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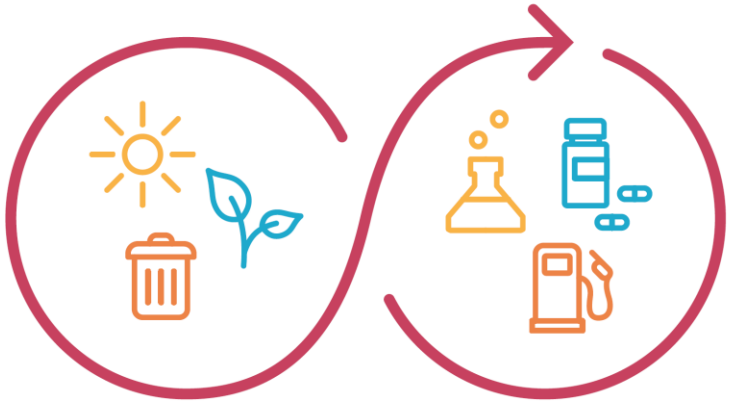
Biodegradable plastics



Group 7

Daniela Wicki, Guillaume Malherbe, Tomas Dubois, Côme Standaert, Anna-Maria Ceccucci, Pauline Blanc, Jonathan Ryser

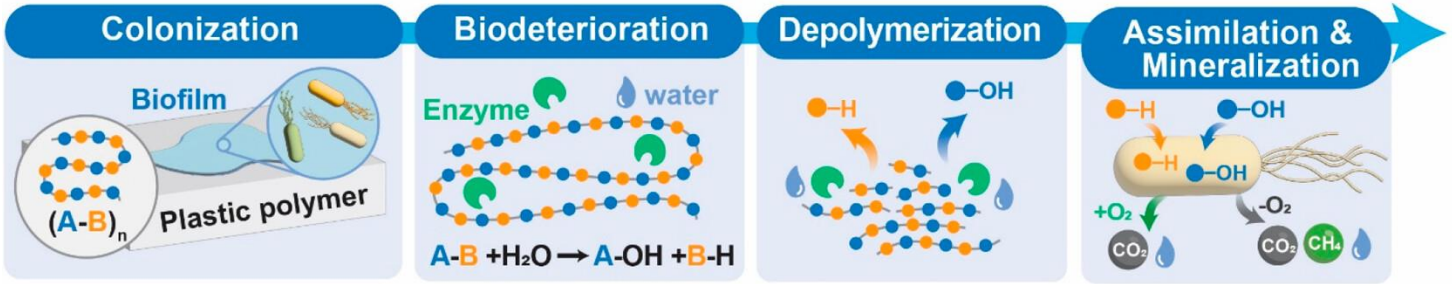
Biodegradable plastics

Definition :

Polymers that undergo **microbial degradation**, when **certain environmental conditions** are met.

Depends on :

- polymer chemical structure rather than raw material from which it's developed
- environmental conditions (temperature, oxygen, humidity and acidity)



A Review of Biodegradable Plastics: Chemistry, Applications, Properties, and Future Research Needs Min Soo Kim, Hochan Chang, Lei Zheng, Qiang Yan, Brian F. Pfleger, John Klier, Kevin Nelson, Erica L.-W. Majumder, and George W. Huber *Chemical Reviews* **2023** *123* (16), 9915-9939 DOI: 10.1021/acs.chemrev.2c00876

