Ideonella sakaiensis, the Earth's saving bacteria?

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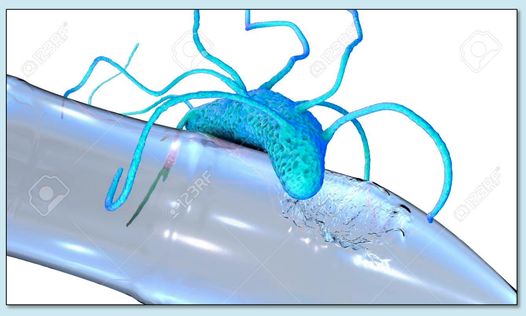
Introduction

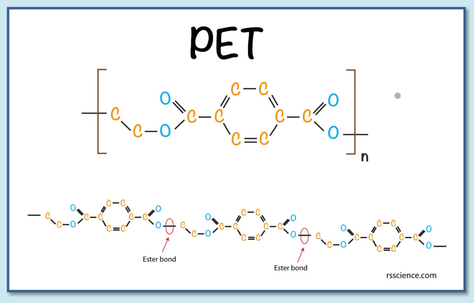
Plastic pollution is a global threat as plastics are rarely biodegradable. One of the most abundant plastic that contributes hugely to this situation is **polyethylene terephthalate (PET).**

PET is used largely in textiles, where it is commonly referred to as polyester, but it is also used as packaging for liquids and foodstuffs.

In 2016, researchers in Japan discovered that a unique bacterium, ***Ideonella sakaiensis*** was feeding on waste from an industrial PET recycling facility[3]. The bacterium had the amazing ability to degrade PET and use it as carbon and energy source. Central to this ability was the production of a PET-digesting enzyme, known as PETase.



What is PET ?



Polyethylene Terephthalate

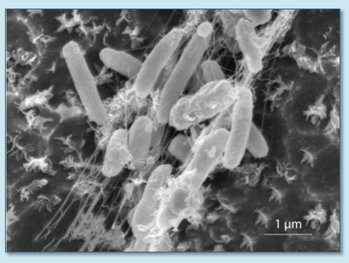
- Highly **water resistant**
- **Xenobiotic** chemical bonds
- Possesses multiples characteristics which renders its **biodegradation** very **difficult**
  - **High MW**
  - **Long-chain polymer structure**

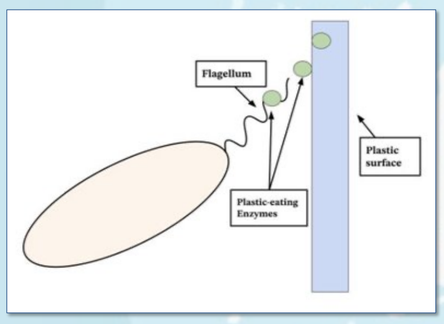
- **Synthetic polymer** made from non-renewable petrochemicals like fossil oil
- Found in products such as **plastic bottles**
- **300 million tons** produced per year
- More than **1 million** sea creatures die from it every year[4]

Ideonella Sakaiensis

What is *Ideonella Sakaiensis*?

- **Bacterium** capable of breaking down and consuming **PET**, using it as carbon and energy source.





Characteristics

- **Gram negative** (with thin cell wall and high lipid content): resistant abilities and genes; could include antibiotic resistance.
- **Flagellum**: mobility; adherence on PET; may also function to secrete PET-degrading enzymes onto the PET surface known as PETase.
- **Aerobic** aspect: can only grow in an oxygen-containing environment (ex: oxygen-rich soil, moist and aerated).

PET degradation

➢ *Is*PETase:

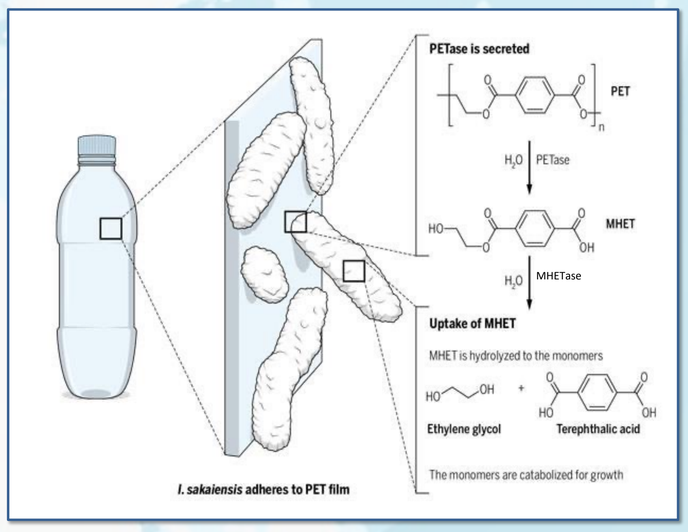
- High activity
- Low stability

➢ *Is*MHETase:

- High specificity

Four elementary **steps of degradation**[1] :

1. Nucleophilic attack
2. Bond cleavage
3. Nucleophilic attack
4. Deacylation



Conclusion

- *Ideonella sakalensis* is a **promising tool to fight plastic pollution**, one of the main challenges of our generation as plastics are rarely biodegradable and they can remain in the environment for centuries.
- The bacteria already caught the eye of young scientists, as Julia Stewart and Jacob Park, two fifth graders, created the concept of a Coagulation Filtration System for Toshiba's ExploraVision contest[6]. They thought of a process where IS would be engineered to survive in water to eat the plastic. Then water would be filtered, coagulated and flocculated to become drinkable.
- However, I.S is **not efficient.** In order to be used at great scale, it needs to be genetically modified to improve its rate of plastic degradation, which is today 0.13mg/24h.

Sources

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