

UNDERSTANDING BIOPLASTICS

Biobased Plastics & Biodegradable-Compostable Plastics

Opportunities & Issues



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BASICS -- TERMINOLOGY

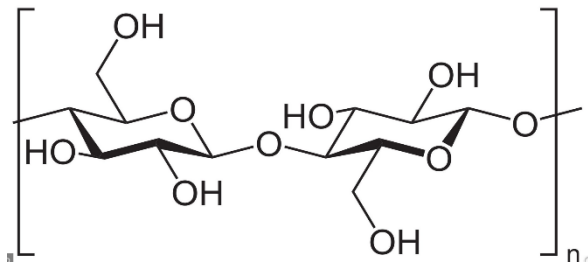
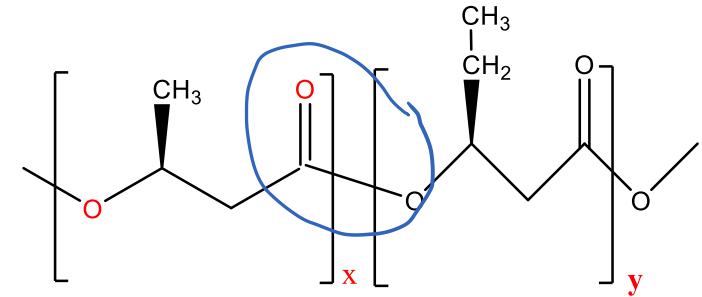
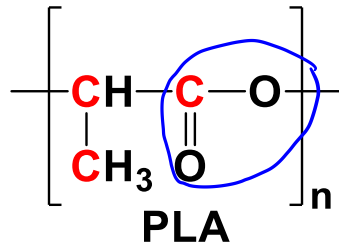
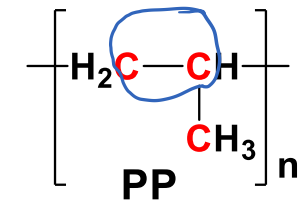
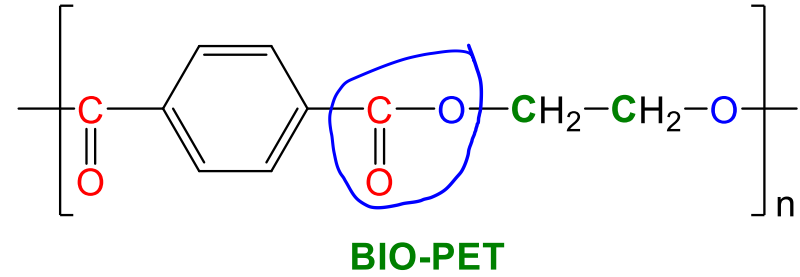
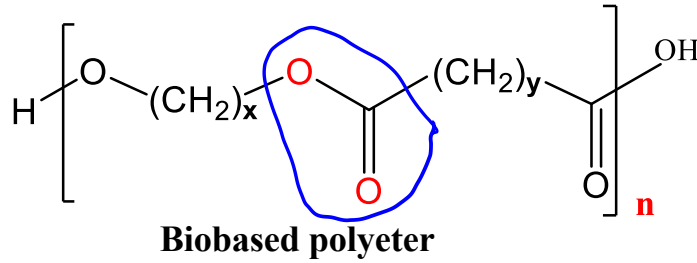
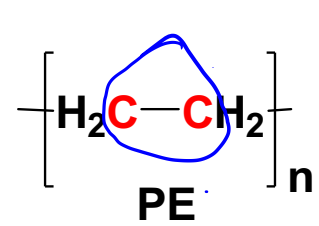
Bioplastics represents two separate and independent concepts:

1. **biobased plastics** representing the “beginning of life” of the plastic
 - Asks which carbon feedstock used for manufacture
 - **petro/fossil** vs **plant-biomass feedstock**
2. **biodegradable-compostable plastic** represents the “end-of-life”.
 - (a) provides for environmentally responsible removal from environment through biological/organic recycling
 - (b) Concept of “Certified Compostable BioPlastic”**

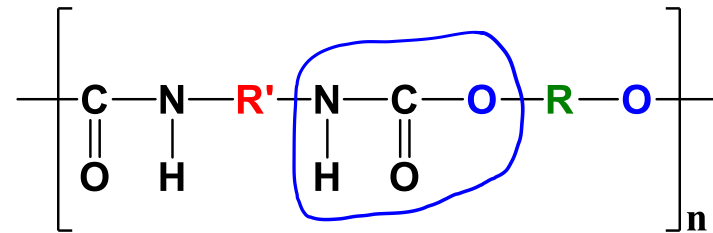
Biobased Plastics are NOT necessarily biodegradable/compostable

