A Content Secondary Science Newsletter from the Southern Nevada Regional Professional Development Program

Science Dissected

Paper or Plastic?
Model-Evidence Link Diagram (MEL)

Since the beginnings of environmental awareness the question of 'Paper or Plastic?' has been asked but never completely answered. Our planet's resources are being depleted at an increasing rate. Pollution and habitat destruction are a cause for concern to every inhabitant of Earth. Exploring ways to prevent or minimize human impact presents a current real-world experience for students.

Paper or plastic bags has been a hot topic for debate among civic-minded adults and students. This activity presents a variety of viewpoints that will entice young minds to analyze the findings and determine a course of action. This type of awareness activity creates an avenue for students to broaden their global thinking and offers suggestions on how to become a part of the solution.

Model A: Plastic bags are better for the environment because they are recyclable.

Model B: Paper bags are better for the environment because they are biodegradable.

Evidence #1: Paper bags are better for the environment when comparing effects of plastic bags with paper bags on the environment. This article believes biodegradability is the key to solving environmental issues.

Evidence #2: Some scientists say plastic bags are economical and environmentally acceptable if use is regulated. This article states less energy; less solid waste; fewer emissions; and fewer water pollutants are used in making plastic bags.

Evidence #3: This article contains data that shows paper is made from a renewable resource and is biodegradable, making it environmentally friendly. This article suggests reusing making plastic the better choice.

Evidence #4: Scientists in this article say plastic bags made from corn are the best environmental solution. Plastic bags made from corn are biodegradable making plastic bags the better choice.

The following is a suggestion for using this MEL with students:

1. Hand out the Paper or Plastic Model Evidence Link Diagram (page 1). Instruct students to read the directions, descriptions of Model A and Model B, and the four evidence texts presented.
2. Handout the four evidence text pages (pages 3-13).
3. Instruct students to carefully review the Evidence #1 text page (page 3), then construct two lines from Evidence #1; one to Model A and one to Model B. Remind students that the shape of the arrow they draw indicates their plausibility judgment (potential truthfulness) connection to the model.
4. Repeat for Evidence #2-4 (pages 4-13).
5. Handout page 2 for the students to critically evaluate their links and construct understanding.

Once students have completed page 2, they can then engage in collaborative argumentation as they compare their links and explanations with that of their peers. Students should be given the opportunity to revise the link weighting during the collaborative argumentation exercise. If time permits, have students reflect on their understanding of renewable and non-renewable resources and create questions that they might explore in the future.

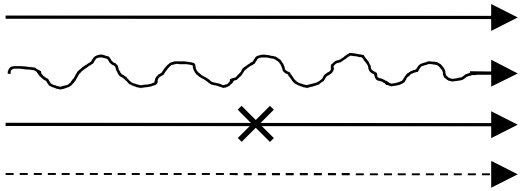
Archived Issues of Science Dissected, *http://www.rpdp.net/link.news.php?type=sciencedis.* ***Instructional Resource resulting from Plausibility, It's All About Connecting the Models Workshop co-sponsored by CPDD and SNRPDP Science March 6, 2012***

Written by: Holly Wheelock

Name:_____ _____ **Period:**_____

Directions: draw two arrows from each evidence box. One to each model. You will draw a total of 8 arrows.

Key:



The evidence **supports** the model

The evidence **STRONGLY supports** the model

The evidence **contradicts** the model (shows its wrong)

The evidence has **nothing to do with** the model

Standard: N.8.B.1

Evidence #1

According to this article paper bags are the best choice when comparing the effects of plastic bags to the effects of paper bags on the environment.

Model A

Paper bags are the best choice for the environment.

Evidence #3

This article contains data that shows paper is made from a renewable resource and is biodegradable making it environmentally friendly.

Evidence #2

Some scientists say plastic bags are economical and environmentally acceptable if use is regulated.

Model B

Plastic bags are the best choice for the environment.

