 1 double bond already, you get one less $FADH_2$ or 7

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(4) During oxidation of odd chain fatty acids, the reaction of propionyl-CoA requires action of an enzyme designated a __(i)___ and formation of succinyl-CoA requires the action of an enzyme designated a ___(ii)____.

(a) (i) carboxylase (b) mutase
(b) (i) carboxylase (b) epimerase
(c) (i) mutase (b) carboxylase
(d) (i) epimerase (b) mutase
(e) (i) mutase (b) epimerase

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(5) Dietary fatty acids are transported through the blood stream bound to structures called __________ while fatty acids mobilized and exported from adipocytes are transported bound to structures called __________.

(a) carnitine; albumin
(b) albumin; carnitine
(c) chylomicrons; cholesterol
(d) albumin; chylomicrons
(e) chylomicrons; albumin

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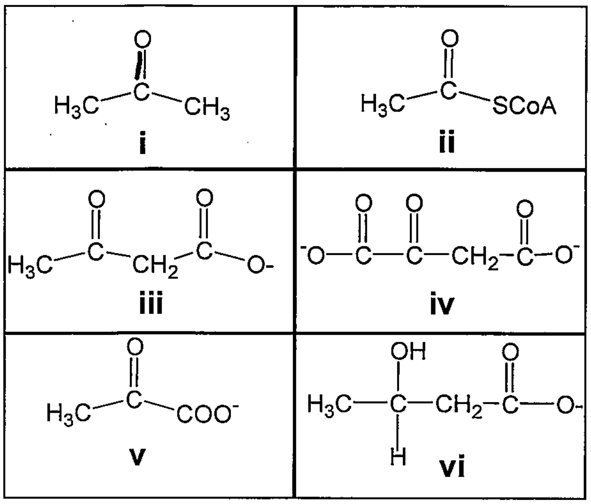
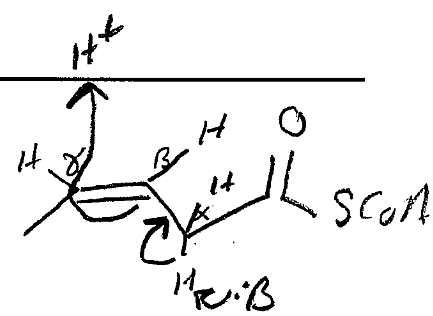
(6) The structures of which of the following compounds are collectively referred to as "ketone bodies"?



(a) i, iii, and iv
(b)ii, iii, and vi
(c) i, iii, and vi
(d) iii, v, and vi
(e) i, iv, and vi

~~(7) The reaction catalyzed by enoyl-CoA isomerase will be initiated by:~~
(a) general base abstraction of a proton from the substrate alpha carbon
(b) general base abstraction of a proton from the substrate beta carbon
(c) hydride transfer to the substrate beta carbon
(d) hydride transfer to the substrate gamma carbon
(e) hydride transfer to the substrate alpha carbon



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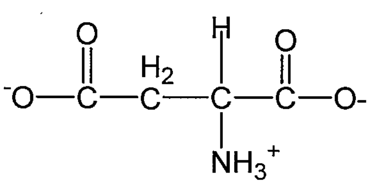
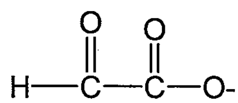
(8) The following compounds would be formed from the transamination of which two compounds?





(a) α-ketoglutarate and glycine
(b) oxaloacetate and glycine
(c) oxaloacetate and alanine
(d) α-ketoglutarate and alanine
(e) α-ketoglutarate and serine

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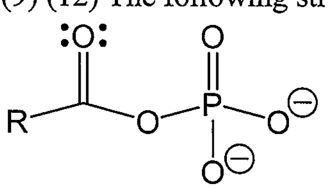
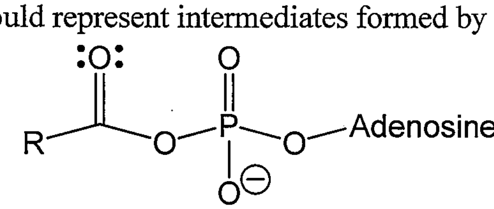
(9) (12) The following structures could represent intermediates formed by what enzymes?



(i)



(ii)

	Fatty acyl-CoA synthetase	Glutamine synthetase	Carbamoyl phosphate synthetase
(a)	(ii)	(i)	(i)
(b)	(ii)	(i)	(ii)
(c)	(i)	(i)	(ii)
(d)	(ii)	(ii)	(i)
(e)	(i)	(ii)	(i)

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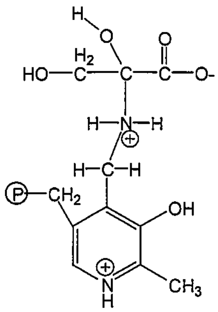
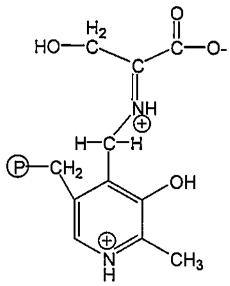
(10) Match the following structures with the correct names for the adducts of PLP and serine:



