1.
In The Blood

For the first time in the history of the world, every human being is now subjected to contact with dangerous chemicals, from the moment of conception until death.

Rachel Carson, *Silent Spring*, 1962

It was a bright, spring day in Midland, Michigan on May 8, 2003. Hundreds of automobiles, SUVs, and minivans streamed into the huge parking lot at the Midland Center for the Arts off Eastman Avenue. The annual shareholders meeting of the Dow Chemical Company was scheduled to begin at 2 p.m. in the center's auditorium. It was a big event for Midland, Dow's corporate headquarters. Nearly 1,000 stockholders, retired employees, and representatives of pension funds and brokerages would attend.

Midland—located in the "palm of the mitt" as locals will tell you, pointing to the center of their hand as surrogate Michigan map—is where Dow Chemical began its enterprise more than 100 years ago. Some call Midland a company town, as Dow's presence looms large in buildings, in the arts, and in the economy. Dow Corning, a part-owned Dow company, is also here. But Midland is known most as the place where Herbert Dow began "mining" the huge underground deposits of brine in the 1890s, fashioning a new kind of chemical commerce. As if by a sorcerer's apprentice, Dow Chemical grew upon the proliferating magic of bromine and chlorine to become the global colossus it is today—the world's largest chemical company. With Union Carbide, acquired in 2001, Dow's global reach now extends to more than 170 countries.

Dow's shareholders are, for the most part, a happy lot. They typically get their dividend. Dow's business has been enormously prosperous; one of the most profitable companies of all time. But not all of Dow's shareholders filing into the Midland Center for the Arts were smiling on May 8, 2003. In fact, a small group of them—dissidents, some might say—were quite concerned about Dow's chemistry, or at least a portion of it. These shareholders wanted to know more about a special group of chemicals that Dow made—the ones that were showing up in the blood and body tissue of polar bears and people.

Inside the Midland Center for the Arts, a resolution on this very topic await-

ed Dow shareholders—a resolution requiring Dow to prepare a public report on those chemicals. Variously labeled "persistent organic pollutants" (POPs) and/or "persistent, bioaccumulative toxic substances" (PBTs), more than 500 such chemicals have been found in human blood and body tissue in the last decade or so. Few of these chemicals existed in the 1920s. Many have come on the scene since the 1940s and 1950s. Some, like the pesticide DDT, or the former electric insulating chemicals, polychlorinated biphenyls, PCBs, have been banned in the United States in recent years. Yet they are still found in the remotest regions of the planet and in most people's blood or body fat. Others have been found insinuating themselves into animal and human reproduction, causing birth defects and other problems. Still others cause cancer, or are believed to be mimicking and tricking hormones, causing varying kinds of developmental and/or metabolic havoc throughout the biological world. All of these concerns have cast a new, hard scrutiny on the synthetic chemical revolution—that seemingly unstoppable cornucopia of thousands and thousands of "new and better" chemical products.

More than 500 chemicals have been found in human blood and body tissue in the last decade or so.

Dow's small group of dissenting shareholders came to Midland to raise pointed questions about POPs and PBTs, and about Dow's role and responsibilities as a "first source" producer. For Dow Chemical is a company that has been there from the beginning; a progenitor of the synthetic chemical revolution and key inventor of its techniques and ingredients—a company still at the manufacturing headwaters of a global chemistry that is both prosperous and poisonous.