Evidence #4

Scientists in this article say plastic bags made from corn are the best environmental solution.

Provide a reason for three of the arrows you have drawn. **Write your reasons for the three most interesting or important arrows.**

A. Write the number of the evidence you are writing about.
B. Circle the appropriate descriptor (**strongly supports | supports | contradicts | has nothing to do with**).
C. Write the letter of the model you are writing about.
D. Then write your reason.

1. Evidence # ____ strongly supports | supports | contradicts | has nothing to do with Model _____ because:

2. Evidence # ____ strongly supports | supports | contradicts | has nothing to do with Model _____ because:

3. Evidence # ____ strongly supports | supports | contradicts | has nothing to do with Model _____ because:

4. Circle the plausibility of each model. [Make two circles. One for each model.]

	Greatly implausible (or even impossible)									Highly Plausible
Model A	1	2	3	4	5	6	7	8	9	10
Model B	1	2	3	4	5	6	7	8	9	10

5. Circle the model which you think is correct. [Only circle one choice below.]

Very certain that Model A is correct	Somewhat certain that Model A is correct	Uncertain if Model A or B is correct	Somewhat certain that Model B is correct	Very certain that Model B is correct

Evidence #1: According to this article paper bags are the best choice when comparing the effects of plastic bags to the effects of paper bags on the environment.

Paper, Plastic, or Something Better?

Reusable Bags Are Best for Both Consumers and the Environment

From Larry West, former About.com Guide

Eco Shopping BagsThe next time the clerk at your favorite grocery store asks whether you prefer "paper or plastic" for your purchases, consider giving the truly eco-friendly response and saying, "neither."

Plastic bags end up as litter that fouls the landscape, and kill thousands of marine mammals every year that mistake the floating bags for food. Plastic bags that get buried in landfills may take up to 1,000 years to break down, and in the process they separate into smaller and smaller toxic particles that contaminate soil and water. Furthermore, the production of plastic bags consume millions of gallons of oil that could be used for fuel and heating.

Is Paper Better Than Plastic?☐Paper bags, which many people consider a better alternative to plastic bags, carry their own set of environmental problems. For example, according to the American Forest and Paper Association, in 1999 the U.S. alone used 10 billion paper grocery bags, which adds up to a lot of trees.

Reusable Bags Are a Better Option☐But if you decline both paper and plastic bags, then how do you get your groceries home? The answer, according to many environmentalists, is high-quality reusable shopping bags made of materials that don't harm the environment during production and don't need to be discarded after each use. [You can find a good selection of high-quality reusable bags online at reusablebags.com. In addition, many organic grocery stores and consumer co-operatives carry reusable shopping bags.]

Experts estimate that 500 billion to 1 trillion plastic bags are consumed and discarded annually worldwide—more than a million per minute.

Here are a few facts about plastic bags to help demonstrate the value

of reusable bags—to consumers and the environment:

Plastic bags aren't biodegradable. They actually go through a process called photodegradation—breaking down into smaller and smaller toxic particles that contaminate both soil and water, and end up entering the food chain when animals accidentally ingest them.

According to the Environmental Protection Agency, more than 380 billion plastic bags are used in the United States every year. Of those, approximately 100 billion are plastic shopping bags, which cost retailers about $4 billion annually.

According to various estimates, Taiwan consumes 20 billion plastic bags annually (900 per person), Japan consumes 300 billion bags each year (300 per person), and Australia consumes 6.9 billion plastic bags annually (326 per person).

Hundreds of thousands of whales, dolphins, sea turtles and other marine mammals die every year after eating discarded plastic bags they mistake for food.

Discarded plastic bags have become so common in Africa they have spawned a cottage industry. People there collect the bags and use them to weave hats, bags and other goods. According to the BBC, one such group routinely collects 30,000 bags every month.

Plastic bags as litter have even become commonplace in Antarctica and other remote areas. According to David Barnes, a marine scientist with the British Antarctic Survey, plastic bags have gone from being rare in the late 1980s and early 1990s to being almost everywhere in Antarctica.