Biodegradable-Compostable Plastics are NOT necessarily Biobased

Understanding “BIOBASED & BIODEGRADABILITY” at Molecular level



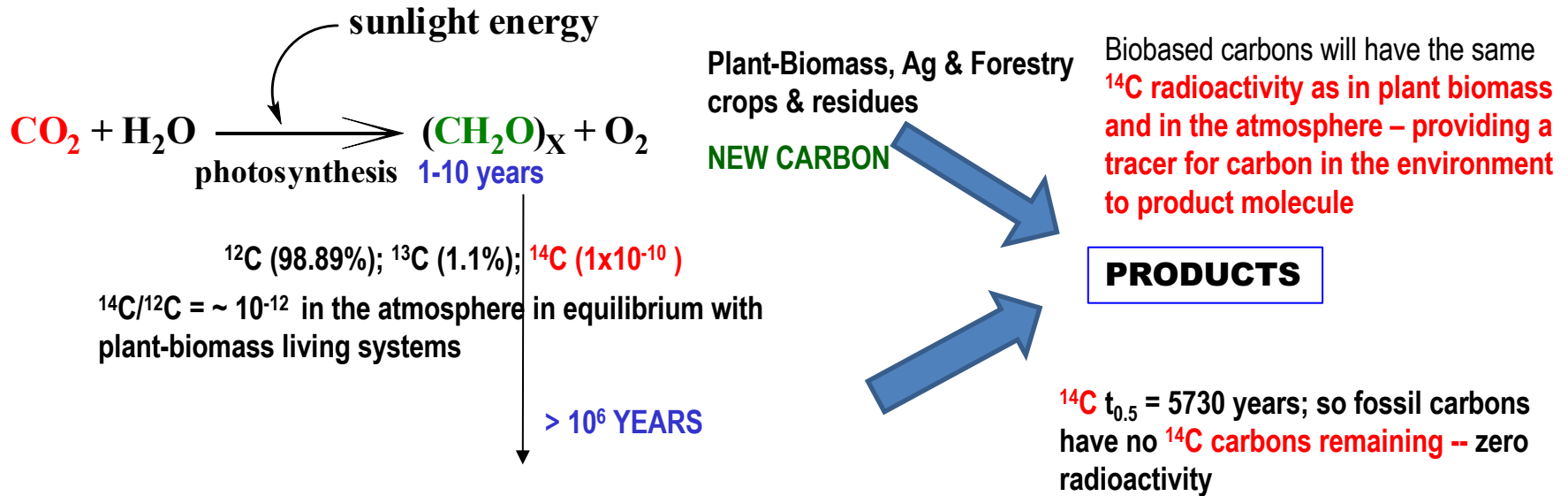
Cellulose



Biobased polyurethane

ASTM D6868; ISO 16620 (Pt 2) -- Fundamentals

biobased –containing organic carbon of renewable origin from agricultural, plant, animal, fungi, microorganisms, marine or forestry materials living in a natural environment in equilibrium with the atmosphere.



Petro-Fossil Resources (Oil, Coal, Natural gas) -- OLD CARBON

The amount of ^{14}C is measured relative to a more abundant isotope (i.e., ^{13}C or ^{12}C) in the ion beam of an AMS (accelerator mass spectrometry) or by decay counting. **Absolute quantification** comes from comparing the sample's measured isotope ratio to that of pre 1950 biobased oxalic acid radiocarbon Standard Reference Material (NIST SRM) 4990c, (referred to as HOxII) **after correcting for isotopic fractionation**. Values must also be corrected for the C-14 pulse injected into the atmosphere (1950-63) from atmospheric testing of nuclear weapons

WHY BIOBASED??

