Chemistry/Biology 260 Final Exam

Name: _____

1.) **Hormonal Regulation** (25 pts)
Imagine that a lion has just leapt into the room! Wisely, you decide to run. Unfortunately for you, the lion decides to chase you. One minute into this ordeal:

i) your skeletal muscle cells will be utilizing the _____ pathway as their primary source of ATP. (2 pts)

ii) your hepatic cells will be undergoing _____ as their major metabolic pathway. (2 pts)

iii) your veins contain the hormone _____ which has lead to these biochemical changes from the resting state within your body. (3 pts)

iv) the signaling cascade generated by the above mentioned hormone utilizes cAMP as a second messenger. Describe in molecular detail the steps between hormone release into the blood and generation of cAMP. (10 pts)

v) as the [cAMP] increases with a cell, _____ is activated. (2 pts)

vi) list at least three targets of the enzyme in (v) which are also activated by this cascade. (6 pts)

2.) **Amino Acid Metabolism** (25 pts)
On average, one out of every twenty amino acids that compose proteins is arginine. The following will guide you through the degradation of arginine within a cell:

i) Begin by drawing arginine. (5 pts)

ii) Arginase catalyzes the reaction of arginine with H_2O to eliminate urea from its sidechain to produce ornithine. Draw ornithine. (4 pts)

iii) In a PLP dependent mechanism, the primary amine of the ornithine sidechain is transaminated to generate glutamate-5-semialdehyde. Draw this product. (4 pts)

iv) The aldehyde of the sidechain of glutamate-5-semialdehyde is taken up one oxidation state to yield glutamate. Draw glutamate. (5 pts)

v) In a PLP dependent mechanism, glutamate is transaminated. Draw the product of this reaction. (5 pts)

vi) where does the product of step (v) fit into the larger scheme of metabolism? (2 pts)

3.) **Lipid Metabolism** (25 pts)

i) Write a balance chemical equation for the complete combustion of palmitate (16:0). (4 pts)

ii) Based on the chemical structure of palmitate, how many

a) $NADH/FADH_2$

b) CO_2

will be produced by the complete oxidation within a cell? (4 pts)

iii) In molecular detail, describe this process of β-oxidation for palmitate. (10 pts)

(#3 cont'd)

iv) How do your answers for i, ii, and iii compare? (1 pts)

v) One of the effects of insulin on some cells is the switching from lipolysis to lipogenesis. Which enzyme plays a central role in this regulation? How? (6 pts)

4.) **Carbohydrate Metabolism** (25 pts)

i) Draw glucose. (3 pts)

ii) Based on the chemical structure of glucose, how many

a) $NADH/FADH_2$

b) CO_2

will be produced by the complete oxidation within a cell? (4 pts)

iii) How many

a) NADH

b) $FADH_2$

c) CO_2

are actually produced in a cell by the complete oxidation of glucose? (6 pts)

iv) Indicate the reactant and product (names are sufficient) for each reaction generating the species in part (iii) for the complete oxidation of glucose. (12 pts)

5.) **Oxidative Phosphorylation** (25 pts; 1 pt/blank)

The catabolism of glucose through glycolysis and TCA cycle yields ____ $FADH_2$ and ____ NADH. The ____ electrons of $FADH_2$ enter the electron transport (ET) chain through _____, while the electrons of NADH enter through _____. When NADH donates its electrons, _____ is the product of this _____ half-reaction.

The complex that accepts electrons from NADH will eventually donate them to _____. During this process _____ H^+ are pumped from _____ to _____. The complex that accepts electrons from $FADH_2$ will eventually donate them to _____. During this process _____ H^+ are pumped.

Eventually, the electrons will be transferred to Complex III. Complex III will transfer these electrons to _____, which is localized to the _____. During this process _____ H^+ are pumped.

Finally, the electrons are transferred to _____ where _____ will act as the final electron acceptor. The electrons from one NADH will produce ___ H_2O. During this process _____ H^+ are pumped.

The energy stored as an electro-chemical gradient is harvested to produce ATP by _____ as H^+ are allowed to flow from the _____ to the _____. It takes approximately ____ H^+ to travel through this system to produce a single ATP. The process is completely analogous to the _____ (a macro-sized machine).

6.) **Enzyme Nomenclature** (25 pts)

In molecular detail, provide an example reaction that we studied for each of the following enzyme classes (include substrate/product structures; cofactors; and enzyme names) and the metabolic process that it is found in:

i) Kinase (5 pts)

ii) Mutase (5 pts)

(#6 cont'd)

iii) Isomerase (5 pts)

iv) Dehydrogenase (5 pts)

v) Lyase (5 pts)

7.) **Lab question** (25 pts)

To run an assay in the lab, you need 250 mL of each of the following solutions:

#1)	200 mM	Tris (pH 8)
	35%	Olive oil emulsion
#2)	750 mM	KCl

You have the following stock materials:

Solid KCl (FW 74.55)
dH_2O
1 M Tris (pH 8)
50% Olive oil emulsion

Describe how you will go about preparing solutions #1 (8 pts) and #2 (8 pts).

Your assay contains a dehydrogenase that converts NAD^+ to NADH. You want to know the [NADH] at the endpoint of the reaction. You mix 200 μL of your reaction product with 800 μL of dH_2O in a cuvette and find the absorbance of the solution to be 0.383 at 340 nm. What is the [NADH] in the <u>original reaction product</u>? (9 pts; $e_{NADH}^{340\ nm} = 6{,}220\ M^{-1}\ \text{cm}^{-1}$)

8.) **Alternate Amino Acid Products**

Several amino acids serve as precursors of hormones and neurotransmitters. The following will walk you through the synthesis of Epinephrine.

i) Draw tyrosine. (3 pts)

ii) Tyrosine hydroxylase catalyzes the addition of a hydroxyl group on C3 (ortho- to the existing hydroxyl group) of the phenyl ring. Draw the product. (2 pts)

iii) Decarboxylase eliminates the carboxyl group as carbon dioxide. Draw the product. What cofactor and/or coenzyme are likely utilized by this decarboxylase? (3 pts)

iv) Hydrolyase catalyzes the addition of a hydroxyl group onto the β carbon (methylene carbon attached to the substituted phenyl ring). Draw the product. (2 pts)

v) Methyltransferase catalyzes the addition of a single methyl group onto the primary amine to yield a secondary amine. Draw this product (epinephrine). What cofactor and/or coenzyme are likely utilized by this transferase? (3 pts)

(#8 cont'd)

vi) In many ways the cellular reaction to epinephrine is opposite to that of insulin. Circle the correct effect of insulin on each of the following tissues.

Muscles (4 pts)

Glycolysis:	Increase	Decrease	No Effect/NA
Gluconeogenesis:	Increase	Decrease	No Effect/NA
Glycogen synthesis:	Increase	Decrease	No Effect/NA
Lipogenesis:	Increase	Decrease	No Effect/NA

Hepatocytes (4 pts)

Glycolysis:	Increase	Decrease	No Effect/NA
Gluconeogenesis:	Increase	Decrease	No Effect/NA
Glycogen synthesis:	Increase	Decrease	No Effect/NA
Lipogenesis:	Increase	Decrease	No Effect/NA

Adipocytes (4 pts)

Glycolysis:	Increase	Decrease	No Effect/NA
Gluconeogenesis:	Increase	Decrease	No Effect/NA
Glycogen synthesis:	Increase	Decrease	No Effect/NA
Lipogenesis:	Increase	Decrease	No Effect/NA