Some governments have recognized the severity of the problem and are taking action to help combat it.

Strategic Taxes Can Cut Plastic Bag Use☐In 2001, for example, Ireland was using 1.2 billion plastic bags annually, about 316 per person. In 2002, the Irish government imposed a plastic bag consumption tax (called a PlasTax), which has reduced consumption by 90 percent. The tax of $.15 per bag is paid by consumers when they check out at the store. Besides cutting back on litter, Ireland's tax has saved approximately 18 million liters of oil. Several other governments around the world are now considering a similar tax on plastic bags.

Governments Use the Law to Limit Plastic Bags☐More recently, Japan passed a law that empowers the government to issue warnings to merchants that overuse plastic bags and don't do enough to "reduce, reuse or recycle." In Japanese culture, it is common for stores to wrap each item in its own bag, which the Japanese consider a matter of both good hygiene and respect or politeness.

Companies Making Tough Choices☐Meanwhile, some eco-friendly companies—such as Toronto's Mountain Equipment Co-op—are voluntarily exploring ethical alternatives to plastic bags, turning to biodegradable bags made from corn. The corn-based bags cost several times more than plastic bags, but are produced using much less energy and will break down in landfills or composters in four to 12 weeks.

Evidence #2: Some scientists say plastic bags are economical and environmentally acceptable if use is regulated.

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http://news.nationalgeographic.com/news/pf/80107147.html
Page 1 of 2

Are Plastic Grocery Bags Sacking the Environment?

John Roach
for National Geographic News
September 2, 2003

The "paper or plastic" conundrum that vexed earnest shoppers throughout the 1980s and 90s is largely moot today. Most grocery store baggers don't bother to ask anymore. They drop the bananas in one plastic bag as they reach for another to hold the six-pack of soda. The pasta sauce and noodles will get one too, as will the dish soap.

Plastic bags are so cheap to produce, sturdy, plentiful, easy to carry and store that they have captured at least 80 percent of the grocery and convenience store market since they were introduced a quarter century ago, according to the Arlington, Virginia-based American Plastics Council. As a result, the totes are everywhere. They sit balled up and stuffed into the one that hangs from the pantry door. They line bathroom trash bins. They carry clothes to the gym. They clutter landfills. They flap from trees. They float in the breeze. They clog roadside drains. They drift on the high seas. They fill sea turtle bellies. "The numbers are absolutely staggering," said Vincent Cobb, an entrepreneur in Chicago, Illinois, who recently launched the Web site http://Reusablebags.com to educate the public about what he terms the "true costs" associated with the spread of "free" bags. He sells reusable bags as a viable solution. According to Cobb's calculations extrapolated from data released by the United States Environmental Protection Agency in 2001 on U.S. plastic bag, sack, and wrap consumption, somewhere between 500billion and a trillion plastic bags are consumed worldwide each year. Of those, millions end up in the litter stream outside of landfills—estimates range from less than one to three percent of the bags.

Laurie Kusek, a spokeswoman for the American Plastics Council, said the industry works with its U.S. retail customers to encourage recycling of plastic bags, which are in high demand from companies such as Trex in Winchester, Virginia, for use in building materials.

"We also feel it is important to understand that plastic grocery bags are some of the most reused items around the house," she said. "Many, many bags are reused as book and lunch bags as kids head off to school, as trash can liners, and to pickup Fido's droppings off the lawn."

But like candy wrappers, chewing gum, cigarette butts, and thousands of other pieces of junk, millions of the plastic bags end up as litter. Once in the environment, it takes months to hundreds of years for plastic bags to breakdown. As they decompose, tiny toxic bits seep into soils, lakes, rivers, and the oceans, said Cobb.