As Dow's shareholders continued to stream into the Midland Center for the Arts, some passed by the silent vigil and banner of a small group of protestors from Bhopal, India. The protestors were assigned a designated area for their demonstration; off to the far side of the main entrance, on a small grassy area at the edge of the parking lot. They were seeking Dow's attention for the still-festering contamination and health problems left behind by Union Carbide 20 years earlier after a chemical plant there released a toxic gas, killing more than 3,000 people and injuring tens of thousands. These quiet protestors, some of whom were on a hunger strike to draw attention to their plight, would later make their way to the microphones inside, imploring Dow to clean up Bhopal. Dow formally acquired Union Carbide in 2001, but maintains it is not responsible for the current problems. However for some, Bhopal wasn't just an anomaly or another part of the "side effects"* ledger of the synthetic chemical revolution; it was sym-

*Some argue that use of the term "side effects" is misleading, especially since the effects that do occur on people and in the environment are—in their lives and place—"main effects."

bol and reality of its inherent dangers. But not for Dow. Dow's managers typically celebrated the chemical revolution at its annual meetings, and the May 2003 gathering was no exception.

Upbeat Dow

The message Dow shareholders would take away at the end of the day on May 8 was a reassuring and upbeat one. Dow was doing just fine, its leaders would tell them, despite a few bumps in the road here and there. When 63-year-old Chief Executive Officer Bill Stavropoulos strode onto the stage in the spacious and comfortable auditorium of the Midland Center for the Arts, he was backed by a huge drop-down screen which had already pumped out a short promotional film on the products, people, and future of the Dow Chemical Company. On stage, the decor was patriotic, with red and royal blue curtains framing the picture. The "Dow Diamond"—company symbol and trademarked logo—was prominently featured, displayed behind the speakers on the big drop-down screen. The word "Dow," set in white lettering in the middle of the red diamond, stood out against a blue background. A large America flag, falling unfurled from its pole, stood silent sentinel on one side of the stage, though clearly in the picture. Behind Stavropoulos, in two tiers of box seats arrayed quiz-show-like, were Dow's board members, some with prominent political pedigree, like former U.S. Senator, John C. Danforth (R-MO), and former President George H.W. Bush's Secretary of Commerce, Barbara Hackman Franklin.

The New York Times / March 31, 1983

During the pre-business warm-up, Stavropoulos played knowingly to his hometown crowd. He singled out former Dow executives in the audience, asking them to rise for special recognition as he called their names. He then asked those in the audience who were former Dow managers, Dow retirees, or Dow employees to stand for recognition. Nearly the entire audience stood up. It was a Dow love-in. Stavropoulos and Dow appeared to be reminding any outsiders in attendance just where they were: on Dow's turf. Was it intentional intimidation? Hard to say. But within minutes of that exercise,

Dow called for the presentation of the one bit of potential controversy on the docket: the toxic chemicals shareholder resolution. What had taken proponents and company officials months and months of prep time and negotiation, move and counter move with the U.S. Securities and Exchange Commission over whether to allow or disallow the resolution, took Stavropoulos and Dow less than 15 minutes to dispense with. Shelley Alpern of Boston's Trillium Asset Management, the brokerage representing the Dow shareholder offering the resolution, delivered the proponent's position. Alpern reeled off all the reasons and supporting data on behalf of the resolution and why Dow shareholders should want to know more about these toxic chemicals and the future of their company—including matters of potential shareholder liability. Dow's corporate secretary, Tina Van Dam, delivered management's position and the case against the resolution, essentially saying that Dow was handling the situation, spending a lot of money on the problem, and was already reporting on the chemicals in company publications and government reports. The vote was then called for, with most proxies submitted in advance of the meeting in any case. When the vote was later reported, Dow had won handily. No surprise. Just over 93 percent of the shareholders had supported their company, or more than 580,000 shareholders voting to oppose the report on toxic chemicals. However, 6.9 percent, or roughly 50,000 Dow shareholders, cast their vote in favor of the proponents' resolution, agreeing that Dow should do the report. Although Dow "won" the popular vote and defeated the resolution, the proponents also "won" on technical grounds, having successfully crossed the 3 percent threshold, which entitled them to bring their resolution back the following year. So for the moment, the untidy unpleasantness—as far as Dow was concerned—had been dealt with quickly. But the issue would not go away.

