



Sleep-B-Gone

(not quite...)

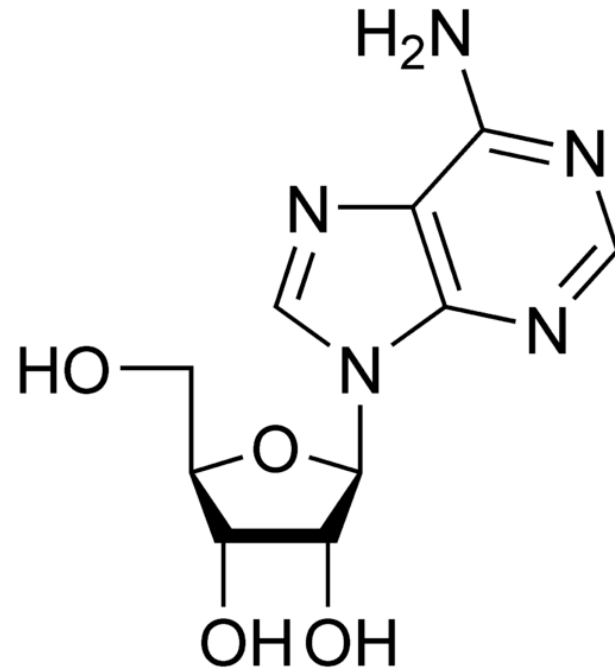
Three anonymous MIT students

Why sleep?

- + Humans spend $\frac{1}{3}$ of their life sleeping
- + Imagine longer productive times

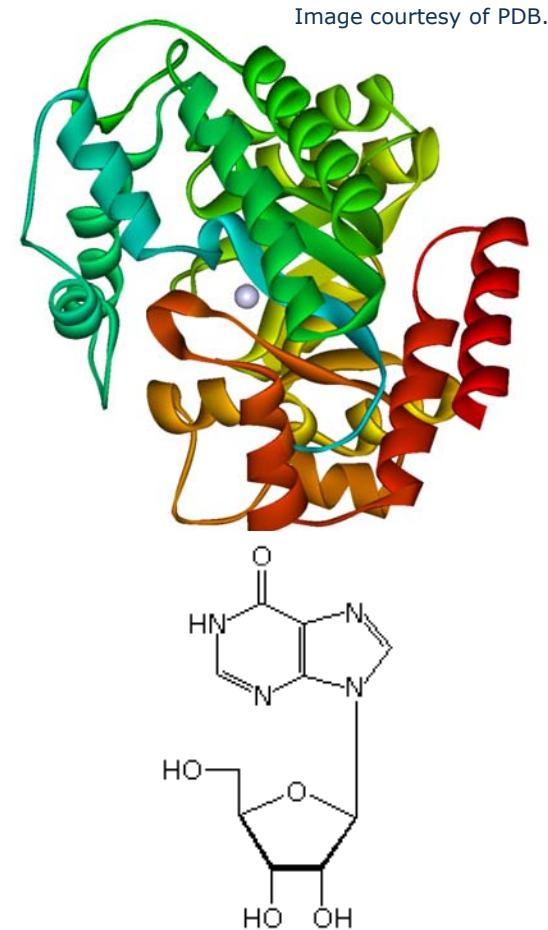
Adenosine

- + One main cause of tiredness
- + Byproduct of cells burning ATP to produce energy
- + Attach to receptors, inhibit production of stimulants
- + Adenosine deaminase breaks adenosine down



Adenosine Deaminase (ADA)

- + ADA breaks down adenosine into the nucleoside inosine by removing an amino group.
- + Inosine has neuroprotective properties
 - + Observed to improve axonal rewiring/repair
 - + Leads to production of uric acid (natural antioxidant)
- + We will use ADA₁, the more common of two isoforms (ADA 1 and 2)



Purpose

- + Creating a system to sequester and break down adenosine in the brain
- + Delay the buildup of adenosine
- + Would act as a replacement for caffeine, except without the side effects 😊

Image collage of various caffeinated drinks removed due to copyright restrictions.

