3 Ideas Presentation

Team T^3 – Trash to Treasure

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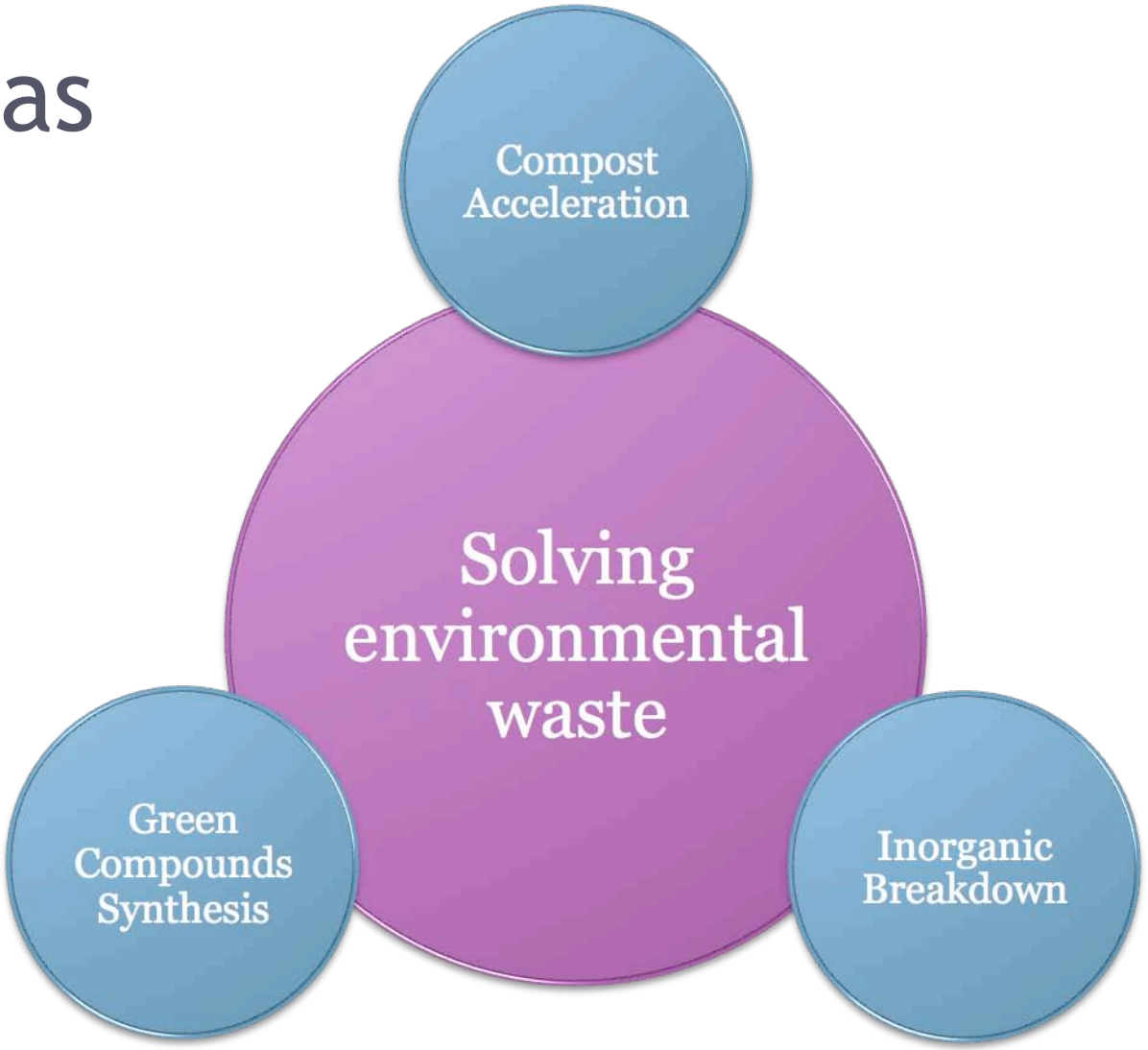
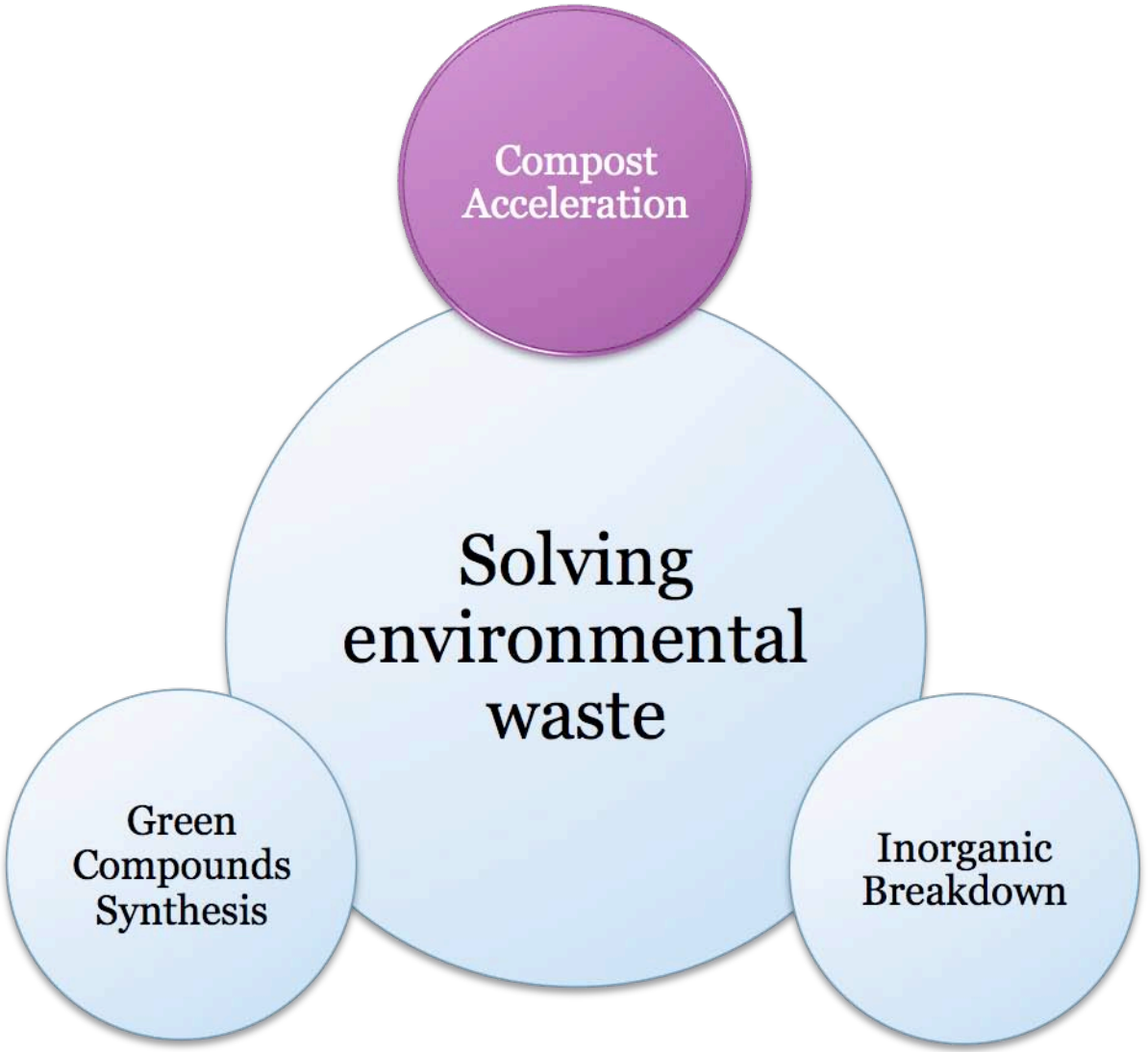
Problems with trash