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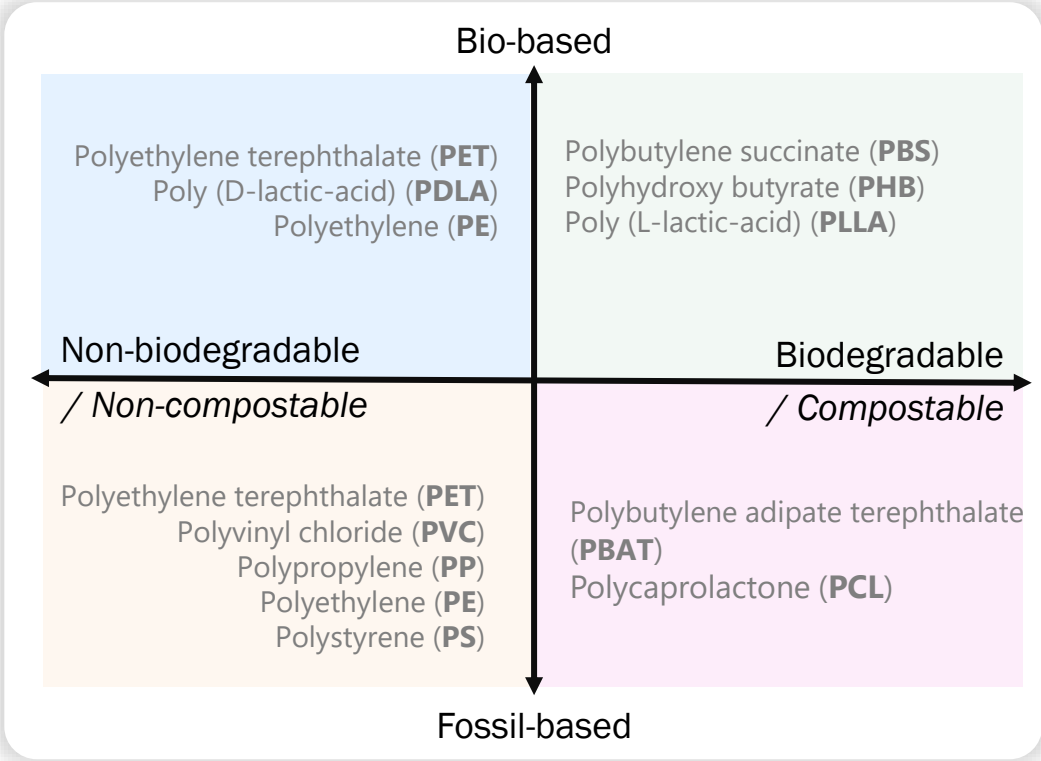
Terms that should not be confused

Bio-based
- Produced from biological material

Biodegradable
- Natural occurring degradation by microorganisms (bacteria, fungi, and algae)

Compostable
- Subset of biodegradable plastics
- Composting conditions:
  - high humidity
  - high oxygen
  - 55 ± 2°C (industrial) or 28 ± 2°C (home)



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Biodegradation time frame

Table I. Biodegradability of biodegradable plastics

Biodegradation	PBS	PCL	PBAT	PLA
Soil	85.1% after 150 days	99% after 136 days	21% after 180 days	16% after 180 days
Industrial compost	90% after 207 days	90% after 45 days	92% after 90 days	90% after 70 days
Home compost	N/A	90% after 88 days	N/A	N/A
Seawater	1% after 28 days	50% after 56 days	7% after 42 days	1% after 28 days
Aqueous (Aerobic)	2% after 117 days	77.6% after 117 days	2% after 117 days	2% after 117 days
Aqueous (Anaerobic)	3.1% after 77 days	4.5% after 77 days	2% after 77 days	4.6% after 77 days

