



A review of Biodegradable Plastics: Chemistry, Applications, Properties, and Future Research Needs

Presented by

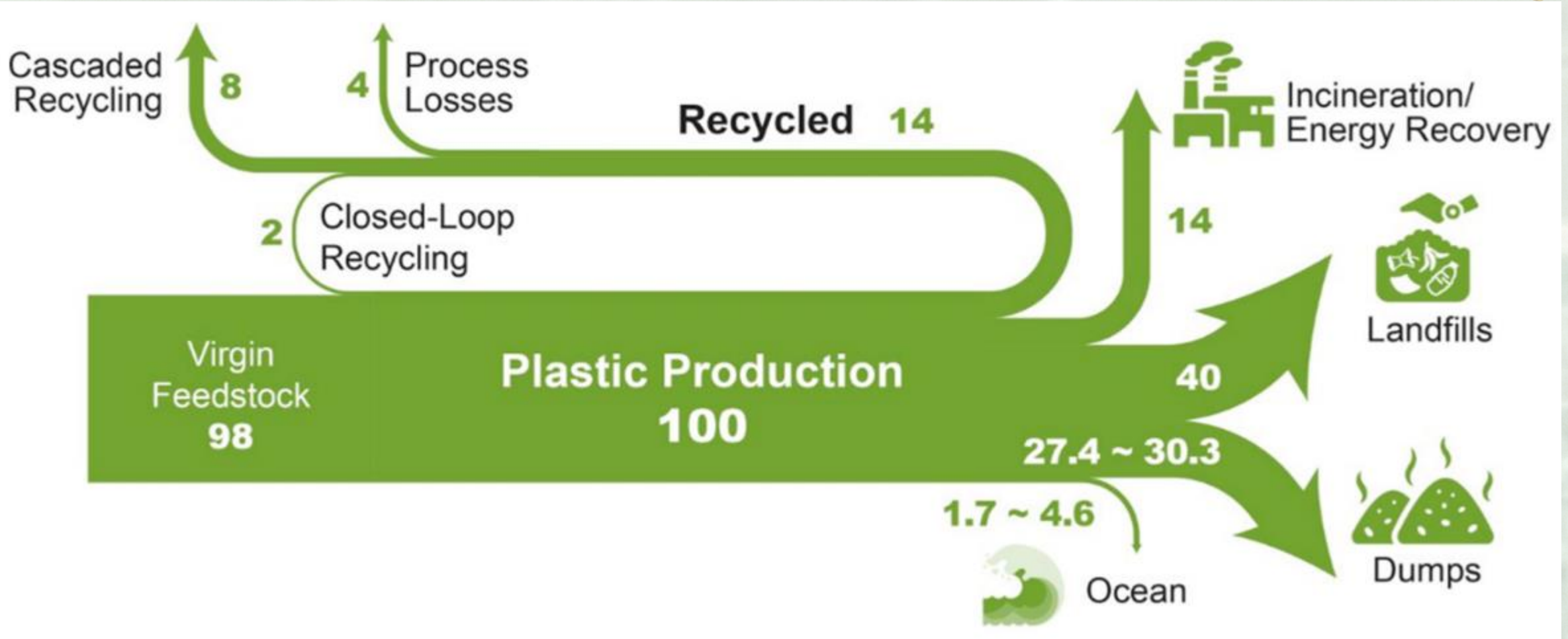