When Stavropoulos made his financial report and review of the previous year, he indicated that 2002 had been "difficult," given the economy. But there were bright spots, too. "Our organization is focused and energized," he said, in his best CEO cheerleaderese, Dow "beat Wall Street expectations by a mile," he proclaimed, earning 9 cents per share while the mavens expected losses of up to 10 cents a share. In a slumping economy with rising energy prices, "this was a 'bravo' performance by Dow people," he said, adding, "that's not to say our job is even close to being done." Still, things were improving, he assured. Speciality chemicals had a growth rate of 9 percent a year. Asia was looking good, and the recent acquisitions Dow had made—Ascot, a U.K. chemical maker; Rohm & Haas' agricultural products division; and Union Carbide—all looked promising, too. There was some problem with asbestos liability inherited with Union Carbide, he acknowledged, but he assured his listeners there was little to worry about. The liability was being quantified, he explained, bringing some certainty to the matter. And it also appeared that Congress might establish a trust fund to deal with the

payout.* Dow's plans going forward were to reduce structural costs and capital expenditures by a combined $800 million. Underutilized and non-competitive assets would also be shut down. At the same time, growth would accelerate through increased production and managed price rises. In addition, "new geographies" and "new products" were looking good for Dow. Among them, the company's *Incite* technology, a new catalyst technology that had spawned 15 new products and $1 billion in sales, and other chemistry, such as polyurethane dispersions, spawning a new line of synthetic leather.

"It is not just my family and our yard that is contaminated, but nearly 2,000 families living all along a 22-mile stretch of river."

Betty Damore

All of the business reporting was textbook and straightforward. No surprises—as one might expect from any *Fortune 500* company. Then came the "open mike" segment, where Dow allowed short questions from the audience.

Stavropoulos personally fielded all the questions, most of which were anticipated, with some of the CEO's replies no doubt practiced in advance and likely run by the lawyers as well. Still, Stavropoulos took questions on Bhopal, genetically-engineered farm seed, toxic chemical dangers, and the possibility of chemical plant accidents. He handled the questions politely and deftly, careful to avoid controversy and legal ensnarement. Dow had previously dealt with the Bhopal issue at other shareholder meetings and was well aware of the current legal situation. However, in that day's edition of the *Wall Street Journal*, a story bearing the headline "Bhopal Haunts Dow Chemical" had appeared.[1] Nevertheless, Stavropoulos, offering perfunctory sympathies for those in India still suffering at the site, stuck to the legal script: the Union Carbide matter is settled and Dow was not involved. "It was a horrific event," he acknowledged, quickly adding that "a separate corporation"—Union Carbide—"accepted moral responsibility. The responsibility ends there," he said. "Dow inherited no responsibility…the responsibility clearly lies with the state and federal governments in India." Indian authorities also held the remainder of the $450 million settlement paid by Union Carbide years earlier, which the Indian Supreme Court reviewed and found reasonable, Stavropoulos noted. The site is also owned by the Indian government. Still, litigation aimed at Dow was pending, and while Stavropoulos may have dealt with the issue at the annual meeting, Dow Chemical may yet be tied to Bhopal and its victims.

Closer to home, Michigan resident Betty Damore rose with a question

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*More on the asbestos issue in Chapter 20.

about dioxin contamination along the Tittabawassee River—the river along whose banks Dow grew to become a global colossus and whose waters flow through Midland. Beyond Midland, the Tittabawassee flows east to the Saginaw River, Saginaw Bay, and Lake Huron. Damore came from a family that had long roots along the Tittabawassee, stretching back more than 100 years. In late 2001, Damore and other residents along the Tittabawassee received notices from the Michigan Department of Environmental Quality informing them about elevated dioxin levels in floodplain soils that could pose possible health threats. Damore was alarmed and angry about the reports, as her children had spent many hours playing outside and at community parks along the river. Her family also planted a yearly garden raising the typical garden vegetables, consuming that produce every season. "It is not just my family and our yard that is contaminated," she explained, "but nearly 2,000 families living all along a 22-mile stretch of river and floodplain running all the way to Saginaw Bay. All of it is contaminated with dioxin and other toxic pollutants." Dioxin, an infinitesimally tiny contaminant with a very potent profile, making it one of the most toxic substances on earth, has been a suspected problem at Dow for at least 40 years. First surfacing as an unwanted "byproduct" in the making of other chemicals, dioxin appears to be bound up in the business of making chlorinated chemical products and is also a pollutant in their disposal, especially when chlorinated substances or wastes are incinerated.* The science and politics of dioxin have a long, unresolved, and continuing history and will occupy a number of pages in the remainder of this book. Suffice it to say here that dioxin is a matter very much at the center of Dow's business in Michigan and elsewhere, and potentially, a huge liability for Dow and others.

