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**Thursday, Apr. 01, 2010**

**The Perils of Plastic**

**By Bryan Walsh**

On the first Earth Day, celebrated 40 years ago this month, the U.S. was a poisoned nation. Dense air pollution blanketed cities like Los Angeles, where smog alerts were a fact of life. Dangerous pesticides like DDT were still in use, and water pollution was rampant — symbolized by raging fires on Cleveland's Cuyahoga River, captured in a famous 1969 story for TIME. But the green movement that was energized by Earth Day — and the landmark federal actions that followed it — changed much of that. Today air pollution is down significantly in most urban areas, the water is cleaner, and even the Cuyahoga is home to fish again. Though climate change looms as a long-term threat, the 40th anniversary of Earth Day will see a much cleaner country.

But if the land is healing, Americans may be sickening. Since World War II, production of industrial chemicals has risen rapidly, and the U.S. generates or imports some 42 billion lb. (19 billion kg) of them per day, leaving Americans awash in a sea of synthetics. These aren't the sorts of chemicals that come to mind when we picture pollution — huge plants spilling contaminated wastewater into rivers. Rather, they're the molecules that make good on the old "better living through chemistry" promise, appearing in items like unbreakable baby bottles and big-screen TVs. Those chemicals have a habit of finding their way out of everyday products and into the environment — and ultimately into living organisms. A recent biomonitoring survey by the Centers for Disease Control and Prevention (CDC) found traces of 212 environmental chemicals in Americans — including toxic metals like arsenic and cadmium, pesticides, flame retardants and even perchlorate, an ingredient in rocket fuel. "It's not the environment that's contaminated so much," says Dr. Bruce Lanphear, director of the Cincinnati Children's Environmental Health Center. "It's us."

As scientists get better at detecting the chemicals in our bodies, they're discovering that even tiny quantities of toxins can have a potentially serious impact on our health — and our children's future. Chemicals like bisphenol A (BPA) and phthalates — key ingredients in modern plastics — may disrupt the delicate endocrine system, leading to developmental problems. A host of modern ills that have been rising unchecked for a generation — obesity, diabetes, autism, attention-deficit/hyperactivity disorder — could have chemical connections. "We don't give environmental exposure the attention it deserves," says Dr. Philip Landrigan, director of the Children's Environmental Health Center at New York City's Mount Sinai Medical Center. "But there's an emerging understanding that kids are uniquely susceptible to environmental hazards."

If scientists were slow to arrive at that conclusion, Washington has been even slower. The Toxic Substances Control Act (TSCA), the 34-year-old vehicle for federal chemical regulation, has generally been a failure. The burden of proving chemicals dangerous falls almost entirely on the government, while industry confidentiality privileges built into the TSCA deny citizens and federal regulators critical information about how substances are made and what their effects are. In the years since the TSCA became law, the Environmental Protection Agency (EPA) has been able to issue restrictions on only a handful of chemicals and has lacked the power to ban even a dangerous carcinogen like asbestos.

But change is coming. The Obama Administration is taking a closer look at chemicals, with the EPA late last month launching a new investigation into BPA. More important, Congress may finally be ready to act. New Jersey Senator Frank Lautenberg is expected to draft legislation soon that would give the TSCA the teeth it needs. "It's obvious that the system doesn't work," says Lautenberg. "We can't permit this assault on our children's health — and our own health — to continue."

**The Low-Dose Threat**
His name was Theophrastus Philippus Aureolus Bombastus von Hohenheim, known to his contemporaries as Paracelsus and to students of science as the "father of toxicology." The 16th century Swiss physician pioneered the use of chemicals in medicine. His dictum "The dose makes the poison" — that even toxic substances can be safe as long as the amount remains below a certain threshold — is still a bedrock principle for modern toxicologists.

That helps explain why industrial chemicals never received the stricter regulatory oversight that drugs and pesticides did. Even if the chemicals used to help make a plastic bottle could infiltrate the human body, the thinking went, surely the dose would be too low to do any harm. But as biomonitoring improved — we can now detect human exposure levels as small as one part per trillion, or about one-twentieth of a drop of water in an Olympic-size swimming pool — scientists realized that people were carrying far more chemicals than we'd thought. At the same time, scientists learned that some toxins could harm at extremely low levels; the limit considered safe for lead, which can directly reduce IQ, has been lowered from 60 micrograms per deciliter of blood in 1970 to 10 micrograms today. Some chemicals like BPA may have strange effects even at very low doses. Invented in 1891, BPA has been used since the 1940s to harden polycarbonate plastics and make epoxy resin, used in the lining of food and beverage containers, among other products. Polycarbonates can be identified by the recycling number 7 on the bottom of some plastics containing it. Other plastic ingredients — including potentially dangerous ones — are also indicated by the recycling number, known as the resin identification code.

