 Name key

Biochemistry 5700
Fall, 2011
Exam 3

INSTRUCTIONS:
Do not begin until 10:30 AM. The exam must be turned in by 11:20 AM.

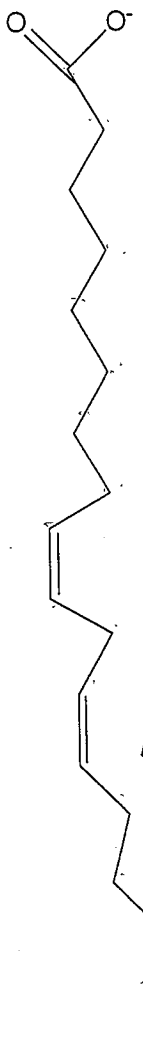
Equations: $\Delta G = \Delta G^{o\prime} + RT \ln Q$ $\Delta E = \Delta E^{o\prime} - \frac{RT}{nF} \ln Q$ $\Delta G' = -nFE'$

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

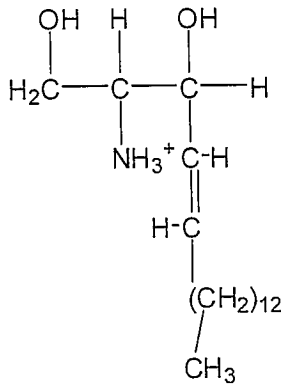
Reduction potentials (biochemical standard state) for important biological redox pairs	
Half reaction	Reduction potential (E´°), V
½ O_2 + $2H^+$ + $2e^-$ → H_2O	0.816
clV cytochrome a (Fe^{3+}) + e- → clV cytochrome a (Fe^{2+})	0.29
cytochrome c (Fe^{3+}) + e^-→ cytochrome c (Fe^{2+})	0.254
clll cytochrome c1 (Fe^{3+}) + e- → clll cytochrome c1 (Fe^{2+})	0.22
ubiquinone + $2H^+$ + $2e^-$ → ubiquinol	0.045
Fumarate2- + $2H^+$ + $2e^-$ → $succinate^{2-}$	0.031
$Oxaloacetate^{2-}$ + $2H^+$ + $2e^-$ → $malate^{2-}$	-0.166
$pyruvate^-$ + $2H^+$ + $2e^-$ → $lactate^-$	-0.185
acetaldehyde + $2H^+$ + $2e^-$ → ethanol	-0.197
FAD (free) + $2H^+$ + $2e^-$ → $FADH_2$ (free)	-0.219
$Glutathione_{ox}$ (GSSG) + $2H^+$ + $2e^-$ → 2 $glutathione_{red}$ (2GSH)	-0.23
Lipoic acid + $2H^+$ + $2e^-$ → dihydrolipoic acid	-0.29
cl FMN + $2H^+$ + $2e^-$ → cl $FMNH_2$	-0.30
NAD^+ + H^+ + $2e^-$ → NADH	-0.320
$NADP^+$ + H^+ + $2e^-$ → NADPH	-0.324
$Acetoacetate^{2-}$ + $2H^+$ + $2e^-$ →β-$hydroxybutyrate^{2-}$	-0.346
α-ketoglutarate + CO_2 + $2H^+$ + $2e^-$ →isocitrate	-0.38
$2H^+$ + $2e^-$ → H_2O (biochemical standard conditions)	-0.414
ferredoxin (Fe^{3+}) + e^-→ ferredoxin (Fe^{2+})	-0.432

 Name _____

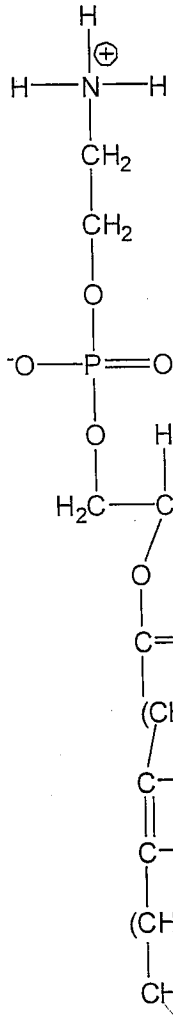
(1) (7 points) Provide proper names for each of the molecules shown below. Be sure each name is complete and unambiguous.



