

GE/BI525 – Assignment #1. Fall, 2008

1. Expand on Figure 4, chapter 2. This will require use of reference materials beyond what is in Lambers et al. (a) Provide the chemical formula for each of the molecules listed in Figure 4 (ATP, ADP, NADP, NADPH, RuBP, PGA, Triose P, Ribulose-1-mono-phosphate). (b). List, step by step, the primary and intermediary reactions in the Calvin Cycle. (c). For the formation of one 6 carbon molecule of sugar, at least how many photons are needed? Explain your calculation.
2. Examine Figure 3 of chapter 2. Now close your text and draw this figure freehand, including labels for everything listed there. List the main functional role of each of the membrane bound proteins. You may or may not need to replicate this figure for the midterm exam!
3. Regarding Box 1, Chapter 2:
 - Assume that the graph of $J/4$ in Figure 1 of Box 1 is piece-wise linear, find an approximate equation for the linear rising portion that roughly matches Figure 1, and assume that $J_{max}/4 = 140 \text{ umol/m}^2\text{s}$, as in the figure.
 - Assume that $\Gamma^* = 3.7 \text{ Pa}$ at 25°C , and also that $R_{day} = 0$ (the latter assumption for simplicity only).
 - (a) Using another web or text source (it is not explained in our text), describe the general form of Michaelis-Menten enzyme kinetics, and explain the physical meaning of the “ k ” parameter for any enzyme-catalyzed reaction.
 - (b) Derive equation (5), Box 1 (Hint: read section 16.2.3.2 in Farquhar and van Caemmerer).
 - (c) Using excel or another program, graph $A(c)$ and $A(J)$, with all parameter values for 25°C , and highlight the minimum of these two curves over the range of P_i from 0 to 60 Pa. In other words, reproduce Figure 1 of Box 1.
 - (d) Graph K_c , K_o , Γ^* , V_{cmax} , and J_{max} over the temperature range from 5°C to 45°C .
 - (e) Redo part (b) with all parameter values at (i) 10°C and (ii) 40°C . How do these curves compare with the one at 25°C ?
4. Refer to section 9, Chapter 2. The primary benefit of C_4 metabolism is to reduce the oxygenation reaction of the Calvin Cycle. In that regard,
 - a. What is the energetic cost (per unit CO_2 transported to the bundle sheath cells) in terms of ATP?
 - b. Global environmental change caused by humans includes increased atmospheric CO_2 , temperature, and soil (and therefore leaf) nitrogen availability. Find $A-p_i$, or $A-p_a$ curves for both a C_3 and a C_4 plant. Assume that AIR temperature affects leaf net photosynthesis the same as LEAF temperature does in Figure 39, chapter 2 (right hand panel), and that the two species you’ve chosen show the C_3 vs. C_4 nitrogen responses in Figure 40. Envision a scenerio (perhaps from IPCC reports or just something you come up with) for an ecosystem containing these two species under elevated levels of CO_2 , Temperature, and Nitrogen deposition. Estimate the % change in relative performance (as indicated by net photosynthesis) for the C_3 vs. C_4 species. I’m only looking for ballpark estimates, so there is no need to extract exact numbers from any of the figures you use for this.