The FoodPrint of Food Packaging

Contents

You have checked the milk carton for an organic certification label. You've scanned the nutrition label on a can of beans, searching for an acceptable salt level. You've spent time finding eggs from hens that were pasture raised. But have you noticed whether those eggs come in a cardboard carton or in a molded plastic container? Do you know what the milk carton is made of? Are you paying attention to what lines the inside of that can of beans?

Ironically, though many of us are spending more time and money to eat the healthiest and most sustainably produced foods that we can find and afford, we frequently overlook the packaging in which this food is found. Shouldn't our food packaging be just as good for our health and the planet as the actual food? We think so.

The Problems with Food Packaging

Single-use food packaging is taking a huge toll on our environment. As our landfills and waterways are increasingly clogged with plastic bags, Styrofoam food containers, disposable coffee cups and more, it's clear that the convenience of food packaging is outweighed by the waste and pollution that the packaging leaves behind. Something less widely understood is that this same food packaging, from the additives like phthalates which give plastics their pliability or perfluorinated chemicals that allow cardboard to contain liquids, all the way to the bisphenol linings that coat our aluminum cans, much of our food packaging is extremely dangerous to our health.

While it might be hard to imagine what daily life would be like without all this convenient packaging, until recently, much of it did not even exist. As our food system grew less local yet able to feed more people across a greater geographic area, and as food became more highly processed, the packaging technology itself increased to keep pace. And while packaging can be essential for certain functions, the industry has evolved with little concern for the environment or for human health.

Better packaging materials and better design could mean less waste and fewer harmful chemicals — and these are goals that can be achieved side by side. As consumers, we have an opportu-

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nity to choose the materials we feel most comfortable with and to ask companies and retailers to do better. We can also ask our government to enact stronger regulations around packaging and plastics. Most importantly, we need to re-think food packaging and single-use food service items, making human health and the environment the priority over convenience.

An Overview Of Food Packaging

When you walk the aisles of your grocery store, you find an array of packaging types on the shelves. There are cans of beans, cartons of milk, plastic containers of yogurt, bags of chips and plastic-wrapped meat on foam trays. Along with the materials you can see (like plastic bottles and metal cans), a lot of food packaging contains chemical additives or linings you cannot see, which are there to prevent leaking or to keep the acid in foods like tomatoes from corroding metal cans.

Most food packaging can be broken down into four major types:

- **Plastic packaging:** This includes a wide array of plastic types, from Styrofoam to clear plastic "clamshell" packages to the lids on takeout coffee cups. The raw materials used to make plastic packaging may be harmful to our health, or there may be harmful chemicals added to the plastic to make it more functional.

- **Metal packaging:** This includes aluminum and other metal cans that both food and beverages are packaged in. Metal cans are often lined with anti-corrosive substances that can leach into our food and affect our health.

- **Paper/fiber packaging:** This includes the increasingly common "tetra" pack cartons, other types of cartons and take-out food containers. Like other types of packaging, paper/fiber packaging often is lined or coated with substances to make it more functional – for example, able to hold liquids – which can be harmful to human health.

- **Glass packaging:** This includes glass bottles and other containers.

The basic materials of our food packaging — whether plastic, metal, paper/fiber or glass — determine the environmental impact and, ultimately, whether it can be recycled, and how it will or will not break down in a landfill or create pollution and waste. The chemical additives and special coatings on or in different packaging types are generally where we are exposed to chemicals of concern, but coatings and additives can, in some cases, also determine if the material can be recycled or not.

Food packaging is becoming a growing global concern, because of the large amount of waste it generates and the chemicals it contains that can be detrimental to our health. In the next section, we delve into the health and environmental issues with food packaging, primarily focusing on plastic, metal and paper packaging. We pay particular attention to plastic packaging, since it's the most ubiquitous and generally the most problematic for both the environment and our health.

Plastic Food Packaging

Plastics are everywhere in the food system, found at every step in our foods' journey to our plates. These plastics, once predominantly made from crude oil, but now increasingly from natural gas, have become the dominant materials because of their unique functional properties and low cost.

Since it was first introduced, plastic quickly became a vital part of the American food system. Many plastic products were developed for the modern ways Americans were purchasing, preparing and storing food; and we grew to not only appreciate but to expect the convenience they provide.

THE PROBLEM WITH SINGLE-USE PLASTICS

Forty percent of the demand for plastic is generated by single-use plastic products.[1] Single-use (or disposable) plastics — like the cup, lid and straw for your iced coffee, or your water bottle, or the plastic container your cherry tomatoes come in — are all designed to be used only once before being thrown away or recycled, with no obvious plan or pathway for reuse.

Some single-use items are essential and have made things not only convenient but safer. A great example is the plastic water bottle, a million of which are bought across the globe every minute.[2] In places where the water supply is not reliable or safe, of course, bottled water can be life-saving. But for many people in this country, bottled water is more about convenience, taste (or the perception of taste) and our susceptibility to the claims of the companies peddling the bottled water: that it comes from fresh mountain springs or offers unspecified health benefits.

It's not just plastic bottles we're using once and tossing. We've come to expect that a lot of our food will be packaged and served to us in a single-use fashion, and it's gotten to the point where it's hard to imagine another way to sell, transport or eat food.

PLASTIC POLLUTION FROM FOOD PACKAGING

Plastic packaging makes our lives more convenient, but at what expense? Its durability means that it never disappears. Its constant presence in our daily lives (including in our food packaging) has led to widespread pollution. So where do plastics go when we're done with them? Some are recycled, some are incinerated, but most end up in landfills or enter the environment as litter.[3] [4]

Most plastics do not biodegrade. Instead, they break down into ever smaller pieces called "microplastics" that are carried by the wind and water and deposited in the environment, spreading plastic pollution to all corners of the world, from the top of the French Pyrenees, to the stomachs

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of whales, to soil on the farms where our food is grown.[5][6][7][8] We know that animals and humans are ingesting microplastic particles, via the food we eat and the water we drink, but we don't yet know all of the implications.[9]