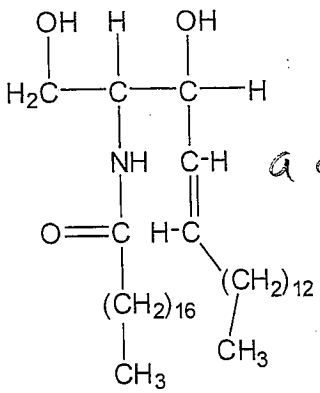
linoleic acid



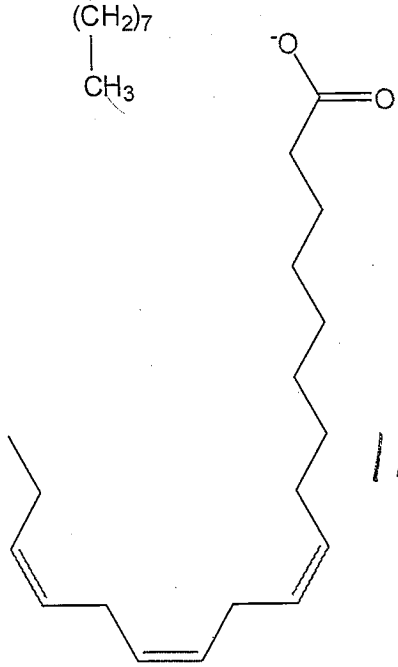
sphingosine



1-palmitoyl-2-oleoyl-3-phosphatidylethanol amine



a ceramide w/ stearic acid at C2



linolenic acid

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 Name _____

(2) (3 points) When relatively large concentrations of fatty acids are placed in aqueous solution they form structures called micelles; when relatively large concentrations of spingolipids are placed in aqueous solution they form structures called liposomes. When relatively large concentrations of ~~aqueos~~ triacylglycerols are placed in solution they form structures called aggregates, droplets (insoluble) 3

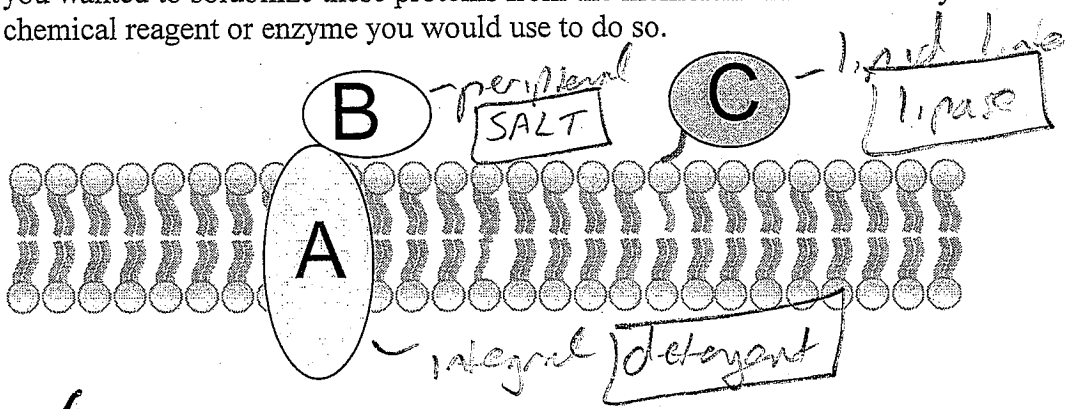
(3) (2 points) The addition of more unsaturated fatty acids to a lipid bilayer will decrease the transition temperature; The addition of more long chain fatty acids to a lipid bilayer will increase the transition temperature. T.T ≈ "melting point" 2

(4) (6 points) Briefly explain how cholesterol helps maintain membrane fluidity both above and below the transition temperature.

Above - serves as a "wedge" to restrict fatty acid tail rotation that would otherwise cause membrane to fall apart

Below - prevents close packing & associated van der Waals attractions between adjacent FA tails on PCL, making membrane more fluid 6

(5) (6 points) What types of membrane proteins are shown below? Identify them by letter. Suppose you wanted to solubilize these proteins from the membrane in a cell free lysate. Provide the name of a chemical reagent or enzyme you would use to do so.



6

(6) (6 points) What is a hydropathy plot, how is it constructed, and how is it used to identify transmembrane spanning domains in integral membrane proteins?