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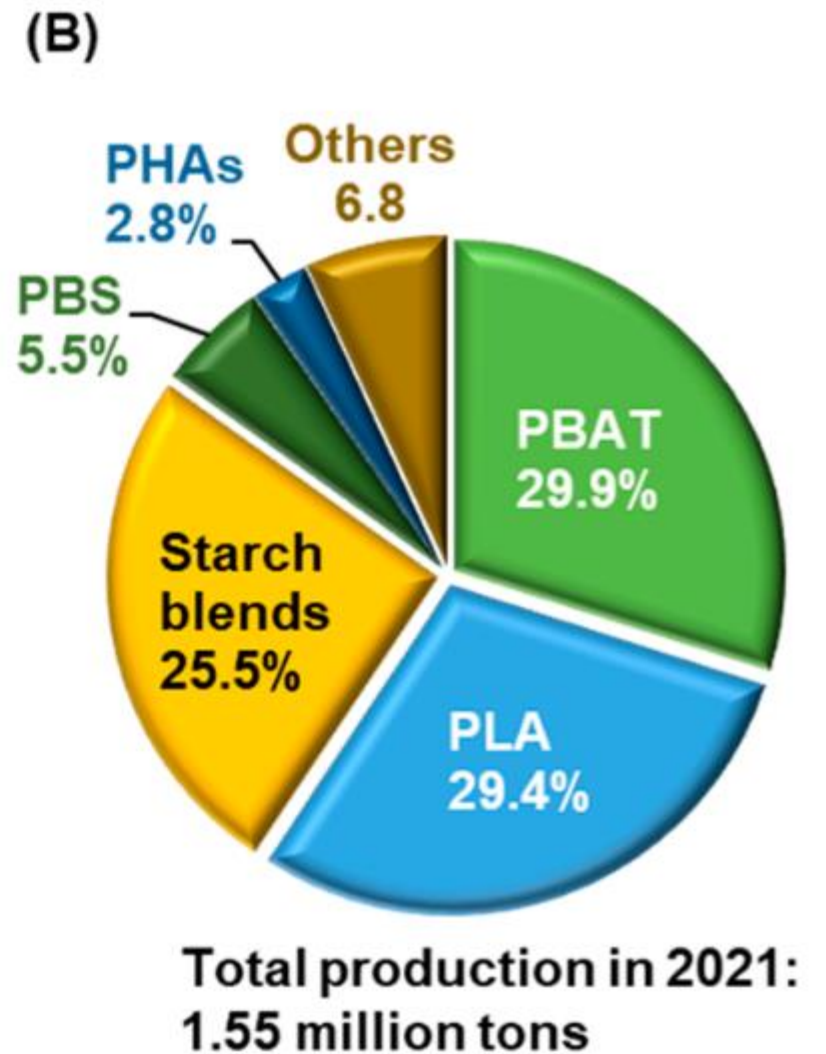
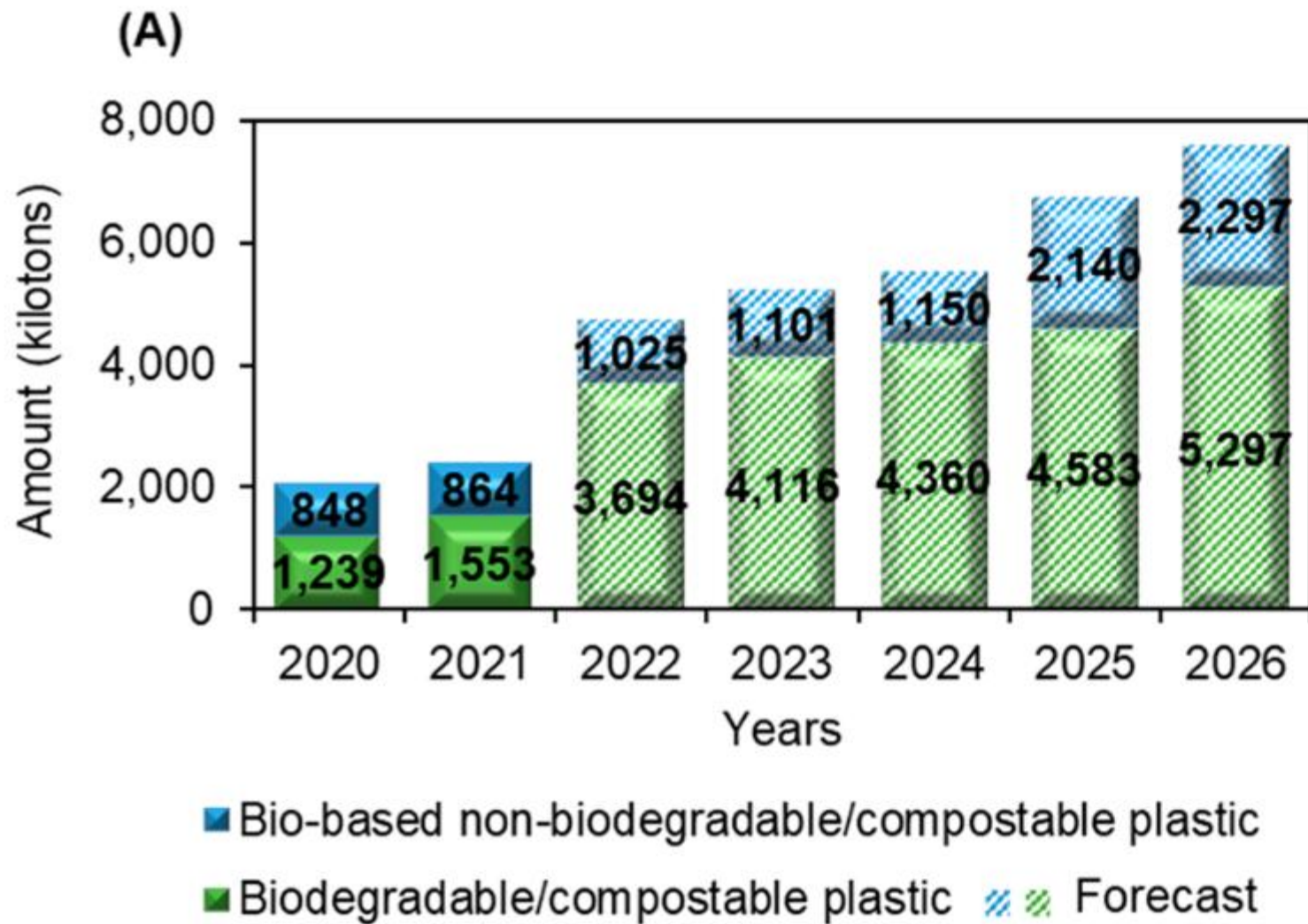
Overview