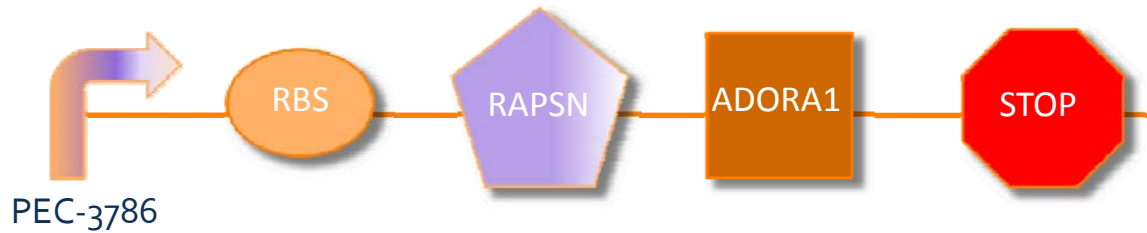
Parts

PARTS	
Liposome	DSPE-PEG
Monoclonal Antibody	OX26
Adenosine Deaminase	608958
Adenosine Receptor	ADORA1
Transcription Terminators	TL1
Promoter	PEC3786
Receptor-Associated Protein of Synapse	RAPSN

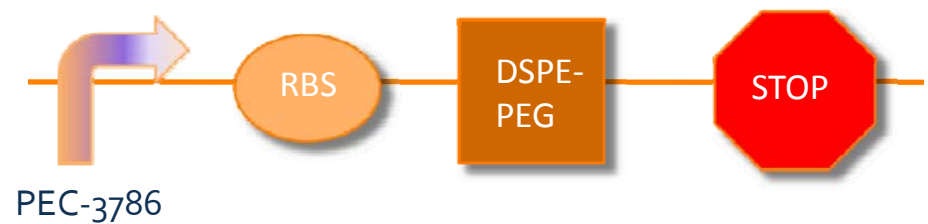
We can produce these system parts through genetic modification of *e. coli* bacteria

Parts (sequence)