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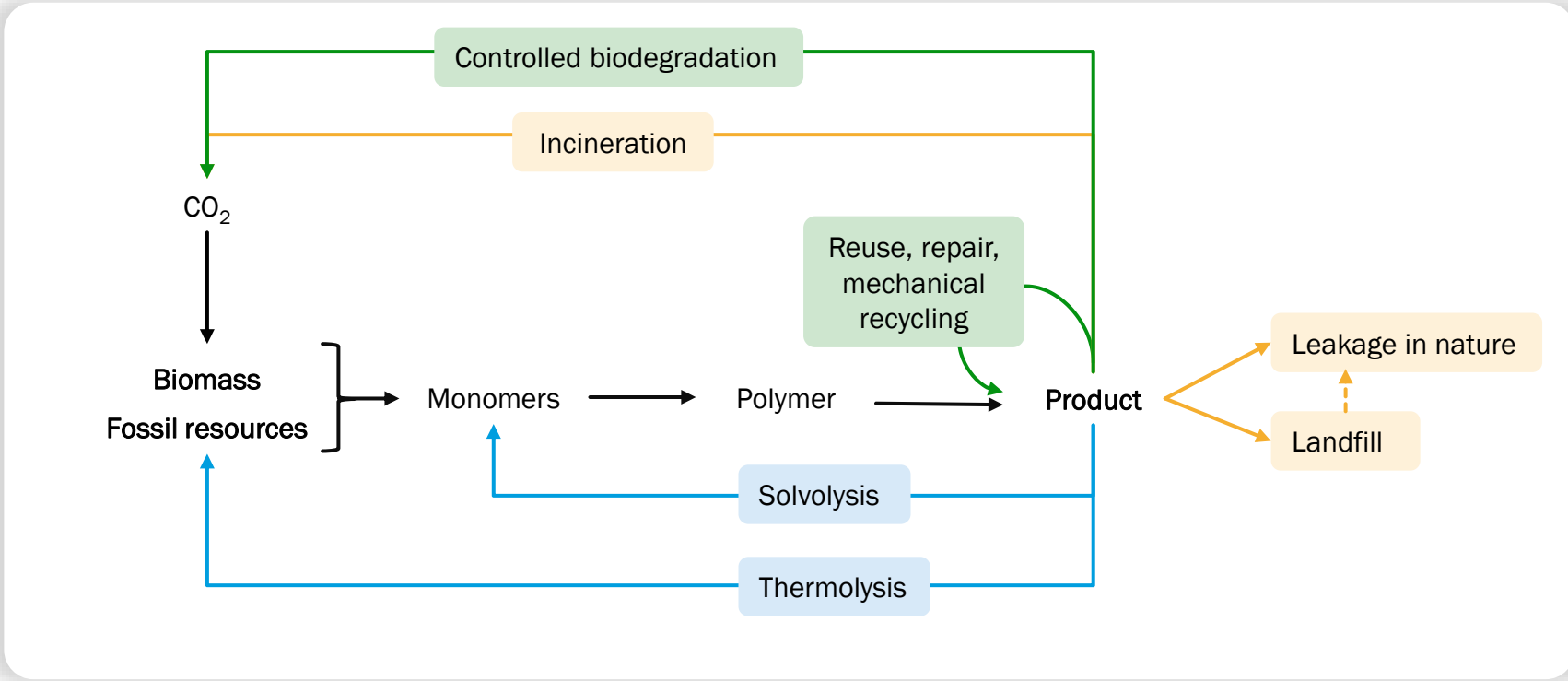
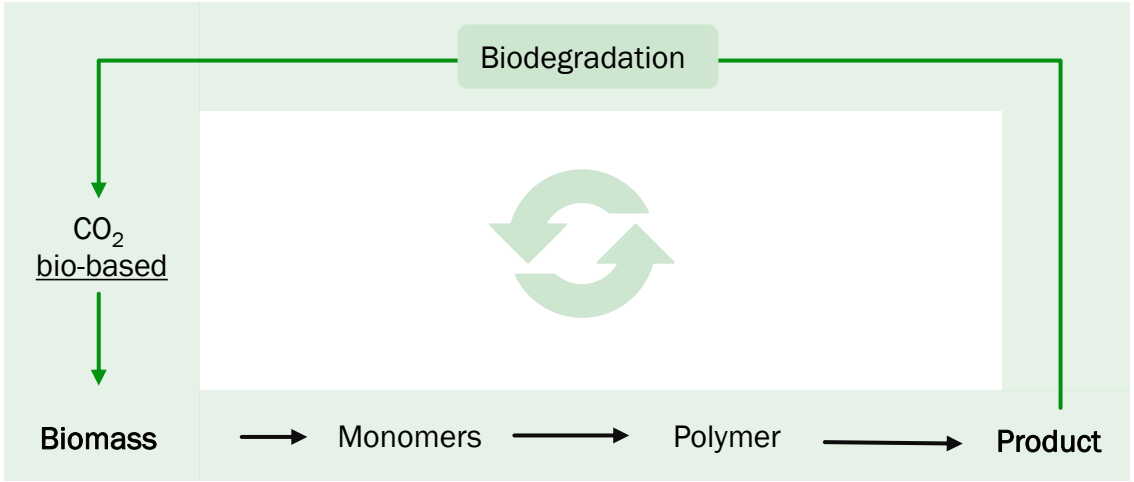
Biodegradability is a sustainable plastics end-of-life treatment