- Environmental concerns of plastic waste.
- Biodegradable plastics can help manage plastic waste.
- PBAT, PLA and PHA are some of the developed biodegradable plastics.
- Polymers can be blend to enhance biodegradation and home compostability.

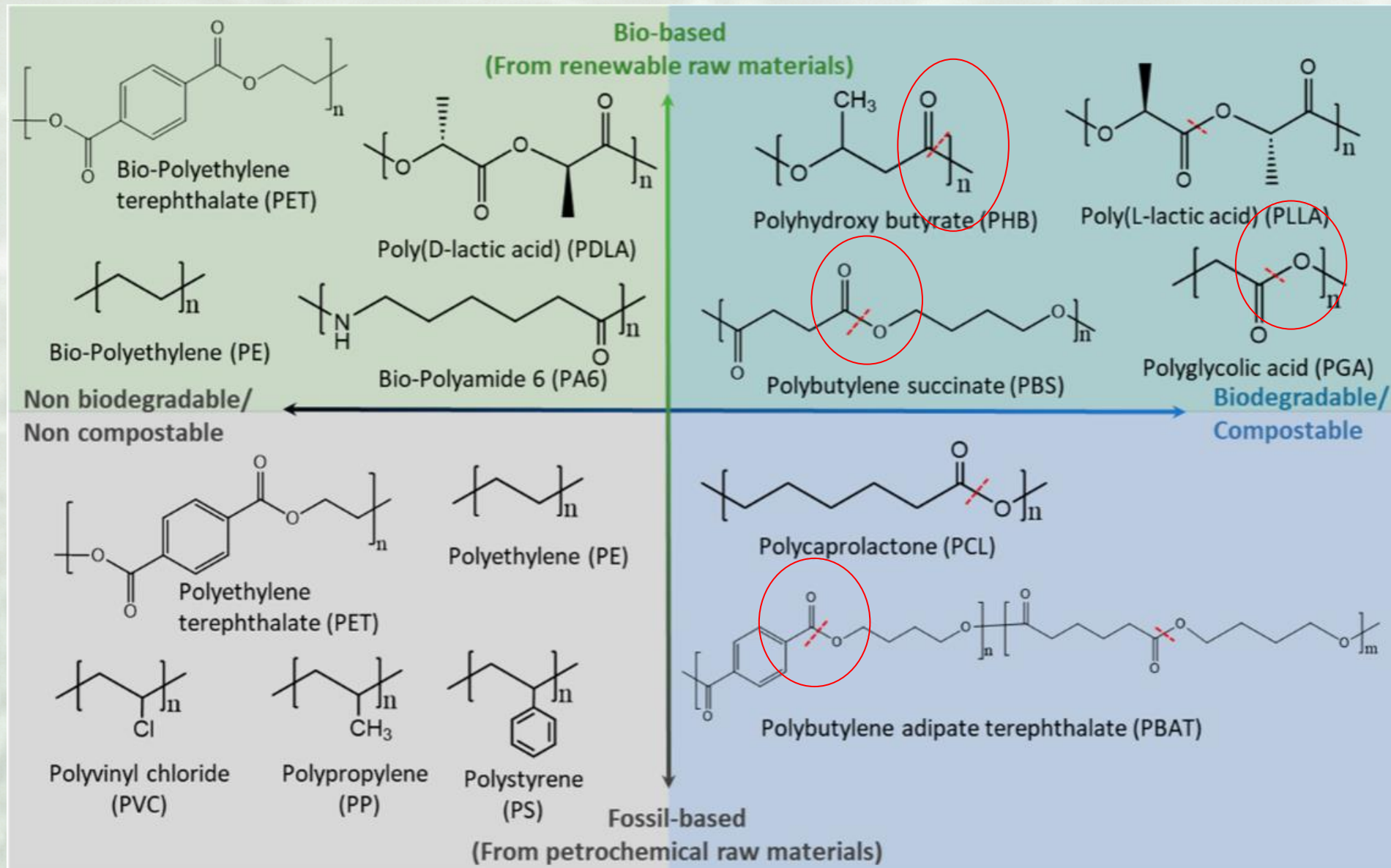
Life cycle of plastic packaging.