A plot of the relative hydrophobicity of segments of a polypeptide vs segment number. Hydrophobicity (HP) is calculated by summing individual HP values for amino acid side chains in a defined segment length (5-15 residues). Hydrophobic side chains have (+) ΔG° values while hydrophilic side chains have (-) values. Segments in the plot for the membrane region of a 18-22 AA in length, would correspond to transmembrane α-helices, ~10 residues might be a β strand 6

23

good student answ

(2) (3 points) When relatively large concentrations of fatty acids are placed in aqueous solution they form structures called micelle; when relatively large concentrations of spingolipids are placed in aqueous solution they form structures called lipid bilayers. When relatively large concentrations of ~~aqueos~~ aqueous triacylglycerols are placed in solution they form structures called globulals. 3

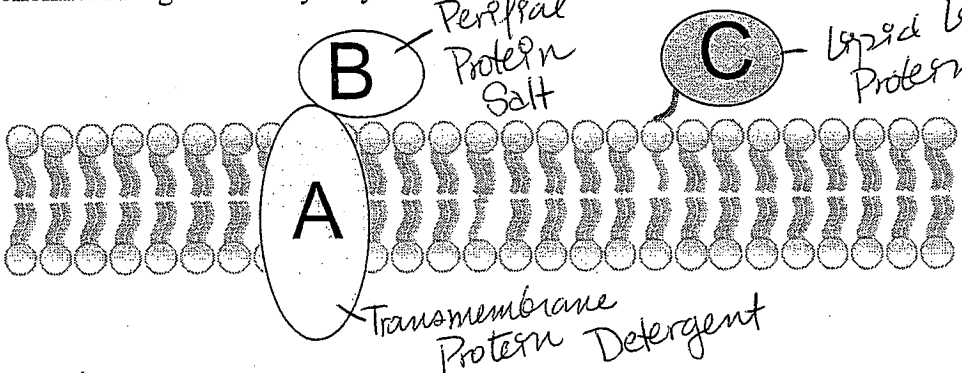
(3) (2 points) The addition of more unsaturated fatty acids to a lipid bilayer will lower the transition temperature; The addition of more long chain fatty acids to a lipid bilayer will raise the transition temperature. 2

(4) (6 points) Briefly explain how cholesterol helps maintain membrane fluidity both above and below the transition temperature.

Cholesterol interrupts the interactions between fatty acid chains - thus allowing it to maintain fluidity at lower levels.

Cholesterol reduces movement of the fatty acid tails at higher temperatures thus keeping the membrane together at higher temperatures. 6

(5) (6 points) What types of membrane proteins are shown below? Identify them by letter. Suppose you wanted to solubilize these proteins from the membrane in a cell free lysate. Provide the name of a chemical reagent or enzyme you would use to do so.



6

(6) (8 points) What is a hydropathy plot, how is it constructed, and how is it used to identify transmembrane spanning domains in integral membrane proteins? 6

a hydropathy plot is developed by adding the hydrophobicity numbers of the AA's in groups. Then you plot the hydrophobicity numbers & the plot is used to identify the transmembrane spanning domains bc those ares will be more hydrophobic - have a positive number on the plot, & be 18-22 AAs long.

