Sleep-B-Gone
(not quite...)

Three anonymous MIT students
Why sleep?

- Humans spend 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
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

<table>
<thead>
<tr>
<th>PARTS</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liposome</td>
<td>DSPE-PEG</td>
</tr>
<tr>
<td>Monoclonal Antibody</td>
<td>OX26</td>
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<tr>
<td>Adenosine Deaminase</td>
<td>608958</td>
</tr>
<tr>
<td>Adenosine Receptor</td>
<td>ADORA1</td>
</tr>
<tr>
<td>Transcription Terminators</td>
<td>TL1</td>
</tr>
<tr>
<td>Promoter</td>
<td>PEC3786</td>
</tr>
<tr>
<td>Receptor-Associated Protein of Synapse</td>
<td>RAPSN</td>
</tr>
</tbody>
</table>

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

- Adenosine deaminase
- Immunoliposome
- Antigen
- Adenosine receptor
- Antibody
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
Immunoliposomes enter brain.

Receptors attach to extracellular adenosine

Immunoliposome opens, releases system.

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

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)

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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?