The highly visible problem of plastic pollution in our waterways and oceans has drawn worldwide attention. We are distressed by images of marine mammals washing up dead on our shores, their stomachs clogged with plastic. There are plastic "gyres" in all of the world's major oceans, including the infamous Great Pacific Garbage Patch (GPGP)[10], an accumulation zone of plastics in the Pacific Ocean between California and Hawai'i that is estimated to contain at least 79,000 tons of plastic floating in an area of 1.6M km. Plastics have been found deep in ocean waters, too, including in the Mariana Trench, the deepest known part of the world's oceans.[11]

Much of the research about plastic pollution has focused on the marine environment. But is there a reason to worry about plastics in soil, too? Recent research indicates that the answer is "Yes."[12] Microplastics can make their way into soil through flooding, littering and by being deposited through the atmosphere (e.g., by wind).[13] They can also be deposited on soil through compost applications or through sewage sludge, which is sometimes used as a fertilizer on farmland.[14] A recent study indicates that microplastics affect the ability of soil to hold water, and have other impacts on soil structure.[15]

THE PROBLEMS WITH PLASTIC PRODUCTION

It's not just a matter of where plastics end up that affects the environment. A recent report indicates that plastic contributes to greenhouse gas emissions at every stage of its lifecycle, from production to refining to the ways it is managed as a waste product.[16]

Extraction of the fossil fuels that are the building blocks of plastic is an environmentally depleting process, whether for petroleum-based plastics or those derived from natural gas. As the hydrau-

lic fracturing (fracking) industry has boomed, so has the availability of cheap plastic, thanks to a fracking byproduct, called ethane, used extensively in plastic production. The manufacturing process that is required to turn that ethane into plastic is energy-intensive and pollutes the air, soil and water of nearby communities — communities already suffering from the environmental and public health impacts of natural gas fracking.[17] [18]

While we know that plastics have carbon-intense life cycles, we do not yet have a full understanding of how their production, in addition to their use and disposal, is contributing to the global climate crisis. We may be on the verge of getting better information, thanks to researchers from the University of California at Santa Barbara. They have conducted what they believe is the first global assessment of the life cycle of greenhouse gas emissions from plastics. The researchers also explore four strategies for reducing the carbon footprint of plastic.

ARE BIO-BASED PLASTICS THE SOLUTION?

Some food and beverage companies have begun using bio-based plastics, and while they are made from renewable sources (such as corn or sugarcane), rather than from fossil fuels, and have a better carbon footprint than other plastics, they're not necessarily a solution to our food packaging problems.[19]

There are tradeoffs to be considered, including the inputs (land, water, chemicals and labor) needed to produce the renewable crop for the bio-based plastic (e.g., corn).[20] Bio-plastics also break down only under certain conditions, so being "bio-based" does not guarantee that they will biodegrade.[21]

PLASTICS OF PARTICULAR CONCERN: POLYSTYRENE

From a health and environmental perspective, some plastic packaging types are more concerning than others. One such plastic type is polystyrene #6. This plastic is everywhere, including takeout containers, cutlery, coffee cups and lids, and other kinds of disposable cups, like the famous red Solo party cup. Styrofoam (a registered trademark of Dow Chemical) is polystyrene that's been puffed with air.

While Styrofoam is becoming increasingly less common due to environmental concerns, its precursor, polystyrene, remains in widespread use, mostly unknown and unseen by consumers. It is unhealthy for both humans and the environment.

POLYSTYRENE IS BAD FOR HUMAN HEALTH

Polystyrene is made from a petroleum-based chemical called styrene. Some US government agencies, including the Agency for Toxic Substances and Disease Registry (ATSDR), the Department of Health and Human Services (DHHS), and the National Toxicology Program (NTP), recognize the health risks of styrene exposure, including neurological effects and cancers, including leukemia. One of the main ways people come into contact with styrene is through "food contamination," which happens when styrene leaches out of the container into the food that it holds. The amount that can leach out depends on a variety of factors, including surface area of the container, the temperature of the food and the fat content of the food.[22] [23] This leaching is the reason to avoid polystyrene coffee cup lids — the combination of hot liquid and the mouth being directly applied makes one particularly vulnerable.

Tip: In general, heating food in plastic should be avoided. Many studies have shown that plastic containers leach into the food and liquid they hold, and it gets worse as time and temperature increase.[24] [25]

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POLYSTYRENE IS BAD FOR THE ENVIRONMENT

Polystyrene, especially in its puffed form, is bad for the environment. Due to its being lightweight, recycling polystyrene in traditional systems is difficult, expensive and in some cases impossible, which makes it even more likely to end up as litter or in landfills. And, in its puffed (i.e., expanded) form, it takes up a lot of space in those landfills, more so than other plastics. Many municipalities have deemed recycling polystyrene too challenging and costly to make it worth their while. The good news? Polystyrene use is on the wane, and some coffee companies — including Dunkin Donuts for its cups and Starbucks for their lids— have phased them out.[26]

Tip: Most plastics have a triangle identifier on them that identifies the plastic type. If you see #6, that's polystyrene. If you buy a cup of coffee, and it's what you would call Styrofoam, that's Polystyrene #6. You can also check the plastic lid. Ask your coffee shop if they would be willing to switch to another type of lid that's better for human health and the environment.

Metal Food Packaging

Metal packaging like cans, used for long term food storage, has the challenge of being susceptible to corrosion, especially from acidic foods, like tomatoes. This vulnerability requires the addition of a plastic coating, often epoxies containing bisphenols, most of which contain harmful chemicals, as we'll go into more, below.

While metal cans are preferable to plastic because of their almost universal ability to be recycled, they are resource-intensive to produce. Much of the metal food packaging in use in the US is made from aluminum. Aluminum production is the result of mined bauxite that is smelted into alumina[27] and, as with any industrial production, the purification of aluminum requires a lot of energy.[28] In addition, aluminum production creates byproducts such as greenhouses gases, sulfur dioxide and polycyclic aromatic hydrocarbons.[29]

Fiber Food Packaging

Molded fiber packaging — meaning paper or cardboard — is very common in single-use food service items, such as cups, plates, bowls and trays. Paper and cardboard have benefits as a packaging choice, namely that they are inexpensive, they can be made of recycled paper-pulp (which makes them more sustainable), and if they haven't been coated with something that prevents it, they can be recycled.

