

## CHEM205 Problem Set 6.

### Oxidative Phosphorylation and Photosynthesis

Due 10am Wednesday December 7

Question 1 (6 points). Normally ATP synthesis is tightly coupled to electron transfer through the electron transport chain. Under these conditions, the ratio of ATP produced per atom of oxygen consumed (P/O ratio) is about 2.5. Predict the effect of a low concentration of an uncoupling agent on the P/O ratio.

Question 2 (12 points). For each of the four complexes in the electron transport chain:

- calculate the total redox potential of the complex
- calculate the free energy available for proton translocation assuming a 2-electron process for each complex
- calculate how many moles of protons can be translocated across the inner mitochondrial membrane if translocation of 1 mole requires 23 kJ.

Question 3 (6 points). When the NADPH/NADP<sup>+</sup> ratio in chloroplasts is high, photophosphorylation is predominantly cyclic.

- is O<sub>2</sub> evolved during cyclic photophosphorylation?
- is NADPH produced?

Briefly explain your reasoning.

Question 4 (10 points). <sup>14</sup>CO<sub>2</sub> is administered to a green plant in a closed system. After a short time, the <sup>12</sup>CO<sub>2</sub> and <sup>14</sup>CO<sub>2</sub> levels in the system reach equilibrium. The plant is harvested, and the following substances are isolated: glucose, sedoheptulose-7-phosphate, ribose-5-phosphate, erythrose-4-phosphate and 3-phosphoglycerate. Draw the structures of these five molecules and indicate which atoms will be <sup>14</sup>C labeled.

Question 5 (6 points). A toxin is discovered that binds reversibly to Asp61 of the c (rotor) subunit in the F<sub>o</sub> subunit of F<sub>1</sub>F<sub>o</sub> ATP synthase.

- What effect would such a toxin have on the P/O ratio?
- What effect would such a toxin have on metabolic rate?
- What effect would such a toxin have on NADPH synthesis if administered to a green plant?

Assume that the F<sub>o</sub> and CF<sub>o</sub> subunits respond to the toxin in the same way and in all cases briefly explain your reasoning.

Question 6 (6 points). An organism is discovered with a mutation in the enzyme rubisco. The mutated enzyme uses fructose-1,6-bisphosphate as its substrate in place of ribulose-1,5 bisphosphate.

- What are the products of the mutant rubisco's action on fructose-1,6-bisphosphate?
- Can this organism fix CO<sub>2</sub> to produce glucose?

Briefly explain your reasoning.

Question 7 (8 points). List four similarities and four differences between photosynthesis and oxidative phosphorylation.