As Damore continued her statement, she noted that most scientists, according to what she had read, found dioxin to be a very potent poison. "It can cause cancer," she said. "It can harm the development of babies. It is toxic to the immune system, the hormone system, and the reproductive system. It has been linked to conditions like endometriosis and diabetes. It is toxic in tiny amounts. . . . Every exposure increases our risk . . . ," she said. But Damore was not optimistic that Dow would clean up the dioxin in the Tittabawassee floodplain, charging that the company had avoided responsibility for problems in the past and would likely "spend a lot of money" to show that dioxin was safe this time too. "They will fight cleanup every step of the way," she said. "That is what they have done in the past. Just a few months

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*Actually there is more than one dioxin, so it should be *dioxins* plural. Technically, dioxins are a "chemical family" of 75 polychlorinated dibenzo-p-dioxins and 135 polychlorinated dibenzofurans. One particular dioxin, 2,3,7,8-tetrachlorodibenzo-p-dioxin (also abbreviated as TCDD), has been described as the most toxic synthetic chemical known to science. And dioxins are not commercially produced chemicals, but rather chemical "byproducts"—the unwanted chemical spawn of making, using, and burning chlorinated chemicals. See also Chapter 4.

ago they tried to get a deal with the previous [Michigan governor] that would have made our area a dioxin hot zone permanently." Dow wanted to raise the allowable dioxin levels in Midland residential soils to 831 parts per trillion (ppt) compared to the state clean up standard of 90 ppt. Damore was angry. "Imagine how you would feel if one day you woke up to this nightmare. You learn that you have raised your children with a highly toxic chemical all around and inside you. Imagine how angry and frightened you would be...." Damore closed by saying the problem wouldn't go away, but would just keep getting bigger until Dow took responsibility and addressed it. "Will you do that," she asked. "Will Dow take responsibility?"

Dow, in fact, has been fashioning chemicals from a particularly active and dangerous region of the periodic table.

"We are a responsible company," Stavropoulos replied. "We will get to the bottom of this. We're doing a river study and a health study, including the areas downstream... We will do the right thing here, when we learn what the right thing is."* But as much as Dow tried to reassure its petitioners about the company's handling of dioxin and persistent toxic chemicals, these concerns were not going to fade away. For the central question facing Dow and the global chemical industry is the "invent-first-ask-questions-later" approach to developing and selling chemicals; an approach that has typically introduced new substances into commerce and society without the benefit of full and thorough toxicological study. Dow, in fact, has been fashioning chemicals from a particularly active and dangerous region of the periodic table—the halogen region, using primarily chlorine, fluorine, bromine, and iodine. Halogens have seven electrons in their outer shells, making them ready partners for many elements. When halogens are combined with carbon to make organohalogens, the results can be, and have been, catastrophic. Commercially-produced organochlorine compounds alone—those combining hydrogen, carbon, and chlorine—number more than 11,000 or so at last count. Dow, for most of its 100-plus years, has been a major organochlorine producer and a key purveyor of bulk chlorine and other halogens for further chemical combination throughout industry. Dow, in other words, is and has been a key chemical enabler and developer, helping to spread synthetic chemistry throughout global commerce.