The problem is that most fiber food packaging provides good physical and UV/light barriers, but isn't a good enough barrier for liquids on its own, and so requires plastic coatings or other additives, like perfluorinated chemicals (PFAS), which can render them unable to be recycled (in the case of a plastic lining) or might be detrimental to our health (in the case of PFAS).

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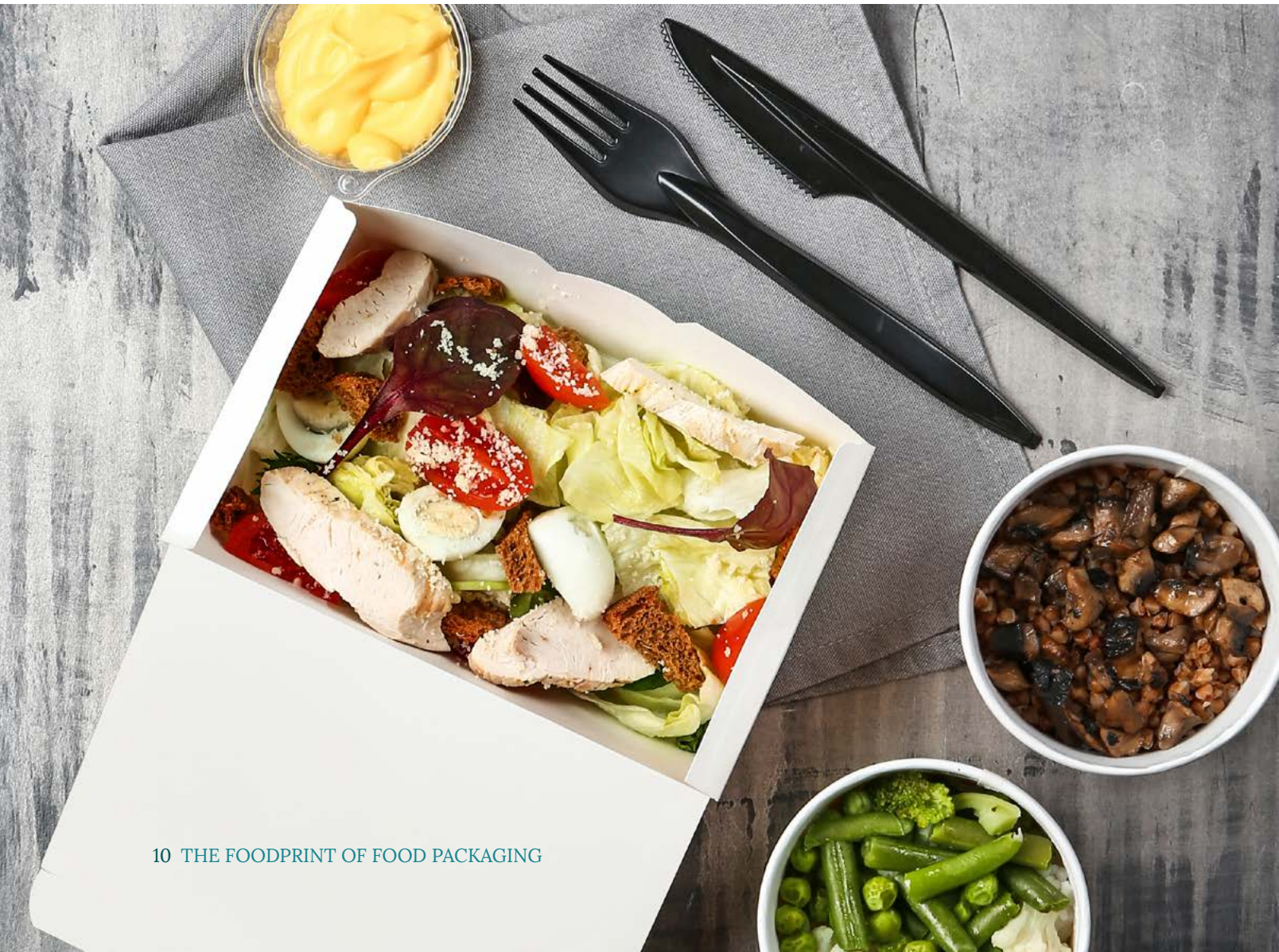
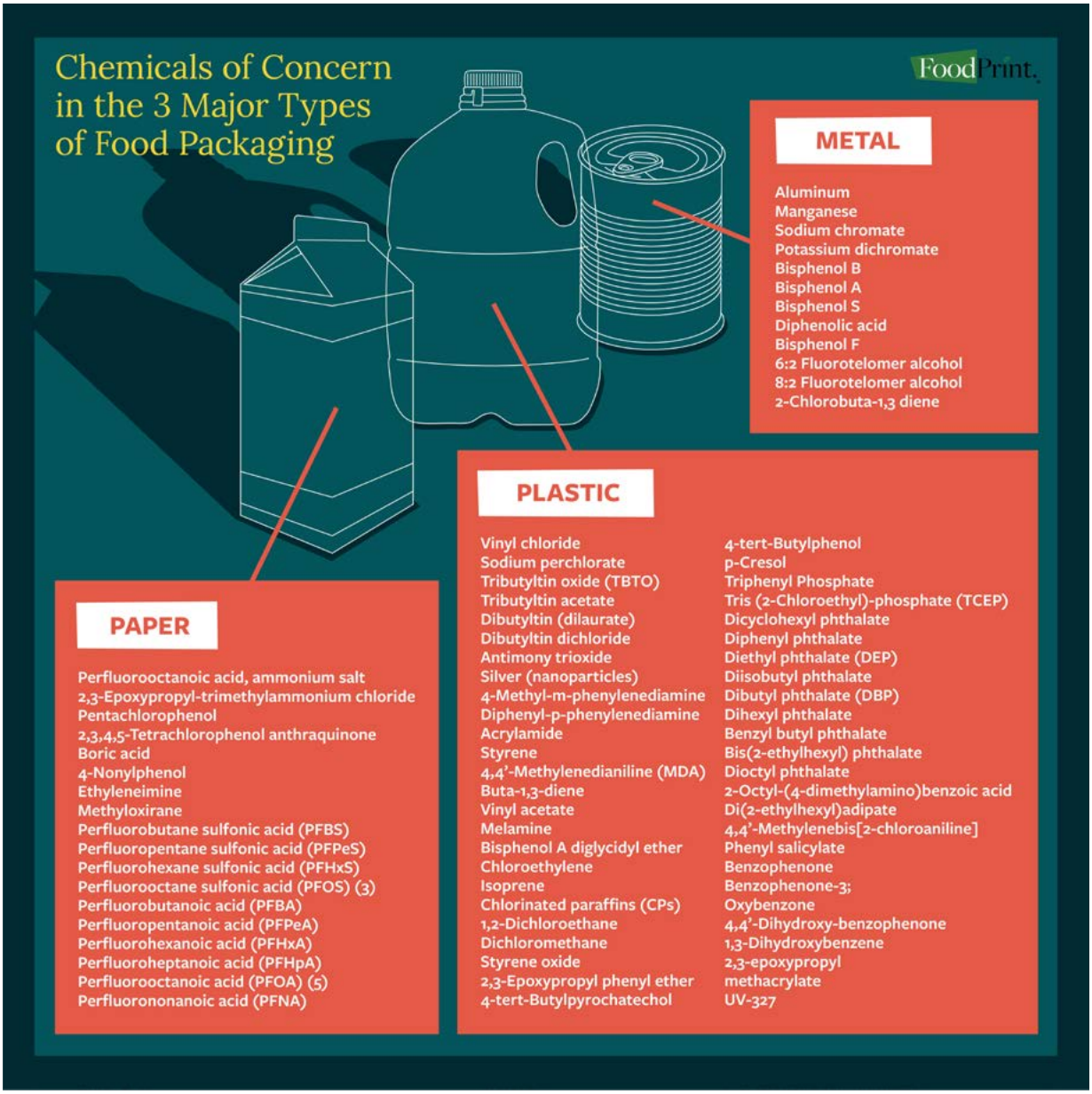


