Designing Systems for Enzymatic Plastic Degradation

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With plastics accumulating across the globe – harming the oceans and other ecosystems – ***taking action now*** *to reduce plastics ahead of the curve with respect to government, consumer, and customer demands for action is critical to protecting the environment.*

---Bengt von Schwerin
South East Asia Business Unit Managing Partner
Environmental Resources Management (ERM)

Problem with Plastics

- Unsustainable
- Plastic pollution
  - Too much plastic!
  - Microplastics
- Health risks

Great Pacific Garbage Patch

Current Solutions

Incineration

Landfill

Shredding

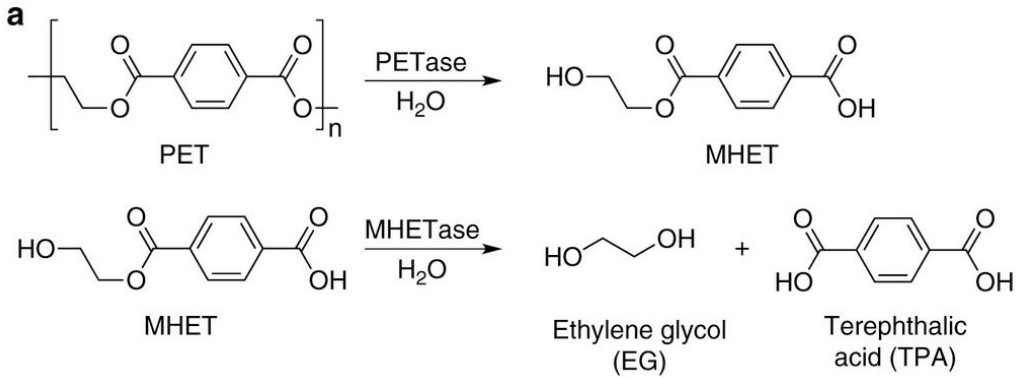
Our Idea:

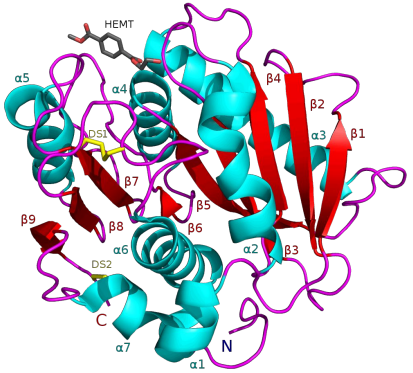
Create a process utilizing enzymes capable of breaking down and recycling plastic for a sustainable future.

Discovery of I. sakaiensis

- Sakai City, Japan
- Officially discovered in 2016
- Degrades polyethylene terephthalate (PET)

The Enzymes





PETase

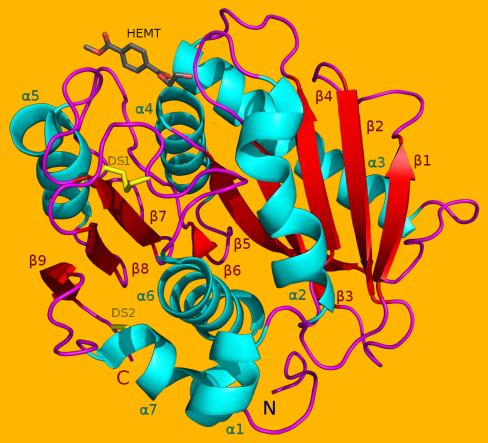
MHETase

Takes only 96 hours to degrade one plastic water bottle.

Why PETase?