Today, Dow continues its business at the headwaters of some of the most troubling chemistry on the planet. In fact, in many ways, Herbert Dow is the "founding father" of chlorinated and brominated products. By inventing and perfecting the electrolysis of brine to harvest bromine and chlorine in the 1890s, Dow and his company helped set the stage for the synthetic

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* Chapter 19 covers the issue of dioxin in the Tittabawassee River floodplain in more detail.

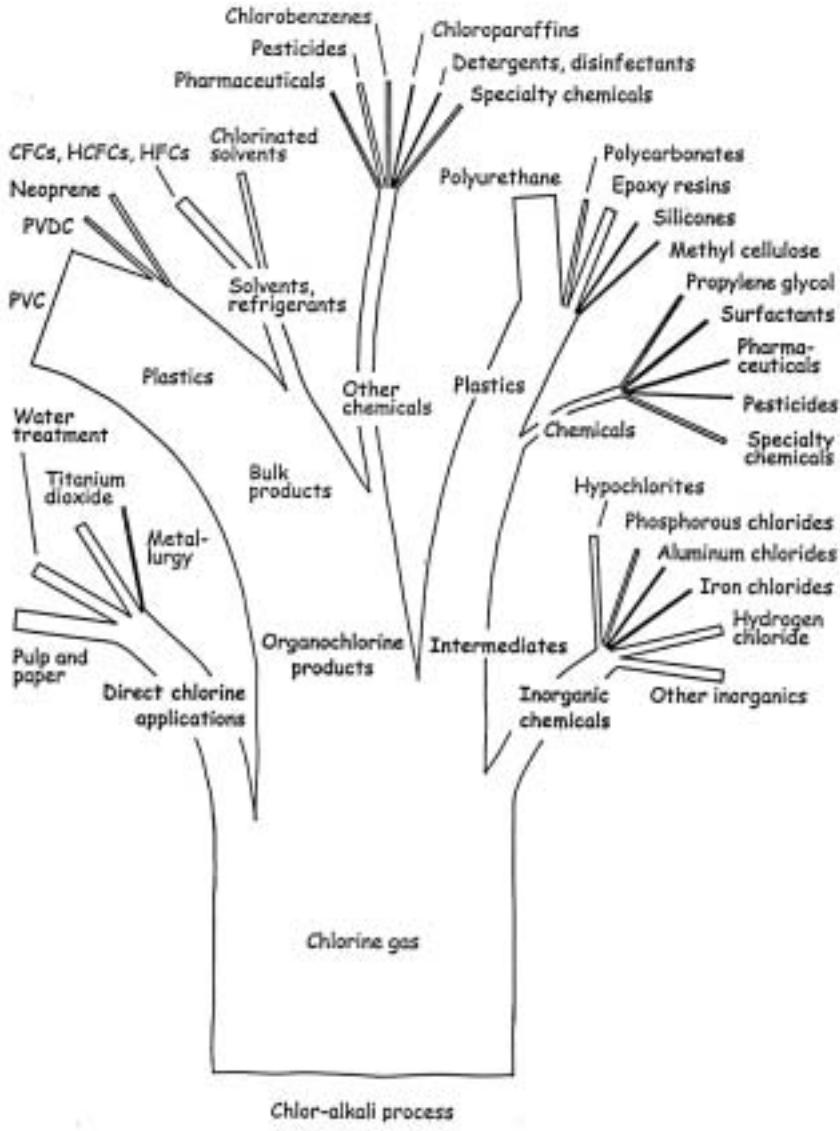
chemical revolution and a near endless manipulation of molecules to produce new compounds. The resulting explosion of toxic and persistent organochlorine products, for example, is only part of the resulting legacy—one which today's world is only now beginning to deal with.

