Name ______________________________

Chem 352 - Spring 2015 - Exam III

Use constants: Ideal gas law constant, R = 0.08206 (l•atm)/(mol•K) = 8.314 (J/(mol•K); Faraday's constant, $\mathscr{F}$= 9.659 x 10^4 J/(V•mol); Planck's constant, h = 6.626 x 10^{-34} J•s.

1. Describe the metabolic purpose for each of the following pathways:
   a. Gluconeogenesis:

   b. The citric acid cycle, when material enters the cycle as Acetyl-CoA:

   c. The alcohol fermentation pathway:

   d. Glycolysis:

   e. The citric acid cycle, when material enters the cycle as oxaloacetate:

   f. The oxidative phase of the pentose-phosphate pathway:

2. The light reactions of photosynthesis and the electron transport chain in plants share many common features.
   a. Identify the components of each that fit the following descriptions:

	Electron Transport Chain	Photosynthesis
The initial donor of electrons		
The final acceptor of electrons		
The mobile 1-electron carrier involved in the Q cycle		
The mobile 2-electron carrier involved in the Q cycle		
The name of the complex that is site of the Q-cycle		
Cellular location of each in eukaryotes		

Reduction half-reaction	$E°'$ (V)
Acetyl CoA + CO_2 + $H^{\oplus}$ + $2e^{\ominus}$ → Pyruvate + CoA	−0.48
Ferredoxin (spinach). Fe^{3+} + $e^{\ominus}$ → Fe^{2+}	−0.43
2 $H^{\oplus}$ + $2e^{\ominus}$ → H_2 (at pH 7.0)	−0.42
α-Ketoglutarate + CO_2 + 2 $H^{\oplus}$ + $2e^{\ominus}$ → Isocitrate	−0.38
Lipoyl dehydrogenase (FAD) + 2 $H^{\oplus}$ + $2e^{\ominus}$ → Lipoyl dehydrogenase ($FADH_2$)	−0.34
$NADP^{\oplus}$ + $H^{\oplus}$ + $2e^{\ominus}$ → NADPH	−0.32
$NAD^{\oplus}$ + $H^{\oplus}$ + $2e^{\ominus}$ → NADH	−0.32
Ubiquinone (Q) + 2 $H^{\oplus}$ + $2e^{\ominus}$ → QH_2	0.04
Cytochrome *c*, Fe^{3+} + $e^{\ominus}$ → Fe^{2+}	0.23
Plastocyanin, Cu^{2+} + $e^{\ominus}$ → Cu^{+}	0.37
$NO_3^{\ominus}$ + 2 $H^{\oplus}$ + $2e^{\ominus}$ → $NO_2^{\ominus}$ + H_2O	0.42
Photosystem I (P700)	0.43
Fe^{3+} + $e^{\ominus}$ → Fe^{2+}	0.77
$\frac{1}{2}O_2$ + 2 $H^{\oplus}$ + $2e^{\ominus}$ → H_2O	0.82
Photosystem II (P680)	1.1

3. Photosystem II (P680) in plants receives two electrons from a water molecule and uses light energy (photons) to use these electrons to reduce an oxidized plastoquinone molecule (PQ).

   a. Write the *net reaction equation* for the reduction of one PQ by one H_2O.

   b. Using the appropriate reduction potentials provided in the table above, calculate the minimum light energy required to drive this reaction under standard condition? You may assume that plastoquinone has the same reduction potential as ubiquinone
   $\Delta G°'$=________________________

   c. The reduced plastoquinone (PQH_2) produced by PSII is subsequently used to reduce two plastocyanin molecules. Write the *net reaction equation* for this reaction.

   d. Using the appropriate reduction potentials provided in the table above, calculate the standard free energy change for this reaction?
   $\Delta G°'$=________________________

4. Describe the biochemical role played by NADPH + H^+?

   a. Write a *balanced chemical reaction equation* for one example of a reaction in which NADPH + H^+ is produced. *Use structural formulas* for the intermediates involved.

   b. What metabolic pathway does your chosen reaction belong to?
   ____

   c. Write a *balanced chemical reaction equation* for one example of a reaction which uses NADPH + H^+. *Use structural formulas* for the intermediates involved.

   d. What metabolic pathway does your chosen example belong to?
   ____

5. The citric acid cycle, along with the pyruvate dehydrogenase reaction, play a big role in the oxidation of the glucose to CO_2 and H_2O ($C_6H_{12}O_6 + 6\ O_2 \rightarrow 6CO_2 + 6\ H_2O$). In this net reaction the carbon atoms from the glucose are oxidized to CO_2 while the hydrogen atoms are oxidized to H_2O.
   a. While the CO_2 molecules produced in the overall oxidation of glucose are released in the pyruvate dehydrogenase reaction, along with reactions in the citric acid cycle, molecular oxygen (O_2) is not used as the oxidizing agent in these reactions. What oxidizing agents are used instead in these reactions? ____
   b. After theses oxidizing agents are reduced in the pyruvate dehydrogenase and citric acid cycle reactions, where are they reoxidized, and what oxidizing agent is used to reoxidize them?

c. Pick one of the three reactions among pyruvate dehydrogenation and the reactions in the citric acid cycle in which both CO_2 is produced and an oxidation occurs, and *using structural formulas* for the intermediates, write a balanced chemical reaction equation for the reaction you have chosen. Also, label the intermediates and give the name of the enzyme involved.
Enzyme Name ________________________________
Reaction Equation:

d. The citric acid cycle also contains two addition oxidation reactions, which are *not coupled* to the release of CO_2. *Using structural formulas* for the intermediates, write a balanced chemical reaction equation for one of these. Also, label the intermediates and give the name of the enzyme involved.
Enzyme Name ________________________________
Reaction Equation:

e. While glycolysis contains more reaction steps than the pyruvate dehydrogenase reaction and citric acid cycle combined, only one of these is an oxidation reaction. *Using structural formulas* for the intermediates, write a balanced chemical reaction equation for this one reaction. Also, label the intermediates and give the name of the enzyme involved.
Enzyme Name ________________________________
Reaction Equation:

f. In the absence of, or ability to use molecular oxygen, describe the two options that organisms have for reoxidizing the oxidizing agent that is used in glycolysis.

6. Describe what the Cori cycle is

7. There are three reactions in glycolysis that are under allosteric regulation. Name two of these using their enzyme names and indicate at least one metabolite that regulates each allosterically. Also indicate the cellular condition that the regulation is responding to.

Enzyme Name	Allosteric Regulator	Activator or Inhibitor	Cellular Condition