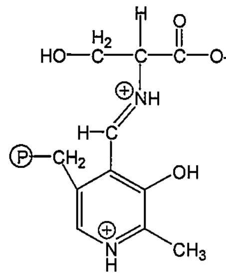
(i)

carbinolamine

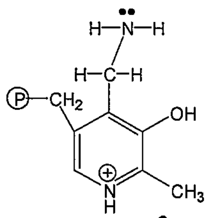


(ii)

ketimine

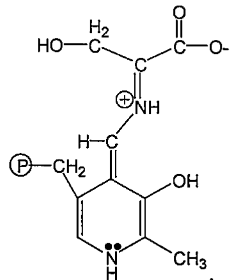


(iii) aldimine

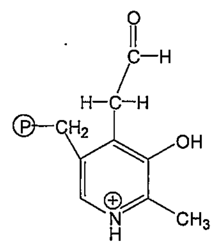


amine

(iv)



(v) carbanion



(vi) al

	Pyridoxamine phosphate	aldimine adduct	ketimine adduct	carbinolamine	Resonance stabilized carbanion
(a)	(iv)	(ii)	(iii)	(i)	(v)
(b)	(iv)	(iii)	(ii)	(i)	(v)
(c)	(iv)	(iii)	(v)	(ii)	(i)
(d)	(vi)	(ii)	(iii)	(i)	(v)
(e)	(iv)	(iii)	(ii)	(iv)	(i)

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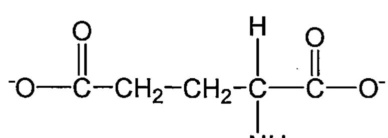
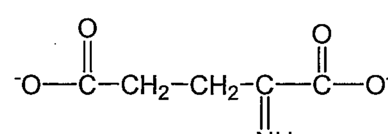
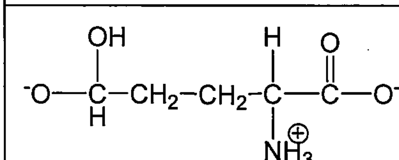
(11) The first oxidized intermediate in the reaction catalyzed by glutamate dehydrogenase will have which structure?



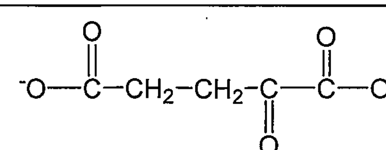
(a)



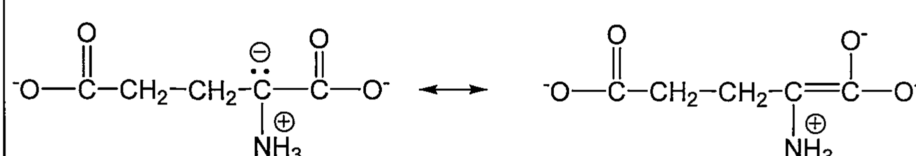
(b)



(c)



(d)



(e)

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(12) In mammals, the reaction that results in the activation of tetrahydrofolate with a C1 unit results in the production of what product(s)?

(a) serine and N^5-N^{10}-methylene-THF
(b) glycine and N^5-N^{10}-methylene-THF
(c) N^5-formyl-THF, ADP and P_i
(d) Glycine and N^5-formyl-THF
(e) Homocysteine and N^5-methyl-THF

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(13) Which of the following processes involves oxidation and/or reduction of substrate molecule(s)?

(i) Transamination of aspartate and alpha-ketoglutarate Y
(ii) Conversion of glutamate to glutamine N
(iii) Deamination of glutamate to alpha-ketoglutarate Y
(iv) Deamination of glutamine to glutamate N
(v) Amination of bicarbonate to carbamoyl phosphate N

(a) (i), (ii), and (iii)
(b) (i), (iii) and (v)
(c) (i), (ii), (iii), and (iv)
(d) ~~(i) and (iii)~~
(e) (i), (ii), and (iv)

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(14) (6) What are the correct oxidation states for the following C1-cofactor adducts?

(i) N^5-methyl-THF -2
(ii) S-adenosylmethionine -2
(iii) N^5-N^{10}-methylene-THF 0
(iv) N^5-formyl-THF +2
(v) N^5- N^{10}-methenyl-THF +2
(vi) carboxybiotin +4

	+4	+3	+2	0	-2	-4
(a)	(iv), (v), (vi)		(iii)		(i), (ii)	
(b)	(vi)		(i), (ii), (iii)		(iv), (v)	(ii)
(c)		(iii)	(i), (ii)		(iv), (v)	(vi)
(d)	(vi)		(iv), (v)	(iii)	(i), (ii)	X
(e)	none	(vi)	(iv), (v)	(iii)	(i), (ii)	

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(15) Elevated levels of homocysteine in your blood stream might indicate a lack of which coenzymes in your body?

(a) biotin, B12, tetrahydrofolate
(b) thiamine pyrophosphate, biotin, tetrahydrofolate
(c) pyridoxal phosphate, B12, tetrahydrofolate
(d) pyridoxal phosphate, thiamine pyrophosphate, biotin
(e) thiamine pyrophosphate, B12, tetrahydrofolate

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(16) Which of the following are correct reactions occurring during the Q cycle?

