Trash to Treasure: Accelerating Composting

Anonymous students CL and SJ
Compost: The Problem

- Naturally takes a year
- Bacteria operate within different temperature zones
  - 0-40°C – mesophilic topsoil bacteria
  - 40-55 °C – thermophilic bacteria ~ similar to hot-springs
- Actinomycetes
  - Dirt smell
  - Breaks down complex organics

Figure by MIT OpenCourseWare.
Goal:

- Accelerate the speed of composting
Solution: Compost Pearls

~1cm

- Thin Protecting Material
- Cell Growth Space
- Sorbant Material
- Magnetic Core
Compost Acceleration

Pearl Harvesting

Hydrocarbon Extraction
Description

- Pearl covered with 2 cell types: Type A and Type B
- Type A has cellulase over-expression
  - Lyses and releases cellulase into surrounding area
- Type B converts cellulose to hydrocarbons
  - Uses pathway of Gliocladium roseum
- Spongy Core to trap hydrocarbons when they are produced
- Metal at the center for easy retrieval
Overall System
2 Methods

- **E-coli**
  - Uses predator-prey model to regulate level of strain A compared to strain B

- **Yeast**
  - Uses mother-daughter cells to regulate level of strain A compared to strain B

Courtesy of Sajith Wickramasekara. Used with permission.
E. Coli Pathway Design

Strain A

Strain B
Timing Diagram

Ecoli Timing

Maximum Hydrocarbon Production

Cell Death/Cellulase Release

Strain A

Strain B
Yeast

Yeast Pathway Design
Timing Diagram

Yeast Timing

Quorum Reached/Brc1 trigger

Cell Death/Cellulase Release

Strain B

Strain A
## Description of Parts

<table>
<thead>
<tr>
<th>Main Parts</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Cellulase</td>
<td>Trichoderma reesei</td>
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<tr>
<td>Hydrocarbon Production</td>
<td>Gliocladium roseum</td>
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</tbody>
</table>

### Yeast Chassis:

<table>
<thead>
<tr>
<th>Part</th>
<th>Name</th>
<th>Availability</th>
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<tbody>
<tr>
<td>Const. Promoter</td>
<td>BBa_I766555</td>
<td>RSBP</td>
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<tr>
<td>Inverter</td>
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<td>Unknown</td>
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<tr>
<td>Three-hybrid System</td>
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<td>Genome</td>
</tr>
<tr>
<td>Brc1</td>
<td>n/a</td>
<td>Synthesis</td>
</tr>
<tr>
<td>Cytokin Quorum System</td>
<td>n/a</td>
<td>Weiss</td>
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<tr>
<td>Daughter HO Promoter</td>
<td>n/a</td>
<td>Genome</td>
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</table>
## Description of Parts

<table>
<thead>
<tr>
<th>E. Coli Chassis:</th>
<th>Indole Deficient</th>
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<tbody>
<tr>
<td><strong>Part</strong></td>
<td><strong>Name</strong></td>
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<tr>
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<tr>
<td>Tet Inverter</td>
<td>BBa_Q04400</td>
</tr>
</tbody>
</table>
Plan for Testing/Debugging

- Debug each pathway separately
- Build basic population functions first
- Test hydrocarbon synthesis
Impact of Solution

- Faster compost
- Can be used in places like restaurants
- Collectable balls with hydrocarbons to use as fuels
- Non industrial solution
Concerns

- Difficult to synchronize populations
- Animals will eat pearls
- Lack of research done on gliocladium roseam pathways
- Yeast vs. E. coli
Proceed with caution...