Harmful Chemicals in Food Packaging

Chemicals that could be harmful to our health are in most types of food packaging, including plastic, metal and fiber. These chemicals can be harmful to adults in a number of ways, but they are especially concerning when it comes to the health of our children. You need only look at the list of chemicals in the image below to see just how many of these "chemicals of concern" are in our food packaging.

While there are literally hundreds of these harmful unregulated chemicals in food packaging, here we focus on a handful of the most well-known, and those that are added to packaging materials for a "functional" reason — for example, to create a liquid barrier or to make plastic less breakable.



THE TOP CHEMICALS OF CONCERN FROM FOOD PACKAGING

In 2018 the American Academy of Pediatrics assessed the risks to children's health posed by several chemical classes found in food, either added as part of processing or having entered the food through transmission from food packaging.[30] They found that three of the top six chemical classes of concern — bisphenols, including BPA and BPB; phthalates; and per- and polyfluoroalkyls (also known as PFAS) are leaching into our food from food packaging.[31] [32]

These three chemical classes are all "endocrine disruptors," which means that they interfere with the hormones that regulate vital body functions, including metabolism, growth and development, sexual function, sleep and mood. Research indicates endocrine disruptors may adversely impact child development in several ways.[33] Children may have greater exposure to chemicals because they are more likely to put objects in their mouths or to touch their mouths. Children weigh less than adults; this means that they eat, drink, and breathe more per body weight. In addition, some chemicals pass through the placenta or through breast milk.[34]

BPA AND OTHER BISPHENOLS

The leaching of Bisphenol A (BPA) out of containers and their linings and into the food inside, and the associated endocrine disruption potential, has been known since 1993, when researchers first characterized the migration of BPA from hard plastic polycarbonate bottles.[35]

Since then, thanks to consumer demand, many products have been redesigned without BPA. Plastic water bottles tout their BPA-free status, and myriad baby products were reformulated

(including pacifiers, sippy cups and baby spoons). But, while BPA in these types of plastic items are on the wane, BPA is still used to line metal food packaging like cans. A 2017 report by the Center for Environmental Health found that roughly 40 percent of canned food they tested from major super markets still contained BPA, although that was down from 67 percent in 2015.[36]

So, while BPA-free cans are increasingly commonplace, a significant percentage of canned foods still use BPA. What most people do not realize is that in most cases where BPA was swapped out, Bisphenol-S or Bisphenol-F has been used as a replacement, even though they are equally harmful as BPA.

Several BPA alternatives have been assessed for safety by governments and advocacy organizations, but more work remains to be done to ensure the alternatives are preferable for human health.[37] [38]

Say no to receipts:
Bisphenols are also used on most receipts, which are printed on thermal paper with a process that employs heat (rather than ink). Unlike liners in cans, the bisphenols in this case (BPA or BPS) are not bound and the paper is coated with them. Both chemicals are easily absorbed through the skin and into the bloodstream, where they act like hormones.[39]

Tip: Packaging made with bisphenols is okay to recycle, but bisphenols themselves are harmful to human health. Your best bet is generally to look for glass alternatives or TetraPaks (multilayered cardboard packaging), where available. If you're wedded to canned goods, look for Eden Foods, which has provided Bisphenol-free cans for a couple of decades. If cans are your only option, look for products that say BPA-free (but understand that they may contain other equally harmful bisphenols, like BPS and PFB, that haven't received the negative attention BPA has).

PHTHALATES

Phthalates are a type of chemical used primarily in plastics. Known as "plasticizers," phthalates increase the flexibility of plastics to make them less brittle; if a plastic product is bendable, it is most likely made with phthalates.[40] In food packaging, phthalates are commonly used in plastic food containers and some plastic wraps, like cellophane.[41]

Exposure to phthalates in humans occurs through leaching from food packaging and plastic wrap, especially when the packaging is exposed to heat such as in the microwave (and to a lesser degree through dust particles contaminated by phthalates).[42] High fat foods such as meat and dairy are particularly susceptible to phthalate contamination when exposed to heat.[43]

Phthalates have been detected in the urine of the general population within the US,[44] but the health effects are still being researched. Similar to the other top chemicals of concern in food packaging, animal studies have linked phthalates to hormone disruption, as well as reproduc-

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tive health issues.[45] Researchers are monitoring the risks of prolonged exposure to phthalates in humans, and especially in infants and children.