BPA does its job well, and today some 6 billion lb. (2.7 billion kg) of the chemical are produced globally each year. The problem is, BPA is also a synthetic estrogen, and plastics with BPA can break down, especially when they're washed, heated or stressed, allowing the chemical to leach into food and water and then enter the human body. That happens to nearly all of us; the CDC has found BPA in the urine of 93% of surveyed Americans over the age of 6. If you don't have BPA in your body, you're not living in the modern world. [(See the top 10 scientific discoveries of 2009.)](http://www.time.com/time/specials/packages/article/0%2C28804%2C1945379_1944416%2C00.html)

The levels observed are considered well below the federal safety threshold of 50 micrograms per kg of body weight per day. But that recommendation was made 22 years ago, and in the time since, scientists have learned more about the effects of even a bit of BPA. In 1998, Patricia Hunt, a geneticist at Washington State University, found that female mice dosed with BPA had serious reproductive problems, including defective eggs. More recently, she published a study showing that the offspring of mice exposed to BPA while pregnant can end up with corrupted eggs, a situation that leads to trouble for their offspring. "That's a powerful effect," says Hunt. "You disrupt three generations with one exposure."

As a synthetic estrogen, BPA can mimic hormones, those powerful chemicals, like testosterone and adrenaline, that run the body. Tiny amounts of hormones produce immense biological and behavioral changes, so it stands to reason that a chemical that mirrors a hormone might do the same, especially if a human being were exposed to it during critical periods of development, like the first trimester of gestation. (Children are particularly vulnerable to chemical exposure, not just because their smaller bodies are developing rapidly but also because they eat and drink more relative to their body weight than adults.) That's exactly what dozens of scientists have found in animal studies, linking fetal BPA exposure in rodents to everything from mammary cancer to male genital defects and even neurobehavioral problems. [(See the top 10 scientific discoveries of 2008.)](http://www.time.com/time/specials/2008/top10/article/0%2C30583%2C1855948_1863947%2C00.html)

Nor is BPA the only industrial chemical in common use that may mess with the endocrine system. Phthalates — a class of chemicals used to soften polyvinyl chloride plastics, found in products ranging from shower curtains to cosmetics to intravenous-fluid bags — have been shown to disrupt hormones in animals and have been linked to reduced sperm counts and other marks of feminization in male rodents. Ditto for a class of long-lived chemical fire retardants known as polybrominated diphenyl ethers (PBDEs), used in electronics, polyurethane foam and other plastics, though they're being phased out. (PBDEs can remain in the body for years. BPA and phthalates are excreted within a day or so, but their ubiquity means we're exposing ourselves anew almost daily.)

While there are fewer studies of endocrine disrupters in humans than in animals, the ones that have been conducted have begun to show worrying associations. Higher levels of phthalates and other endocrine disrupters have been linked to earlier breast development in girls — a possible risk factor for breast cancer — and endocrine disrupters are a suspect in the rise in hypospadias, a correctable deformity of the urethra in boys. A 2008 study by Shanna Swan, director of the Center for Reproductive Epidemiology at the University of Rochester, found that boys born to women with high phthalate exposure during pregnancy were more likely to have genital abnormalities like undescended testicles and smaller penises than those born to women who had lower exposure. "I worry what will happen to these children as adults, whether they'll have reproductive problems," says Swan. "We're trying to piece that question together."

The science around endocrine disrupters is far from settled. Studies like Swan's show a correlation between phthalate exposure and developmental defects, but that doesn't mean the chemicals are causing the problems. Industry defenders point out that human exposure to BPA and phthalates is still well below safety levels set by the government and that health agencies around the world say the chemicals are safe for humans. And some peer-reviewed studies fail to show a positive connection between endocrine disrupters like BPA and health defects. "I think the research [on BPA] has been overhyped," says Richard Sharpe, an investigator at the Centre for Reproductive Biology at the Queen's Medical Research Institute in Edinburgh. "If you restrict the question to its estrogenic effects, I just don't see them."