- 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

3 Ideas


Compost Acceleration
Solving environmental waste
Green Compounds Synthesis
Inorganic Breakdown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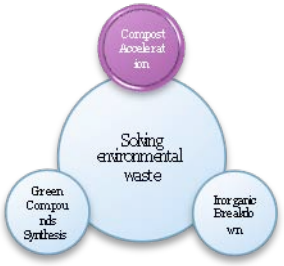
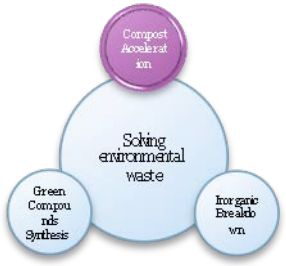


Compost Acceleration



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

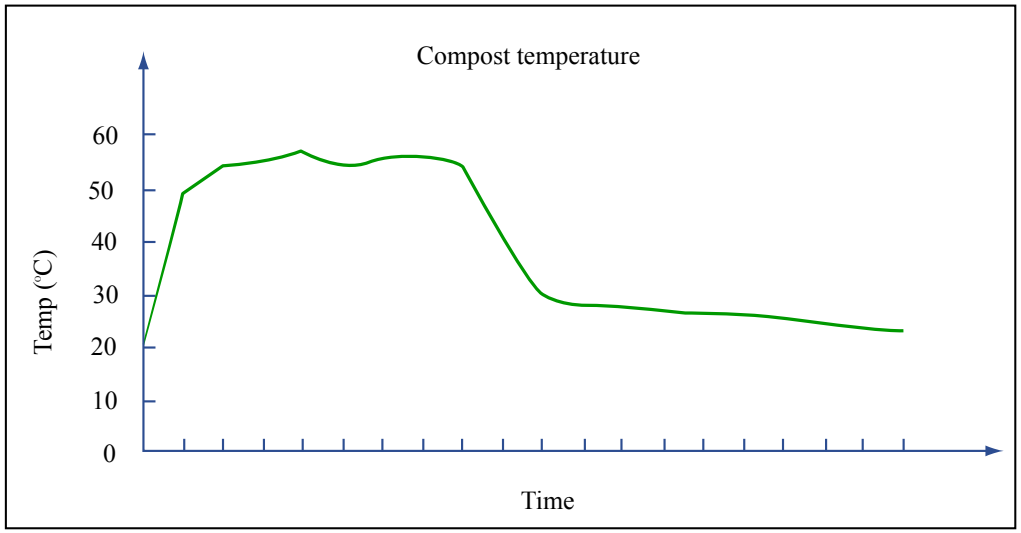
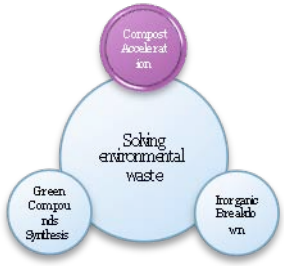
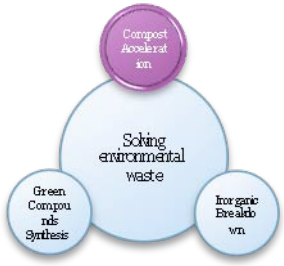


Image by MIT OpenCourseWare, after Cornell Waste Management Institute



Goal

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



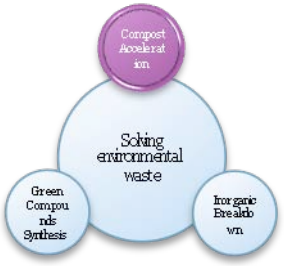
Compost Acceleration

Challenge Importance

- Limited composting today
- Landfills continue to grow
  - Locks up potential resources

Solution Impact

- Global Impact
  - Eliminate waste in landfills
  - More recycling
  - Possibility of converting waste to energy
  - Increase soil nutrients



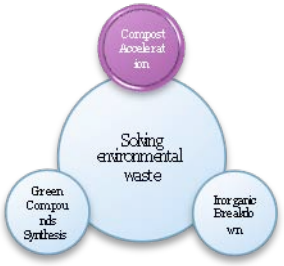
Compost Acceleration

Knowns

- Soil bacteria already characterized
- Metabolic pathways
- Public understands basic composting

