

1-HYDROXYCHRYSENE

1-HYDROXYPYRENE

DECA BOE

9-HYDROXYFLUORENE

2-HYDROXYBENZOICIPHENANTHRENE

DI-N-BUTYL PHTHALATE

ORTHO-XYLENE

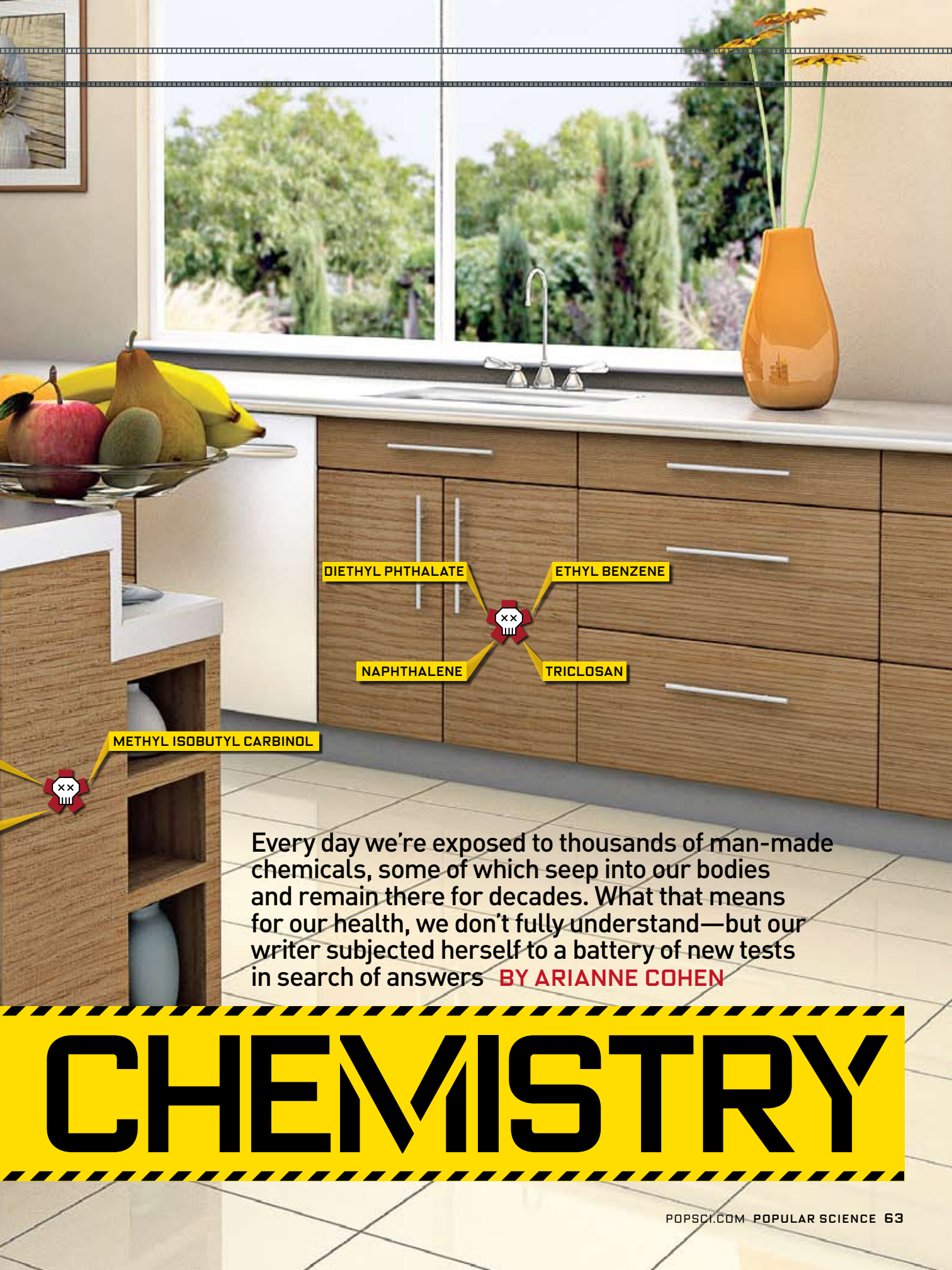
META-XYLENE

BUTYL BENZYL PHTHALATE

MONOBENZYL PHTHALATE

CYCLOHEXANE

PERSONAL



DIETHYL PHTHALATE

ETHYL BENZENE

NAPHTHALENE

TRICLOSAN

METHYL ISOBTYL CARBINOL

Every day we're exposed to thousands of man-made chemicals, some of which seep into our bodies and remain there for decades. What that means for our health, we don't fully understand—but our writer subjected herself to a battery of new tests in search of answers **BY ARIANNE COHEN**

CHEMISTRY

LET'S START WITH THE BAD NEWS: You are saturated with man-made chemicals, some of them toxic. Today's exposure began when compounds in your shampoo and shaving cream seeped into your skin cells, and during your morning coffee, when you drank chemicals that were released into your brew as hot water ran against the plastic walls of your coffeemaker. It continued all day as you touched industrial chemicals in packaging, or walked through pesticide-sprayed lawns, or cooked dinner on nonstick pans. This very minute, your skin is probably touching a piece of clothing or furniture that was doused in protective chemicals to make it resistant to microbes, fungus or water. Tonight, there's a good chance you'll curl up in sheets treated with flame retardants.

Some of these chemicals can stay in the body for decades, and in numerous studies over the past eight or so years, environmental toxins have been linked to everything from early puberty to cancer. David Servan-Schreiber, a founding member of Doctors Without Borders in the U.S. and a cancer researcher who survived the disease himself, summarized our predicament in the *New York*

longer in aggregate, so we must be doing something right," says Brian Buckley, the laboratory director at the Environmental and Occupational Health Sciences Institute at Rutgers University. Still, we do know a few unnerving things. One, all American adults carry around hundreds of synthetic chemicals in their bodies. Two, as a study published in the *British Medical Journal* in 2004 put it, "many synthetic chemicals have intrinsic hormonal activity," and hormonal disruptions carry a high likelihood of causing disease. And three, according to the same study, "it is clear that environmental and lifestyle factors are key determinants of human disease—accounting for perhaps 75 percent of most cancers."

