3 Ideas Presentation

Team T³ – Trash to Treasure

Cory, Amber, Saloni, Julie
Problems with trash

- 251 million tons of solid waste generated in 2006 (US)
- 3091 active landfills in the US. Over 10k inactive
- 82 percent of landfills have leaked
- Every square mile of ocean has 46,000 floating pieces of trash
8% glass
10% plastic
5% wood
30% paper
10% metal
5% rubber
15% yard trimmings
15% food scraps
2% everything else
3 Ideas

Solving environmental waste

- Compost Acceleration
- Green Compounds Synthesis
- Inorganic Breakdown
Solving environmental waste

Compost Acceleration

- Green Compounds Synthesis
- Inorganic Breakdown
Compost Acceleration
Overview

• 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
Goal

- Use microbes to accelerate the decomposition process
  - Reduction of cycling stages
  - Temperature tolerance increase
  - Metabolic engineering
  - Systems design, tuning and control
Compost Acceleration

<table>
<thead>
<tr>
<th>Challenge Importance</th>
<th>Solution Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Limited composting today</td>
<td>• Global Impact</td>
</tr>
<tr>
<td>• Landfills continue to grow</td>
<td>▪ Eliminate waste in landfills</td>
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<tr>
<td>▪ Locks up potential resources</td>
<td>▪ More recycling</td>
</tr>
<tr>
<td></td>
<td>▪ Possibility of converting</td>
</tr>
<tr>
<td></td>
<td>waste to energy</td>
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<td>▪ Increase soil nutrients</td>
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</table>
Compost Acceleration

<table>
<thead>
<tr>
<th>Knowns</th>
<th>Unknowns</th>
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</thead>
<tbody>
<tr>
<td>• Soil bacteria already characterized</td>
<td>• Bacterial regulation</td>
</tr>
<tr>
<td>• Metabolic pathways</td>
<td>• Cost</td>
</tr>
<tr>
<td>• Public understands basic composting</td>
<td>• Maximum rate of decomposition</td>
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<td></td>
<td>• Technology acceptance</td>
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<td>• Product usage, disposal &amp; distribution</td>
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</tbody>
</table>
Competing Technologies

- Composition technology virtually unchanged for centuries
- New methods exist for acceleration
  - Active upkeep
  - Chemistry knowledge
  - Not practical
Solving environmental waste

Compost Acceleration

Green Compounds Synthesis

Inorganic Breakdown
Inorganic Breakdown
Overview

- Preliminary bioremediation exists
- Breaks down toxic compounds into natural environmental compounds
- Also sequestering and cleanup of toxins
Goal

- Getting rid of environmental toxins in a safe and cost-efficient way through microbes
  - Lead
  - Cadmium
  - Sodium Chloride
  - Nuclear waste
### E-Waste Toxic Components and their Damage to Human Health

<table>
<thead>
<tr>
<th>Toxic Materials</th>
<th>Birth Defects</th>
<th>Brain Damage</th>
<th>Heart, Liver, Lung &amp; Spleen Damage</th>
<th>Kidney Damage</th>
<th>Nervous/Reproductive System Damage</th>
<th>Skeletal System Damage</th>
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</thead>
<tbody>
<tr>
<td>Barium</td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Cadmium</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Lead</td>
<td>X</td>
<td></td>
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<td>X</td>
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<tr>
<td>Lithium</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
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<td>X</td>
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<tr>
<td>Mercury</td>
<td>X</td>
<td>X</td>
<td></td>
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<td></td>
<td>X</td>
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<tr>
<td>Nickel</td>
<td>X</td>
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<td>X</td>
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<tr>
<td>Palladium</td>
<td>X</td>
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<td></td>
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<tr>
<td>Rhodium</td>
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<td>X</td>
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<tr>
<td>Silver</td>
<td>X</td>
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Source: EPA-Municipal Solid Waste in the United States

Without safe recycling, most of these toxic components will end up in landfill - poisoning the soil and water.

500 MILLION electronic units are waiting to be safely recycled in the U.S. today!
Inorganic Breakdown

**Challenge Importance**
- Human Disease Causing
  - Neurological disorders (Parkinson's, Alzheimer's, etc),
  - Allergies
  - Hormonal imbalances, etc
  - Degradation in quality of life
- Environmentally Damaging
  - Affects ocean, fish, and other inhabitants of the earth

**Solution Impact**
- Great consequences for not only the United States, but the whole Earth
  - Fewer cases of diseases in all humans and other creatures.
## Inorganic Breakdown

<table>
<thead>
<tr>
<th>Knowns</th>
<th>Unknowns</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Several pathways exist for inorganic breakdown</td>
<td>• Side-effects</td>
</tr>
<tr>
<td></td>
<td>• Environmental impact after release</td>
</tr>
<tr>
<td></td>
<td>• Effectiveness</td>
</tr>
<tr>
<td></td>
<td>• Maintenance</td>
</tr>
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<td></td>
<td>• Circuit reliability (mutations)</td>
</tr>
</tbody>
</table>
Competing Technologies

- Bio-engineered plants
- Chemical / mechanical cleanup systems
- Filters
Solving environmental waste

- Compost Acceleration
- Green Compounds Synthesis
- Inorganic Breakdown
Green Compound Synthesis
Overview

- **Bioplasics**
  - Naturally produced as carbon storage mechanism
  - Biocompatible
  - Biodegradable
Goal

- Construction of a comprehensive synthesis platform primarily for bioplastics
  - Tuning
  - Controllability
  - High output
# Green Compound Synthesis

## Challenge Importance
- Towards millennium goal of sustainability
- Reduce dependence on limited natural resources
- Reduce both waste and toxicity

## Solution Impact
- Depends on the cost
  - Low cost alternative would provide huge impact
- Improvements in medical tools and care
## Green Compound Synthesis

<table>
<thead>
<tr>
<th><strong>Knowns</strong></th>
<th><strong>Unknowns</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>• Various biopolymers and</td>
<td>• Circuit optimization</td>
</tr>
<tr>
<td>related pathways</td>
<td>• Maximum allowable metabolic</td>
</tr>
<tr>
<td>• Enzymatic activity and output</td>
<td>strains</td>
</tr>
<tr>
<td>• Reactor-level optimizations</td>
<td>• Cost / Efficiency</td>
</tr>
<tr>
<td></td>
<td>• Yield</td>
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<tr>
<td></td>
<td>• Reaction mechanisms</td>
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<td></td>
<td>• Granual formation, termination</td>
</tr>
</tbody>
</table>
Competing Technologies

- PLAs
  - Corn-starch / Sugarcane derivative
- Plant-based production
- Re-engineered conventional plastics
- New plastic recycling techniques
Summary

• Reduction of overall environmental pollution
  ▫ Acceleration of composting
  ▫ Inorganic breakdown and sequestering
  ▫ Improved synthesis of green compounds
Sources

• “Trash Lady” http://i.ivillage.com/green/90k_lb_trash_lady.jpg