(A) Global production capacities of bioplastics

(B) biodegradable/compostable plastics by material type in 2021

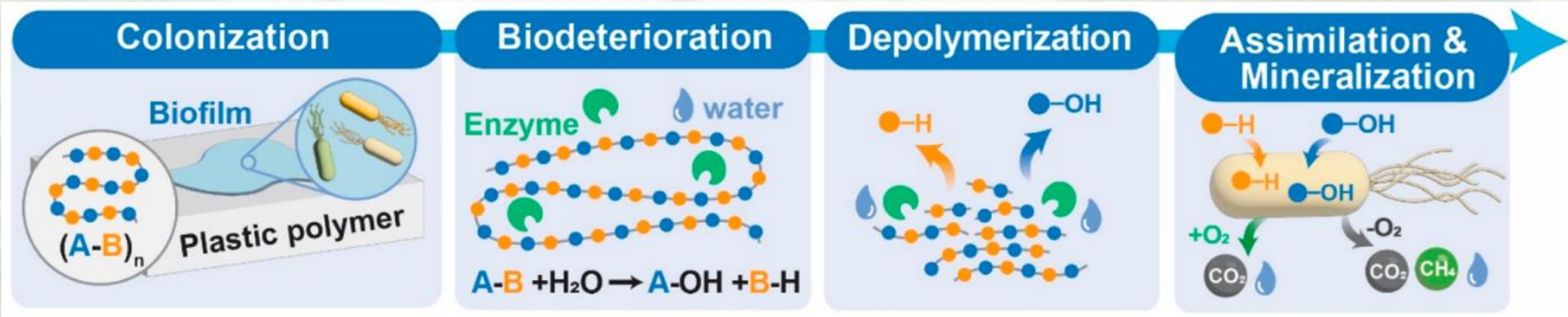


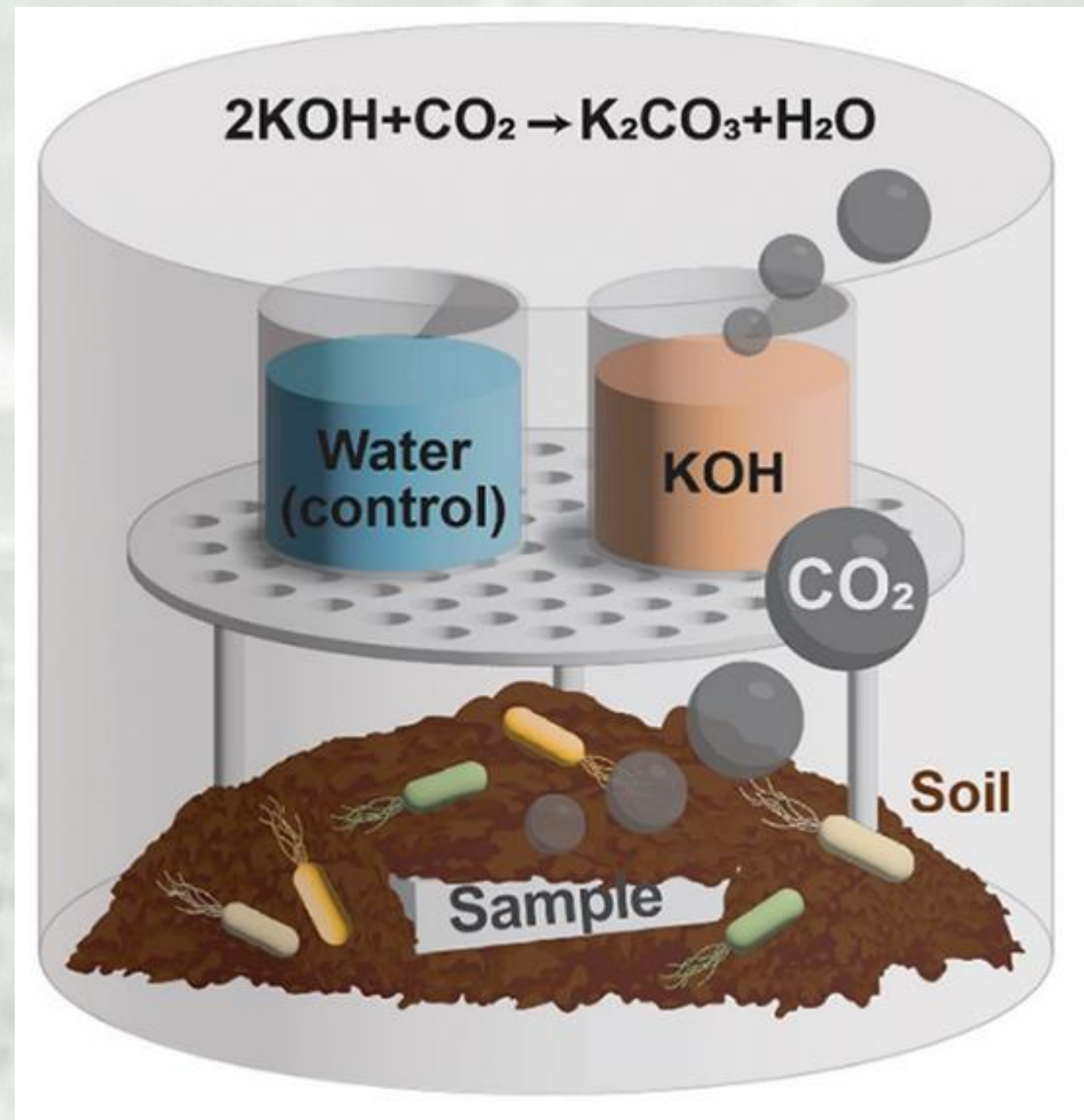
Classification of plastics based on biodegradability.