Tip: Avoid heating plastic wrap and non-microwavable plastic in the microwave.

PERFLUORINATED CHEMICALS (PFAS)

Perfluorinated chemicals (PFAS), in use since the 1940s, are a class of synthetic chemicals used primarily on fiber-based food packaging, including on paper plates, bowls, cardboard clamshells and other kinds of food packaging to make them water and oil-resistant. The grease-resistant paper wrapped around your burger, your pizza boxes, rotisserie chicken bag, bakery wrapper and hot bar takeout box: they all are likely to contain PFAS. PFAS are also found in a range of other products having nothing to do with food (including firefighting foam and apparel), but it's worth noting that they make their way into our food through their other uses, by lingering in our soil and water.[46]

PFAS, sometimes called "forever chemicals," have been linked to a range of negative health outcomes, including delayed learning, growth and behavior issues in children; reduced female fertility; endocrine system disruption; increased cholesterol levels; immune system disruption; and increased risk of cancer. Since PFAS do not biodegrade, they stay in the environment and the human body, gradually accumulating over time.[48]

Some US government agencies have identified PFAS as an "important public health concern."[49] [50] [51] Nineteen states have legislation and/or policies that regulate PFAS[52] and the EPA has issued a national PFAS Action plan.[53] In a rare (for these times) bipartisan effort, a group of US Senators recently introduced legislation that would require the EPA to declare PFAS to be "hazardous sub-

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stances" eligible for funding from the EPA Superfund.[54] The FDA is concerned enough about PFAS in our food that they are evaluating how it gets into our food through environmental contamination and through food packaging.[55] In 2019, due to concerns about levels of PFAS in our drinking water, Congress introduced at least 20 bills that address PFAS limits or regulation in some way.[56]

Despite all of this concern, PFAS remains in so much of our food packaging, including some products that had not been widely known to contain them, like molded fiber bowls used at various takeout fast casual stores and touted as compostable.

The search for alternatives to PFAS coatings and additives for fiber-based food contact packaging is intensifying. Stores like Whole Foods have committed to removing them from their prepared food bars and, recently, one of the largest manufacturers of PFAS, Chemours, started phasing them out of production.[57] Multiple organizations including Clean Production Action and Center for Environmental Health have put together a resource guide for people trying to source PFAS free food service products.[58] [59]

Tip: To find products that are PFAS free and PFAS-Free Food, check out these resources: Purchasing Safer Compostable Food Service Ware and Avoiding Hidden Hazards: A Purchaser's Guide to Safer Foodware. Uncoated paper products, and products made from materials other than paper, including bamboo, are good alternatives. Other ways to limit exposure: Avoid using non-stick (Teflon) cookware, which also is made with PFAS. The Biodegradable Products Institute (BPI) provides certification for compostable products and packaging (similar to a Good Housekeeping seal of approval). As of 2020, no BPI-certified compostable paper products can contain PFAS linings, which means BPI-certified products are compostable and free of a dangerous additive that never biodegrades (although there is now evidence that BPI-certified molded fiber bowls may contain PFAS). Check out this list of PFAS-free products.

HOW CHEMICALS IN FOOD PACKAGING ARE REGULATED

In the US, the Food and Drug Administration (FDA) maintains oversight over indirect food additives (chemicals) that may come into contact with food through packaging, but they have taken a generally permissive stance. As a result, it has fallen to industry to monitor which chemicals are of concern and determine, and to monitor and regulate themselves. Consumers have limited ability to weigh in, except through the feedback they provide to brands, companies and retailers.

Most chemical management policies in the packaging industry focus on banned chemicals or those that might be impacted by legislation, such as Bisphenol A, for example.[60] In 2015 and 2016, bills seeking a wide range of actions around BPA were introduced in both the House and the Senate, but they died in session and have not been reintroduced. Some states have taken action; for a list of states with restrictions on BPA, visit the National Conference State Legislatures policy page.[61] [62] More recently, entire chemical classes have been included in chemical management policies, such as phthalates or fluorinated compounds (PFAS). These are allowed by regulatory agencies but have come under scrutiny for the potential harm they pose, including hormone disruption, organ toxicity and as potential carcinogens.[63]

Many brands have banned or have announced their intentions to ban a handful of these chemicals. While this is a positive sign, we should remember that these few bad-actor chemicals represent a small fraction of the chemicals of concern not regulated. In addition, current industry standards are weak and highly fragmented.

Can All Types of Food Packaging Be Recycled or Composted?

The short answer is no. What to do with packaging at the end of its useful life to us — whether to compost it, recycle it or simply throw it away — is a complicated question. One of the challenges of sustainable packaging design is that materials designed for certain functions, such as blocking light, may not work for other needs, like keeping packaging waterproof. To solve this, multi-material or multi-layered packaging is often used, like a paper takeout container lined with plastic. But this makes it hard, if not impossible, to separate out streams of waste. That takeout container, for example, cannot be recycled with the regular paper because of its plastic liner.

In some cases, materials may technically have the ability to be recycled or composted, but that does not mean that the appropriate infrastructure exists or that the materials are properly separated and eventually recycled or composted.

Regardless of whether materials go the route of recycling or composting at end of life, it is critical that we use safer materials and chemical building blocks, otherwise we may contaminate compost and recycling streams.[64] [65]

RECYCLING ISSUES WITH PLASTIC

While you might think that the solution to plastic waste is recycling, the hard truth is that the majority of plastics do not go into the recycling system. It is estimated that 91 percent of plastic is not recycled.[66] [67]

For decades, the US sent the bulk of our recycling, including plastics, to China.[68] However, in 2018, China stopped accepting some recyclables, including most plastics. The US recycling industry has

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been upended, recycling rates are down, and communities are struggling with what to do. Since there is no longer a "market" for recycling, municipalities must pay higher rates to get rid of recyclable items, stockpile them and hope for better times, incinerate them, or send them to a landfill.[69 70] We are using more plastics than ever, and yet we have fewer places to responsibly dispose of them.