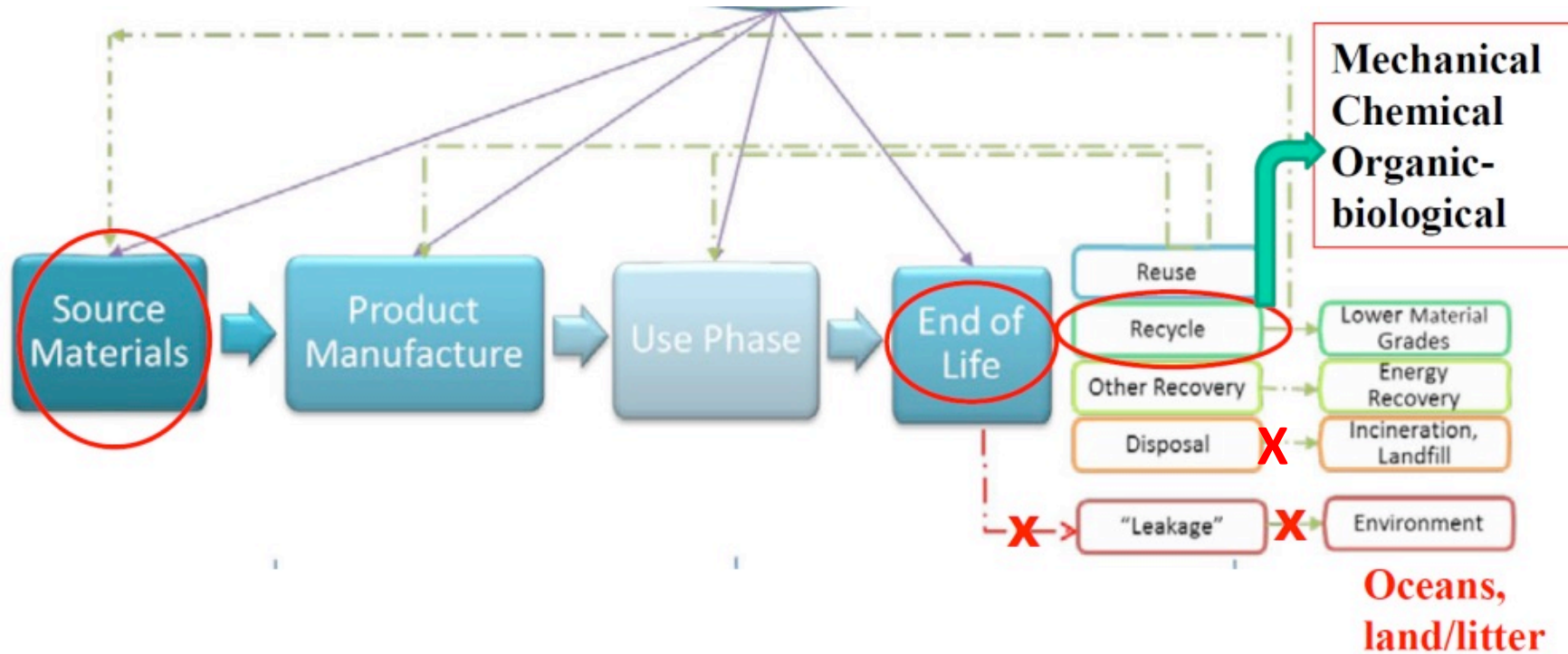
What are the benefits of replacing petro/fossil carbon with biocarbon?

- **Reduced carbon footprint**
- **Food security and creating value for rural agrarian economy**
- **Create “wealth” in rural agriculture through value-added industrial products**

CAUTION:

**Need to still address the issue of end-of-life
mechanical, chemical, biological/organic**

Design for End-of-Life -- Strategy



ISO series standards on biodegradability in target disposal systems like composting, AD, soil (mulch film not litter), ocean? – ISO TC61/SC14 “Certified Compostable BioPlastic”

ISO 18606 -- Packaging and the environment — Organic recycling
Emballage et environnement — Récyclage organique

EPA, MSW – Food waste numbers 2013

Other wastes	Generated	Recovered	Percent	Discarded
Food, other‡	37.06	1.84	5.0%	35.22
Yard trimmings	34.20	20.6	60.2%	13.60

Wt. recovered mtons GHG benefits (MMT CO2-eq)

Food, other^	1.84	1.7	308 thousand
Yard trimmings	20.6	1.04	220 thousand

**Recovered through composting
EPA warm model , 2013**

Certified/ Verified Compostable Plastics is the “enabling technology” to efficiently and efficaciously divert food and other organic wastes from landfills to environmentally responsible end-of-life solutions like composting and anaerobic digestion.