Adenosine Receptors



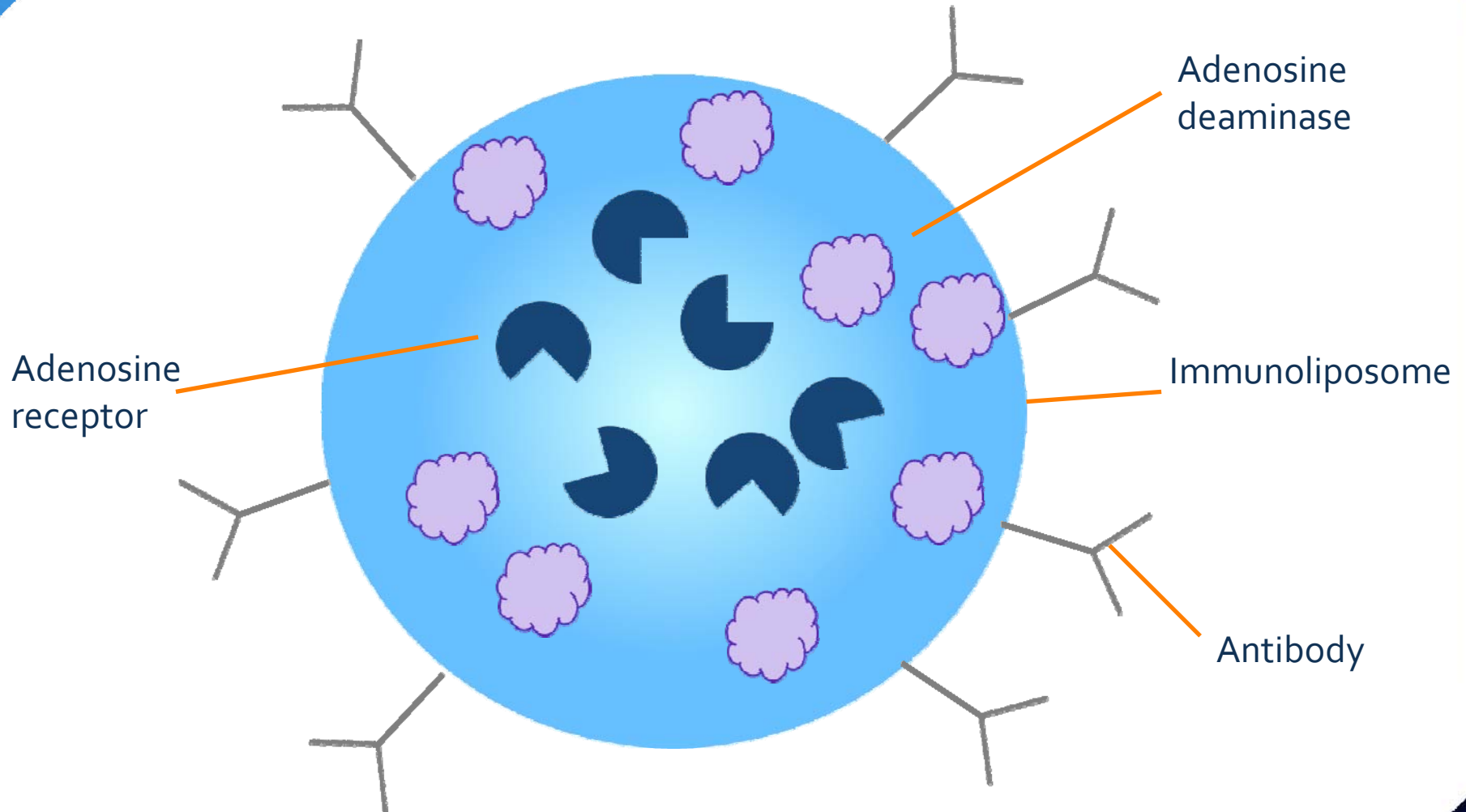
Liposome



Adenosine deaminase



Immunoliposome Structure



General System Diagram

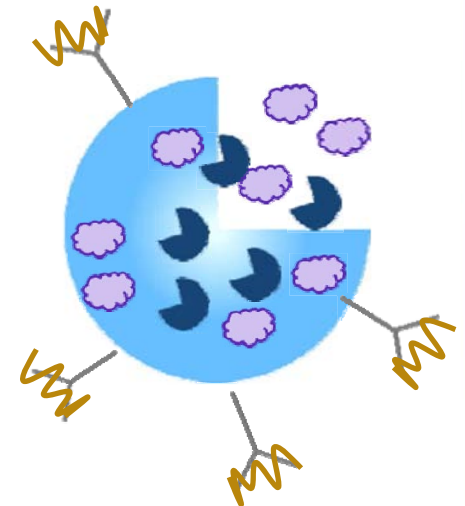
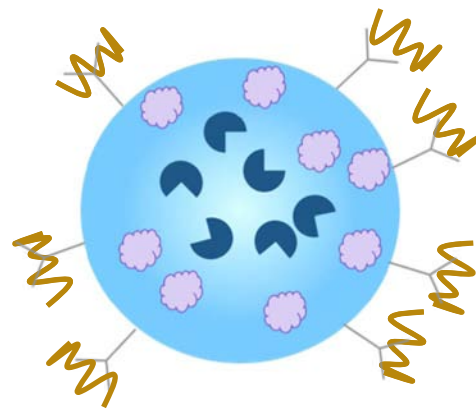
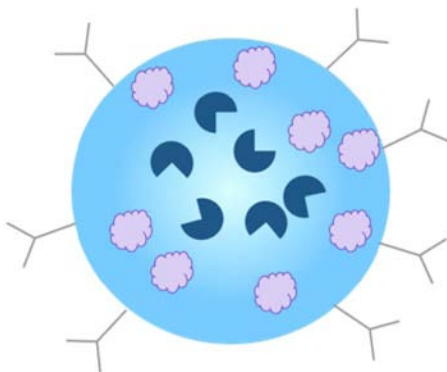
Immunoliposomes



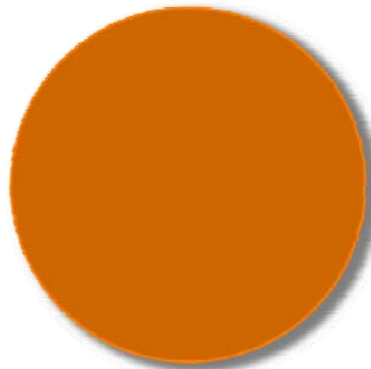
Immunoliposomes enter brain



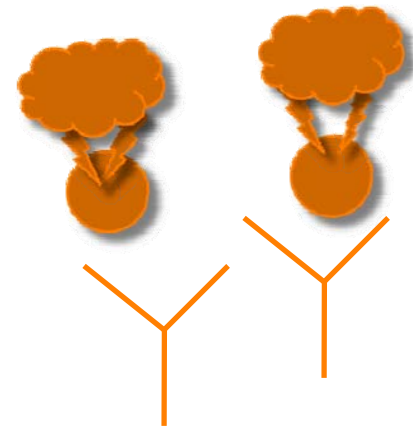
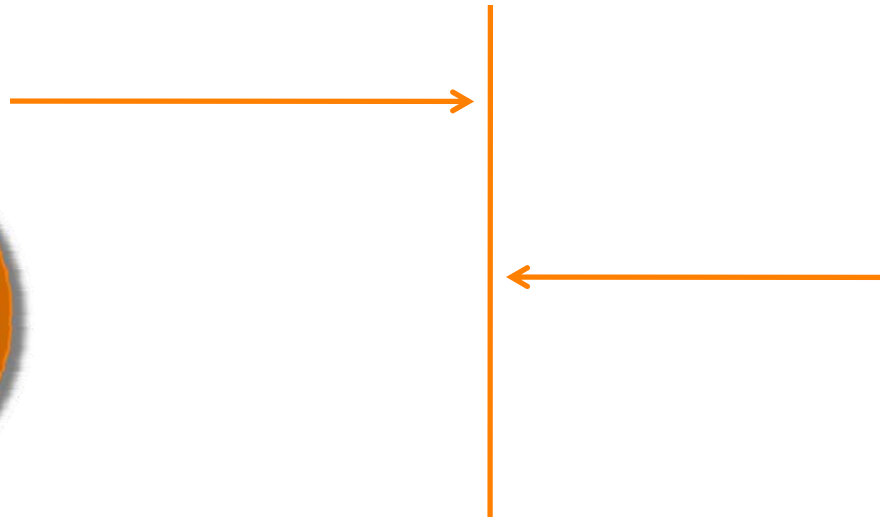
Releases the receptors and enzymes