Tips: Overall, use fewer plastics. Start by looking for glass and metal alternatives, which are generally easier to recycle. If you are purchasing an item that is packaged in plastic, check the bottom of the product you're considering purchasing. If it's labeled 3, 4, 6 or 7, try to find a different item, since those numbers are more challenging to recycle. Check with your local recycler to find out what plastics can and cannot be recycled in your community.

The Packaging Path Forward

How do we get to a world of safe packaging and less packaging-related pollution? We need an "all of the above" approach that promotes new and safer materials, reduces the amount of plastic used through design changes, and maximizes reuse and recycling rates, all while meeting functional needs at a reasonable cost.

THE PROMISE OF REUSABLE FOOD PACKAGING

Given all we know about the environmental and health concerns regarding single-use food packaging, and given how much of it cannot be — or simply is not — recycled, reusing food and drink

containers is an important part of the solution. Before we all became used to the convenience of using something once and throwing it away, food containers were reused. Milk, cola and seltzer bottles were all made of glass, and we returned them to the manufacturer for cleaning and reuse. Grocery shoppers often brought their own containers to the dry grocer to stock up from bulk bins.

We know that consumers have done it and can do it again, but it's a matter of making a huge cultural shift, away from single-use and back towards reuse. It's true that reusable containers can be more expensive, and it's true that they might put the onus of cleaning (in some cases) on the consumer. But the stakes are high. If consumers are able to afford alternatives, we feel confident that people can transition to reusable materials.

A company called TerraCycle agrees. They're launching the Loop box, which will enable consumers to recycle packaging of products they receive via home delivery. Consumers will use a box to return the empty containers to the product manufacturers, who will take responsibility for the packaging waste they create. The service was piloted in Paris and New York in 2019, and if it's successful, it's likely that we'll see other companies following suit.[71]

A similar trend is emerging in the food storage sector. New products are emerging, and they aren't your grandmother's Tupperware. Brands like Stasher (silicon), Beeswrap (cloth treated with beeswax) and Blue Avocado (reusable bags) are offering alternatives to single-use plastic food

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storage containers, including sandwich bags and plastic wraps. A new generation of consumers appreciates the importance of food storage as a means to reduce food waste, and are making environmentally-friendly and health-conscious decisions.

PROMISING DEVELOPMENTS IN BETTER FOOD PACKAGING

The fact remains the reusable containers cannot be the complete solution to our food packaging problems. Innovations in packaging are needed, and researchers, companies and entrepreneurs are stepping up. There is a need for alternatives to petroleum-based plastic, for improved end-of-life functions (including degradable plastics, better recycling technologies and reusable packaging) and safer linings and coatings. But is it fast enough? Here are some examples of organizations that are rethinking everything from materials to processes to distributio.

What if plastics could be used over and over? Scientists at the US Department of Energy's Lawrence Berkeley National Laboratory have designed a plastic they believe can be manufactured, used, recycled and used repeatedly without losing value.[72] They are calling it polydiketoenamine, or PDK.

Other new materials may also hold promise.[73] Researchers at Penn State have developed an inexpensive, compostable material they believe could replace the plastic barrier coatings that are problematic in packaging.[74] A company called CuanTech is developing a fully compostable plastic wrap made from langoustine shells.[75] Some other exciting packaging trends feature renewable, natural materials — including bamboo and cassava leaves — to reduce packaging waste. A new product called ReCUP uses a mineralized resin coating that the manufacturer claims makes them easily recycled using traditional paper recycling equipment.

Designing better systems may help end, or at least greatly reduce, plastic waste. A New Plastics Economy Innovation Prize launched in 2017 invites designers, entrepreneurs, academics, scientists and others to rethink the kinds of plastic packaging, like single-use plastics, that are most likely to end up in landfill or in the environment. It's organized by the Ellen MacArthur Foundation, the Prince of Wales's International Sustainability Unit, and funded by Wendy Schmidt, and innovative ideas are already emerging.[76]

PROMISING DEVELOPMENTS IN PLASTIC BAN LEGISLATION

In an effort to tackle the single-use plastics problem, many cities and states are passing legislation designed to limit the use of plastic bags, Styrofoam and drinking straws. Since the beginning of 2019, for example, state lawmakers have introduced nearly 100 bills related to plastic bags. That number is sure to grow.

State and citywide Styrofoam bans are also gaining momentum. Maryland became the first state to prohibit restaurants, cafes, food trucks and supermarkets from packaging foods in foam containers. Several cities, from New York and Seattle to Freeport, Maine, and Encinitas, California, have similar legislation in place.

Plastic straw bans have also begun to gain popularity. Straws represent a small percentage of plastic pollution, but have gained a great deal of attention lately, in part because for most people they are simply not necessary. Plastic straws are generally made from #5 (polypropylene), which is technically able to be recycled, but people often forget to recycle them because they are so small. In addition, many recycling facilities do not accept them, because they clog up the machinery. This means they are much more likely to end up in landfill or in the environment as pollution.

A concerted effort to raise awareness of the issue was started by the Surfrider Foundation early in 2018.[77] A coalition soon formed, and legislative solutions began appearing. California became the first state to restrict the use of plastic straws, barring their use in full service restaurants

(although they are available upon request).[78] Other states and a growing number of cities have followed suit. Some major corporations have also joined the effort to eliminate plastic straws, including Starbucks, which has pledged to phase them out by 2020.[79]

Consumers Can Make a Difference: Action Toolkit

There are two tasks at hand for consumers when it comes to addressing the problems of food packaging: to make meaningful personal changes and to push companies and legislatures to make change on a larger scale. This can result in a reduction in the amount of plastic food packaging produced and discarded of as well as a shift away from the chemicals that are most dangerous to human health.