In response to these concerns, in recent years scientists have begun testing the population's chemical loads in the same rigorous manner that they've been testing the environment for decades. This science—called biomonitoring—is slowly helping us understand what our chemical-filled world is doing to us.

I am a paranoid and curious person, and I've been following environmental-exposure studies for years. Over time, I developed

WHERE TOXINS COME FROM

Not all brands contain the chemicals listed here, but enough do that informed shopping is important.

[See more tips on page 66.]

Times last year. "Since 1940, we have seen in Western societies a marked and rapid increase in common types of cancer," he wrote. Since 1974, leukemia and brain cancer rates in children have risen by 28 percent. The federal government began regulating environmental toxins with the Toxic Substances Control Act of 1976, but in a way, that's when the real trouble began. The act established a weak system for chemical testing and regulation, but it also grandfathered in any previously produced chemicals, to the tune of more than 60,000 free passes. To Servan-Schreiber, surveying the situation 32 years later, the culprit was clear: "Reducing exposure to many of the well-characterized chemical carcinogens abundant in our modern environments (pesticides, estrogens, benzene, PCBs, PVCs and bisphenol-A from heating liquids in plastic containers; alkylphenols in cleaning products; parabenes and phthalates in cosmetics and shampoos, etc.) would contribute to lessen the cancer risk."

Of the 85,000-plus industrial chemicals now registered with the federal government, most are completely unstudied. That doesn't mean they're all going to kill us, of course. "We're living



PAINT AND VARNISH VOLATILE ORGANIC COMPOUNDS

VOCs, as they're known, cause eye, nose and throat irritation, and chronic exposure may damage the central nervous system, kidney and liver. Look for low- or zero-VOC paint.