Device Diagram



Immunoliposome
containing the
enzyme and receptors



Enzymes and
receptors will
capture and break
down adenosine

Time Diagram

A

Immunoliposomes enter brain.

B

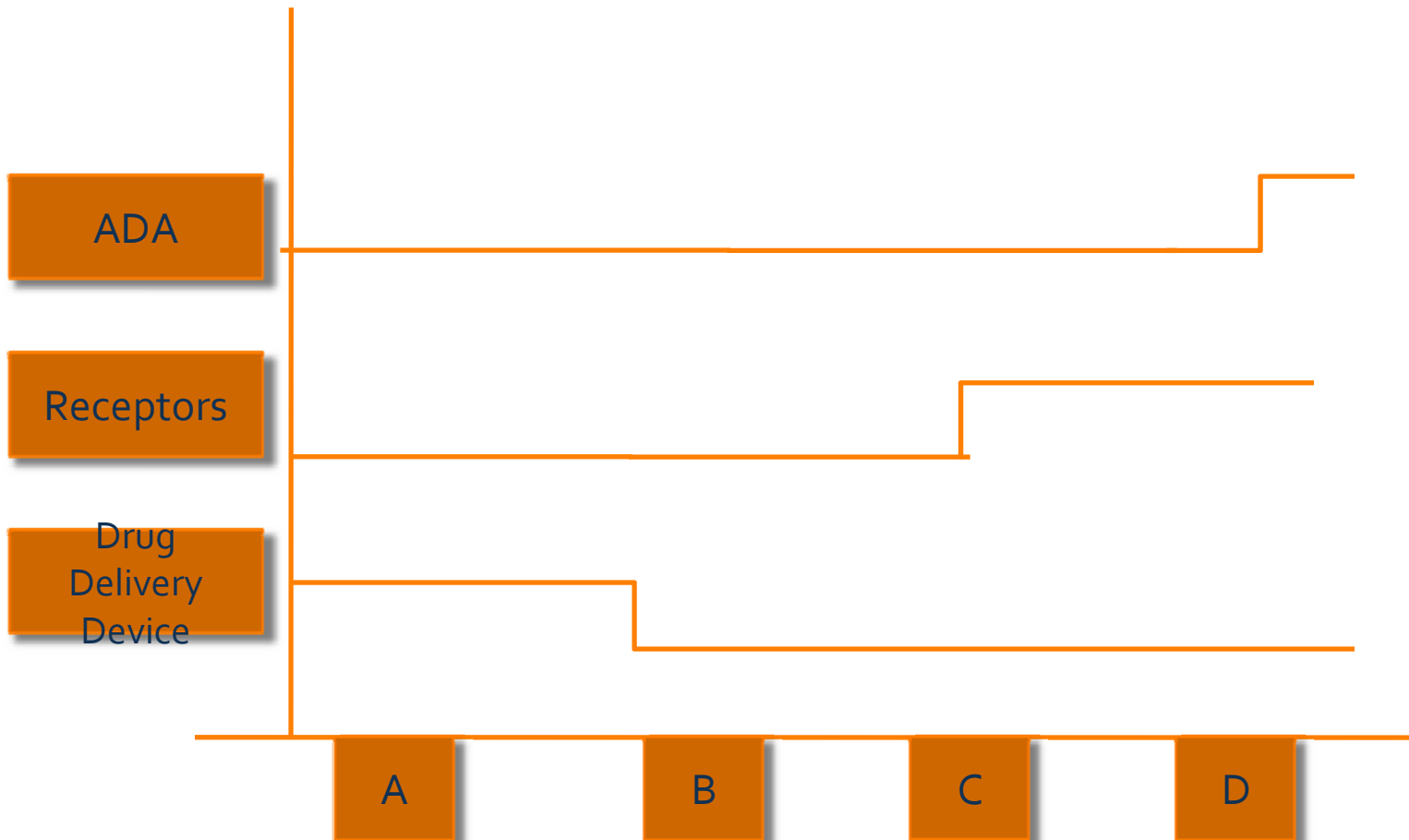
Immunoliposome opens, releases system.