Plastic Fantastic

The Film and Bag Federation, a trade group within the Society of the Plastics Industry based in Washington, D.C., said the right choice between paper or plastic bags is clearly plastic. Compared to paper grocery bags, plastic grocery bags consume 40 percent less energy,generate 80 percent less solid waste, produce 70 percent fewer atmospheric emissions, and release up to 94 percent fewer waterborne wastes, according to the federation. Robert Bateman, president of Roplast Industries, a manufacturer of plastic bags—including reusable ones—in Oroville, California, said the economic advantage of plastic bags over paper bags has become too significant for store owners to ignore. It costs one cent for a standard plastic grocery sack, whereas a paper bag costs four cents, he said. "The plastic bags are so inexpensive that in the stores no one treats them as worth anything … they use two, three, or four when one would do just as well," he said.

First introduced in the 1970s, plastic bags now account for four out of every five bags handed out

at the grocery store.
"When you look at it as a product, it is an unbelievable success story," said Cobb.
The success of the plastic bag has meant a dramatic increase in the amount of sacks found floating in the oceans where they choke, strangle, and starve wildlife and raft alien species around the world, according to David Barnes, a marine scientist with the British Antarctic Survey in Cambridge, England, who studies the impact of marine debris. Barnes said that plastic bags have gone "from being rare in the late 80s and early 90s to being almost everywhere from Spitsbergen 78° North [latitude] to Falklands 51° South [latitude], but I'll bet they'll be washing up in Antarctica within the decade."
Bateman said that plastic bags are becoming a victim of their success. "The industry is at the stage where its success has caused concerns and these concerns need to be addressed responsibly," he said. Among other initiatives, Bateman supports the development of biodegradable plastic bags, a technology that has made strides in recent years.

Plastax to the Rescue?
Plastic bag litter has become such an environmental nuisance and eyesore that Ireland, Taiwan, South Africa, Australia, and Bangladesh have heavily taxed the totes or banned their use outright. Several other regions, including England and some U.S. cities, are considering similar actions.
Tony Lowes, director of Friends of the Irish Environment in County Cork, said the 15 cent (about 20 cents U.S.) tax on plastic bags introduced there in March 2002 has resulted in a 95 percent reduction in their use. "It's been an extraordinary success," he said.
According to Lowes, just about everyone in Ireland carries around a reusable bag and the plastic bags that once blighted the verdant Irish countryside are now merely an occasional eyesore.
Cobb believes a similar tax in the U.S. would have a similar effect on reducing consumption.
The American Plastics Council is wary of such a tax in the U.S. They say it would cost tens of thousands of jobs and result in an increase in energy consumption, pollution, landfill space, and grocery prices as store owners increase reliance on more expensive paper bags as an alternative. Bateman said the Irish tax of about U.S. 20 cents per bag is too high, but that a tax of 3 to 5 cents could have a positive impact on reducing plastic bag consumption by changing people's behavior.
"Having bags charged has some merits because it gets them used more responsibly," he said. For example, instead of a bagger using six bags to package a person's dinner, the bagger might use just two. As for Cobb, he hopes people will begin to realize that paper and plastic bags both come at great cost to the environment and instead of scratching their head when asked which type they prefer, they'll pull a tightly packed reusable bag from their pocket. "We want to make it cool to carry reusable shopping bags," he said.

Evidence #3: This article contains data that shows paper is made from a renewable resource and is biodegradable making it environmentally friendly.