(i) $QH_2 \rightarrow FeS \rightarrow CytC_1 \rightarrow CytC$ Y
(ii) $QH_2 \rightarrow FeS \rightarrow CytC_1 \rightarrow Q$ N
(iii) $QH\cdot \rightarrow CytC_1 \rightarrow FeS \rightarrow CytC$ N
(iv) $QH\cdot \rightarrow FeS \rightarrow CytC_1 \rightarrow CytC$ N
(v) $QH\cdot \rightarrow CytB_L \rightarrow CytB_H \rightarrow Q$ Y
(vi) $QH\cdot \rightarrow CytB_L \rightarrow CytB_H \rightarrow QH\cdot$ Y
(vii) $QH_2 \rightarrow CytB_L \rightarrow CytB_H \rightarrow Q$ N
(viii) $QH_2 \rightarrow CytB_L \rightarrow CytB_H \rightarrow QH\cdot$ N

(a) (i), (iv), (v), and (vi)
(b) (ii), (iii), (vii), and (viii)
(c) (i), (v), and (vi)
(d) ~~(ii), (iii), (iv),~~ and (viii)
(e) (i), (iv), (vi), and (viii)

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(17) What is a correct sequence of electron transfer events involved in transferring electrons from NADH to molecular oxygen in the electron transfer chain? Note: Not every electron carrier in every complex is included (some are omitted)

(a) NADH → FMN → FeS → Q → FeS → CytC1 → CytC → CuA → CuB → O_2
(b) NADH → FeS → FMN → Q → FeS → CytC1 → CytC → CuA → CuB → O_2
(c) NADH → FMN → FeS → Q → $CytB_L$ → $CytB_H$ → CytC → CuA → CuB → O_2
(d) NADH → FMN → FeS → CytC → FeS → CytC1 → Q → CuA → CuB → O_2
(e) NADH → FMN → FeS → Q → $CytB_L$ → $CytB_H$ → CytC → CuB → CuA → O_2

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(18) Based on your knowledge of the reaction catalyzed by complex IV of the respiratory chain, which of the following is the best properly balanced "proton inventory" equation to describe what reaction complex IV catalyzes?

(a) $4CytC_{red} + O_2 + 6H^+_N \rightarrow 4CytC_{ox} + 2H_2O + 2H^+_P$
(b) $4CytC_{red} + O_2 + 8H^+_N \rightarrow 4CytC_{ox} + 2H_2O + 4H^+_P$
(c) $2CytC_{red} + O_2 + 4H^+_N \rightarrow 2CytC_{ox} + H_2O + 4H^+_P$
(d) $4CytC_{red} + O_2 + 4H^+_N \rightarrow 4CytC_{ox} + 2H_2O$
(e) $2CytC_{red} + 2O_2 + 8H^+_N \rightarrow 2CytC_{ox} + 2H_2O + 4H^+_P$

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(19) The transfer of two electrons from NADH to coenzyme Q pumps _(i)4_ protons; the synthesis of one ATP requires the movement of 3 (ii)__ protons through the ATP synthase, the transport of inorganic phosphate into the mitochondrial matrix requires movement of __(iii)_1 protons, and the transport of ADP and ATP between the matrix and intermembrane space requires the movement of ___(iv) 0 protons.

	(i)	(ii)	(iii)	(iv)
(a)	2	3	1	0
(b)	4	3	2	1
(c)	2	3	1	1
(d)	4	3	1	0
(e)	4	3	1	1

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(20) Electrons from cytosolically-produced NADH enter the electron transfer chain at proton pumping __(i)__ when the malate-aspartate shuttle is used and proton-pumping __(ii)___ when the glycerol-phosphate shuttle is used.

(a) (i), complex I; (ii), complex I
(b) (i), complex I; (ii), complex II
(c) (i) complex I; (ii), complex III
(d) (i) complex II; (ii) complex I
(e) (i), complex I; (ii), complex IV

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(21) The transporter that carries malate across the inner mitochondrial membrane also transports _________ , and the transporter that carries aspartate also transports _________.

(a) α-ketoglutarate; alanine
(b) glutamate; oxaloacetate
(c) oxaloacetate; glutamate
(d) glutamate; α-ketoglutarate
(e) α-ketoglutarate; glutamate

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(22) Of the following lists, which contains compounds that are ALL involved in the coupling of the citric acid and urea cycles?

(a) fumarate, malate, oxaloacetate, glutamate, aspartate
(b) fumarate, succinate, malate, glutamate, alpha-ketoglutarate
(c) succinate, malate, oxaloacetate, glutamate, aspartate
(d) fumarate, malate, oxaloacetate, glutamate, alpha-ketoglutarate
(e) both a and d are correct

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(23) What nitrogenous compounds directly enter the Urea cycle and donate their amino groups for urea synthesis?

(a) ammonia, aspartate
(b) carbamoyl phosphate, aspartate
(c) ammonia, glutamate
(d) carbamoyl phosphate, glutamate
(e) two ammonias

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(24) What effects will the following compounds have on the rate of ATP synthesis (no effect, slow down, stop completely) after several minutes exposure to isolated mitochondria oxidizing succinate? Compare each set of choices before choosing the best available answer.