The scientific consensus, however, has been moving away from the idea that BPA is completely safe. When researchers began raising alarms about BPA in the late 1990s, they were in the minority. Under the Bush Administration, the FDA reviewed the chemical and ruled it safe. But that report was criticized by the agency's own science-review board for relying almost exclusively on industry-funded studies. In 2008 Canada deemed infant exposure to BPA potentially unsafe and banned the sale of baby bottles that use the chemical — a step later taken by a number of American states and major retailers, including Walmart. Though European regulators declared BPA safe in a 2008 assessment, last month Denmark enacted a ban on BPA in baby bottles.

In 2009 the International Endocrine Society released a statement declaring that endocrine disrupters were a significant concern for public health and called for regulation to reduce human exposure. And even the FDA has changed its tune somewhat: in January the agency expressed "some concern" over BPA as the Obama Administration launched a $30 million study of the chemical. "Especially given that children in the early stages of development are exposed to BPA, the data and the research deserve a closer look," Dr. Josh Sharfstein, the FDA's principal deputy commissioner, told reporters at the time. [(See TIME's special report on the environment.)](http://www.time.com/time/specials/2007/0%2C28757%2C1730759%2C00.html)

The woman in charge of that closer look is Linda Birnbaum, head of the National Institute of Environmental Health Sciences (NIEHS) and the National Toxicology Program. A scientist who has spent decades in government service, Birnbaum isn't quite ready to give up on Paracelsus' axiom, but she knows that toxicology has to catch up with the real world. Scientists must realize that the body doesn't encounter a single chemical in isolation — though that's how tests are done — but a number of chemicals in combination, which might interact in unpredictable ways. The dose may still make the poison, but we'll never know unless we test the chemical soup we actually experience in the world — unless, that is, we find the environmentally relevant dose. "There's been a tendency to ask the old questions in the old way," says Birnbaum. "But if it's dark and you only look for your keys under the lamppost and they're not right there, you'll never find them."

Good science means widening that search, asking not only which chemicals may play a role in illnesses — essentially, where else the keys might be — but also how those chemicals do their damage. Certain substances — including BPA and some phthalates — seem to be able to switch in vitro cells from becoming connective tissue to becoming fat cells, and a 2009 study from Belgium found that children exposed to higher levels of toxic chemicals like polychlorinated biphenyls (PCBs) before birth were fatter than those who had lower exposure. Even autism, which remains a mystery, may have environmental triggers. (Vaccines have been repeatedly exonerated in autism debates, a conclusion that's accepted even by scientists who see the possibility of other environmental risk factors in the condition.) And a recent study by Swan found that women who had higher levels of phthalate exposure during pregnancy were more likely to have children with behavioral problems. None of this is proof, but all of it is worrisome. "We need to know where these chemicals are and what they're doing to us," says New York Representative Louise Slaughter, author of legislation that would establish a new research program focused on endocrine disrupters. "We shouldn't be in the dark." [(See the top 10 green ideas of 2009.)](http://www.time.com/time/specials/packages/article/0%2C28804%2C1945379_1944307%2C00.html)

**Failure to Protect**
If you want to market a new drug, you need to convince the FDA — in multiple tests, over the course of years — that it won't cause serious harm. If you want to sell a new pesticide, you need to prove the same thing. The burden of proof is on manufacturers to make the grade, and government regulators are the final judge.

But if you want to market a new chemical for use in a product — even one that will come into contact with children or pregnant women — it's up to the EPA to prove that it's unsafe, using whatever data are provided by the chemical company, with little power to ask for more. And if it's one of the 62,000 chemicals that were already in use when the TSCA went into effect in 1976 — a category that includes BPA — chances are it was never really tested by the government at all. "Chemicals are deemed safe until the EPA can prove that they are dangerous," says Richard Wiles, executive director of the nonprofit Environmental Working Group. "It's completely backward."

The result is a catch-22 for regulators and an information vacuum for consumers. Chemical companies don't have to develop toxicity data or submit it to the EPA for an existing product unless the agency finds that it will pose an unreasonable risk to human health or the environment — which is difficult to do if the agency doesn't have much data in the first place. The EPA can issue rules requiring testing, but that can take years and cost hundreds of thousands of dollars — which helps explain why the agency has required testing for only about 200 of the 83,000 chemicals in the TSCA inventory and has issued restrictions on just five. (Companies have voluntarily agreed to provide the EPA with some data about the most common chemicals, but there's no guarantee that the data will be timely or complete.) The TSCA also gives the industry wide latitude to claim confidentiality on products, so nearly 17,000 of those chemicals are virtual trade secrets. It's no surprise that the Government Accountability Office has reported that the TSCA is in desperate need of reform. "The only fix is to change this law or modernize it," says EPA Administrator Lisa Jackson. [(See the top 50 space moments since Sputnik.)](http://www.time.com/time/specials/2007/article/0%2C28804%2C1664897_1664899%2C00.html)