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Good student answer

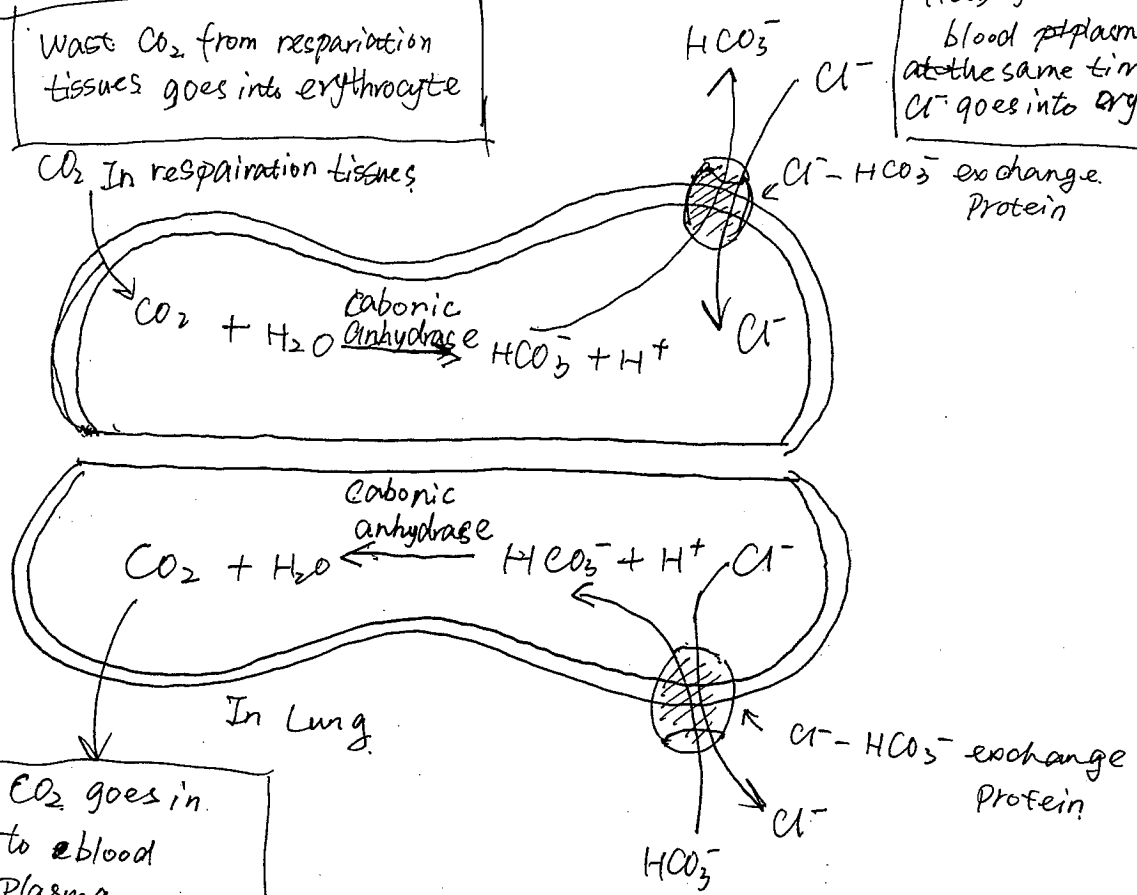
 Name _____

(7) 12 points. Membrane transport. Answer either of the following questions in the space provided. You choose which question to answer. ANSWER ONLY ONE OF THEM! Feel free to use diagram(s) to assist in answeringthe question

Option 1: Provide a detailed description of the transporter mechanism employed to transport Na^+ out of cells and K^+ in. Name the transporter. What is the purpose of this transporter?

Option 2: Provide a detailed description of how CO_2 produced in the tissue is processed and exported to the lung where it is expelled in your breath. In answering this question be sure and explain what transporter(s) and/or enzyme(s) participate in this process, and what they do.

option 2: Waste CO_2 from respiration tissues goes into erythrocyte



CO_2 goes in to blood Plasma and is exhaled

HCO_3^- reenter erythrocyte in Lung From blood plasma, at the same time, $Cl^- - HCO_3^-$ exchange protein transport Cl^- out of erythrocyte

$Cl^- - HCO_3^-$ exchange protein is a antiport what can transport Cl^- and HCO_3^- in different direction.

12

Good student answer

 Name _____

(7) 12 points. Membrane transport. Answer either of the following questions in the space provided. You choose which question to answer. ANSWER ONLY ONE OF THEM! Feel free to use diagram(s) to assist in answeringthe question

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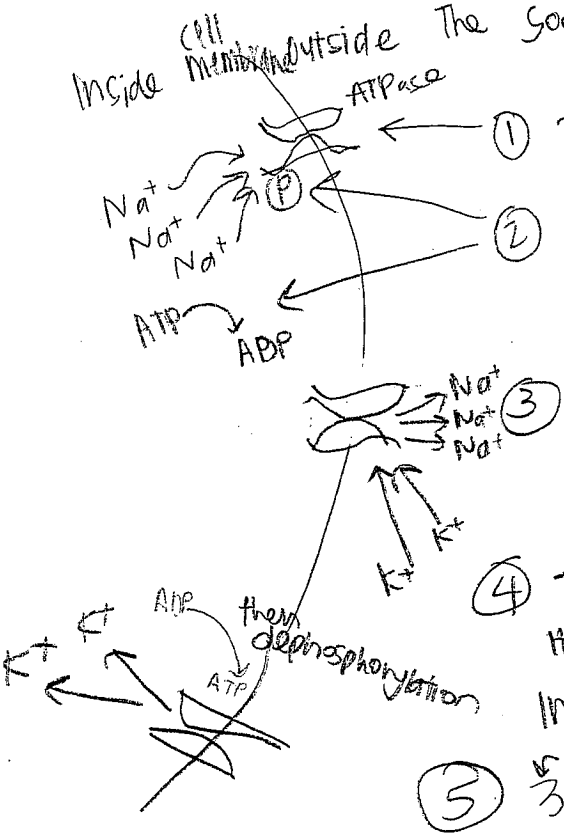