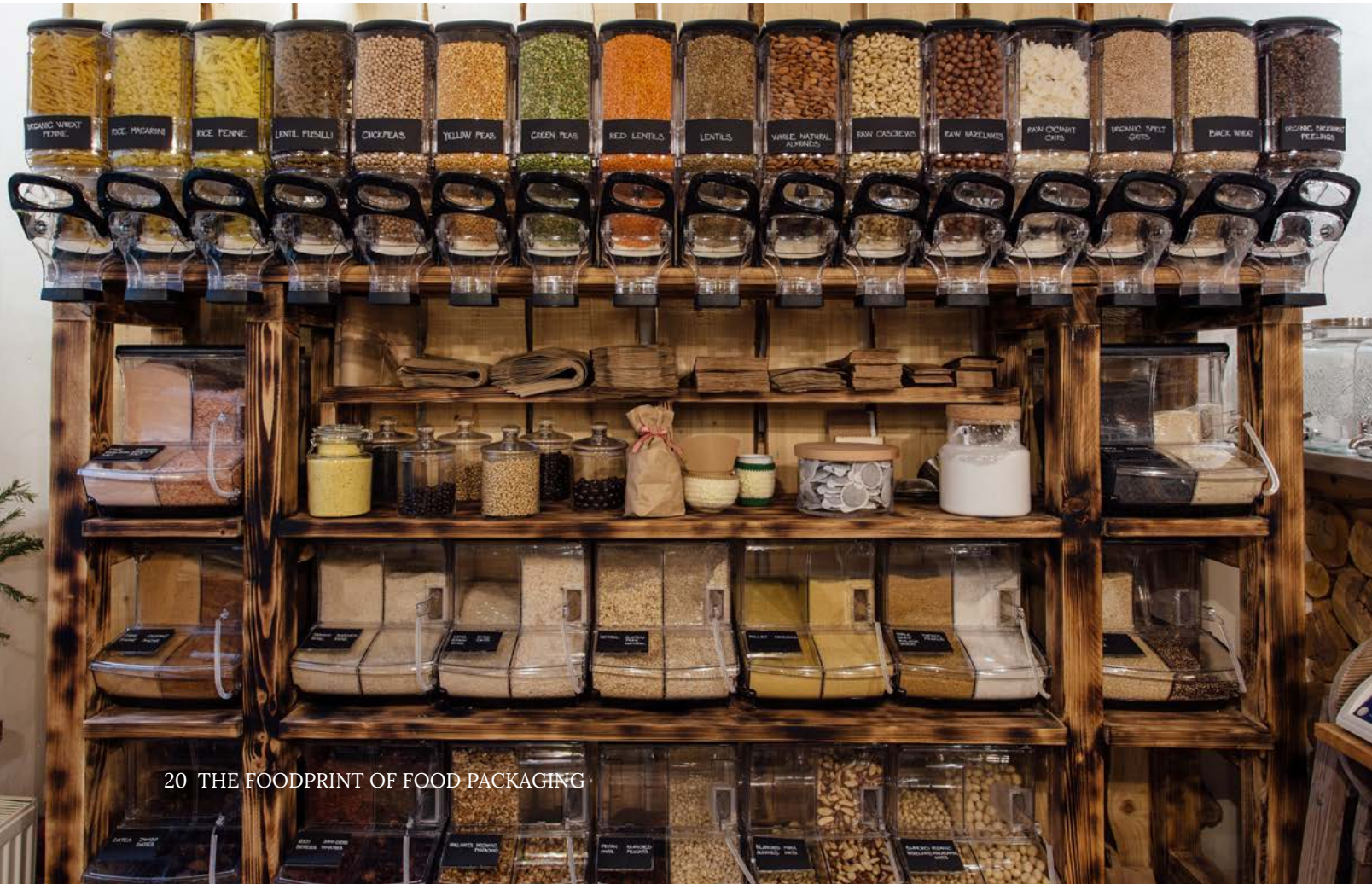
Dive into our Toolkit to learn more.

HOW TO USE LESS PLASTIC FOOD PACKAGING

Reduce, refuse and reuse are three ways that we can reduce plastics in our environment, with reducing being the most important one for a zero-plastic future.

The Earth Day Network has created a calculator for estimating your plastic consumption and for making a plan to reduce it. We have you covered with this list of tips:

Use Less Plastic in Your Kitchen: Reuse freebies, like bread bags or yogurt containers. Consider alternatives to plastic storage and plastic wrap, like beeswax wrappers, glassware with silicone lids, canning jars or simply a kitchen bowl with a plate placed on top. When hosting get-togethers,



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avoid plastic cutlery, cups and plates — or paper plates lined with PFAS — by choosing reusable party ware or unlined, compostable items made out of bamboo or biodegradable plastic.

Use Less Plastic While Dining Out or Getting Food to Go: Minimize waste by using less and saying "no" to single-use plastic items. If you need a straw, request a paper straw or bring a reusable metal straw with you. Carry a reusable coffee mug with you to your local coffee shop. If you forget your reusable cup and have to use a disposable one, skip the stirrer and recycle the lid (or skip the lid entirely). If ordering takeout to eat at home, request that napkins, utensils and single-use condiments not be included. If dining out and planning on taking leftovers home, consider bringing your own container. View this VOX/UC Climate Lab video for more good strategies.

Use Less Plastic While Grocery Shopping: Bring reusable or cloth bags. If you forget, choose paper over plastic bags and make sure those paper bags end up in the paper recycling bin. Select fruits and vegetables from a bin, rather than pre-packed units (those on Styrofoam trays and shrink-wrapped in plastic). Avoid putting produce in the plastic bags provided by the grocery. Bring reusable bags or skip bagging produce altogether. Eat fewer processed foods, which tend to have more plastic packaging. Consider shopping from an initiative like Loop (by Terra Cycle), which provides products in reusable containers that customers return for reuse.

Shop at a Zero Waste Grocery Store: Some communities now have "zero waste" grocery stores. In many ways, they work like old-time grocers. You bring a container and fill it from a bin, or use a reusable container provided by the retailer. Litterless, a website with tips for zero waste living, has produced a helpful nation-wide zero waste grocery shopping guide. The site also provides information about where to buy in bulk.

HOW TO ACE RECYCLING AND COMPOSTING

A diverse and complex mix of materials end up in our recycling bins. Understanding the terms is essential to understanding the best way to make sure packaging doesn't end up in the environment. You've gotten your salad in a compostable bowl with a recyclable lid. Which bins do you place each part in when you're done? And what if you've taken it to go? Is that bowl still compostable if it goes in the corner trash can?