(i) a protonophore
(ii) a potassium ionophore
(iii) rotenone (an inhibitor of complex I)
(iv) cyanide (inhibitor of complex IV)

	(i) protonophore	(ii) K^+ ionophore	(iii) rotenone	(iv) cyanide
(a)	stop	slow down	no effect	stop
(b)	slow down	no effect	no effect	stop
(c)	slow down	stop	stop	stop
(d)	stop	slow down	no effect	no effect
(e)	slow down	stop	stop	no effect

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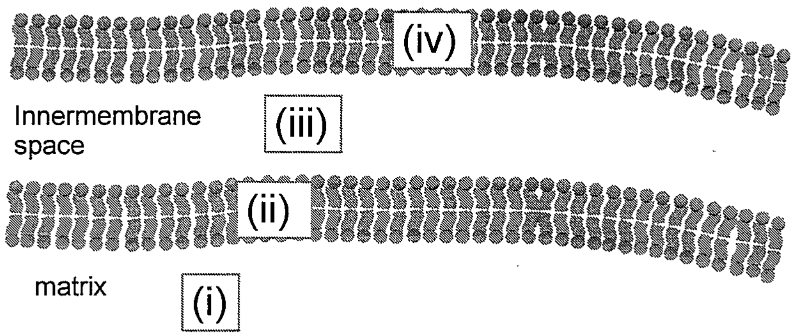
(25) The following is a representation of the portions of the mitochondrion important in respiration and oxidative phosphorylation. In which locations will the following components of these processes reside for proper catalysis to occur?

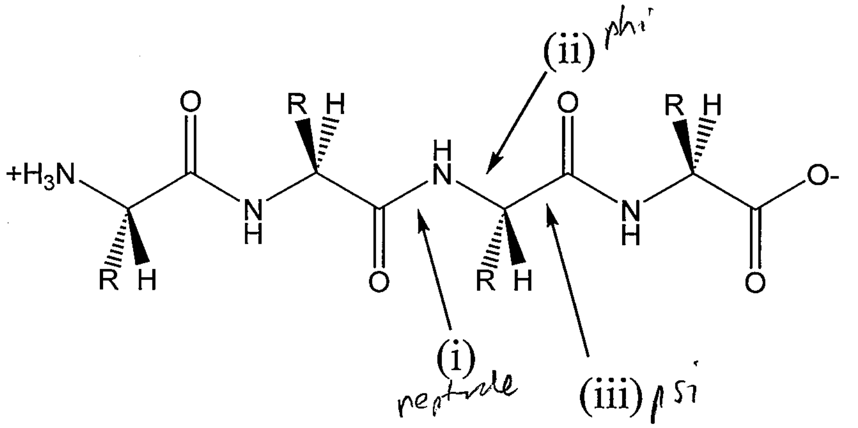


	NADH (i)	ubiquinone (ii)	Cytochrome C (iii)	ATP and ADP (i)	succinate (i)	adenine nucleotide translocase (ii)	Where H^+ move during ATP synthesis (i)
(a)	(i)	(ii)	(i)	(i)	(i)	(ii)	(iii)
(b)	(i)	(iv)	(iii)	(i)	(i)	(ii)	(i)
(c)	(i)	(iii)	(ii)	(i)	(i)	(iv)	(iii)
(d)	(i)	(ii)	(iii)	(i)	(i)	(ii)	(i)
(e)	(iii)	(iii)	(i)	(iii)	(i)	(iv)	(iii)

Name ____________________________

COMPREHENSIVE SECTION

(26) Name the bonds indicated by the arrows and associated numbers.



	peptide	phi	psi
(a)	(i)	(ii)	(iii)
(b)	(iii)	(ii)	(i)
(c)	(ii)	(iii)	(i)
(d)	(iii)	(i)	(ii)
(e)	(ii)	(i)	(iii)

(27) In an alpha helix, an intrachain hydrogen bond is formed between residue n and residue __(i)___; in a three-stranded beta sheet, how many hydrogen bonds are formed, on average, per amino acid residue on each outer strand __(ii)__?

	(i)	(ii)
(a)	n + 3	1
(b)	n + 4	1
(c)	n + 5	1
(d)	n + 3	2
(e)	n + 4	2

(28) Match the following levels of protein structure with the appropriate partner. (Write the correct letter next to the term in the left hand column).

i.	A regular, recurring arrangement in space of adjacent amino acid residues in a polypeptide chain 2°
ii.	spatial relationship between all amino acids in polypeptide; the 3-D structure of the polypeptide 3°
iii.	A simple combination of a few 2° elements with a specific geometric arrangement motif
iv.	a polypeptide chain or part of a polypeptide chain that can independently fold into a stable tertiary structure domain

	(i)	(ii)	(iii)	(iv)
(a)	Secondary	Domain	Motif	tertiary
(b)	Motif	tertiary	Domain	Domain
(c)	Secondary	Motif	tertiary	Domain
(d)	Motif	quaternary	tertiary	Secondary
(e)	Secondary	tertiary	Motif	Domain

Name ______________________

(29) Kinetic analysis of a homotetrameric enzyme of 200,000 molecular weight (that is the Mr of the α_4 tetramer) catalyzing conversion of substrate S to product P provides the following kinetic constants: V_{max} = 5,000 U when 1 mg of protein is assayed, and K_m = 0.050 mM. Assume each subunit contains an active site; i.e. there are four active sites per tetramer.
Calculate the catalytic efficiency (units of $M^{-1} \cdot s^{-1}$) of the enzyme on the basis of monomeric units (i.e. per active site).