LOTIONS PHTHALATES

Often listed on labels as "fragrance," phthalates may cause reproductive disorders.

a morbid curiosity about how many chemicals were lodged in my body. Would I learn how to detoxify? Would I learn that I'm screwed? Would the information be useful at all? In any case, I decided to undergo the most comprehensive testing available to find out.

LAST DECEMBER, I lay on a clinic bed in Buckley's laboratory at Rutgers. A nurse named Rosalind swabbed my arm in preparation for the Ironman of blood testing. My presence had caused a stir in the lab. They had agreed to take the blood samples I needed for my experiment, but it was far from standard procedure. To get a sense of what I was asking for, think of a lab as a restaurant. I was ordering 150 different dishes—one of everything on the menu—and each would require 10 to 30 complex steps to make. In addition to Rosalind, two other nurses stood by, studying pages of instructions from Quest Diagnostics and Axys Analytical, the labs that would later be analyzing my blood for chemicals including flame retardants, pesticides, plastics and metals.

Rosalind picked up a needle, and the two nurses positioned themselves to grab vials as quickly as my arm could fill them. As I wondered what all that blood would reveal, my mind wandered to memories of a summer childhood ritual: standing in the bathroom in my bathing suit as my mother slathered me with thick layers of sunblock, pausing to let the greasy lotion soak in. Then she'd reach for another canister. "Shut your eyes." This was my signal to clamp my eyes tight, stop breathing, and turn in a circle while my mother hosed me down with bug spray.

Rosalind read aloud: "OK, ladies. Now we are going to 'Remove 14 size-large vials of blood from the patient, or *as much as is safe.*'" She looked up. "OK?"

It was the beginning of my experiment, designed to mimic research conducted by the Centers for Disease Control and Prevention, the nation's primary source for information on exposure to industrial chemicals in the population. In the late 1970s, the agency began searching for

That's only a fraction of the few thousand chemicals produced in large quantities, but it's also a major leap from several decades ago, when there was lead in the gas, asbestos in the walls, and no official effort to figure out whether these things were causing harm. To choose the chemicals it will test for, the CDC publishes a notice in the Federal Register soliciting recommendations from scientists. After the suggestions flood in, it gradually narrows the list, choosing chemicals that are widely distributed and suspected of causing harm. Practical concerns rule out searching for more than a few hundred chemicals. "There's a limit if you're getting just a few tubes of blood," says Jim Pirkle, deputy director of science for the CDC.

The NHANES survey begins when the CDC uses a computer algorithm to select 15 counties nationwide. Surveyors appear on the doorsteps of 800 to 1,600 people in each county and interview them, and around a third of the finalists—5,000 or so



COSMETICS
PARABENS, PHTHALATES, LEAD

A variety of chemicals found in certain cosmetics have been linked to maladies ranging from hormonal disruptions and infertility to heart disease and various cancers.



COFFEE-MAKERS
DECA BDE

A toxic flame retardant in plastic can leach into your brew.



OLDER NONSTICK COATINGS
PFOA

Associated with testicular, liver, and pancreatic cancers.

MOST OF THE CHEMICALS IN USE TODAY ARE UNTESTED AND UNREGULATED.

exposure to heavy metals like lead and cadmium. Since then, the CDC has periodically conducted a census of American bodies called the National Health and Nutrition Examination Survey (NHANES). The agency uses the data for many things, ranging from children's growth charts to obesity statistics—and, since 2001, to produce a study called the National Report on Human Exposure to Environmental Chemicals. The next such report, due out late this year, will include data on the prevalence of 228 of the most common environmental toxins.

people nationwide—are ultimately screened. The agency takes measurements on height, weight, body-fat levels, blood pressure and heart rate, among other things. It does an oral-health exam, a bone scan and a vision test. The study participants fill out questionnaires on diet, sexual behavior and drug use. And yes, they also give copious amounts of urine and blood. The results are anonymous, although participants get a copy, along with a toll-free number to call for help understanding them.