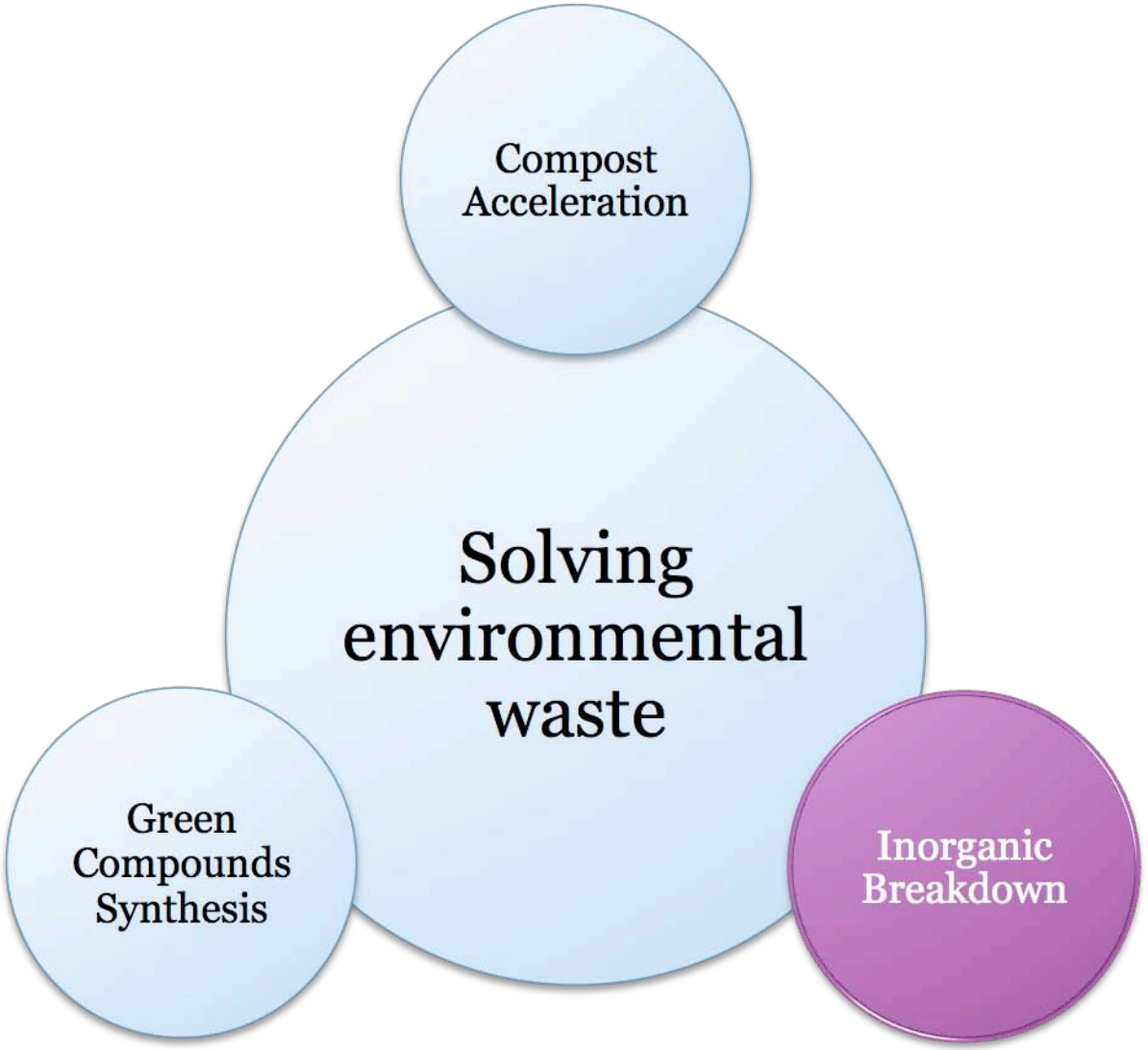
Unknowns

- Bacterial regulation
- Cost
- Maximum rate of decomposition
- Technology acceptance
- Product usage, disposal & distribution



Competing Technologies

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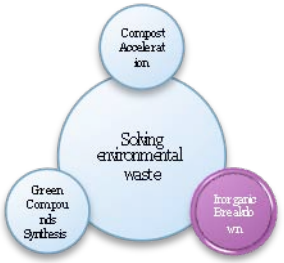

Inorganic Breakdown

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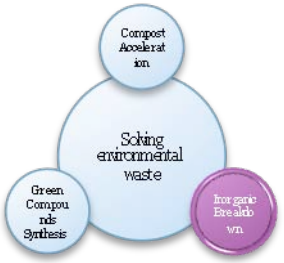
Mercury.