- Environmentally friendly
- Substrate specific enzyme
- May be able to decompose a range of polyesters

Enzyme

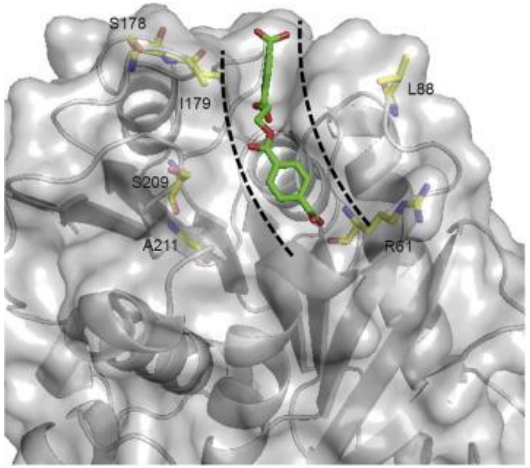


Vs.

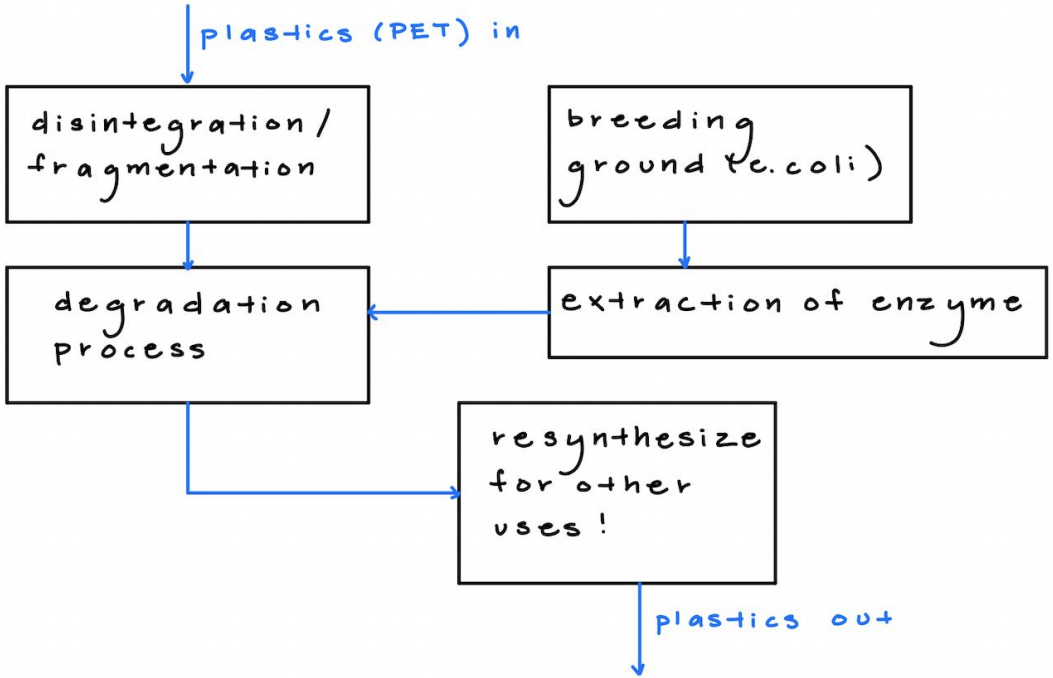
Bacteria

Optimizing PETase

- Altering the binding site
- Computer aided molecular design
  - 50% increase in degradation activity towards highly crystalline PET