UNDERSTAND DEGRADABLE PLASTICS, RECYCLING TECHNOLOGIES, AND REUSABLE PACKAGING

It is important to understand the difference between compostable, recyclable and biodegradable materials. Compostable materials need to go into a compost stream to be effectively broken down. If a compostable item ends up in the trash, it will simply go to landfill. Once in a landfill it might not have enough oxygen to break down at all, or it might break down and release methane, a potent greenhouse gas.[80] [81]

Plastic should never be labeled solely as "biodegradable" since different types of plastic — including bio-based plastics — break down differently depending upon what environment they are in (i.e., they might be soil biodegradable or marine biodegradable).

"Compostable" plastic is one that breaks down in municipal or commercial composters — which can achieve higher temperatures than home composters — to create soil within less than 180 days. (This is according to the Biodegradable Products Institute BPI, and ASTM D6400 standards).[82] [83] These will not compost in your backyard pile; you should put them into municipal curbside compost pickup, if possible. If compostable plastic gets into the recycling stream, it will be removed and sent to landfill.

"Biodegradable" and "compostable" are terms that are sometimes used by companies in marketing materials to "greenwash" their products. These kinds of claims have confused consumers to

the extent that the Federal Trade Commission provides additional information for companies in its Green Guides.[84] The state of California has gone a step further, enacting strict labeling guidelines for bio-based and degradable plastics.[85]

HOW TO RECYCLE PLASTICS

Many plastics can be recycled, but according to a recent study, 91 percent of the plastic we produce is never recycled.[86] Every community has its own recycling rules, and some of those rules depend on the market for recycled materials. This means only some of the plastic you use and discard can be placed into household/curbside recycling bins. While these rules may vary from

CODE	WHAT IT MEANS	TIPS
1 PETE	PET or PETE. Water and soda bottles; peanut butter jars; salad dressing and ketchup bottles. Can be recycled and are generally accepted at curbside recycling. Susceptible to chemical leaching, especially if exposed to heat, via a microwave, dishwasher or even the sun.	**TIP:** Reduce your use of #1 by drinking from reusable bottles.
2 HDPE	HDPE. Milk jugs, juice bottles, yogurt tubs, bleach, detergent, shampoo bottles. These can be recycled and made into a range of products, including new detergent and shampoo bottles. Generally accepted at curbside recycling. 	**TIP:** Reduce your use of #2 plastics by using cloth shopping bags.
3 PVC	PVC. Some shampoo bottles, cooking oil bottles, blister packaging, siding and PVC piping. This is rarely recycled. Don't put into your recycling bin, as this type of plastic is very toxic and can contaminate larger batches of recycled materials.	**TIP:** Avoid.
4 LDPE	LDPE. Includes squeezable bottles, plastic bags, dry cleaning bags, frozen food packaging. If recycled, can be made into trash can liners, compost bins, etc. Check with your local recycler. #4 products are safe to reuse. 	**TIP:** Use cloth grocery bags and instead of sandwich bags, try environmentally-friendly alternatives, like silicone or bags or cloth wrappers.
5 PP	PP. Includes some yogurt containers, medicine bottles, caps and straws. These can be recycled into a range of items, including brooms, brushes, rakes, etc. Generally accepted by curbside recycling. #5 plastics are safe to reuse.	**TIP:** Skip plastic straws and choose reusable bottles.
6 PS	Polystyrene. Includes disposable plates and cups/coffee lids, some egg cartons, some take out containers. Rarely recycled but when it is, into egg cartons, insulation, and foam packing. Recycling for polystyrene is not widely available. Damaging to human health and the environment. 	**TIP:** Try a reusable coffee cup.
7 OTHER	Miscellaneous and Polycarbonate. A catch-all for all plastics that don't fit into the categories above, including plastics that contain Bisphenols (like BPA). Includes items like sunglasses and DVDs. Generally not recycled and not recommended for reuse. Some compostable plastics are also included in #7 (they have the initials "PLA" on the bottom).	**TIP:** Avoid as much as possible, since it's not always clear what plastics are included and what their dangers might be.

town to town and city to city, one takeaway is universal: try reduce your use of plastics, and be sure you know the difference between the plastics you do use.

You can identify a plastic by the numeric symbol you find on the bottom, inside a triangle formed of arrows. Numbers ranging from "1" to "7" are assigned to each item (these are called resin identification codes). The numbers provide a clue to a plastic's ability to be recycled, as well as what chemicals it may contain. Most plastic items have a code, but not all do.

Here's a brief explanation of the codes:

ADVOCATING FOR CHANGE

We can use less packaging ourselves, but we can also ask food companies to do better – for people and for the environment.

Ask companies to:

1. Set targets for the reduction of waste by incorporating recycled and/or bio-based content into their packaging along with reduction and recycling targets.

2. Explore reusable options, where possible.

3. Invest in materials that are truly biodegradable or compostable.

4. Ban certain materials — such as all bisphenols or PFAS.

5. Assure their suppliers disclose more detail about chemicals, materials, products and their packaging.

Uniform standards for packaging would be beneficial for a number of reasons. They create a common language and understanding, can increase transparency for consumers, and ensure compliance. We can encourage players to do more than is required by law.

About This Report

This report is written by FoodPrint and based on a March, 2019 report, *Safer Materials in Food Packaging*, by Safer Made. Commissioned by Forsythia Foundation, the *Safer Materials in Food Packaging* report discusses the needs for innovation in food packaging and showcases innovative companies and potential solutions to the sector's health and environmental challenges.

Safer Made is a venture capital fund that invests in safer products and technologies and works with brand manufacturers and retailers that lead in safety and sustainability. Safer Made's General Partners are Adrian Horotan and Martin Mulvihill. For more about Safer Made and to read the *Safer Materials in Food Packaging* report, see: http://www.safermade.net.

Forsythia Foundation promotes healthier people and environments by reducing harmful chemicals in our lives. Forsythia Foundation believes in putting the full spectrum of philanthropic capital — time, networks, grants, and investments — to work. For more about Forsythia, see: http://www.forsythiafdn.org/

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