Biodegradable/compostable plastics: ester bond that can be broken down by enzymes (red dashed lines).

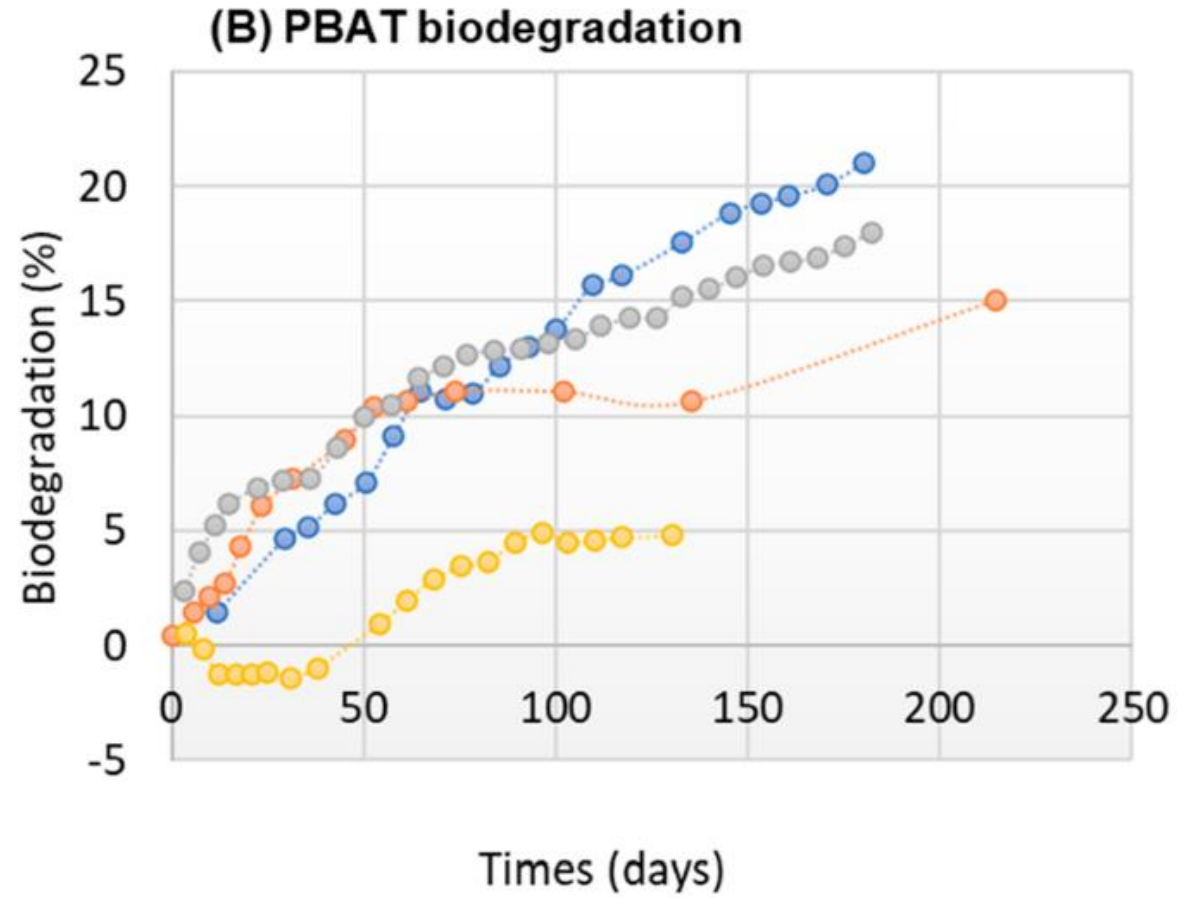
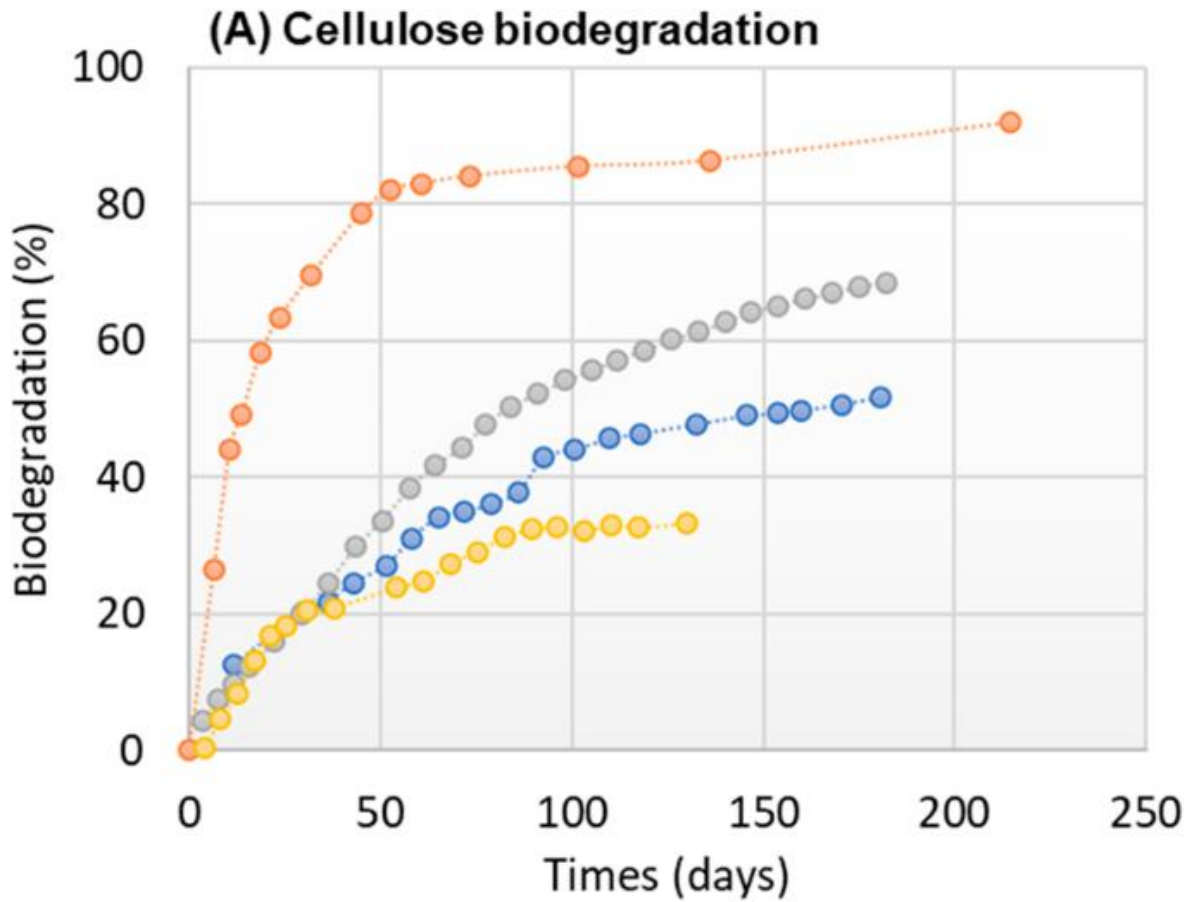


General process of plastic degradation under aerobic or anaerobic conditions





Schematic view of the biodegradation test setup according to ASTM D5988.