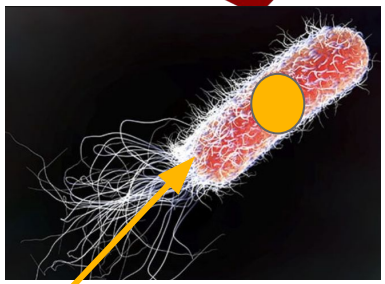
Process Overview



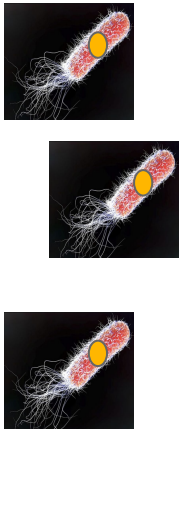
PETase Production

I.sakaiensis

PETase



E.coli



Lots of PETase

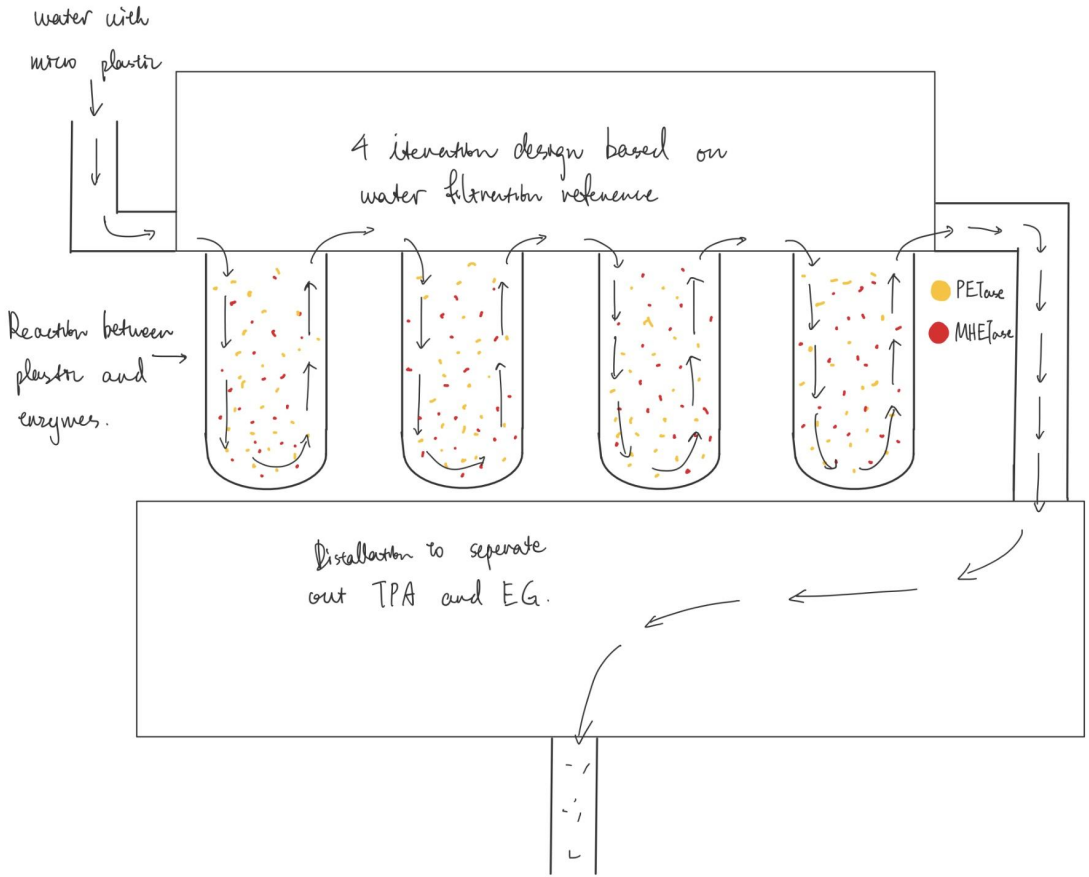
Degradation Process

- Inspired by water filtration systems
- Microplastic is pressurized and pushed through 4 cycles of enzyme degradation

Optimal Environment in the system:

Temp: 40 ˚C–70 ˚C

pH: 7–9


water with
micro plastic
4 iteration design based on
water filtration reference
Reaction between
plastic and
enzymes.
PETase
MHETase
Distallation to seperate
out TPA and EG.

The Limitations

- Restricted to PET plastic
- Exact logistics unknown
- Non-implementable: model and idea has a long way to go
- Costly

Impacts

- Sustainable: More efficient way of recycling PET plastics
- Cuts out emissions: Reduces carbon footprint
- Economical: EG and TPA produce - Variability

Next Steps

- Policy Advocacy
  - Producer responsibility
  - Push for new recycling technologies

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Thanks!

Any questions?

Designing an Enzyme