“Compostable” defines the boundary conditions under which complete biodegradation (microbial utilization) needs to be validated using ASTM/ISO International Standards

Enabler for the “Circularity Model”

Enabler for “Organics Recycling”

- **Green Sports Alliance – sports team events**
- **Schools & College (U of Michigan, Penn State, Michigan State)**
- **Corporate campuses (Google)**
- **Venues and events, airport concourses**
- **Cities – San Francisco, Seattle and others**



IMPORTANT LEARNING

Unqualified use of the term “biodegradable” is wrong, misleading, and deceptive.

It violates the law in the State of California and U.S. Federal Trade Commission (FTC) green guides & in Australia too

- **Need to define disposal environment, time/rate and extent of biodegradation – **qualified** biodegradability claim**
 - **Integrated to Composting or AD coupled to composting or soil biodegradability (mulch films & ag products)**
- Need **complete** microbial assimilation and removal from the environmental compartment in a short time period otherwise may have environmental and health consequences
 - **Degradable, partial biodegradable not acceptable – serious health and environmental consequences**
 - Phil. Trans. Royal. Soc. (Biology) July 27, 2009; 364

Example – A false and misleading “biodegradable” claim



- BIODEGRADABLE: Yet tough enough to handle kitchen waste, yard trash, lawn clippings and much more. Use our eco-friendly trash bag and help contribute to plastic waste management & environmental conservation.

https://www.amazon.com/Freedom-Living-Biodegradable-Contractor-Janitorial/dp/B079K8QW3P/ref=sr_1_9?ie=UTF8&qid=1534520822&sr=8-9&keywords=biodegradable+trash+bags

Small Garbage Bags, 4 Gallon kitchen trash Bags, Wastebasket Liners Bags
biodegradable trash bags For Office, Home, Bathroom, Kitchen, 90 counts
drawstring trash bags. (Grey)

Example – A false and misleading “biodegradable” claim



Amazon.com agreed to pay **\$1,512,400** in civil penalties and investigative costs to settle the case. The judgment also includes an injunction that prohibits Amazon from unlawfully selling or offering for sale plastic products labeled as “biodegradable” or using similar terms, or selling or offering for sale plastic products labeled as “compostable” without appropriate certification. Amazon also agreed to make an additional payment of \$50,000 to CalRecycle to fund testing of plastic products marketed to consumers as compostable or degradable.

Walmart -- \$1 million settlement

Costco -- \$0.5 million settlement

Twins @ Target Field



Newest MLB ballpark to embrace a *systems approach to waste diversion*

Compostable packaging and front of house compost collection now complement other sustainability initiatives such as water and energy conservation

A simple two bin system throughout the ballpark captures bottles and cans in one bin and everything else in another

Because “everything else” is almost all compostable, contamination is kept to a minimum and a ***diversion rate of over 90% is within reach***

Organic stream is sent to a county transfer station that sends material to The Mulch Store and Full Circle Organics compost facilities