$\left(\frac{5000\ \mu mol}{min \cdot mg}\right)\left(\frac{200,000\ mg}{mmole}\right)\left(\frac{mmol}{1000\ \mu mole}\right)\left(\frac{1\ min}{60\ s}\right)\left(\frac{1\ mol\ E}{4\ mol\ active\ sites}\right)$

(a) Catalytic efficiency = 5.0 x 10^9 $M^{-1} \cdot s^{-1}$
(b) Catalytic efficiency = 1.3 x 10^9 $M^{-1} \cdot s^{-1}$
(c) Catalytic efficiency = 3.3 x 10^8 $M^{-1} \cdot s^{-1}$
(d) Catalytic efficiency = 8.3 x 10^7 $M^{-1} \cdot s^{-1}$
(e) Catalytic efficiency = 3.3 x 10^5 $M^{-1} \cdot s^{-1}$

---

(30) Match the following properties with the appropriate amino acids. There is only one correct solution.

(i) posttranslationally modified by hydroxylation in collagen Pro
(ii) achiral amino acid Gly
(iii) crosslinks chains of alpha-keratin Cys
(iv) contains a side chain that might form a salt bridge with Lys at pH 7 Asp, Glu
(v) has a side chain containing a thioether group Met
(vi) has a side chain containing a guanidinium group Arg
(vii) absorbs significant UV light F Y W

	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)
(a)	Lys	Gly	Pro	Asp	Met	Asn	Phe
(b)	Pro	Gly	Cys	Glu	Met	Arg	Tyr
(c)	Cys	Gly	Pro	Asn	Cys	Arg	Tyr
(d)	Met	Ala	Cys	Asp	Cys	Asn	Ala
(e)	Pro	Pro	Lys	Glu	Met	Arg	Trp

---

(31) What are the average charges on the following amino acids at pH 7? "Mostly neutral" means that the net charge on a population of amino acids at the indicated pH rounds to "0" (one significant figure). "Mostly negative" means that the net charge on a population of amino acids at the indicated pH rounds to "-1" (one significant figure) or a value even more negative than -1. Mostly positive" means that the net charge on a population of amino acids at the indicated pH rounds to "+1" (one significant figure) or a value even more positive than +1.

	Asn	His	Glu	Lys
(a)	Mostly neutral	Mostly positive	Mostly negative	Mostly neutral
(b)	Mostly positive	Mostly positive	Mostly neutral	Mostly neutral
(c)	Mostly neutral	Mostly neutral	Mostly negative	Mostly positive
(d)	Mostly neutral	Mostly positive	Mostly negative	Mostly positive
(e)	Mostly positive	Mostly neutral	Mostly negative	Mostly positive

Name ______________________

(32) You have an aqueous 0.10 M solution of the amino acid histidine at pH 6.4. Determine the concentration of the protonated form of histidine in this solution.

(a) 0.028 M
~~(b) 0.040 M~~
(c) 0.060 M
(d) 0.072 M
(e) 0.090 M

$[HA] + [A^-] = 0.10$

$pH = pK_a + \log \frac{[A^-]}{[HA]}$ $\quad 6.4 = 6.0 + \log \frac{[A^-]}{[HA]}$

$\frac{[A^-]}{[HA]} = 10^{0.4} = 2.51$; $[A^-] = 2.51([HA])$

$[HA] + 2.51[HA] = 0.10$

$\boxed{[HA] = 0.028M}$

---

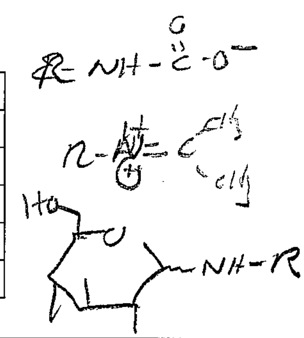
(33) The presence of a competitive inhibitor will ___(i) no affect___ V_{max} and ___(ii) increase___ K_m, while the presence of an uncompetitive inhibitor will ___dec___ V_{max} and ___dec___ K_m.

	(i)	(ii)	(iii)	(iv)
(a)	Not change	Increase	Decrease	Decrease
(b)	Not change	Increase	Increase	Decrease
(c)	Decrease	Increase	Decrease	Increase
(d)	Not change	Decrease	Decrease	Increase
(e)	Not change	Decrease	Decrease	Decrease

---

(34) The functional groups created by the reactions of the side chain of lysine with (i) CO_2, (ii) acetone and (iii) the C1 carbon of β-D-glucopyranose are, respectively:

	(i)	(ii)	(iii)
(a)	Carbamate	Schiff base	Amide
(b)	Amide	Schiff base	N-ether
(c)	Carbamate	Amide	Amide
(d)	Carbamate	Schiff base	N-ether
(e)	Amide	Schiff base	Amide



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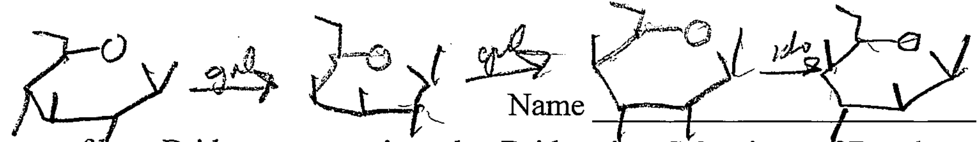
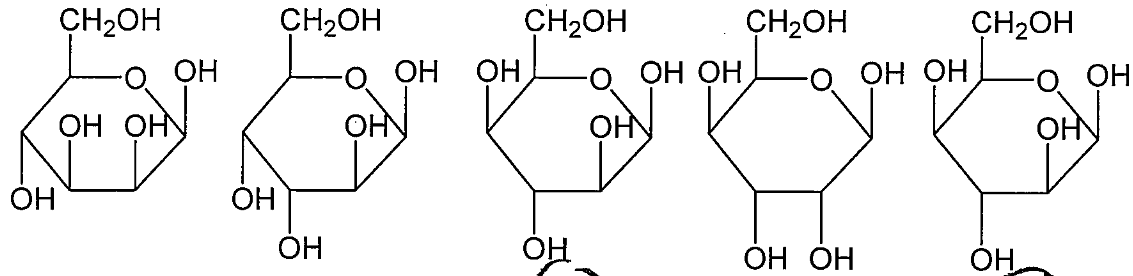
(35) What type of functional groups will be present at the indicated position of the following lipids?
(i) on C3 of glycerol in phosphatidylcholine PD
(ii) on C2 of glycerol in a triacylglycerol E
(iii) on C1 of sphingosine in sphingomyelin PD
(iv) on C2 of sphingosine in sphingomyelin A
(v) on C2 of glycerol in a glycerophospholipid E