Unless the CDC shows up at your house, it's just about impossible to get this kind of testing. Until the past few years, chemical-exposure testing was available only in research labs, where academics focused on specific families of chemicals, using expensive techniques like gas chromatography and mass spectroscopy. "It really wasn't available to the public-health community, or to groups of people who figured they might be exposed to pesticides or other agents, because no one had the hundreds of thousands of dollars to open labs and do the testing," says environmental-exposure researcher Michael McCally, a senior scientist at Physicians for Social Responsibility in Washington, D.C. The technology has slowly moved into specialized commercial labs, but it's still wildly expensive to access it. My

FROM LEFT: ISTOCK; GETTY IMAGES; ISTOCK

testing would cost me more than \$4,000, and that was with Quest agreeing to do much of the blood analysis for free.

The CDC's Report on Environmental Exposure doesn't declare any chemicals harmful or safe. "It's not their job," Buckley says. "There are people at the National Institutes of Health who do that stuff, and the ATSDR"—the Agency for Toxic Substances and Disease Registry, created by Congress with the Superfund act of 1980—"and there are epidemiologists, and all of us academics who spend our whole lives interpreting what the CDC puts out."

Studies on the connection between environmental disease and chemicals have proliferated since the CDC published its first exposure report. Still, the field is young, and such is the state of the art that my makeshift test would give me only raw data about the chemicals in my body; it wouldn't tell me anything about the likelihood that a particular chemical would give me cancer. I'd have to assemble a personal posse of experts—

surrogates for other chemical exposures or lifestyle practices."

"There are almost no smoking guns," Buckley says. "True smoking guns usually happen in occupational contamination, where a high percentage of people in a factory come down with, say, lung cancer. Everything else is just estimate or conjecture."

As for product safety testing, it's far rarer than you might think. The Food and Drug Administration requires pharmaceuticals to be rigorously tested before entering the marketplace, but although the cosmetic industry conducts tests on animals for skin rashes and allergic reactions, those tests, overseen by an industry organization called the Cosmetic Ingredient Review, aren't mandatory.

Cosmetics and general products are rarely, if ever, tested for long-term health effects, let alone potential effects on a fetus. All those air fresheners and cleaning products and perfumes that are sprayed liberally in the air you breathe? Never tested.

If evidence appears that a chemical might be harmful, it's still tough to get



SHAMPOO
PHTHALATES, PARABENS, 1,4-DIOXANE
 These additives are linked to hormonal disruptions.



SOAP
PHTHALATES, TRICLOCARBANS (IN ANTIBACTERIAL SOAP)
 Certain chemicals found in bar soap are associated with hormonal disruptions that may increase the risk of reproductive problems and cancers.



SUNCREEN
OXYBENZONE
 Absorbed through the skin, this compound may cause hormonal disruptions.

those people who spend their lives interpreting CDC data—to help me understand the results.

AS I ARRANGED the follow-up to my bloodwork, the inherent difficulty of biomonitoring research became clear. Researchers have uncovered plenty of associations between toxins and diseases, and they're uncovering more all the time. But it's nearly impossible to quickly and definitively link an individual chemical to a specific disease without knowingly poisoning test subjects. It's staggeringly hard to prove causation in a system as complicated as the body, particularly when a fetus exposed to a chemical might not show any sign of harm until it becomes an adult. In one study, men who lived in an agricultural area of Missouri were 40 percent less fertile than city-dwellers. Knockout punch for pesticides, right? Wrong. The *British Medical Journal* study cites this research as a classic example of the difficulty of linking chemicals to disease. "Although these new findings are suggestive, for none [of the findings] is the mechanism of the chemical's effect self evident," the researchers wrote. "This leaves doubts as to whether the measured chemicals are the real culprits or are

WHAT YOU CAN DO

We actually do have a lot of control over the chemicals we're exposed to in our homes, where they are 1,000 times as likely to be inhaled as outdoors. Here's how to start purifying your environment.