The Sodium/potassium ATPase is employed. Na^+/K^+ ATPase This is 1° active transport.

① 3 Na^+ bind the transporter

② ATP is converted to ADP as a phosphate is transported/attached to the transporter. This induces a conformational change in the transporter

③ The 3 Na^+ are released from the transporter
2 K^+ bind the transporter
This happens in ECF

④ The transporter releases the phosphate, transforming it back to ADP → ATP.
Induces a conformational change in transporter

⑤ $\frac{2}{3}$(2) K^+ are then released INTO the ICF.

This transporter establishes a net neg charge in the cell, referred to as the resting membrane potential. This gradient can then serve as a gradient for 2° active transport or cell signaling processes, or action potential processing

12

Good student answer

 Name

(7) 12 points. Membrane transport. Answer either of the following questions in the space provided. You choose which question to answer. ANSWER ONLY ONE OF THEM! Feel free to use diagram(s) to assist in answeringthe question

Option 1: Provide a detailed description of the transporter mechanism employed to transport Na^+ out of cells and K^+ in. Name the transporter. What is the purpose of this transporter?

Option 2: Provide a detailed description of how CO_2 produced in the tissue is processed and exported to the lung where it is expelled in your breath. In answering this question be sure and explain what transporter(s) and/or enzyme(s) participate in this process, and what they do.

Option 1:

The transporter that is used to transport Na+ out of cells and K+ in is called the sodium/potassium pump or Na+/K+ ATPase. It is a primary active antiporter that helps the cell create a negative potential inside of its membrane, by transfering 3 Na+ out of the cell (3 (+) charge leaving) and 2 K+ into the cell (2 (+) charge entering). It is driven by the free energy given off when ATP is broken down into ADP and Pi.

The process of transportation will start with the Na+ ions binding to the transporter. Phosphomylation of ATP will occur and will induce a conformational change in the transporter. The Na+ ions will now be released to the outside of the cell and two K+ ions will attach to the transporter. The phosphomylation will be reversed and the transporter will go back to its original conformation. The K+ ions will be released to the inside of the cell.

About 25% of all of the energy we consume goes towards making this pump function. This suggests that the concentration gradients created by this transporter are important and can be used to drive other transporters.

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 Name _____

6

(8) (4 points) Match the following transporter properties with the type of transporter. There may be more than one correct match for each.

(i) transport from high solute side to low solute side
(ii) transport from low solute side to high solute side
(iii) requires energy of ATP hydrolysis
(iv) requires light energy
(v) exhibits saturation kinetics for substrate
(vi) does not exhibit saturation kinetics for substrate
(vii) synport
(viii) antiport
(ix) uniport
(x) requires coordinated action of a primary active transporter

6

(a) glucose permease (i), (v) (ix)

(b) bacteriorhodopsin (ii), (iv) (v) (ix)

(c) lactose permease (i) (ii), (v), (x) (vii)

(d) potassium ion channel (i) (vi) (ix), (x) is ok but not required

(9) (4 points) Name the type of organism that uses the following growth modes.

Carbohydrate	Organism name
Light energy, glucose as carbon source	photoheterotroph
Energy source = hydrogen gas, CO_2 is carbon source	chemoauto "
Energy and carbon source is fructose	chemohetero "
Light energy, CO_2 is carbon source	photoauto "

4

(10) (2 points) Circle the correct term (e.g. either convergent or divergent) from the underlined choices to complete the sentences. In general, catabolic pathways are **convergent/divergent** and anabolic pathways are **convergent/divergent.**

2

11. (4 points) Circle ALL of the following features that can contribute to providing a large free energy of hydrolysis for a "high energy" compound.