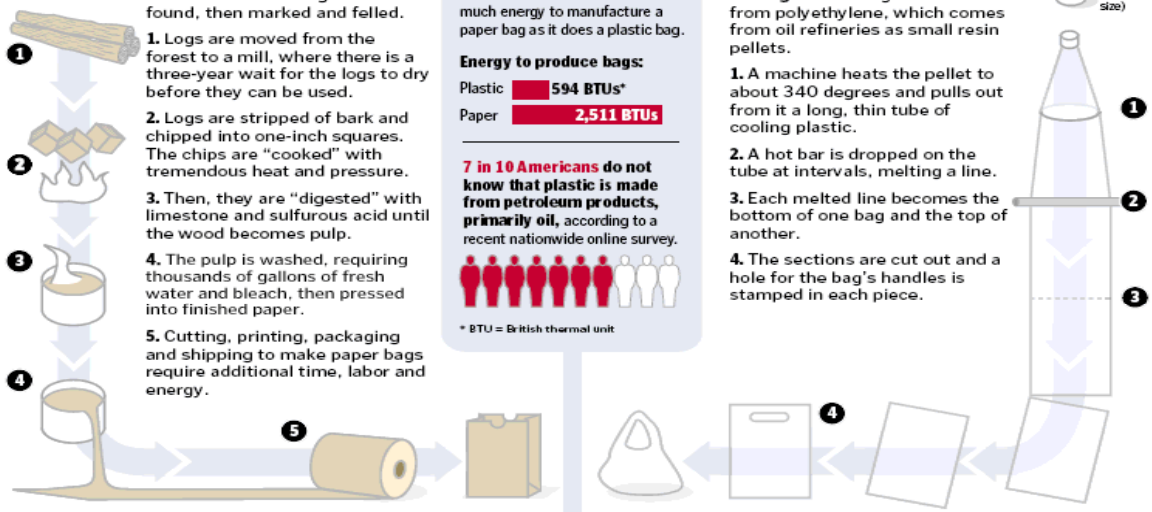
MORE THAN MEETS THE EYE

An occasional feature that digs deeper into things you've been wondering about

Paper or Plastic?

We hear the question almost every time we go grocery shopping. Some shoppers answer automatically: plastic — convinced that they are making a better choice for the environment. Others ask for paper, believing the very same thing. The reality is that both paper and plastic bags gobble up natural resources and cause significant pollution. When you weigh all the costs to the environment, **you might just choose to reuse:**

	PAPER		PLASTIC
CONSUMPTION	Americans consume more than **10 billion paper bags** each year. Some **14 million trees** are cut down annually for paper bag production.	**Four out of five grocery bags in this country are plastic.** The U.S. uses 100 billion plastic bags annually, made from an estimated 12 million barrels of oil. 	Worldwide, an estimated 4 billion plastic bags end up as litter each year. Tied end to end, **the bags could circle the Earth 63 times.** 
PRODUCTION	**Paper, of course, comes from trees.** Trees are grown or found, then marked and felled. **1.** Logs are moved from the forest to a mill, where there is a three-year wait for the logs to dry before they can be used. **2.** Logs are stripped of bark and chipped into one-inch squares. The chips are "cooked" with tremendous heat and pressure. **3.** Then, they are "digested" with limestone and sulfurous acid until the wood becomes pulp. **4.** The pulp is washed, requiring thousands of gallons of fresh water and bleach, then pressed into finished paper. **5.** Cutting, printing, packaging and shipping to make paper bags require additional time, labor and energy.	It takes more than four times as much energy to manufacture a paper bag as it does a plastic bag. **Energy to produce bags:** Plastic 594 BTUs* Paper 2,511 BTUs **7 in 10 Americans do not know that plastic is made from petroleum products, primarily oil,** according to a recent nationwide online survey. * BTU = British thermal unit	**Plastic is a by-product of oil refining.** Plastic bags are made from polyethylene, which comes from oil refineries as small resin pellets. **1.** A machine heats the pellet to about 340 degrees and pulls out from it a long, thin tube of cooling plastic. **2.** A hot bar is dropped on the tube at intervals, melting a line. **3.** Each melted line becomes the bottom of one bag and the top of another. **4.** The sections are cut out and a hole for the bag's handles is stamped in each piece.
POLLUTION	The use of toxic chemicals during the production of paper for bags contributes to air pollution, such as acid rain, and water pollution.	The production of paper bags generates 70 percent more air and 50 times more water pollutants than production of plastic bags. **Air pollutants** Plastic Paper **Water pollutants** Plastic Paper	Plastics production requires toxic chemicals. In an EPA ranking of chemicals that generate the most hazardous waste, five of the top six were commonly used by the plastics industry. Hundreds of thousands of marine mammals die every year after eating discarded plastic bags. Turtles think the bags are jellyfish, their primary food source. Bags choke animals or block their intestines.
RECYCLING	Paper must be returned to pulp by using many chemicals to bleach and disperse the fibers. Although paper bags have a higher recycling rate than plastic, each new paper grocery bag you use is made from mostly virgin pulp for better strength and elasticity. Bags that are recycled are often turned into corrugated cardboard, not new paper bags.	It takes 98% less energy to recycle a pound of plastic than it takes to recycle a pound of paper. **Energy used to recycle bags:** Plastic 17 BTUs Paper 1,444 BTUs But recycling rates of both types of bags are extremely low. **Percentage of bags recycled:** 1-3% Plastic 10-15% Paper	Recycling almost any kind of plastic involves remelting and re-forming it. Because bags must first be separated by the type of plastic they were made from, the process is time-consuming and expensive. For example, it can cost $4,000 to process and recycle 1 ton of plastic bags. This can then be sold on the commodities market for about $32. More often than not, bags collected for recycling never get recycled. A growing trend is to ship them to countries such as India and China, where they are cheaply incinerated under more lax environmental laws.
BIODEGRADABLE?	Paper is degradable, but it cannot completely break down in modern landfills because of the lack of water, light, oxygen and other necessary elements. About 95	Even though petroleum-based plastic will never biodegrade, nearly **4 in 10 believe plastic will biodegrade** underground,	Petroleum-based plastics are not biodegradable, meaning they will not decompose over time. But they do take up less space than paper in a landfill;