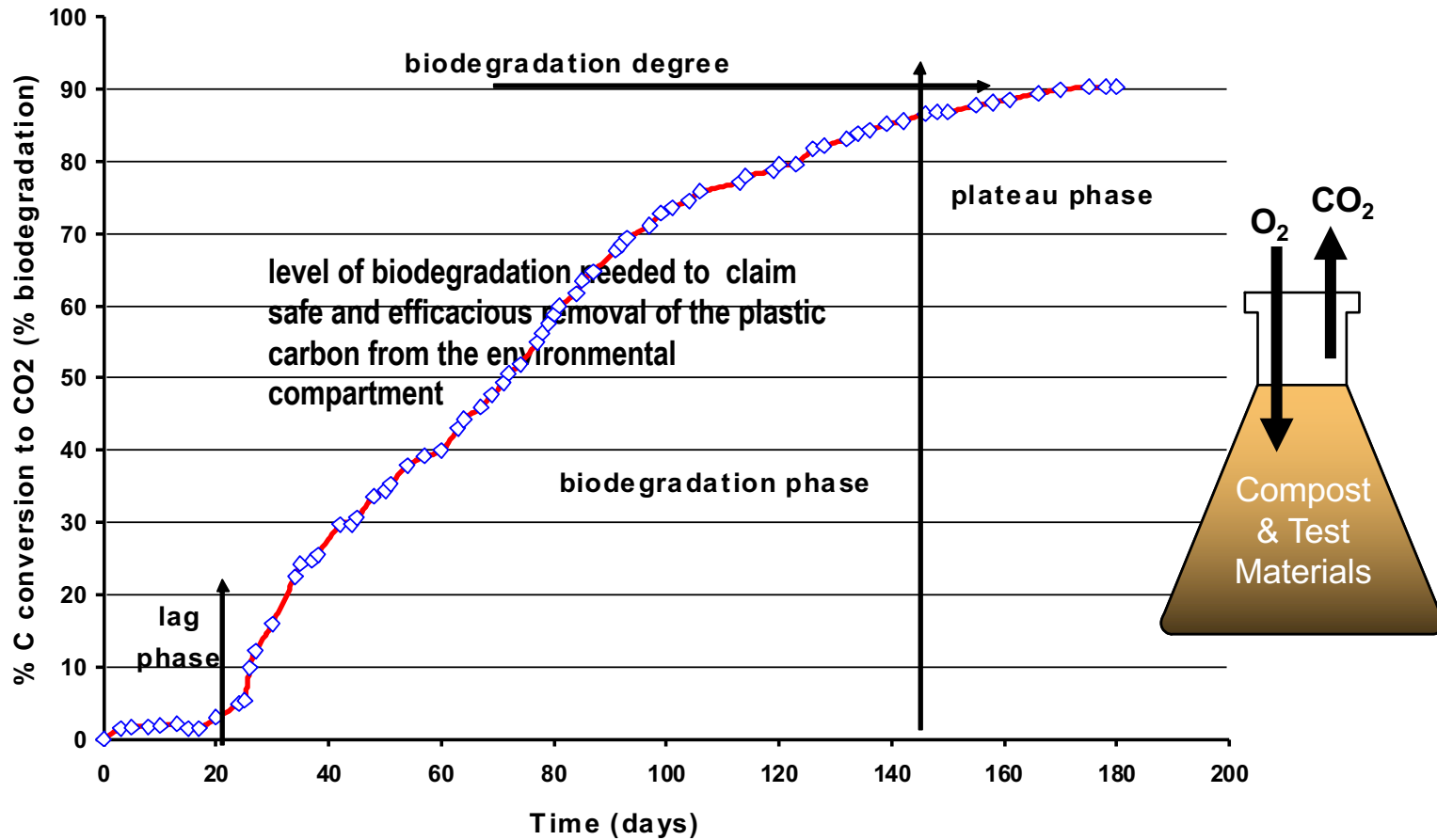


100% reusable, recyclable or compostable plastic packaging by 2025

FOLLOW THEIR LEAD



- **Eliminate** problematic or unnecessary plastic packaging and move from single-use to reuse packaging models
- **Innovate** to ensure 100% of plastic packaging can be easily and safely reused, recycled, or composted by 2025
- **Circulate** the plastic produced, by significantly increasing the amounts of plastics reused or recycled and made into new packaging or products



ASTM D5338; ISO 14855; ISO 18606; EN 13432 AS 4736 & 5810

Figure 3. Measuring rate and extent of biodegradability using test plastic as the sole carbon source

THE MISUSE OF BIODEGRADABILITY AS AN EOL OPTION

- Articles have appeared in literature and widely covered in print and E-media of macro-organisms like meal worms and wax moth eating plastics as solutions for plastic waste management.
- CNN news reported “the gut bacteria in worms can transform plastic into safe biodegradable waste”; News headlines proclaimed “Styrofoam-Eating Mealworms Could Happily Dispose of Plastic Waste”.
- Another one said “The Indian meal-moth, can degrade polyethylene”.

Caterpillars & mealworms are NOT the ^{^ next} new biodegradable magical solution to plastic waste management? Nor are the oxo-biodegradable or enzyme additives plastics



TAKE HOME MESSAGE

- Recent articles in literature and widely covered in print and E-media of macro-organisms like meal worms and wax moth eating plastics **as solutions for plastic waste management are misleading, troublesome and irresponsible.**
- Biodegradability is not a **magical solution** for plastics waste management.
- Complete biodegradation of single use disposable plastics along with food and other biowastes in managed, closed loop disposal systems like composting and anaerobic digestion is environmentally responsible. This helps divert food and other biowastes from landfills and oceans.
 - **Certified Compostable BioPlastics**
- Complete soil biodegradability for agricultural products like mulch films is beneficial and environmentally responsible
- Degradation resulting in release of small fragments (microplastics) into the terrestrial and ocean environment has been shown to cause harm to the environment and to human health.
 - Many papers in the literature document that such fragments pick up toxins from the environment like a sponge and become a vehicle to transport toxins up the food chain.
- Use biobased, renewable carbon feedstocks (carbon footprint reductions) and in harmony with the new “Circular Economy” model



Thank You