	(i)	(ii)	(iii)	(iv)	(v)
(a)	phosphodiester	ester	phosphodiester	amide	ester
(b)	phosphodiester	ester	amide	phosphodiester	ester
(c)	ester	phosphodiester	alcohol	amide	phosphodiester
(d)	ester	ether	phosphodiester	amide	ester
(e)	phosphodiester	ester	amide	ester	ester



Name ____________________

(36) What is the structure of beta-D-idopyranose, given that D-idose is a C-2 epimer of D-gulose, D-gulose is a C-3 epimer of D-galactose, and D-galactose is a C-4 epimer of D-glucose.



(a) (b) (c) (d) (e)

C & e are same so either one is correct

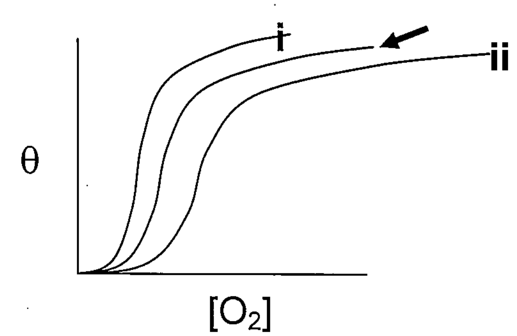
(37) Predict whether the formation of the following O-glycosidic linkages between two sugars would result in the production of a reducing or nonreducing disaccharide

(i) C1 of D-glucose and C1 of D-glucose	NR
(ii) C1 of D-glucose and C4 of D-glucose	R
(iii) C1 of D-glucose and C2 of D-fructose	NR
(iv) C1 of D-glucose and C1 of D-fructose	R

	(i)	(ii)	(iii)	(iv)
(a)	reducing	reducing	nonreducing	reducing
(b)	nonreducing	nonreducing	nonreducing	reducing
(c)	nonreducing	~~non~~reducing	reducing	nonreducing
(d)	reducing	nonreducing	reducing	nonreducing
(e)	nonreducing	reducing	nonreducing	reducing

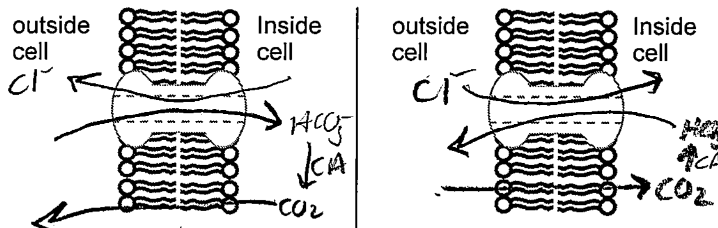
(38) (32) Given that the line indicated by the arrow corresponds to the normal hemoglobin O_2 dissociation curve at pH 7.6, which lines are consistent with the following change in conditions?

	Increase pH	Increase [DPG]	Increase [CO2]
(a)	(i)	(ii)	(i)
(b)	(ii)	(i)	(i)
(c)	(i)	(ii)	(ii)
(d)	(ii)	(ii)	(i)
(e)	(i)	(i)	(ii)



Name ___________________________

(39) In which direction are Cl^-, and HCO_3^- transported for the chloride-bicarbonate exchanger when red blood cells are in the following tissues, and in what direction does carbonic anhydrase (CA) operate within the cell?



(i) In erythrocyte in blood vessels in the lung

(ii) In erythrocyte in blood vessels in muscle tissue

	(i)	(ii)
(a)	HCO_3^- goes in, Cl^- goes out, CA converts HCO_3^- to CO_2	HCO_3^- goes out, Cl^- goes in, CA converts CO_2 to HCO_3^-
(b)	HCO_3^- goes out, Cl^- goes in, CA converts CO_2 to HCO_3^-	HCO_3^- goes in, Cl^- goes out, CA converts HCO_3^- to CO_2
(c)	HCO_3^- goes in, Cl^- goes out, CA converts CO_2 to HCO_3^-	HCO_3^- goes out, Cl^- goes in, CA converts HCO_3^- to CO_2
(d)	HCO_3^- goes out, Cl^- goes in, CA converts HCO_3^- to CO_2	HCO_3^- goes in, Cl^- goes out, CA converts CO_2 to HCO_3^-
(e)	HCO_3^- goes in, Cl^- goes out, CA converts HCO_3^- to CO_2	HCO_3^- goes out, Cl^- goes in, CA converts HCO_3^- to CO_2

---

lower pKa H_2O

(40) Regarding metal ion catalysis, the role of zinc ion in carbonic anhydrase is ___(i)_____, the role of zinc ion in alcohol dehydrogenase is ___(ii) Stab___ and the role of magnesium ion in a phosphatase is ___(iii) Shield___.

