**BCH 4054** **FINAL EXAM** **NAME**_____
**December 14, 2000**

**This exam consists of six pages. Make sure you have one of each. For questions indicating a choice, answer only one of the choices. (If you answer both, you need to indicate which answer is to be counted, otherwise the first one will be graded.) A seventh page contains the genetic code. You may tear that page off and use it for scratch work.**

**Good luck, and have a nice Christmas.**

| Page | Points |
|---|---|
| 1 | ____ |
| 2 | ____ |
| 3 | ____ |
| 4 | ____ |
| 5 | ____ |
| 6 | ____ |
| Total | _____ |

**Answer question 1 or 2**

(12) 1. Mitochondria can oxidize succinate to fumarate by catalyzing the following overall reaction:

succinate + 1/2 $O_2$ ----> fumarate + $H_2O$

(a) Calculate $\Delta G^{o'}$ for this reaction (F = 96.5 kJ/volt)
($E'_o$ succinate/fumarate = 0.031 volt; $E'_o$ $H_2O/O_2$ = 0.82 volt)

(b) Give the intermediate re-dox carriers which participate in this reaction in the order in which the electrons are passed (not just the complexes, but the components of the complexes).

(c) Explain the reasoning by which one concludes that this process is coupled to the formation of 1.5 moles of ATP.

(12) 2. ATP synthesis in chloroplasts has many similarities to that in mitochondrial complex III. Compare and contrast these two systems by drawing diagrams of the mitochondrial inner membrane and the thylakoid membrane showing the **identity**, **location** and **orientation** of the following components in each: a quinone, cytochromes, a peripheral membrane protein, the ATP synthase. How does the nature of the proton motive force differ in the two systems?

**Answer 3 or 4**

(12) 3. Calculate the number of ATP's that can be obtained from oxidation of stearic acid ($C_{18:0}$) to acetoacetate in the liver. Consider that NADH and $CoQH_2$ are reoxidized by the electron transport chain. Sketch the overall pathway, showing where ATP, NADH and $CoQH_2$ would by used or produced. Why wouldn't acetoacetate be further oxidized in the liver?

(12) 4. The liver cannot synthesize glucose from fatty acids, but it can make some glucose from fat by metabolizing glycerol. Glycerol released from adipose tissue when fats are hydrolyzed can be taken up by liver and converted to glycerol-3-phosphate by the enzyme **glycerokinase**. Show the overall pathway by which the following reaction can occur, giving all intermediates involved (names or structures), and summarize the overall stoichiometry (i.e. net production or utilization of NADH, $CoQH_2$, ATP, and GTP).

2 glycerol $\rightarrow$ glucose

**Answer 5 or 6**

(9) 5. Bacteria have three distinct DNA polymerases, Pol I, Pol II, and Pol III. Describe the role of each in DNA synthesis.

(9) 6. Eukaryotic cells have three distinct RNA polymerases, RNA Pol I (or A), RNA Pol II (or B) and RNA Pol III (or C). Describe the function of each, and the sensitivity of each to á-amanitin.

**Answer question 7 or 8.**

(12) 7. Cyclic AMP has been called "an ancient hunger signal". Explain how this concept applies to its action in both bacteria and animals.

(12) 8. Explain how epinephrine **stimulates** the breakdown of glucose (glycolysis) in muscle. (Note: I am not talking about breakdown of glycogen, but of glucose). Identify the glycolytic enzyme stimulated, the compound causing the stimulation, and all the signaling intermediates involved in producing this compound.

**Answer question 9 or 10**

(12) 9. Identify the enzyme catalyzing the **regulatory step** for each of the following pathways, and the substance(s) that activate or inhibit the enzyme.

**(a) cholesterol biosynthesis**

**(b) fatty acid biosynthesis**

**(c) pyrimidine biosynthesis in prokaryotes**

(12) 10. The **Calvin Benson Cycle** converts $CO_2$ into carbohydrate. The pathway requires NADPH and ATP and involves an enzyme found in the pentose phosphate pathway. Identify the following steps of the cycle by giving the reactants and products of each reaction:

(a) The step fixing $CO_2$.

(b) The two steps requiring ATP.

(c) The step requiring NADPH.

(d) A step catalyzed by the enzyme **transketolase**.

**Answer 11 or 12**

(11) 11. Draw the structure of guanine and cytosine, and indicate the source of **each C and N atom** in the structure. (For example, N might be from glutamine, C from $CO_2$, etc.)

(11) 12. Give the pathway by which acetyl-CoA is converted to isopentenyl pyrophosphate, showing the structures of each intermediate. How many ATP's are required for this conversion?

**Answer question 13 or 14**

(12) 13. Propionyl-CoA is a product of catabolism of both odd chain fatty acids and several amino acids. Explain how it is converted to a TCA cycle intermediate, showing all the intermediates in the conversion, and identifying the enzymes involved and their prosthetic groups.

(12) 14. Metabolism of amino acids begins with the action of transaminases.

(a) Give the overall reaction catalyzed by a transaminase.

(b) What prosthetic group is involved?

(c) Give the structure of the intermediate formed between this prosthetic group and the amino acid.

(d) How does the nitrogen atom ultimately get converted to ammonia?

**Answer 15 or 16**

(8) 15. In prokaryotes, translation begins before transcription is completed. Compare transcription and translation with respect to:

(a) Identification of the "start" position.
(b) Direction of synthesis.
(c) Source of energy driving the polymerization.
(d) Identification of the termination point.

(8) 16. Explain how "proofreading" is accomplished in:

(a) Synthesis of DNA.
(b) Synthesis of aminoacyl tRNA.
(c) peptide bond formation in protein synthesis.

**Answer 17, 18 and 19**

(6) 17. Circle the following mutations which could result from a single base substitution. Give a codon change that could be responsible for the mutation. (The genetic code table is on the last page).

Glu ---> Val  Ile ---> Terminate (Stop)  Arg ---> Pro

Cys ---> Gly  Leu ---> His  Phe ---> Tyr

(6) 18. The following sequence from the middle of a m-RNA could encode three different polypeptide sequences. What are they?

5'-GCCUACUGACGACUAA-3'

**The Genetic Code (mRNA)**

## Second position

| First position | U | C | A | G | Third position |
|---|---|---|---|---|---|
| U | UUU Phe | UCU Ser | UAU Tyr | UGU Cys | U |
| | UUC Phe | UCC Ser | UAC Tyr | UGC Cys | C |
| | UUA Leu | UCA Ser | UAA Stop | UGA Stop | A |
| | UUG Leu | UCG Ser | UAG Stop | UGG Trp | G |
| C | CUU Leu | CCU Pro | CAU His | CGU Arg | U |
| | CUC Leu | CCC Pro | CAC His | CGC Arg | C |
| | CUA Leu | CCA Pro | CAA Gln | CGA Arg | A |
| | CUG Leu | CCG Pro | CAG Gln | CGG Arg | G |
| A | AUU Ile | ACU Thr | AAU Asn | AGU Ser | U |
| | AUC Ile | ACC Thr | AAC Asn | AGC Ser | C |
| | AUA Ile | ACA Thr | AAA Lys | AGA Arg | A |
| | AUG Met | ACG Thr | AAG Lys | AGG Arg | G |
| G | GUU Val | GCU Ala | GAU Asp | GGU Gly | U |
| | GUC Val | GCC Ala | GAC Asp | GGC Gly | C |
| | GUA Val | GCA Ala | GAA Glu | GGA Gly | A |
| | GUG Val | GCG Ala | GAG Glu | GGG Gly | G |