Pandora's Poison

A vast river of products and processes commences from the making of chlorine—a highly toxic gas released in the breaking apart of sodium chloride. About one-third of all U.S. chlorine is used to make plastics such as polyvinyl chloride, found in shoe soles, shower curtains, automobile components, and vinyl siding. Chlorine also plays a major role in synthesizing thousands of commercial chemicals, such as carbon tetrachloride found in non-stick frying pans, and chlorosilanes used in making semiconductor components, or chlorinated solvents. In fact, today, chlorine is used in about 60 percent of all modern chemical products. To illustrate the wide-ranging influence of chlorine in the chemical industry, Dow and others, including Euro Chlor, an affiliate trade group of the European Chemical Industry Council, have sometimes used chlorine product charts or "chlorine trees" to show the vast array of products and processes that derive from, or begin with, chlorine.[2] The chlorine tree displayed on the opposite page, for example, illustrates the four major industrial uses of chlorine: 1) direct applications as in pulp and paper making, metallurgy, and titanium dioxide production; 2) organochlorine product manufacturing—from plastics and detergents to pharmaceuticals and refrigerants; 3) intermediate chemicals used to make nonchlorinated plastics, pharmaceuticals, and other products; and 4) inorganic chemicals such as iron and aluminum chlorides.[3] Dow Chemical is involved in all four, either as supplier, intermediary, and/or manufacturer.

Yet, the very qualities that have made chlorine such an industrial wunderkind also make it problematic in the environment, in the workplace, and for public health. Chlorine gas, the progenitor medium for making chlorinated products, is highly reactive, making it effective in bleach or for synthesizing other chemicals. But chlorine's reactive quality also makes it capable of creating incidentally—within the manufacturing process or in the environment—hundreds, if not thousands, of organochlorine by-products like dioxin. Chlorination also affects stability, making chemicals useful in producing products like plastics or refrigerants, but also making them stable over time, and therefore persistent and capable of resisting biodegradation—sometimes for decades. Reactive organochlorines are often converted into highly toxic and cancer-causing forms. "The chemical effect of chlorination," explains Joe Thornton, author of *Pandora's Poison*, "is therefore to increase, in one way or another, the hazard that a chemical poses." Chlorine atoms also give their compounds the ability to dissolve in oils, which is why many

A Global Products "Chlorine Tree"



Source: Joe Thornton, *Pandora's Poison*, Cambridge: MIT Press, 2000, Figure 6.4, p. 248.

organochlorines make excellent solvents and grease-cleaning agents. The same feature, however, makes them "fat loving," or gives them an affinity for lodging in animal tissue. Many organochlorines are also "bioaccumulative," which means they can build up or accumulate in the tissues of living things over time. They can also be magnified in their concentration through food-chain dynamics—whether plankton-to-blue whale, algae-to-fish-to-eagles, or to humans at the top of many plant and animal food chains. Organochlorine levels in such chains may start out in tiny amounts, but over time—through bioaccumulation and biomagnification—wind up to be quite substantial and harmful, at thousands of times their ambient levels in some cases.*

The suite of characteristics that makes organochlorines persistent, reactive, and oil-soluble, also makes them apt to do damage in human beings.

Generally for organochlorines, the suite of characteristics that makes them persistent, reactive, and oil-soluble, also makes them apt to do damage in human beings. And the damage can occur at crucial times—including in the womb—disrupting key natural processes involving basic physiology, developmental processes, and/or hormonal activity. In fact, many pesticides, pharmaceuticals, and antibiotics are *intentionally designed to be biologically disruptive* in some way. So it should not be surprising that in addition to killing or disrupting the unwanted biological target, such chemicals are also doing collateral damage to the rest of the living world. "Virtually all organochlorines examined to date," observes Joe Thornton in *Pandora's Poison*, "cause one or more of a wide variety of adverse effects on essential biological processes, including development, reproduction, brain function, and immunity."[4]

Chemical Roulette

Synthetic chemistry first emerged in the mid-19th century, initially in European laboratories seeking anesthetics and disinfectants. DDT was first synthesized, for example, in 1874, but not developed as a pesticide until the 1930s. Plastics were first synthesized from wood cellulose in the 1890s. Around 1900, however, things really started to get interesting when oil-based

