

Question 1 (35 points total)

Refer to the standard genetic code table if needed.

A. Circle any open reading frame(s) encoded in the double stranded DNA fragment shown below (10 points).

5' -TTAATGGTGCCGCGGCATTAA-3'
3' -AATTACCACGGCGCCGTAATT-5'

The restriction endonuclease SacII cuts the DNA sequence shown here:

5' -CCGCGG-3'
3' -GGCGCC-5'

B. Underline any SacII site(s) on the DNA shown in part A (5 points).

C. Design a new piece of DNA that does not contain any SacII site(s) but that still encodes the same protein(s) as the DNA shown in part A (15 points).

Before
DNA: TTAATGGTGCCGCGGCATTAA
AATTACCACGGCGCCGTAATT

ORF1: ATG GTG CCG CGG CAT TAA
Met Val Pro Arg His *

ORF2: ATG CCG CGG CAC CAT TAA
Met Pro Arg His His *

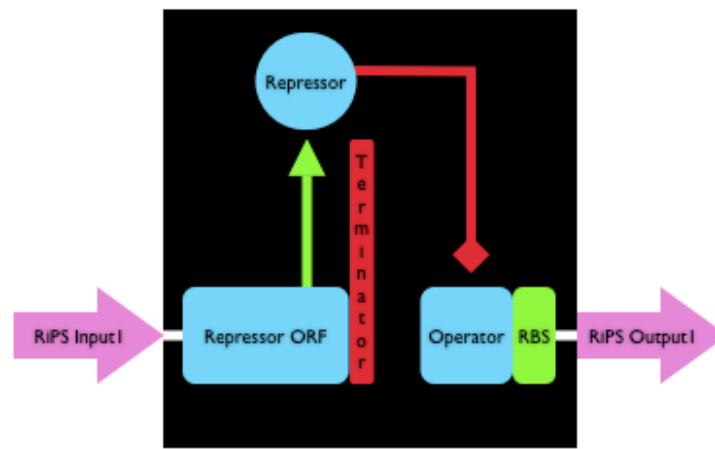
After
DNA: TTAATGGTGCCtCGGCATTAA
AATTACCACGGaGCCGTAATT

ORF1: ATG GTG CCt CGG CAT TAA
Met Val Pro Arg His *

ORF2: ATG CCG aGG CAC CAT TAA
Met Pro Arg His His *

Question 2 (30 points total)

Caltech has decided to start a new undergraduate course of study in Biological Engineering. The Caltech second years are promulgating a new signal carrier for genetic devices called RiPS (for Ribosomes Per Second). They claim that RiPS represents the rate at which ribosomes flow along mRNA, into and out of genetic devices (Figure below).



A. Can RiPS-based devices be re-used in combination with one another? That is, is RiPS a common signal carrier? (8 points)
Yes. The device is sending and receiving signals via the same signal carrier. Thus, RiPS is a common signal carrier.