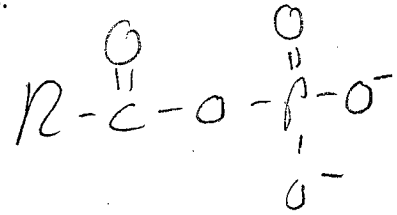
a. electrostatic repulsion present in the substrate
b. a low activation energy barrier for the conversion of substrate to product(s)
c. a high activation energy barrier for the conversion of substrate to product(s)
d. increased solvation of products vs. substrate
e. more resonance forms in the products than reactant
f. less resonance forms in the products than reactant
g. ionization of the immediate product(s) of hydrolysis

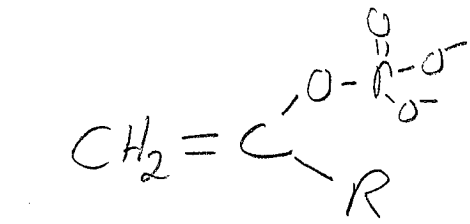
4

16

-6 Name _____

12. (6 points) Draw the general structures for an (a) acyl phosphate, (b) enolphosphate, and (c) phosphoguanidine.

(a) 

(b) 

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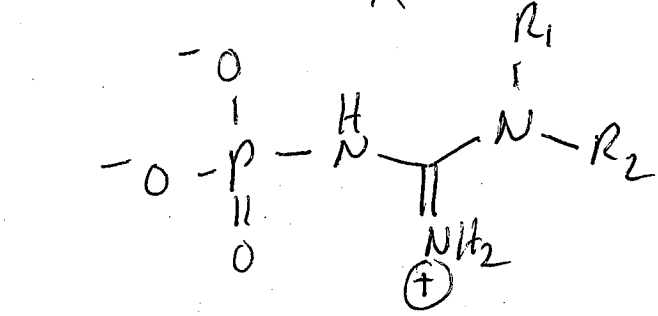
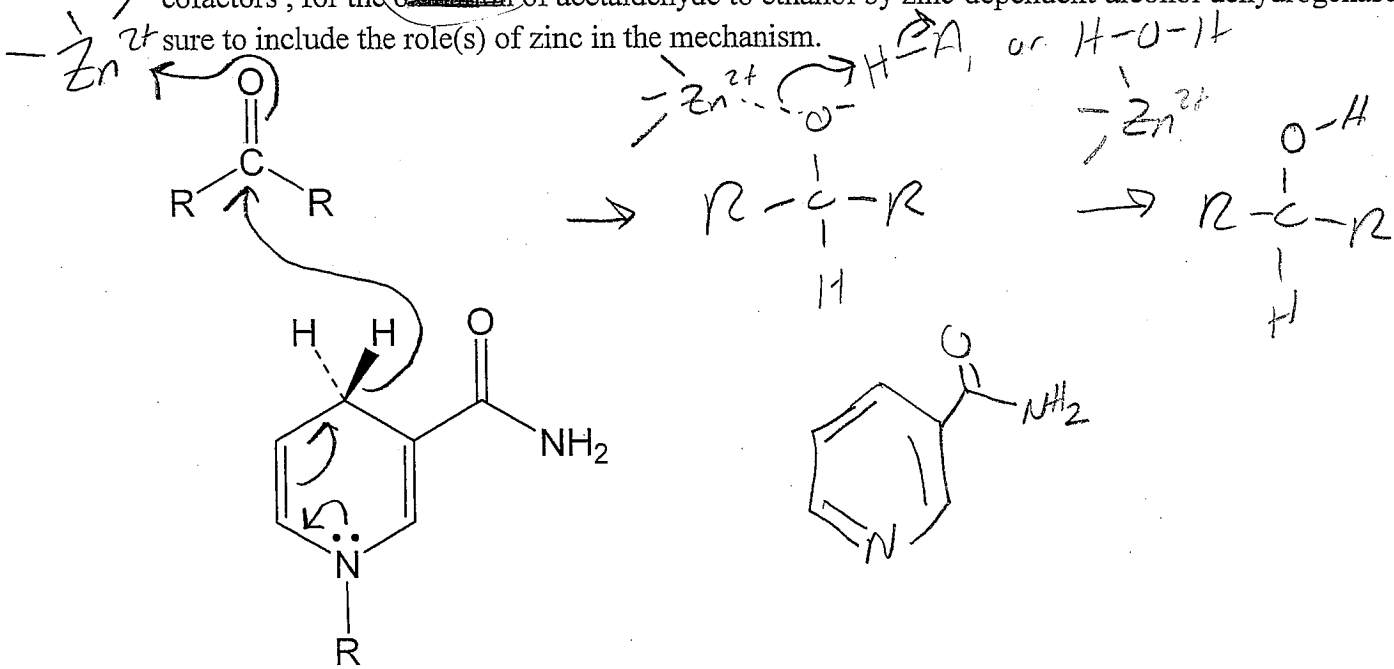
(c) 