	(i)	(ii)	(iii)
(a)	Charge stabilization	Charge stabilization	Charge shielding
(b)	Lower pK_a of water	Charge stabilization	Charge shielding
(c)	Charge stabilization	Lower pK_a of water	Charge shielding
(d)	Lower pK_a of water	Charge shielding	Charge stabilization
(e)	Lower pK_a of water	Charge stabilization	Charge stabilization

---

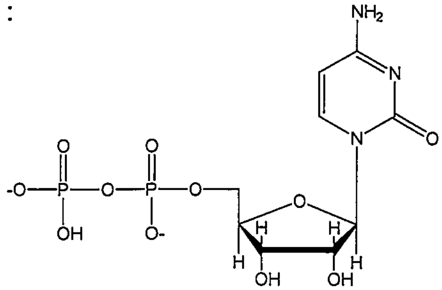
(41)In the reaction catalyzed by chymotrypsin, histidine first serves as a general base, then as a general acid, then as a general base, then as a general acid.

(a) base; base; acid; acid
(b) acid; acid; base; base
(c) acid; base; acid; base
(d) base; acid; base; acid
(e) base; acid; acid; base

Name ______________________________

(42) The compound shown below is correctly referred to by which three terms?

:



	(i)	(ii)	(iii)
(a)	Nucleoside diphosphate	Cytosine-~~5'-diphosphate~~	~~nucleoside~~
(b)	Nucleoside diphosphate	Cytosine~~-5'-diphosphate~~	nucleotide
(c)	~~Nucleotide diphosphate~~	Cytosine-~~5'-diphosphate~~	nucleotide
(d)	Nucleoside diphosphate	Cytidine-5'-diphosphate	nucleotide
(e)	~~Nucleotide diphosphate~~	Cytidine-5'-diphosphate	nucleotide

Glc $\downarrow$ = 2NADH + 2ATP net (4 made, 2 consumed)

2pyr

(43) The conversion of 1 mol of glucose to 6 mol of CO_2 via central metabolism also yields ___(i)__ mol of NADH, __(ii)___ mol of $FADH_2$ (or QH_2), __(iii)__ mol of ATP, and __(iv)___ mol of GTP.

Pyr $\downarrow$ = 1NADH

AcCoA

AcCoA $\downarrow$ = 3NADH, 1FADH, 1GTP

2CO2

	(i)	(ii)	(iii)	(iv)
(a)	10	2	4	2
(b)	8	2	2	2
(c)	10	2	2	2
(d)	8	4	4	2
(e)	8	4	2	1

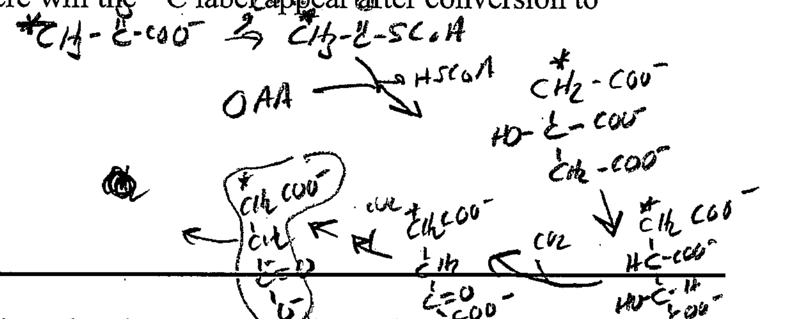
2 + 1(2) + 2(3) = 10NADH

2(1) = 2 FADH2

2(1) = 2GTP

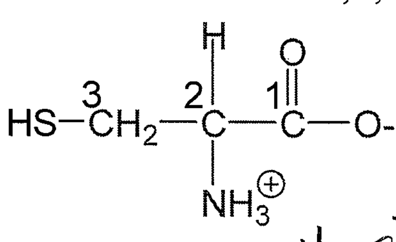
(44) If pyruvate labeled with ^{14}C at the C3 position is converted to oxaloacetate (OAA) via pyruvate dehydrogenase and the citric acid cycle, where will the ^{14}C label appear after conversion to oxaloacetate (one turn of citric acid cycle)?

(a) as CO_2
(b) C1 of OAA
(c) C2 of OAA
(d) C3 of OAA
(e) Both C2 and C3 of OAA

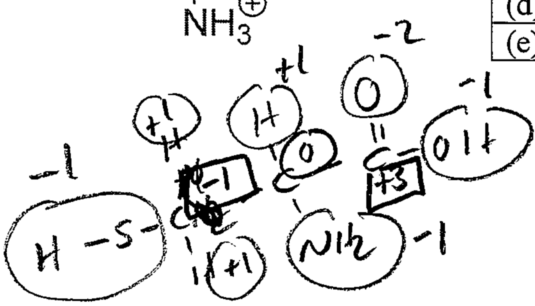


Succinate is symmetric, so C2 now is equiv to C3

(45) What are the oxidation states of the indicated carbon atoms on the molecule shown here (make sure to match the number 1, 2, and 3 properly):



	(1)	2)	(3)
(a)	+3	0	-1
(b)	+4	0	-1
(c)	+3	+1	0
(d)	+4	0	0
(e)	+3	+1	-1



Name ______________________

(46) Using information on the first page of the exam to guide you, calculate $\Delta G^{\circ\prime}$ for the reaction of 1 mol of ubiquinol (QH_2) with oxidized cytochrome c to produce one mol Q.