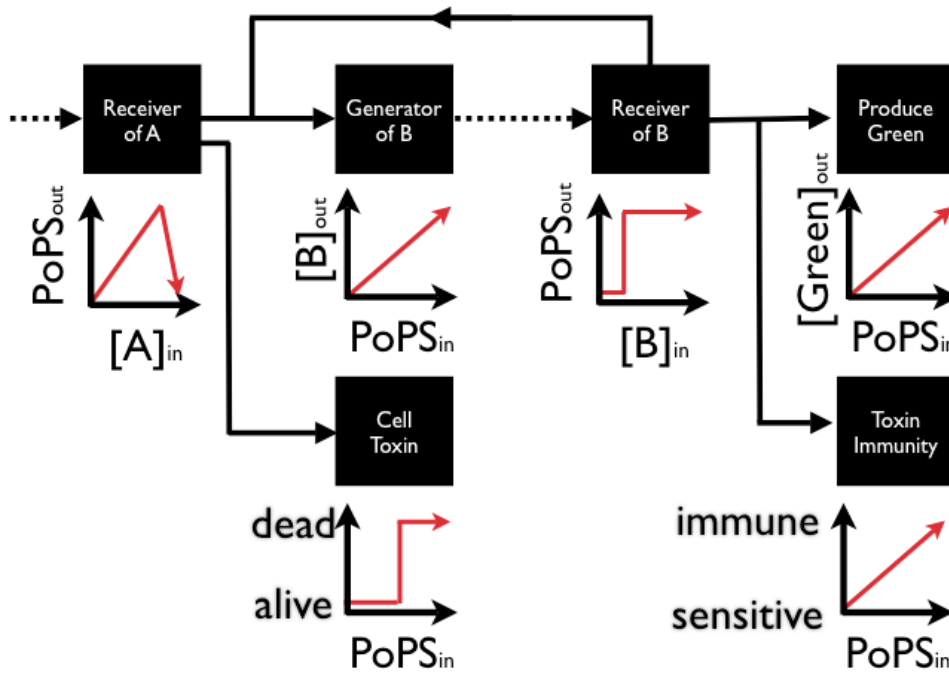
B. Can the output of a RiPS-based device be usefully connected to the input of a PoPS-based device? (8 points)
Yes. RiPS-based devices end with a RBS. PoPS-based devices start with a RBS. Although a RiPS:PoPS junction would produce two RBSs in tandem, the devices will still function in combination.

C. Can the output of a PoPS-based device be usefully connected to the input of a RiPS-based device? (8 points)
No. PoPS-based devices end with an operator. RiPS-based devices start with an ORF. Thus, while an mRNA will be produced, the mRNA will not contain a RBS and thus the devices will not function in combination.

D. Is there any reason to favor PoPS over RiPS, or vice versa? Why? (6 points, please keep your answers short)
PoPS is based at the level of transcription, so it is a "lower-level" signal carrier. However, RiPS, in practice, combines the operator part with the RBS part, which may make device composition more reliable.

Question 3 (35 points total)

Consider a two-dimensional field of cells, with each cell containing a set of genetic devices organized as shown below; each device's transfer function is depicted just below the device itself.

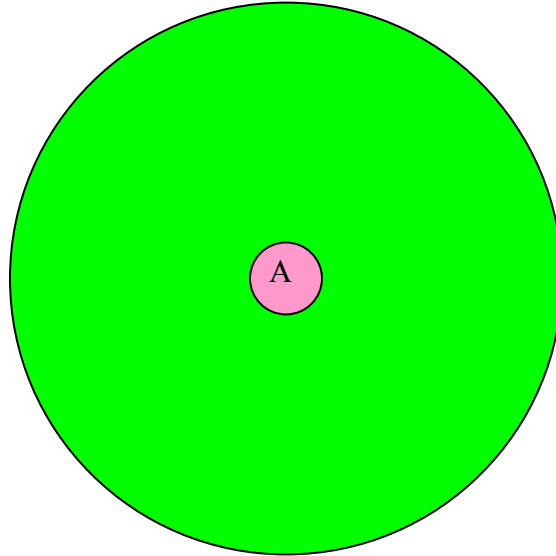


A continuous point source of A is turned ON in the middle of the field of cells (below). Sketch the spatial pattern that the cells produce at steady state (35 points).

From working through the chain of device transfer functions, as the signal A increases, the B Generator will respond which in turn will trigger full response of the B Receiver. Note that this response will occur before the Cell Toxin device responds. Because the B Receiver is producing full output, there will be full Toxin Immunity before the A Receiver's about rises high enough to activate the Cell Toxin device. Note also that the B Receiver feeds back into the B Generator. Thus, even after the A Receiver saturates (i.e., turns off) at high input levels, all cells will be generating and responding to B, and thus Immune and Green.

20.180 Exam 2
11 May 2006
Closed Book

Name _____



Note that certain other sketches are possible depending on the subtleties of transcription/translation delay times.