note how it is related to the guanidinium functional group in arginine

13. (6 points) Complete the reaction mechanism, with all necessary electron pushing arrows and cofactors , for the reduction of acetaldehyde to ethanol by zinc-dependent alcohol dehydrogenase. Be sure to include the role(s) of zinc in the mechanism.



6

12

Name _____

(14) (18 points) You derive a significant amount of energy by oxidizing the membrane-bound electron carrier ubiquinol to ubiquinone, with the electrons ultimately being transferred to molecular oxygen. Use information on the first page of the exam to guide you in answering this question. 3

(a) Write the balanced chemical equation for the reduction of one molecular oxygen by ubiquinol. 5

(b) calculate E°′ for the reaction of ubiquinol and O_2 that you balanced in (a). 5

(c) Determine ΔG°′ for the reaction in (a).

(d) Given that the energy of hydrolysis of ATP is -30.5 kJ/mol, how many ATP, in theory, could be synthesized under standard biochemical conditions from the energy derived from the reaction you balanced in (a). 5

$O_2 + 4H^+ + 4e^- \rightarrow 2H_2O$ +0.816V

2 Ubiquinol $\rightarrow$ 2 Ubiquinone + $4H^+ + 4e^-$ −0.045V

(a) 2 Ubiquinol + $O_2 \rightarrow 2H_2O$ + 2 Ubiquinone 3pts

$E^{o\prime} = 0.771V$

5pts b) $E^{o\prime} = +0.771V$

(c) $\Delta G^{o\prime} = -nFE^{o\prime} = -(4)\left(96.5\frac{kJ}{V \cdot mol}\right)(+0.771V)$

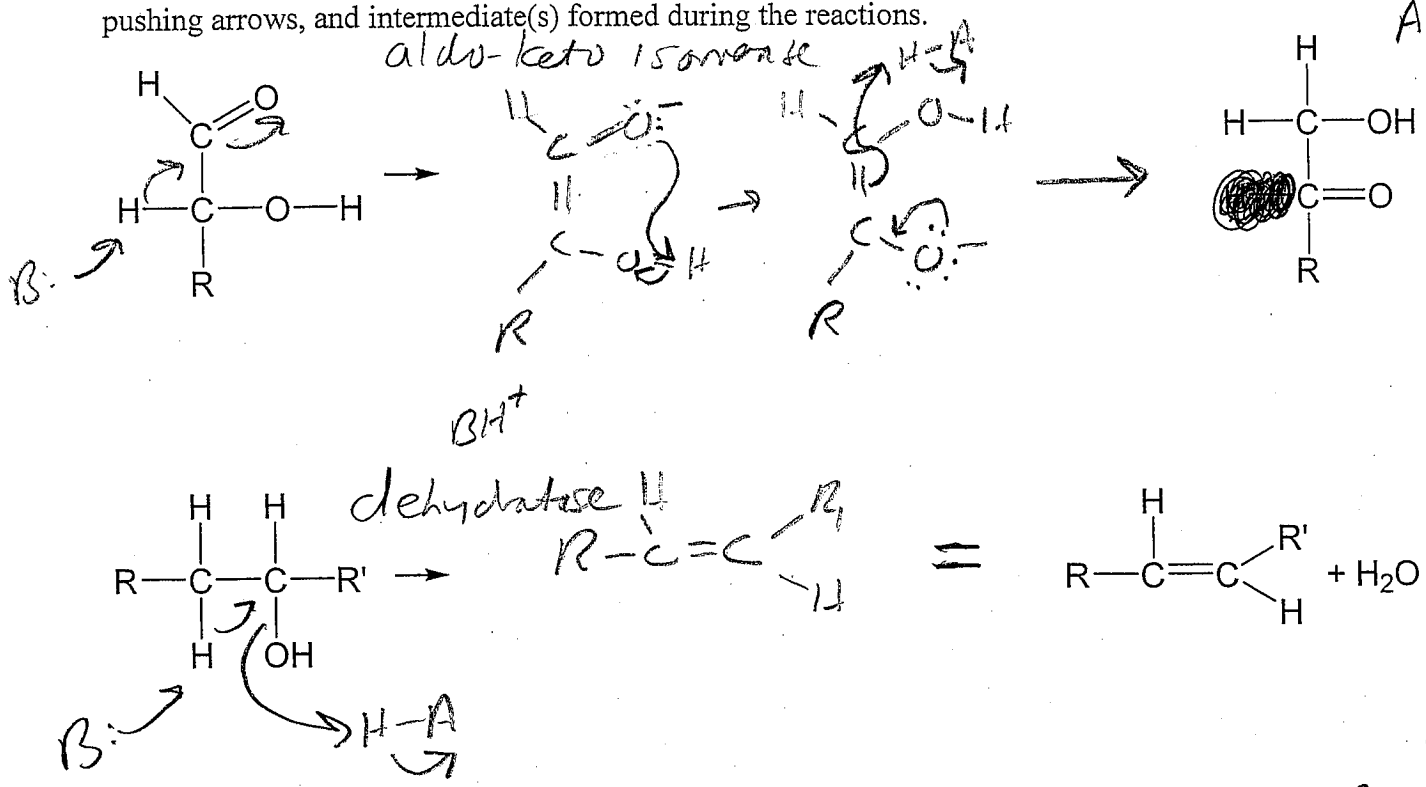
$\Delta G^{o\prime} = -297.6\frac{kJ}{mol}$