- Vent your gas stove outside to avoid releasing polycyclic hydrocarbons, created by incomplete combustion, into your home, says Shelly Miller, an air-pollution researcher at the University of Colorado.
- Use minimal carpet and drapery. "Carpets can be a reservoir for all sorts of particles," Miller says.
- Use a HEPA filter on your vacuum to keep captured particles from escaping back into the air.
- Look up cosmetic and cleaning products on the Environmental Working Group's "Skin Deep" database (www.ewg.com), which rates more than 50,000 products on a scale of 0 (safe) to 10 (hazardous). A "data gap" rating lets you know whether the conclusion is based on comprehensive safety data or industry research.

it off the market. Our regulatory system treats chemicals the same way our judicial system treats people, maintaining that they are innocent until proven guilty and trying them one by one. "Chemical-regulation policy deals with individual chemicals, not families of chemicals," McCally says. That makes banning potentially harmful chemicals inefficient, because typically, if a single molecule has health effects, all its very similar cousins,

THE VERDICT FROM MY EXTENSIVE BLOOD TESTING: I AM FULL OF CHEMICALS.

I started by calling Trasande. When I read him the first incomprehensible line from my results, he laughed. "I don't know what that means," he said. "Tetrachlorodibenzo-p-dioxin is nasty stuff. But I would need to also see the benchmarks." I found the latest NHANES benchmarks and called him back. After going through the rest of the results with my panel, we arrived at a verdict: I am full of chemicals.

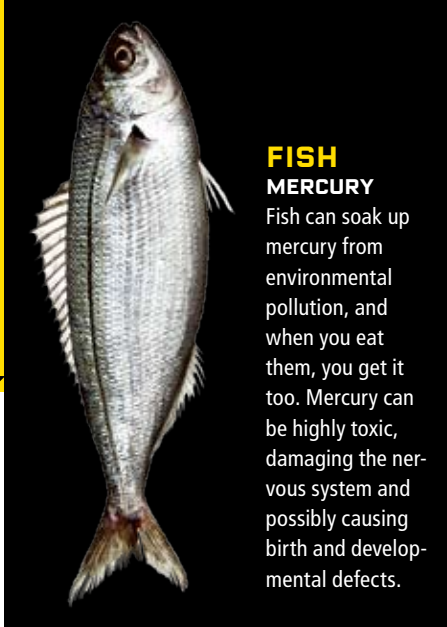
My levels of dioxins and furans, older chlorinated chemicals that are usually released into the air by manufacturing and garbage incineration, are above population averages. Industrial releases have decreased 80 percent since the 1980s, yet I'm still full of them because dioxin exposure is the gift that keeps on giving. The body stores dioxin in fat cells and occasionally releases it into the blood, recirculating the same chemicals throughout the body. These have been linked to reproductive disorders, cancer and other maladies.

My levels of polycyclic aromatic hydrocarbons—the result of incomplete combustion, these are commonly emitted by stoves and charred meat—are typical for the population. Some of these



PLASTIC BOTTLES BISPHENOL-A (BPA)

BPA may cause hormonal and reproductive problems.



FISH MERCURY

Fish can soak up mercury from environmental pollution, and when you eat them, you get it too. Mercury can be highly toxic, damaging the nervous system and possibly causing birth and developmental defects.



CHARRED MEAT POLYCYCLIC AROMATIC HYDRO- CARBONS

Caused by incomplete combustion, some of these chemicals are probable carcinogens.

known as congeners, may as well. "Each congener is a different chemical, so you spend 10 years in court for each," he says.

MY TEST RESULTS may be the most confusing things I've ever received in the mail. I expected to rip them open and find a variant of the routine bloodwork I get from my doctor, complete with a little thumbs-up icon next to good cholesterol results. Instead, over four months I received six individual spreadsheets that said things like "2,3,7,8-TCDD UN 3373 L12090-1 WG27842 30.8g (wet) pg/g (wet weight basis) <.0065 spiked matrix WG27842-102 % Recov 78.3." Gibberish to me.

