Four major areas (√ : covered in the following example problems):
Non-isothermal reactors (√)
Biological reactors (√)
Ligand/receptor binding kinetics
Surface reactions/catalysis kinetics

Go over the first problem in PS7 to review the ligand/receptor binding kinetics and the first problem in PS8 to review the surface reactions/catalysis kinetics.

Problem 1.
The irreversible liquid phase reaction A →R + S is carried out in a CSTR. The reaction is first order in A. The feed stream is available at a temperature of 298 K.

$k = 1.7 \times 10^{-4}\ s^{-1}$ at 298 K.

$E_a = 41.87 \times 10^{3}$ kJ/kmol

$\Delta H_R(298) = -167.5 \times 10^{3}$ kJ/kmol

$C_{A0} = 2.0$ kmol/m^3 (Feed is pure A)

$V = 0.5$ m^3

$\rho = 1050$ kg/m^3

Cp = 4.19 kJ/kg/K

These values can be considered to be constant over the used interval of concentration and temperature. The CSTR is made of carbon steel and weighs 800 kg.

$Cp_{,steel} = 502.4$ J/kg/K

Calculate:

a) Conversion and heat duty for an isothermal reactor operating at 298 K.
b) Conversion and reactor temperature for an adiabatic reactor with inlet temperature of 298 K.
c) Conversion and preheating temperature for an adiabatic reactor with a reactor temperature of 363 K.
d) Conversion and heat duty if the reactor is operated non-adiabatically without preheating and at a temperature of 363 K.

Problem 2.
Consider an organism which follows Monod equation of growth with $\mu_{max} = 0.5\ h^{-1}$ and $K_s = 2$ g/L.

a) In a continuous perfectly mixed vessel at steady state with no cell death, if the substrate concentration in the feed is $S_{feed} = 50$ g/L, the yield Y = 1 (g cells / g substrate), what dilution rate D gives the maximum *volumetric productivity*?
b) For the same dilution rate as part (a) using tanks of the same size in series, how many vessels will be required to reduce the substrate concentration to less than 1 g/L?