(d) $\frac{-297.6\ kJ / mol\ O_2}{-30.5\ kJ / mol\ ATP} = \boxed{9.76\ \frac{mol\ ATP}{mol\ O_2}}$

18

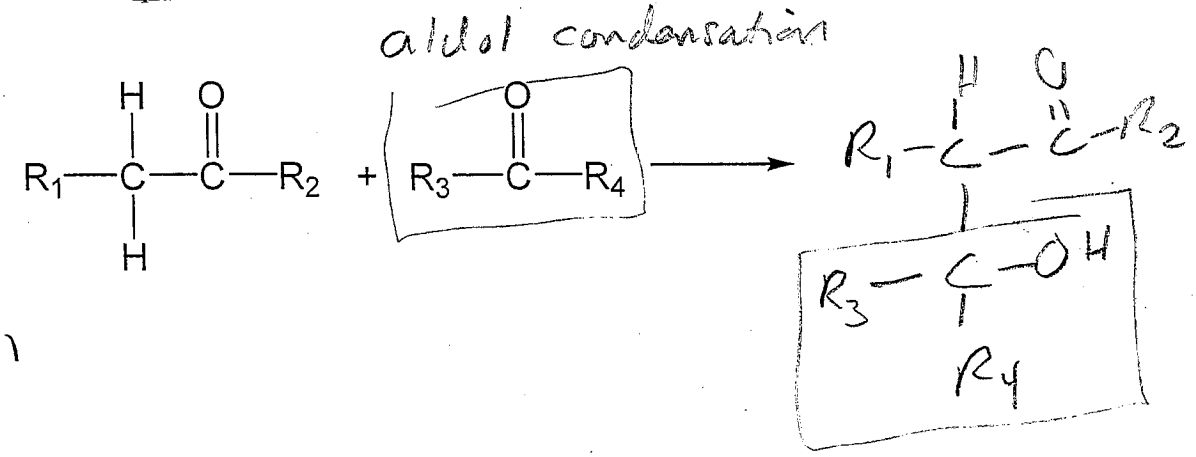
 Name _____

(15) (8 points) Name the general type of enzyme that would catalyze the two transformations shown below. Then, complete the reaction mechanisms by adding all necessary general acids, bases, electron pushing arrows, and intermediate(s) formed during the reactions.



8

(16) (4 points) What general type of enzymatic transformation will occur in the reaction shown below? Draw the product of the reaction, but DO NOT write the reaction mechanism.



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