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BIODEGRADABLE? Paper is degradable, but it cannot completely break down in modern landfills because of the lack of water, light, oxygen and other necessary elements. About 95 percent of garbage is buried beneath layers of soil that make it difficult for air and sunlight to reach it.

Even though petroleum-based plastic will never biodegrade, nearly **4 in 10 believe plastic will biodegrade** underground, in landfills or in the ocean.

Petroleum-based plastics are not biodegradable, meaning they will not decompose over time. But they do take up less space than paper in a landfill: 2,000 plastic bags weigh 30 pounds; 2,000 paper bags weigh 280 pounds.

WHAT YOU CAN DO

Invest in high-quality reusable bags, each of which has the potential to eliminate an average of 1,000 plastic bags over its lifetime. The bag will pay for itself if your grocery store offers a 5- or 10-cent credit per bag.

Buy collapsible plastic crates and keep them in your car. At checkout, food goes into the crates, making it easy to bring food into the house in one or two trips.

No bag at all? Think twice about requesting a plastic bag if your purchase is small and easy to carry.

Reuse the bags you have. Line your litter box with them; crumple them and use them for packing; cut the handles off, add some string and make a toy parachute; use them for an impromptu diaper pail; line your trash cans with them; be creative.

Keep reusable bags in your home, office or car so they are available when you go shopping.

SOURCES: American Chemistry Council; American Forest and Paper Association; "Comparison of the Effects on the Environment of Polyethylene and Paper Carrier Bags," Federal Office of the Environment, August 1988; Institute for Lifecycle Environmental Assessment; Paper Industry Association Council; "Resources and Environmental Profile Analysis of Polyethlyene and Unbleached Paper Grocery Sacks," Franklin Group, 1990; Reusablebags.com; Society of Plastics Industry; U.S. Environmental Protection Agency; Worldwatch Institute; GRAPHIC: Brenna Maloney and Laura Stanton - The Washington Post

***Sources: American Chemistry Council; American Forest and Paper Association; 'Comparison of the Effects on the Environment of Polyethylene and Paper Carrier Bags," Federal Office of the Environment, August 1988, Institute for Lifecycle Environmental Assessment, Paper Industry Association Council, "Resources and Environmental Profile Analysis of Polyethlyene and Unbleached Paper Grocery Sacks "Franklin Group, 1990, Reusablebags.com. Society of Plastics Industry, U.S. Environmental Protection Agency, Worldwatch Institute; GRAPHIC: Brenna Maloney and Laura Stanton> The Washington Post

Evidence #4: Scientists in this article say plastic bags made from corn are the best environmental solution.