C

Receptors attach to extracellular adenosine

D

ADA breaks down adenosine held in receptors



Testing

+ Testing parts *in vitro*

- + Immunoliposome
 - attaching antibodies
 - inserting receptors and enzyme
- + Adenosine attachment to receptor
- + Effectiveness of ADA

+ Testing system *in vivo*

- + Trials with mice
 - Drug delivery system
 - Side effects of system components
 - Side effects of delaying sleep
- + Trials with humans
 - Similar steps

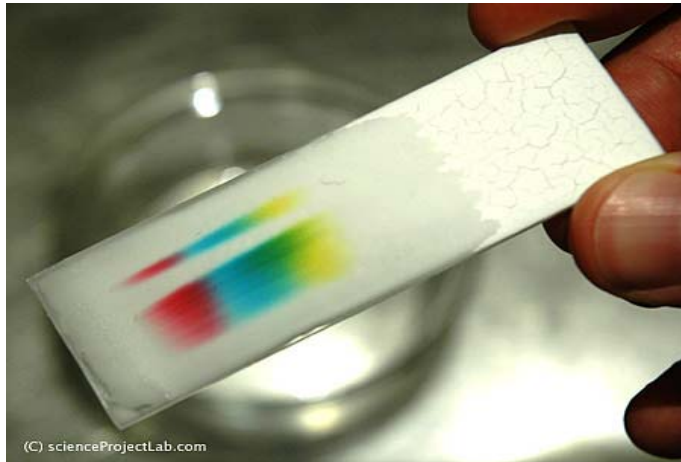
Adenosine Receptor/Enzyme Testing

+ Adenosine Receptor

- + Add determined amount of receptor to adenosine solution
- + Use chromatography to determine efficacy of receptors

+ Adenosine Deaminase

- + Create solution with known amount of adenosine
- + Add ADA, measure change in adenosine levels
 - + Can use methylene blue-based detector for adenosine



(C) scienceProjectLab.com

Photo courtesy of ScienceProjectLab.com. Used with permission.
<http://www.scienceprojectlab.com/ink-chromatography-cool-picture-004.html>

Immunoliposome Testing

- + Two steps to test:
 - + Attach antibodies
 - + Insert receptors and enzyme
- + Can use chromatography after each step
 - + Separates particles by mass
 - + Only select immunoliposomes with specific mass (i.e., successful attachment of antibodies or insertion of contents)

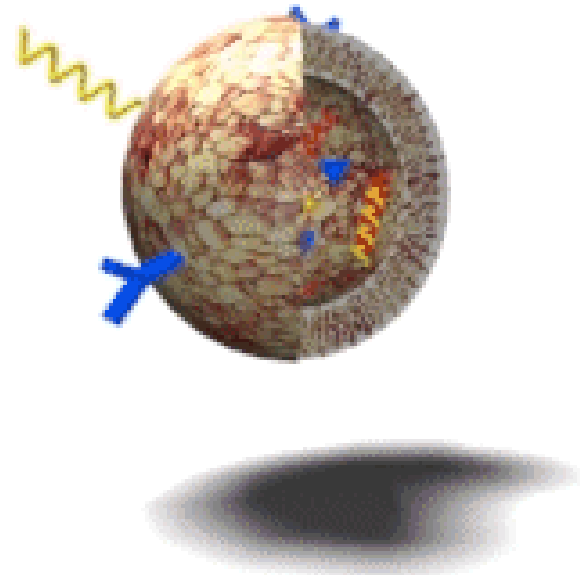


Image courtesy of Reto A. Schwendener Ph.D.
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Unknowns

- + Purpose and effects of sleep
- + Other factors that cause tiredness in the brain
- + Possible side effects
- + How much receptor/enzyme should we use?
 - + Test with different doses
- + Feasibility

Safety, Security, and Ethical Issues

- + System emulates a natural process in brain
 - + No side effects from system parts or treatment itself (theoretically)
 - + Unknown effects of delaying sleep for extended periods
- + Must always exercise caution when inserting substances into brain
- + Possible ethical issues?
 - + “Cheating” sleep?

Questions?

MIT OpenCourseWare
<http://ocw.mit.edu>

20.020 Introduction to Biological Engineering Design
Spring 2009

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