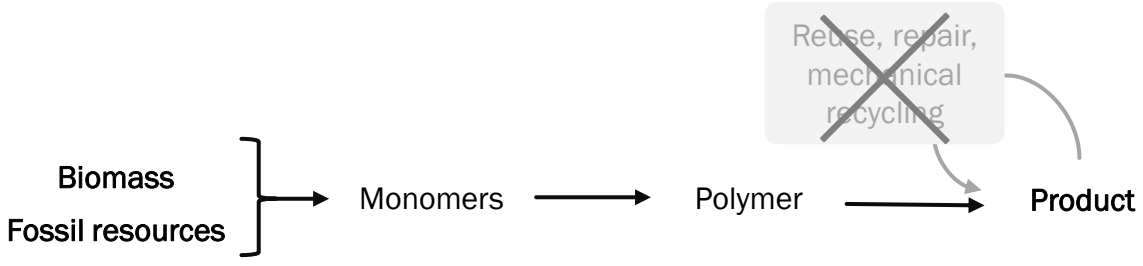
Biodegradability is a sustainable plastics end-of-life treatment

1 Controlled biodegradation is a way to create a sustainable carbon closed loop.



Biodegradability is a sustainable plastics end-of-life treatment

2 Composting is more sustainable than landfill, incineration and natural leakage.



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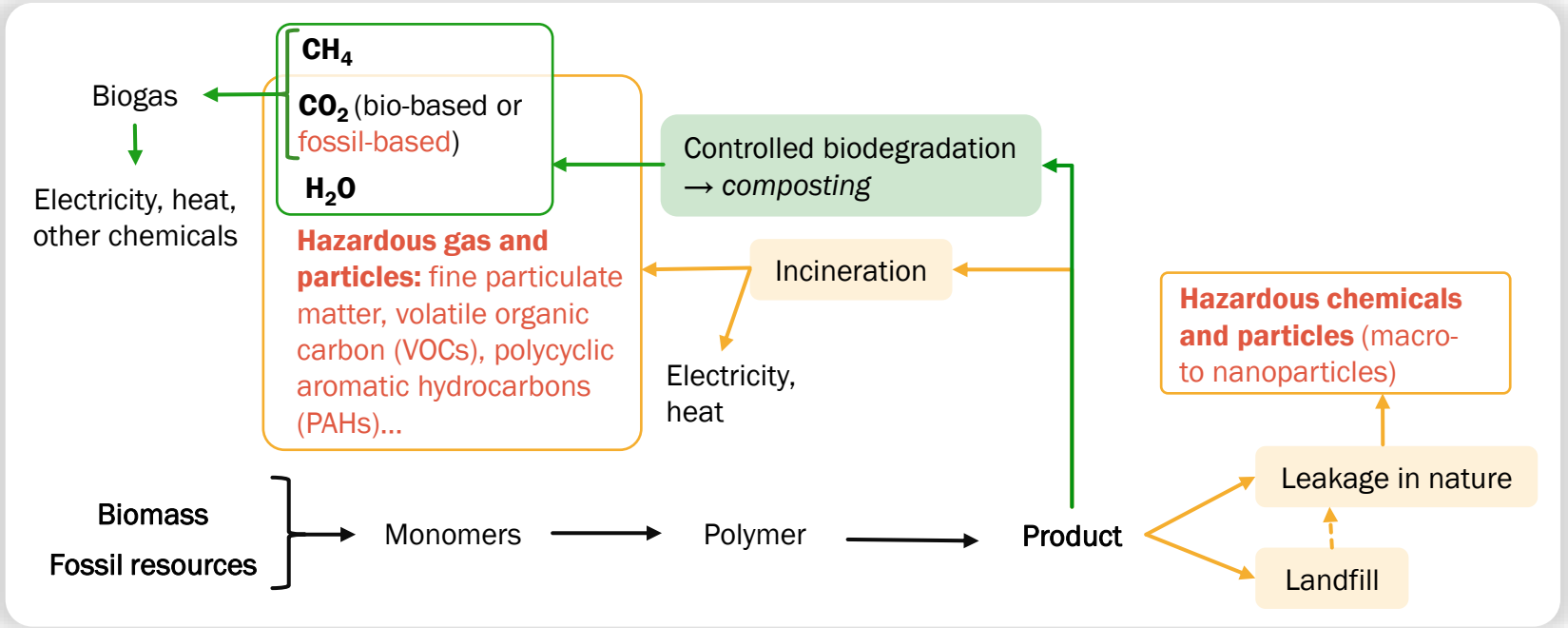
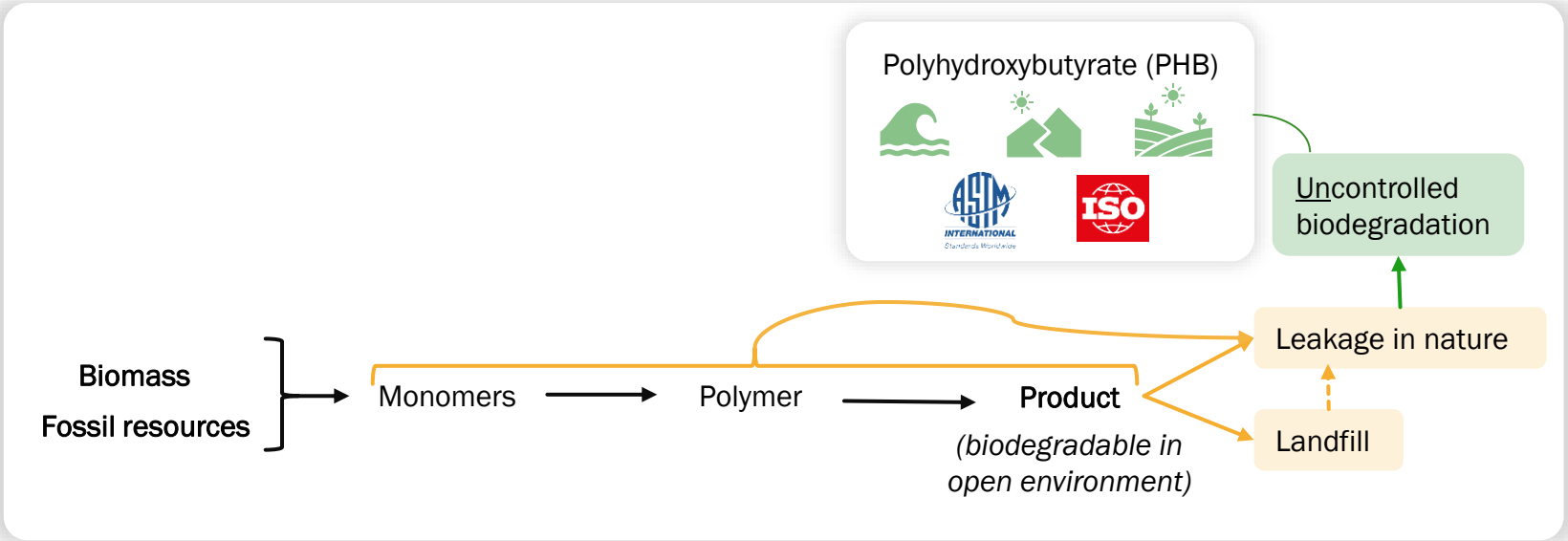