(a) ~~-57.7 kJ/mol~~
(b) -40.3 kJ/mol
(c) ~~+40.3 kJ/mol~~
(d) +57.7 kJ/mol
(e) +20.2 kJ/mol

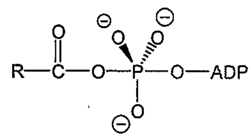
$2\,Cyt\,C_{ox} + 2e^- \rightarrow 2\,Cyt\,C_{red}$ $\varepsilon^{\circ\prime} = +0.254$

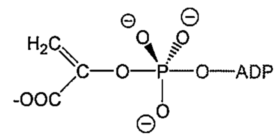
$QH_2 \rightarrow Q + 2H^+ + 2e^-$ $\varepsilon^{\circ\prime} = -0.045$

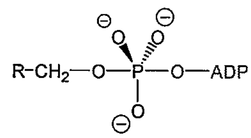
$2\,CytC_{ox} + QH_2 \rightarrow 2\,CytC_{red} + Q + 2H^+$ $\varepsilon^{\circ\prime} = 0.209V$

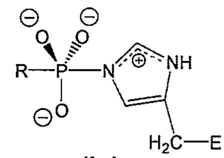
$\Delta G^{\circ} = (-2)(96.5)(0.209)$

(47) The following are pentavalent intermediates that might be formed in reactions of glycolysis or the citric acid cycle. For each one, name a specific enzyme where that intermediate would be formed.


(i)


(ii)


(iii)


(iv)

I accepted b, c, or e

OK for the form of SuccCoA syn that makes ATP.

So I will accept b, c, or e

	(i)	(ii)	(iii)	(iv)
(a)	Pyruvate ~~kinase~~	phospho~~glycero~~kinase	hexokinase	phosphoglyceromutase
(b)	phosphoglycerokinase	Pyruvate kinase	Phosphofructokinase	Succinyl-CoA synthetase
(c)	Succinyl-CoA synthetase	Pyruvate kinase	hexokinase	phosphoglyceromutase
(d)	hexo~~kinase~~	Pyruvate kinase	phosphoglycerokinase	phosphoglyceromutase
(e)	Both (b) and (c) are correct answers.			

all ok

(48) The following is a list of enzymes and mechanistic strategies they might employ. Which of the following matches correctly relates the enzymes and mechanisms?

Enzyme	Mechanistic strategy
phosphoglucoisomerase (i)	(i) cis-ene-diolate intermediate
aldolase (iv)	(ii) thiohemiacetal intermediate
Triose phosphate isomerase (i)	(iii) dehydration/rehydration
Glyceraldehyde-3-phosphate dehydrogenase (ii)	(iv) Schiff base adduct
aconitase (iii)	

	Phosphor-gluco-isomerase	aldolase	Triose phosphate isomerase	Glyceraldehyde 3-phosphate dehydrogenase	aconitase
(a)	(i)	(iv)	(i)	(ii)	(iii)
(b)	(i)	(i)	(iv)	(ii)	(iii)
(c)	(iii)	(iv)	(iii)	(ii)	(i)
(d)	(i)	(iv)	(iii)	(iv)	(ii)
(e)	(iv)	(i)	(iv)	(iii)	(ii)

Name ________________________

(49) Typical intracellular concentrations of ATP, ADP, and Pi in a bacterial cell are 5.0, 0.7, and 2.5 mM, respectively. What is the free energy of hydrolysis of ATP under these conditions (at 25 degrees Celsius). Recall R = 8.3144 J/mol/K and $\Delta G'^{\circ} = -30.5$ kJ/mol for ATP hydrolysis to ADP and Pi.

(a) -33.1 kJ/mol
(b) -10.8 kJ/mol
(c) -50.2 kJ/mol
(d) -27.9 kJ/mol
(e) -29.6 kJ/mol

$$\Delta G' = -30.5\frac{kJ}{mole} + \left(8.3144\frac{J}{mole\,K}\right)(298K)\left(\frac{KJ}{1000J}\right)\ln\frac{(0.7\times10^{-3})(2.5\times10^{-3})}{5.0\times10^{-3}}$$

---

(50) The regulatory cascade leading to glycogen breakdown in the liver follows what correct sequence of events?
(a) hormone-receptor binding, adenylate cyclase activation, G protein activation, protein kinase activation, phosphorylase kinase activation, glycogen phosphorylase activation
(b) hormone-receptor binding, G protein activation, protein kinase activation, adenylate cyclase activation, phosphorylase kinase activation, glycogen phosphorylase activation
(c) hormone-receptor binding, G protein activation, protein kinase activation, phosphorylase kinase activation, adenylate cyclase activation, glycogen phosphorylase activation
(d) hormone-receptor binding, G protein activation, adenylate cyclase activation, protein kinase activation, phosphorylase kinase activation, glycogen phosphorylase activation
(e) hormone-receptor binding, phosphorylase kinase activation, G protein activation, adenylate cyclase activation, protein kinase activation, glycogen phosphorylase activation