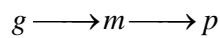HW1, Intro to Synthetic Biology

1. Synthetic Biology
(a) What are potential hazards associated with synthetic biology?
(b) What was the Asilomar Conference on Recombinant DNA? Do the conclusions from that conference apply to synthetic biology?

2. Life isn't digital, so why are scientists trying to implement digital logic in cells (and why do we use digital logic in electronics)?

3. In class, we introduced a simple model of gene expression:
$$g \longrightarrow m \longrightarrow p$$
Here g is the gene (DNA), m is messenger RNA, and p is the protein and reactions occur at rates $a1$ and $a2$ for the first and second reaction, respectively. (The complete model also contains terms for degradation of protein and mRNA.)
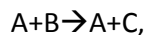(a) Now, assume that there is a small RNA (S) which can hybridize to the messenger RNA (m), and degrade it.
  (1) Write a reaction equation for this system assuming that the small RNA s (i) is itself degraded or (ii) is not degraded in the process.
  (2) Derive the differential equations for both systems.

(b) A transcriptional repressor is a protein that can inhibit transcription by binding to a gene. Assume that the protein p in the model above is a repressor that can bind to gene g.
  (1) What chemical reactions can you use to model such a feedback system?
  (2) Write down the differential equations for this system
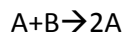
4. Solving differential equations.
(a) A catalytic reaction is modeled as follows:
A+B→A+C,
$A(t=0)=A_0$, $B(t=0)= B_0$
Write the differential equations for this system, solve them, and plot B as a function of time

(b) An auto-catalyst system is modeled as follows:
A+B→2A
$A(t=0)=A_0$, $B(t=0)=B_0$
Write the differential equations for this system, solve them, and plot B as a function of time.