Biodegradability is a sustainable plastics end-of-life treatment

3 If a plastic *"is intrinsically biodegradable in the open environment, biodegradation reduces the likely permanence time and the risks that result from the product's persistence and accumulation."* Degli Innocenti & Breton



Biodegradable plastics have applications in many fields

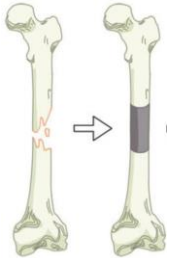
Plastic management

food-plastic contamination
(= heterogenous waste)

✗ other recycling

✓ biodegradation

Biomedical



- bones scaffold
- sutures
- wound dressing
- medical screw
- drug delivery systems

...

Agriculture

✓ Easier to manage

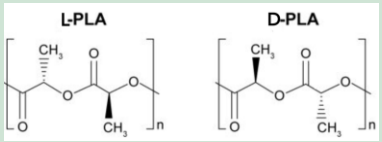
✗ Also leak microplastics

But biodegradable plastics are not miraculous

Misconceptions lead to littering increase

Biodegradation requires specific facilities.

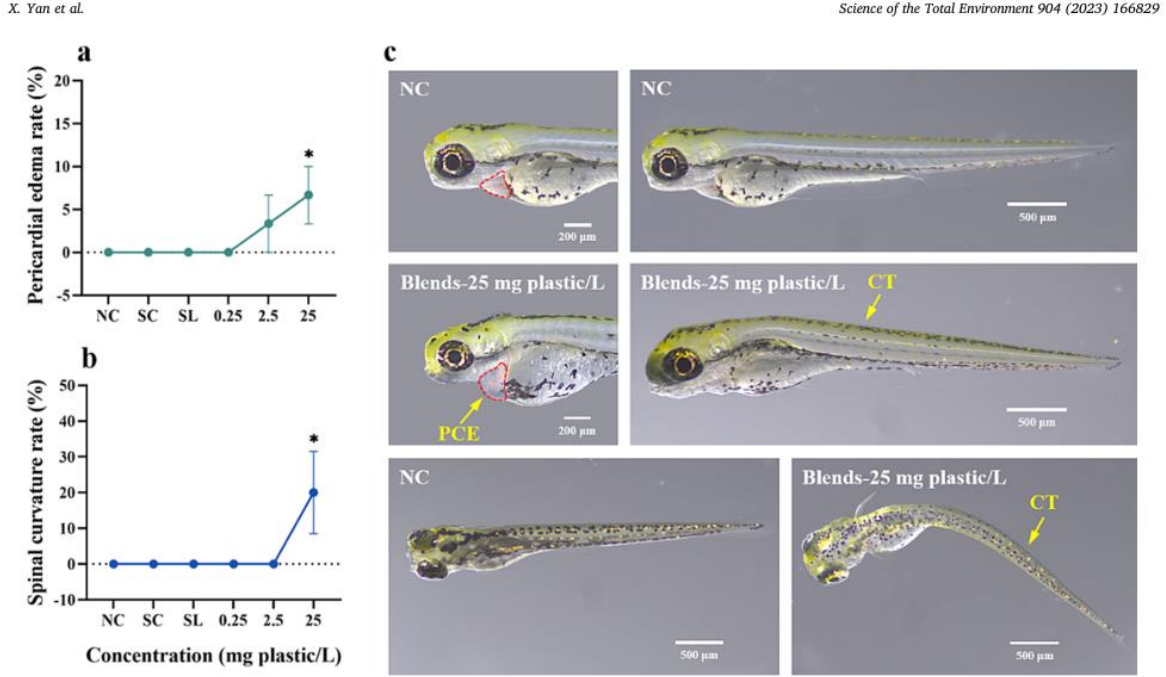
Biodegradation rates are composition, thickness and post-polymerization additives dependent.
Moreover, they are strongly influenced by biotic and abiotic factors



Like for conventional plastics, microplastics are a problem

What does Science say about biodegradable plastics?