Overview

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

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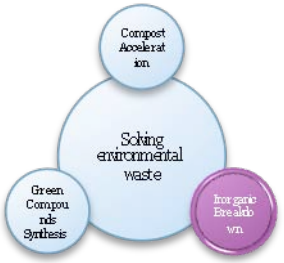
Schematics of processes for enzyme enhanced and petroleum bioremediation.



Goal

- Getting rid of environmental toxins in a safe and cost-efficient way through microbes
  - Lead
  - Cadmium
  - Sodium Chloride
  - Nuclear waste

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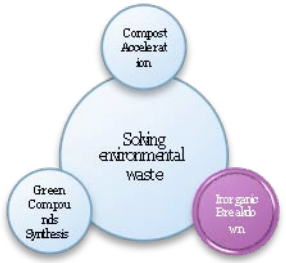
a) Graph showing growth in U.S. electronics units: "500 Million units are waiting to be safely recycled today..."
b) Table outlining correlations between toxic materials in electronics and human health risks.



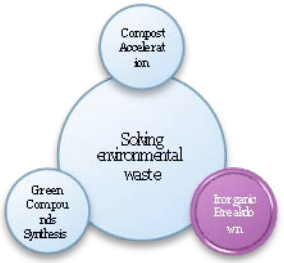
Inorganic Breakdown

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.



