# Pharmaceutical production in deep space using microbes

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## Problem

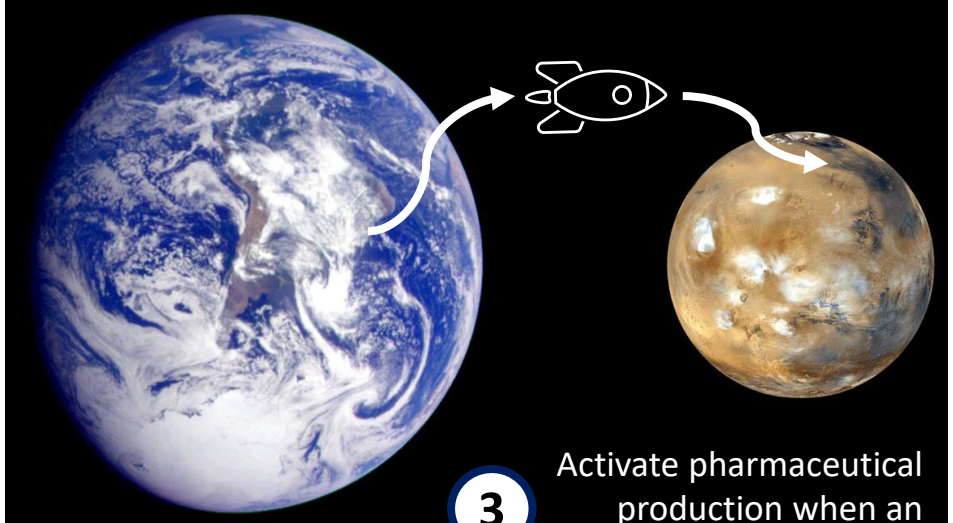
Significant risks to human health during long-duration spaceflight beyond LEO will require pharmaceutical intervention

**Transporting pharmaceuticals will not be feasible:**

- Mass & volume constraints
- Limited shelf-life & refrigeration
- Reduced drug stability in space

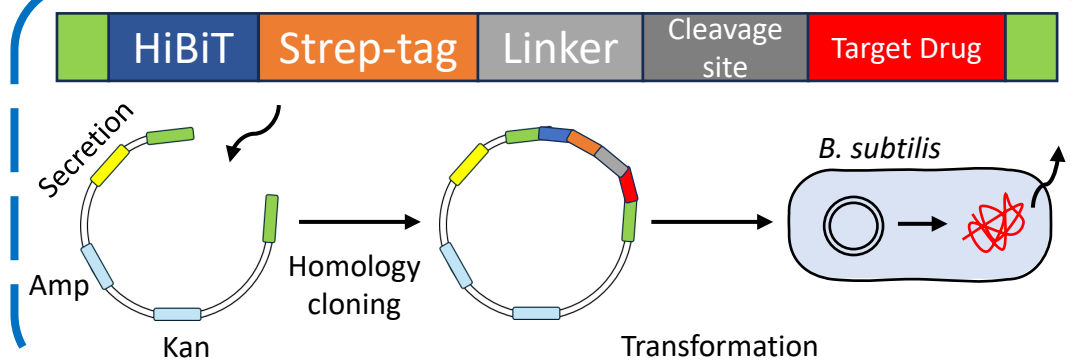
## Solution

1. On Earth, engineer microbes to produce pharmaceuticals. Put microbes into spore form.
2. Transport spores & Astropharmacy hardware with astronauts.
3. Activate pharmaceutical production when an astronaut gets sick.



## How do we produce pharmaceuticals using microbes?

1. Genetic engineering of *Bacillus subtilis*




2. Detection

HiBiT to confirm secretion of target protein

HiBiT sequence interacts with reagent to luminesce

3. Purification & Concentration

- Strep-Tactin®XT spin columns that bind Strep-tagged protein
- Pierce™ protein concentrators

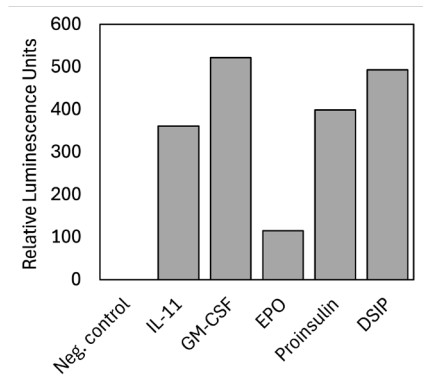
4. Quantification & Identification

- BCA assay for quantification
- Protein gel electrophoresis and western blot to confirm identity

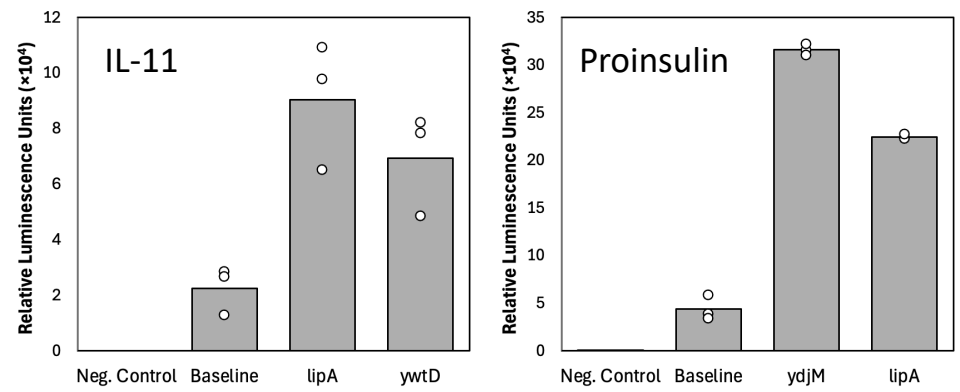
## Results

Expressed **5 new peptides**

Interleukin 11, molgramostim, proinsulin, erythropoietin, delta sleep-inducing peptide




Screened **secretion peptides** for IL-11 and proinsulin




Work in Progress

- Secretion peptide screening for other drugs
- Purification optimization
- Protein identity confirmation (gel & western blot)