"MPs originating from biodegradable plastics can adsorb and transport pollutants, resulting in synergistic or antagonistic effects on exposed organisms" Ali et al.



Chemical features and biological effects of degradation products of biodegradable plastics in simulated small waterbody environment - ScienceDirect

What does Science say about biodegradable plastics?

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What does Science say about biodegradable plastics?

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"Biodegradable Microplastics contain more toxic heavy metals that non-biodegradable plastics" S.Yan et al.

"PHA (BPs) production impacts are about 69% higher, compared to the impacts from PP (conventional) bags." Khoo et al.

Key barriers for adoption

Economical

- Higher production cost

Technical

- Limited Performances
- Lack of end-of-life infrastructure
- Lack of biodegradability data

Social

- Lack of awareness / greenwashing
- Competition between feedstock and food

Opportunities for growth

Economical

- Avoid taxes
- Reduce cleaning costs
- Better branding

Technical

- New high-performance biodegradable plastics
- More renewable sources of energy
- Energy recovery

Social

- Reduction in CO_2 emissions
- Improve health / cleaner environment

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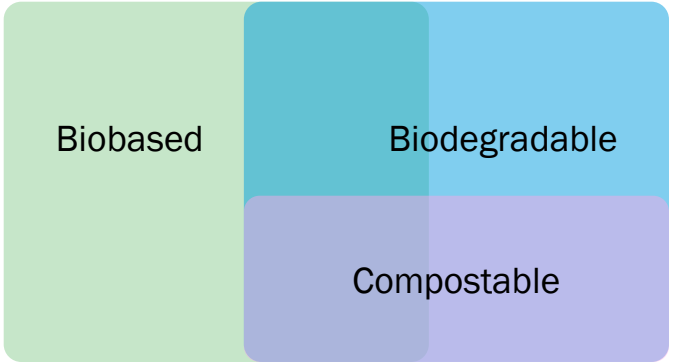
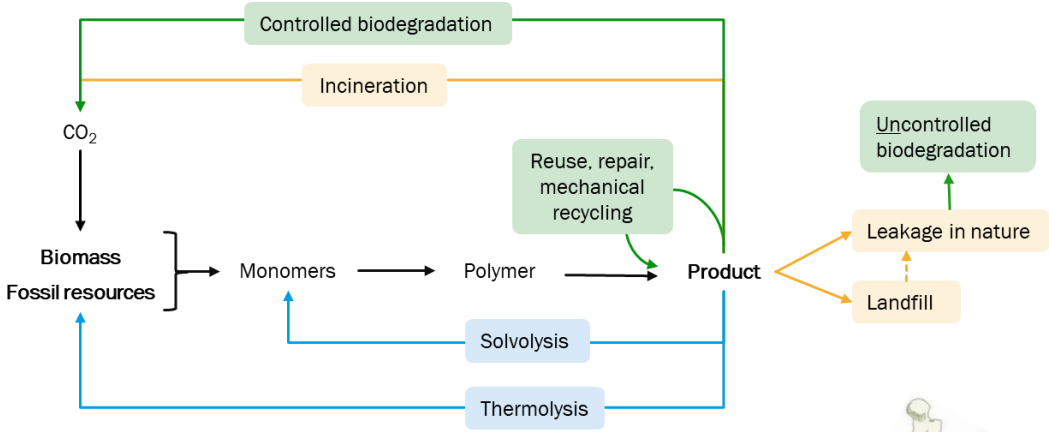
Thank you for your attention !





Misconceptions

Physical and chemical concerns

Treatment requirements