The good news is that more than 30 years after the TSCA was signed, the pieces may finally be in place for much needed retooling. Jackson has made chemical-safety reform one of the top priorities of her energetic administration, and on Capitol Hill, the tenacious, 86-year-old Lautenberg and Illinois Representative Bobby Rush are pushing to craft an update to the TSCA and may have legislation ready to introduce after the Easter break. Even the chemical industry has admitted a need to reform the TSCA and is ready to negotiate. "Science has advanced a long way since the TSCA was adopted, and we recognize that more can be done to create a system that people have comfort and confidence in," says Cal Dooley, president and CEO of the American Chemistry Council.

But agreeing on the need for reform is a long way from agreeing on how to reform. One model might be the safety laws recently put into place by the European Union, called REACH, which shift the burden of proof to industry, requiring chemical companies to prove that their products don't harm human health or the environment and to obtain special authorization for any chemicals of very high concern. The American chemical industry has reservations about a REACH-style program in the U.S., citing the cost of additional regulations, but such a change could represent a long-overdue safety step. "It would make a major difference if we could do for chemicals what we do now for pesticides and drugs," says Richard Denison, a senior scientist at the Environmental Defense Fund. [(See the top 10 green ideas of 2008.)](http://www.time.com/time/specials/2008/top10/article/0%2C30583%2C1855948_1863706%2C00.html)

Reform alone, though, won't defuse the basic debate over how much of an impact chemicals really are having on human health — and when protective measures may go too far. Nearly everything we buy, sell and use depends on chemicals, and the industry employs 803,000 Americans. Replacing the keystone ingredients of modern life would be challenging, not to mention costly. And smarter regulation won't change the fact that the science on chemicals and health — especially for complex endocrine disrupters — will never be clear-cut, no matter how many studies each side carries out. "You can ban BPA all you want, but if there are no better materials, you'll just move to the next case," says Joel Tickner, an associate professor at the University of Massachusetts' School of Health and Environment. "We need solutions that will be win-win."

One such solution may lie in the new field of green chemistry, in which chemicals are designed in a way that minimizes hazardous risk from the start. Less a practice than a philosophy, green chemistry seeks to sidestep the debate altogether by engineering products not only to be nontoxic but also to leave no dangerous residue and to use less energy. The EPA's Presidential Green Chemistry Challenge Awards recognize achievements in sustainable design like a new biocatalytic process for cosmetics that uses no toxic solvents, and at last month's annual meeting of the American Chemical Society, more than 1,600 of 12,000 presentations were dedicated to sustainability. "There'll be a day in the future when all chemistry is going to be green," says John Warner, director of the Warner Babcock Institute for Green Chemistry. "In that world we'd never need regulation again."

But even Warner admits that such a day is far off. Meanwhile, we'll need to decide just how cautious we want to be as a society. "Science isn't just about data," says the NIEHS's Birnbaum. "It's about the interpretation of data." That interpretation, ultimately, won't be up to scientists. It will be up to us. The lesson of Earth Day, 40 years on, is that smart policy — fired by popular will — can make a difference that we can see. The question is whether we'll bring the same passion to environmental threats that are invisible but could be just as dangerous.

* [http://content.time.com/time/specials/packages/article/0,28804,1976909\_1976908\_1976938,00.html](http://content.time.com/time/specials/packages/article/0%2C28804%2C1976909_1976908_1976938%2C00.html)

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**Demonstrate Understanding**

1. *Identify the* ***main idea*** *of the article. Then below, list* ***details*** *from the article that clearly support the main idea.*

The main idea of the article is that \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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The main idea is supported by the following details from the article:

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**The author includes experts to back up his thesis. List an expert and the information they give. Evaluate if you think the expert is credible (a qualified person to be trusted on this information).**

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| **Expert name and expert title (doctor, professor, etc)** | **Copy the quote used** | **Is this person credible, and believable? Is the information shared useful? Why, why not?** |
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**Analyze Text (Informational)**

**3.** *Facts vs. Opinions*

*Find two* ***facts*** *in the article. Copy them into the chart below and explain why you think the author included each fact.*

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| **Fact from the article:** | **Reason the author included the fact:** |
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*Find an* ***opinion*** *in the article and record the opinion below.*

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*Why do you think people have this opinion?*

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