Name: SID Number

Midterm 1b – BioE 110

Please write the following on the first page of your exam and sign it.

> "I pledge my honor that I will not violate this Honor Code during this examination. I certify that all solutions will be entirely my own, that I will not consult people or sources other than the cheat sheets, and that I will not share information with others during the exam."

1. (15 pts) Assume a red blood cell has a volume of 100 μm^3 in a person who is relatively healthy. If, by mistake, 1 lt of distilled water is rapidly added to his blood stream (which has 5 lt of blood).
    a. If his blood originally had an osmolarity of 300 mOsm/lt, what is the osmolarity of his blood now assuming that it happened so fast that his body hasn't adjusted in any way.
    b. How will this affect his red blood cells?
    c. What will be the new volume of a red blood cell?

2. (20 pts) Consider a round cell with a diameter of 10 microns that is just hanging around at equilibrium in an infinite bath. The conditions are:

Ion	Internal Conc	External Conc	$E_m = V_i - V_o$	Diffusive Parameters
Cl^-	10 mM	100 mM	-50 mV	$D = 10^{-3}$ mm^2/s K = 0.5 $\Delta x = 10^{-3}$ mm
Na^+		170 mM		

   a. Ignoring any electro-chemical effects, what is the rate of passive diffusion of sodium ions into the cell?
   b. If there were no electro-chemical forces, what would be the equilibrium concentrations of sodium inside and outside the cell?
   c. Why doesn't this happen in real life, i.e. why does the cell have the chloride concentration listed in the table?
   d. Assuming that the sodium and chloride ions are at equilibrium, what is the internal concentration of Na^+?

3. (20 pts) Matt was a professional bicycle racer who was really intensely competitive. To gain an advantage over Lance, he used a ton of EPO plus blood doping to raise his hematocrit,H, the volume percentage of RBCs in blood, from its normal value of 40% to 60% so that he can get more oxygen to his muscles because of the proportional increase in the oxygen in his arterial blood. This increase will also double the viscosity of his blood.

   Assume Matt's resting O_2 consumption is 10 ml O_2/sec, his normal (H = 40%) [O_2] in his pulmonary vein is 0.2 ml/ml blood and 0.15 ml/ml blood in his pulmonary artery. His resting heart rate is 60bpm and blood pressure is 120mm Hg (systolic) over 80mm Hg (diastolic). When racing his pulse and O_2 consumption triple but the [O_2] in his pulmonary artery and vein stay the same. Assume that there are no other changes in his circulation.

   To see why he would do this **look at his cardiac function before he increased his hematocrit**: (use ratios, e.g. CO(racing)/CO(normal))

   a. Calculate how much Matt's Cardiac Output has to increase when he is racing.
   b. How much does his mean arterial pressure increase when he is racing?

   After increasing his hematocrit:

   c. Calculate his CO after 'enhancing' his performance when H = 60 relative to regular racing CO.
   d. How much does his mean arterial pressure change relative to regular racing?
   e. Would EPO/Blood doping help him and why?

4. (20 pts) Consider Matt with his H – 60% riding intensely trying to catch Lance. Assume his heart rate goes up to 180 bpm.
    f. What is his stroke volume?
    g. How much pressure—volume work is his heart doing during ejection?
    h. Draw two graphs showing Matt's pressure-volume curve for an entire cardiac cycle showing what changes with and without the EPA/Blood-doping.
    i. Describe the differences.