Chemistry 431b Test #2 Guidelines Spring, 2005

The Second Midterm (scheduled for May 20, 2005, Friday) will include lecture materials and chapters covering Chapters 14-16 : Krebs cycle, pentose phosphate pathway, the glyoxylate cycle, the electron transport chain as well as the biosynthesis of carbohydrates. Review previous chapters (i.e. already covered for the first midterm) as needed to elucidate these topics further. Study the lecture notes, the quiz questions, the corresponding textbook chapters and the homework problems assigned. Typically, the midterm may contain a variety of types of questions including: fill in the blanks, multiple choice, true or false, essay questions, chemical structures and calculational problems.

For starters, be able to do the following before you take the test.

1) Tricarboxylic Acid Cycle (TCA) related material:
Write the TCA cycle and give details as to its regulation. Know all the steps in detail including enzymes, coenzymes, substrate structures, particular features of the steps indicated.

Write down all common anaplerotic reactions complete with enzymes, coenzymes and metabolites. Differentiate between the ability of plants and animals to convert fats to sugars. Write down the glyoxylate cycle - give the names of substrates and enzymes. What vitamins are involved?

Pentose phosphate pathway – show all steps in the oxidative phase. Elucidate nonoxidative phase to the detail discussed in the lecture. Know the roles of the pentose phosphate pathway. Can you prove that each carbon is glucose is equivalent as far as obtaining NADPH is concerned. For practice, show that oxidation via the PPP is equivalent to oxidative phosphorylation via the electron transport chain in a typical cell (you will need to invoke the transhydrogenase reaction).

2) Electron Transport Chain (ETC):
Recall all carriers (and the complexes I, II, III, & IV) in the electron transport chain. Describe each one and determine its unique properties if any. Locate the sites of energy conservation.

Know the common inhibitors to the ETC and common nonenzymatic electron donors and acceptors. Understand the use of difference spectroscopy in determining the oxidation states relative to the "normal" mitochondria and thus the sequence of electron carriers.

What is the P/O ratio for various electron donors? How many ATPs can you get from various glycolytic intermediates being aerobically metabolized completely? How efficient (%energy utilized) is the aerobic breakdown of glucose in terms of trapping free energy in the form of ATP? Compare that with anaerobic glycolysis.

Discuss and illustrate the Mitchell Model and how it explains oxidative phosphorylation's "tight coupling" in normal mitochondria. Explain the structure of complex 5. Write down a table summarizing the 5 “states” of the mitochondria. Be prepared to interpret the oxygen tension, pO_2 vs time graph in terms of states of the mitochondria as well as relating the effects of ETC inhibitors, uncoupler's, oligomycin, ionophores (like nigericin, valinomycin, etc). What is RCR?

Calculate the free energies for the problems involving electron transport and the production of ATP (recall homework problems). Be able to calculate the ΔG° based on the proton motive force under conditions involving both or either/or chemical and electrical gradients across the mitochondrial membrane. Try predicting the ΔG° for proton transfer as well as the transfer of ATP, Pi etc across the inner membrane, What are the different types of transport proteins in the inner membrane which are involved in the the ETC? What are symports, etc?

3) Carbohydrate Metabolism II:
Be able to write the steps in gluconeogenesis and describe its regulation. Compare its steps with glycolysis. Know also: glycogen synthesis, the regulatory cascades affecting glycogen synthesis and mobilization. Know the biosynthesis of other polysaccharides only to the extent discussed in class.

Practice problems:

(1) Suppose the inner mitochondrial membraneshas a membrane potential, $\Delta\Psi$, of 0.10 V and a pH difference, ΔpH of 2.0.

a) Calculate the free energy released by the transport of protons "downstream" under standard conditions. If NADH is oxidized with a P/O ratio of 3.0, what is the free energy required to generate the concomitant ATP per NADH? How efficient is this process? For this problem assume that 4 protons are required to generate 1 ATP.

b) What is the standard free energy for the transport of an inorganic phosphate ion to the inner mitochondrial matrix from the intermembrane space. Calculate and explain your calculation.

2) How can a plant convert fats to glucose? Explain using all the steps needed.

3) Draw a graph of O_2 vs time for a mitochondrial preparation showing how to show the various states of the mitochondria. How will a respiring mitochondrial preparation in state III be affected by the addition of the inhibitors and uncouplers? Illustrate with an example. How will you be able to distinguish which types of inhibitors (i.e. oxphos or ETC inhibitors) are affected?