Name ______________________________

Chem 352 - Fall 2018 - 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 oxaloacetate:

   c. The lactic acid fermentation pathway:

   d. Glycolysis:

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

   f. The reductive 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:

	Photosynthesis	Electron Transport Chain
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 I (P700) in plants receives an electron from a plastocyanin molecule and uses light energy (photons) to give this electron enough energy to reduce a ferredoxin molecule.

   a. Write the *net reaction equation* for the reduction of one ferredoxin molecule by one plastocyanin molecule.

   b. Using the appropriate reduction potentials provided in the table above, calculate the minimum light energy required to drive this reaction under standard condition?
   $\Delta G°'$=________________________

   c. Two reduced ferredoxin molecules produced by PSI can be subsequently used to reduce an $NADP^+$ to NADPH + H^+. 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. Nicotinamide adenine dinucleotide (NAD^+) is one of the coenzymes commonly used by oxidoreductases.
   a. Describe the biochemical role played by NAD^+?

   b. *Using structural formulas,* write a balanced chemical reaction equation for one example of a reaction in which NAD^+ is used as the oxidizing agent.
      Enzyme Name ___________________________
      Reaction Equation:

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

   d. *Using structural formulas,* write a balanced chemical reaction equation for one example of a reaction in which $NADH+H^+$ is used as the reducing agent.
      Enzyme Name ____
      Reaction Equation:

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

5. Pyruvate represents a crossroads in metabolism where a number of metabolic pathways intersect. For example, it is the end product of the breakdown of glucose in glycolysis, it is produced in the liver from lactate in the Cori cycle, and in protein degradation, it is just one reaction away from the amino acid alanine. Pyruvate is also the starting point for a number of anabolic pathways
   a. *Using structural formulas*, write a balanced chemical reaction equation for the first reaction leading from pyruvate to the synthesis of a fatty acid.
      Enzyme Name __________________________________
      Reaction Equation:

b. *Using structural formulas*, write a balanced chemical reaction equation for the first reaction leading from pyruvate to the synthesis of a glucose in the liver.
Enzyme Name ________________________________
Reaction Equation:

6. The pentose phosphate pathway has both oxidative and non-oxidative phases.
   a. *Using structural formulas*, sketch out the three reactions that comprise the *oxidative phase* of the pentose phosphate pathway.

   b. Discuss the purpose of each phase and describe how they can be used in conjunction with glycolysis and gluconeogenesis to meet various needs for the cell.

7. Then enzyme phosphofructokinase 1 (PFK-1) catalyzes the first committed step in glycolysis and is therefore regulated by a number of allosteric effectors. Identify whether each of the following allosteric effectors for PFK-1 activates or inhibits PFK-1 activity. Also indicate the cellular or systemic conditions that each is signaling:
   a. Citrate:

   b. 2,6-bisphosphofructose

8. Extra Credit:
   a. Ask the one question that you wanted me to ask, but I did not ask. (Up to 2 points will be awarded for an insightful, probing and well-worded question.)

   b. Answer the question you posed in part 1. (Up to 1 point will be awarded for answering your question correctly.)