10.37 Problem set 7
Due 4/11/07

Problem 1.

A protein P reversibly binds a ligand L to form a complex C.The table below lists complex concentration measured as a function of time t with varying initial ligand concentrations ($[L]_\circ$ = 1, 5, or 15 μM). The initial protein concentration $[P]_\circ$ was always 1 nM. Estimate k_{on}, k_{off}, and K_d of the reaction. *(Contributed by P. Bransford).*

t (sec)	$[L]_\circ = 1\mu$M	$[L]_\circ = 5\mu$M	$[L]_\circ = 15\mu$M
0.0	0	0	0
0.1	95	392	774
0.2	180	627	945
0.3	256	768	982
0.4	324	953	991
0.5	385	904	993

Problem 2.

The objective of this exercise is to compare the volumetric productivity of a steady-state chemostat to that of a batch reactor. The batch operating time is the time for exponential biomass growth from $X_\circ$ to X plus a turnaround time t_{turn}. Show that the ratio of volumetric biomass productivity for a chemostat vs. a batch reactor is approximately $ln\frac{X}{X_\circ} + \mu_{max} t_{turn}$.

Problem 3.

The notion of computers with circuits built from cells has been proposed previously. If the switches in such a computer involve changes in the level of expressed proteins, what expression would describe the time to change from an "off state" (no expression) to an "on state" (95% of the new steady-state level)? What would the half-time for switching be in the following two cases: a) cells rapidly growing (doubling time 30 minutes) and a stable protein (degradation half-time one day); or b) cell not growing at all (infinite doubling time) and a protein with a degradation half-time of 1 hour? How do these switching times compare to those for silicon logic circuits? Would you invest in a company developing such cellular computers?