Pros and Cons of the Corn-based Plastic PLA

PLA is carbon neutral and burns clean, but has a host of unsolved problems

From Larry West, former About.com Guide

Dear EarthTalk: What are the environmental pros and cons of corn-based plastic as an alternative to conventional petroleum-based plastic? -- *Laura McInnes, Glasgow, Scotland*

Polylactic acid (PLA), a plastic substitute made from fermented plant starch (usually corn) is quickly becoming a popular alternative to traditional petroleum-based plastics. As more and more countries and states follow the lead of China, Ireland, South Africa, Uganda and San Francisco in banning plastic grocery bags responsible for so much so-called "white pollution" around the world, PLA is poised to play a big role as a viable, biodegradable replacement.

PLA Helps to Reduce Greenhouse Gas Emissions☐Proponents also tout the use of PLA—which is technically "carbon neutral" in that it comes from renewable, carbon-absorbing plants—as yet another way to reduce our emissions of greenhouse gases in a quickly warming world. PLA also will not emit toxic fumes when incinerated.

PLA Biodegrades Slowly Unless Subjected to Industrial Composting☐But critics say that PLA is far from a panacea for dealing with the world's plastic waste problem. For one thing, although PLA does biodegrade, it does so very slowly.

According to Elizabeth Royte, writing in Smithsonian, PLA may well break down into its constituent parts (carbon dioxide and water) within three months in a "controlled composting environment," that is, an industrial composting facility heated to 140 degrees Fahrenheit and fed a steady diet of digestive microbes. But it will take far longer in a compost bin, or in a landfill packed so tightly that no light and little oxygen are available to assist in the process. Indeed, analysts

estimate that a PLA bottle could take anywhere from 100 to 1,000 years to decompose in a landfill.

Recyclers Can't Mix PLA and Other Plastics☐Another issue with PLA is that, because it is of different origin than regular plastic, it must be kept separate when recycled, lest it contaminate the recycling stream. Being plant-based, PLA needs to head to a composting facility, not a recycling facility, per se, when it has out served its usefulness. And that points to another problem: There are currently only 113 industrial-grade composting facilities across the United States.

Most PLA Uses Genetically Modified Corn☐Another downside of PLA is that it is typically made from genetically modified corn, at least in the United States. The largest producer of PLA in the world is NatureWorks, a subsidiary of Cargill, which is the world's largest provider of genetically modified corn seed.

With increasing demand for corn to make ethanol fuel, let alone PLA, it's no wonder that Cargill and others have been tampering with genes to produce higher yields. But the future costs of genetic modification to the environment and human health are still largely unknown and could be very high.

Green-Minded Consumers May Prefer Alternatives to Plastics☐While PLA has promise as an alternative to conventional plastic once the means of disposal are worked out, consumers might be better served by simply switching to reusable containers—from cloth bags, baskets and backpacks for grocery shopping (most chains now sell canvas bags for less than a dollar apiece) to safe, reusable (non-plastic) bottles for beverages.

Despite Problems, PLA Has Many Uses☐As for other types of PLA items—such as those plastic "clamshells" that hold cut fruit (and there is a whole host of industrial and medical products now made from PLA)—there is no reason to pass them by. But until the kinks are worked out on the disposal and reprocessing end, PLA may not be much better than the plain old plastic it's designed to make obsolete.

GOT AN ENVIRONMENTAL QUESTION? Send it to: EarthTalk, c/o E/The Environmental Magazine, P.O. Box 5098, Westport, CT 06881; submit it at: www.emagazine.com/earthtalk/thisweek/, or e-mail: earthtalk@emagazine.com.

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