My interpretation team was made up of three experts: McCally, Buckley, and Leo Trasande, director of the Mt. Sinai Center for Children's Environmental Health and Disease Prevention Research in New York and a lead investigator on the federally funded National Children's Study, which will ultimately set benchmarks for toxic exposures among our most chemical-sensitive population.

chemicals are classified by the EPA as probable carcinogens, and they can stay in the body for 25 years, but scientists still don't understand how potency and length of exposure relate to illness.

I'm carrying above-typical levels of residue from nonstick coatings like Teflon, specifically one called PFOA that

is associated with cancer. "Preliminary studies suggest that even low-level exposures can be problematic," Trasande says.

I'm loaded with nitrate. "This is principally from processed foods, and there's a cancer risk associated," Buckley says.

I also have typical levels of exposure to plastics and plasticizers like phthalates, which add flexibility to soft plastics and vinyl and stability to creams and washes. "They're ubiquitous," McCally says. Phthalates are linked to reproductive disorders, and it's unclear what exposure level could be considered safe.

Lastly, my levels of the notorious bisphenol-A, or BPA, an estrogenic compound found in plastic and plastered all over the news for the past two years, are typical. BPA has entered my system every time I've ever taken a swig

[CONTINUED ON PAGE 84]

(CONTINUED FROM PAGE 67)

PERSONAL CHEMISTRY

from a water bottle—which I did a lot of as a teenager, training five hours a day as a swimmer.

The overall takeaway is not soothing. “The core message is that we are all exposed to a wide array of chemicals in the environment, as you have been,” Trasande says. “And what little we know suggests cause for concern. And equally concerning is what we don’t know.”

AS I SPENT DAYS decoding spreadsheets, one uplifting fact became clear: I tested notably clear of the majority of pesticides, fungicides and metals that I would most likely ingest outdoors. In fact, with the exception of the dioxins and furans that I and the rest of the country picked up decades ago, I was probably exposed to most of the chemicals in my body indoors—which means more of this is under my control than I thought.

“It doesn’t take a lot of something released indoors to cause exposure,” says Kirk Smith, a professor of global environmental health at the University of California at Berkeley, who taught me the Rule of 1,000: Anything released indoors is about 1,000 times as likely to be inhaled as something released outdoors.

Over the next decade, as the cost of chemical-exposure testing continues to drop, it will probably become more widely available for consumers. But is it worth it? Not according to Trasande, who suggests lifestyle changes over testing. “I wouldn’t advise routine body-burden testing for people,” he says. It’s expensive and invasive, and so far there’s not much that can be done with the knowledge such testing produces. “It’s important to understand that right now, what people can do is proactively reduce their exposure.” That means changing

your lifestyle to avoid as many suspect chemicals as possible.

There is, however, only so much you or I can do. Approximately 1,000 new chemicals are added every year to the 85,000 already on the federal registry. As Jane Houlihan, the senior vice president for research at the nonprofit watchdog organization Environmental Working Group, testified in Congress last year, “Companies are free to use almost any ingredient they choose in personal-care products, with no proof of safety required.” Houlihan argues that the FDA should claim the authority to oversee cosmetic safety, by requiring registration and testing of products and ingredients, making public-health-injury reports mandatory, and enforcing safety requirements—which is the way the agency oversees pesticides and food additives.

There are movements afoot to reform the Toxic Substances Control Act to look more like European Union regulations, which allow the banning of families of chemicals. Most notable is the Kids-Safe Chemical Act, which would empower the EPA to require safety testing of baby products before their release.

Still, any attempt at regulation has to reckon with the fact that there’s no going back to a chemical-free world—we’re far beyond that point. “The presence of these industrial chemicals in your bloodstream or tissues is not normal,” McCally says. “Your grandfather didn’t have these.” He pauses to recalibrate. “It’s a consequence of the chemical environment that we live in, and it’s a new normal. We’re just trying to figure out what that is.”

Arianne Cohen, author of The Tall Book, wrote about high-tech triathlete Andy Potts in the August 2008 issue.