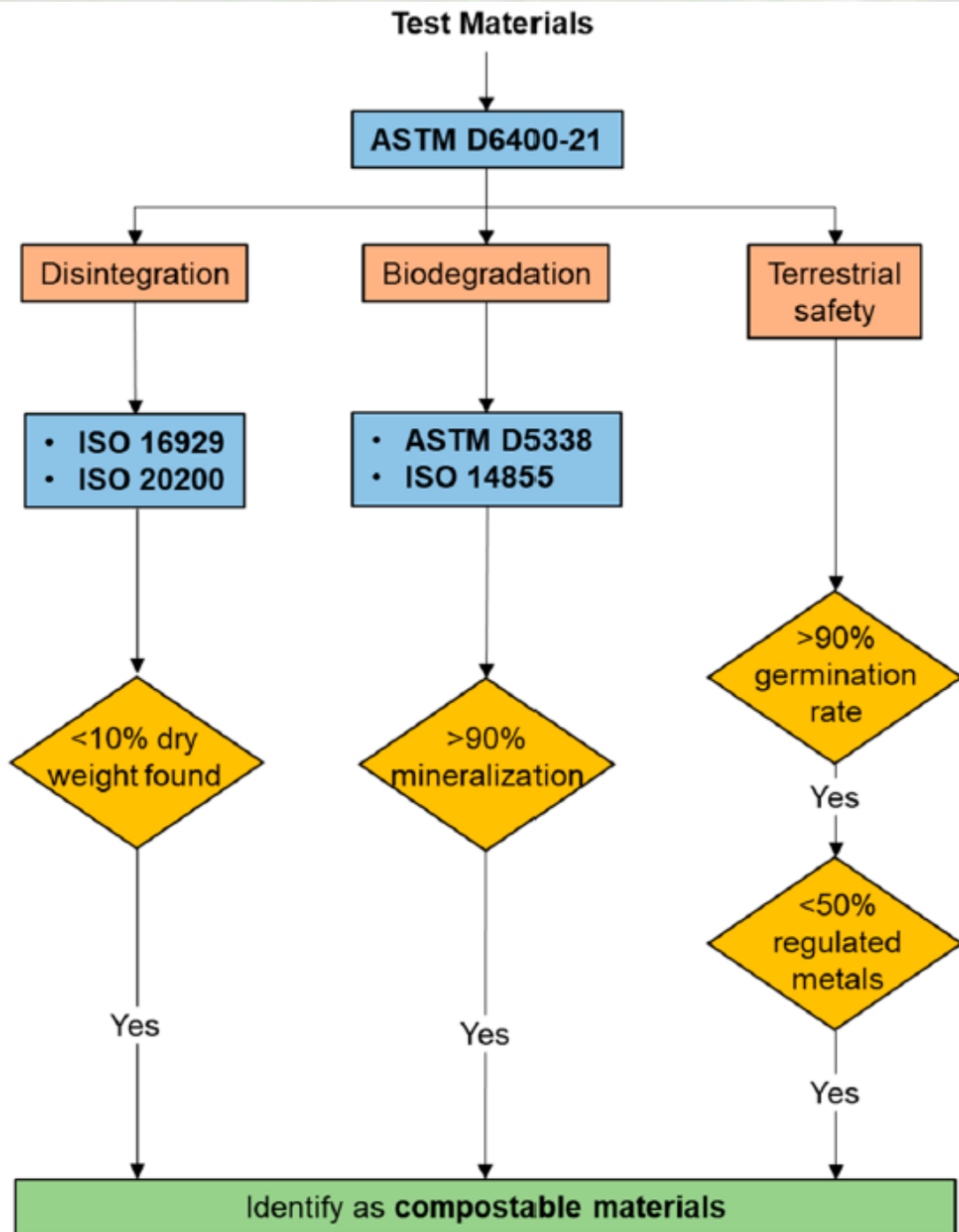


● *Palsikowski et al.'s work*
 ● *Saadi et al.'s work*
 ● *Souza et al.'s work*
 ● *Pinheiro et al.'s work*

