Name_____

BIOC 302
Final Exam

Spring, 1999

1. (21 pts) a. **Compare** the mode(s) of transfer of reducing equivalents (i.e. any relevant combination of electrons and protons) carried out by NAD^+, FAD, heme and iron-sulfur clusters?

b. **Describe** a series of enzyme catalyzed reactions that would lead to the conversion of acetate to malonate. The reactions chosen should have a precedent in those that you studied in class.

c. **What** is the difference between a mutase and an isomerase?

d. Given that CO_2 is an exceptionally powerful electrophile **why** is it necessary to expend ATP in those reactions that introduce CO_2 into an acceptor as in the conversion of pyruvate to oxaloacetate?

e. A neighbor has just isolated an enzyme that catalyzes

CH_3-CH(CO-SCoA)-COOH CoAS-CO-CH_2-CH_2-COOH.

You suggest that she analyze the enzyme for the presence of cobalt. **Why** do you make this suggestion?

f. **What** one slight modification would you make to one enzyme already present in the glycolytic path so that glucose and mannose could be used equally well as starting points for glycolysis?

g. The genetic engineers at Rice vineyards have developed a strain of yeast in which the alcohol dehydrogenase has been mutated to lactate dehydrogenase. They introduce this strain into the working cultures of A & M vineyards where it takes over from the wild-type yeast. Shortly thereafter the sales of wine from A & M vineyards declined precipitously. **Why**?

2. (11 pts) Glucose radio-labeled in C2 is added to fresh (undialyzed) yeast juice in the presence of air and a source of ATP. **How** many revolutions of the citric acid cycle are needed before radiolabel appears in CO_2? **Explain** your answer (a guess in the absence of supporting logic will not receive any credit). **Will** the answer be different if the glucose had been labeled in C1? **Explain**!

Name_____

3. (10 pts) a. $\Delta G^{o'}$ for the hydrolysis of phosphoenolpyruvate to pyruvate and Pi is - 14.4 kcal/mole and $\Delta G^{o'}$ for the hydrolysis of ATP to ADP and Pi is –7.4 kcal/mole. **What** is the equilibrium constant at pH = 7 for the reaction

$$PEP + ADP \Leftrightarrow pyruvate + ATP$$

b. Consider the segment of the citric acid cycle represented in abbreviated form as

$$.....malate \Leftrightarrow oxaloacetate \Leftrightarrow citrate.....$$

The values of $\Delta G^{o'}$ for the first and second steps are +8 and –7 kcal/mole respectively. **Why** is this pair of values more desirable (from a biochemical point of view) than is the alternative situation in which the values are -7 and +8 kcal/mole respectively.

4. (16 pts) a. **What** are the structural requirements that proteins that are intrinsic to a membrane must satisfy?

b. Are the amino acids present in trans-membrane helices required to be completely non-polar? **Explain**!

c. The glucose transporter is an particular intrinsic protein that presumably provides a pore that traverses the membrane. **How** would you establish whether this pore is a barrel composed of helices or is made from a β-sheet?

d. Reactive oxygen species (ROS) are derivatives of dioxygen that are chemically very reactive. They are blamed for a number of pathological conditions. **Why** are they deleterious for biological membranes? Explain.

5. (16 pts) a. **Explain** the functional difference(s) between channels, carriers and pumps. Give an example of each.

Name_____

b. Siderophores are molecules that promote the passage of ferric iron across the membrane of E. coli. **What** experiments would you perform to determine if a siderophore is a channel, carrier or pump?

6. (16 pts) a. **Explain** the phenomenon of Respiratory Control and how it can be used to measure P:O ratios. **Why** are these ratios 3 when malate is used as substrate and 2 when succinate is used?

b. **Describe** the alternating sites mechanism for ATP synthesis.

c. Given that ion gradients can be used as an energy source, as is demonstrated in the chemiososmotic theory of active transport, **why** is ATP synthesis by the mitochondrion necessary for cell survival?

d. There is a specialized form of adipose tissue called brown fat-it is so named because the tissue is so rich in mitochondria that the cytochromes impart a brown color. Brown fat is essential for maintaining body temperature notably in the newborn. The inner membrane of brown fat mitochondria contain a protein called thermogenin; this protein is an efficient anion transporter. **Explain** how this protein accomplishes the biological function of this tissue.

7. (30 pts) **Illustrate** the metabolic fates of two of the major metabolic fuels: fats and glucose from **dietary sources**. **Indicate,** in general, the pathways they feed into and show fates of energy and carbon derived from the fuels (structures not required). **Indicate** what major tissues use the components and via what pathways they accomplish this. **Include** transport mechanisms from the digestive system.

8.

8. (12 pts) **Illustrate or describe** the metabolic conditions that would cause a liver cell to choose to use acetyl CoA for fatty acid synthesis, energy production, or ketone body formation and how the regulation occurs to accomplish this (discuss each possibility- pathway names are sufficient).

9. (10 pts) **Illustrate** the *formation* of deoxyTTP from dUTP and the *regulation* of the pathway (general discussion- names of compounds sufficient- need to identify the points of regulation).

Name_____

10. (15 pts) **Illustrate** in a schematic manner how the amino group on alanine formed in muscle can be converted to urea for nitrogen excretion and how the carbons are returned to muscle (specific reactions not required but *major pathway precursors and products (names or structures) are necessary*, *transport should be indicated*). i.e. you do not have to show the complete pathways, just where they start and end if you give the name of the pathway.

11. (20 pts) **Illustrate** the **possible fates** of glucose 6-P in the liver and **what functions** these fates support. **Illustrate** how fructose 2,6-bisphosphate and cAMP are involved in regulating these pathways. (Note that only fates of G-6P are requested, not synthesis of G-6-P. You may simply name the pathways and indicate starting point and final product(s))

12. (10 pts) **Illustrate** the transport of cholesterol from liver to peripheral tissues (show transport forms and how uptake occurs).

13. (13 pts) **Indicate** if the following statements are true (**T**) or false (**F**) and **if they are false**, **correct them** so they are true scientific statements. *Corrections should involve only the italicized words*.

a. _____ C_4 plants do *not* have the Calvin cycle.
b. _____ Cysteine is an *essential* amino acid.
c. _____ *Urea* is the end product of amino acid catabolism in pigeons.
d. _____ Pyrimidine biosynthesis is inhibited by *CTP*.
e. _____ *Insulin* levels rise shortly after a full meal.
f. _____ *Bile salts* provide a pathway for excretion of cholesterol.
g. _____ *Oxidation* of fatty acids is inhibited during starvation.
h. _____ Heart muscle uses *only anaerobic* energy pathways.