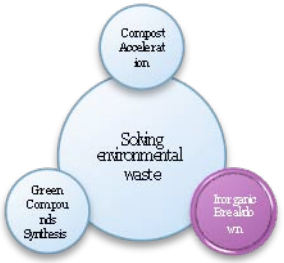
Inorganic Breakdown

Knowns

- Several pathways exist for inorganic breakdown

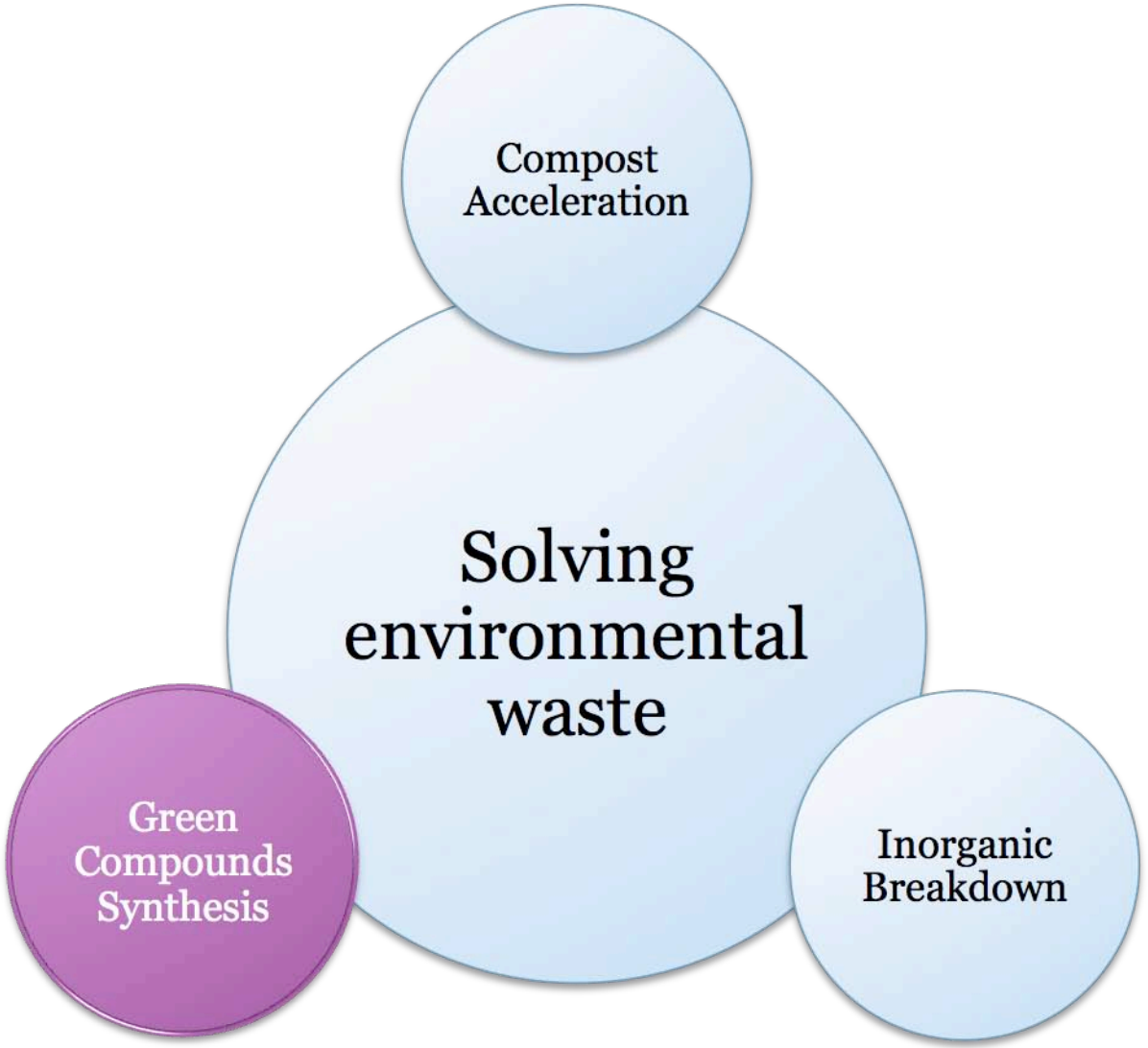
Unknowns

- Side-effects
- Environmental impact after release
- Effectiveness
- Maintenance
- Circuit reliability (mutations)



Competing Technologies

- Bio-engineered plants
- Chemical / mechanical cleanup systems
- Filters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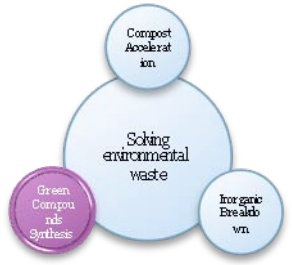
Green Compound Synthesis

Overview

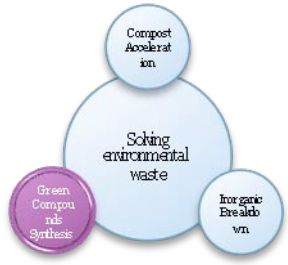
- Bioplasics
  - Naturally produced as carbon storage mechanism
  - Biocompatible
  - Biodegradable

Photo removed due to copyright restrictions.
Degradation of P(3HB-3HV) bottles in aerobic sewage sludge.
Figure 2 in Madison, L. L., and G. W. Huisman. "Metabolic Engineering of Poly(3-Hydroxyalkanoates): From DNA to Plastic." *Microbiol Mol Biol Rev 63,* no. 1 (March 1999): 21–53.



Goal

- Construction of a comprehensive synthesis platform primarily for bioplastics
  - Tuning
  - Controllability
  - High output



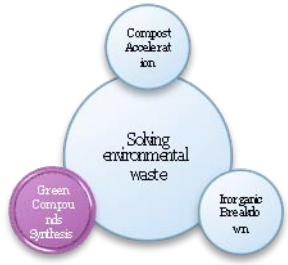
Green Compound Synthesis

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



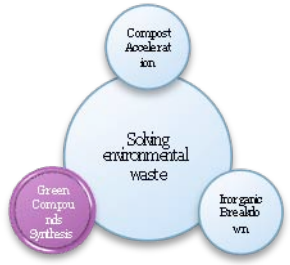
Green Compound Synthesis

Knowns

- Various biopolymers and related pathways
- Enzymatic activity and output
- Reactor-level optimizations

Unknowns

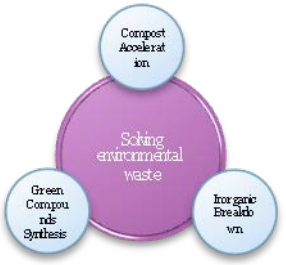
- Circuit optimization
- Maximum allowable metabolic strains
- Cost / Efficiency
- Yield
- Reaction mechanisms
- Granual formation, termination



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

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20.020 Introduction to Biological Engineering Design

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