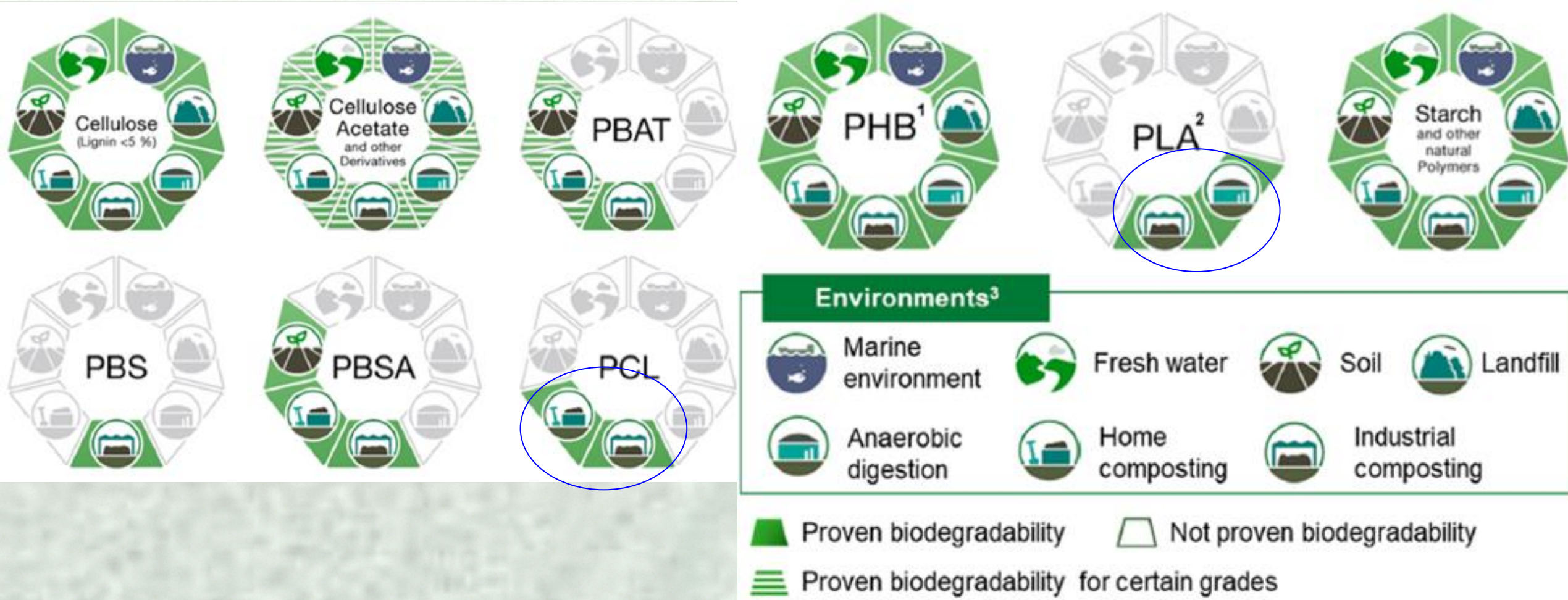
Comparison of (A) cellulose degradation and (B) PBAT biodegradation in soil according to ASTM D5988.



Compostable material identification flowchart ASTM D6400-21.



- **ASTM D5338** - Biodegradation rate under controlled composting. Determine % of carbon in the sample converted to CO₂ (>90%).
- **ASTM D6400** - 4 part test with elemental analysis, plant germination, and mesh filtration. Label products from plastics designed to be composted in industrial/municipal facilities.
- **AS 5810** - Australian standard. Materials disintegrate 6 months, and biodegrade and form compost in 1 year.
- **OK compost HOME** - TUV Austria certification. Product can compost in a home compost environment < 1 year.



Biodegradable plastics in various environments are based on established standards and certification schemes. ¹PHB includes its copolymers. ²PLA not biodegradable in mesophilic digestion (in absence of oxygen).



	Controlled environments			Uncontrolled environments			
Standard	ISO 14855	ISO 15985	ISO 14855	ASTM D6691	ISO 14851	ISO 14853	ISO 17556
Medium	Industrial composting	Anaerobic digestion	Home composting	Marine	Fresh water	Anaerobic aqueous digestion	Soil
PLA/PCL (80/20)	Pass	Pass	Pass	Fail	Fail	Fail	Fail
PLA/PBS (80/20)	Pass	Fail	Fail	Fail	Fail	Fail	Fail
PLA/PHB (80/20)	Pass	Pass	Fail	Fail	Fail	Fail	Fail
PLA/PHO (85/15)	Pass	Pass	Fail	Fail	Fail	Fail	Fail
PHB/PHO (85/15)	Pass	Pass	Pass	Fail	Fail	Pass	Pass
PHB/PCL (60/40)	Pass	Pass	Pass	Fail	Fail	Fail	Pass
PHB/PBS (50/50)	Pass	Fail	Pass	Fail	Fail	Fail	Fail
PCL/PHO (85/15)	Pass	Pass	Pass	Fail	Fail	Fail	Fail
PCL/TPS (70/30)	Pass	Pass	Pass	Fail	Fail	Fail	Pass
PLA (Polylactic acid)	Pass	Pass	Fail	Fail	Fail	Fail	Fail
PCL (polycaprolactone)	Pass	Pass	Pass	Fail	Fail	Fail	Pass
PBS (polybutylene succinate)	Pass	Fail	Fail	Fail	Fail	Fail	Fail
PHO (polyhydroxy octanoate)	Pass	Fail	Fail	Fail	Fail	Fail	Fail
PHB (Polyhydroxy butylate)	Pass	Pass	Pass	Pass	Pass	Pass	Pass
TPS (thermoplastic starch)	Pass	Pass	Pass	Pass	Pass	Pass	Pass

Pass Fail

Figure 9. Biodegradation capacity of several plastics in controlled and uncontrolled environments tested following international biodegradation standards.¹⁸³ “Pass” represents that plastic passed the appropriate test.



THANK YOU