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*For example, "TCDD [dioxin] accumulates in the tissues of fish to levels 159,000 times greater than in the waters in which fish swims," explains Joe Thornton. That number is known as a "bioconcentration factor." Such factors have also been calculated for other dioxins, furans, PCBs, hexachlorobenzene, and octachlorostyrene—all at 10,000 or more. Chlorinated pesticides have bioconcentration factors in this range as well. Hexachlorobutadiene has a bioaccumulation factor of up to 17,000. See Joe Thornton, *Pandora's Poison*, pp. 35–36.

synthesis of dye production began. By the 1930s, Germany became a leader in the early commercialization of synthetic chemicals. About this time too, companies like Dow and DuPont were also synthesizing new chemicals, manipulating and combining molecules in new ways. With World War II and post-war expansion, the synthetic chemical revolution exploded, resulting in some 50,000 to 100,000 chemicals brought into commercial production. Between 1935 and 1995, according to the Worldwatch Institute, the production of all synthetic organic compounds in the United States rose 1,000-fold. By 1998, biochemists had identified the *18 millionth synthetic chemical substance* known to science.[5]

A new chemical substance is discovered approximately every nine seconds.

Today, a new chemical substance is discovered approximately *every nine seconds*. Granted, many new chemicals don't go much beyond the curiosity stage. Still, new compounds are introduced into global commerce at an average rate of about three per day. That's about 90 per month, or more than 1,000 new chemicals every year. Global chemical production is now about 400 million tons annually.[6] In the United States alone, annual production of carbon-based synthetic chemicals is roughly 1,600 pounds per capita.[7] While much of this inventiveness and productivity are welcomed for generating jobs, economic value, and generally improving things, environmental and public health analysis of these same chemicals has typically come as an afterthought. As a result, detailed toxicological and health-effects knowledge of many chemicals has lagged well behind their commercial use. Even today, only about 700 of the existing registered 100,000 chemicals used in global commerce have complete toxicological profiles. Most have not been studied in-depth for potential ecological problems or reproductive effects. Of the 2,500 "high production volume" chemicals—those used most heavily and regularly in global commerce—roughly half have been profiled from a hazards standpoint. Science and society continue to play a game of "catch up," taking a chemical-by-chemical approach, which is laboriously slow and often prone to lengthy reviews and/or litigation. But the problems are real now, manifest in the environment and human populations.

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Most alarming, of course, is the fact that many synthetic chemicals are now routinely found in human blood, body fat, and/or breastmilk—more than 500, as already mentioned, have been found to date. No one knows for sure how many others may have lodged in human biology since tests for detecting many chemicals do not exist. The discovery that chemical sub-

stances could invade the human body and do harm is not new. In 1775 or so, British surgeon Percival Pott concluded that London's chimney sweeps were having a high incidence of cancer of the scrotum because they were accumulating chimney soot in their genitals.[8] Problems with worker deaths and illness in the manufacture of tetraethyl lead in the 1920s and 1930s—made as an additive for gasoline—raised the level of awareness that such substances could kill and invade the blood of the general population, with lead emissions and residues proving especially harmful to children. Still, leaded gasoline wasn't banned in the United States until 1972, and is currently used in some regions of the world. Synthetic pesticides began to be identified as potential problems in the 1950s by a few medical researchers using anecdotal evidence. The American Medical Association raised its voice in 1951 about the growing concentration of pesticides in human body fat.[9] But it wasn't until 1962, when Rachel Carson, focusing on pesticides, brought the synthetic chemical issue home to a broader public with her book, *Silent Spring*. Still eloquent more than 40 years later, Carson's book foresaw the chemical "body burden" problem:

> . . . The chemicals to which life is asked to make its adjustment are no longer merely the calcium and silica and copper and all of the rest of the minerals washed out of the rocks . . . ; they are the synthetic creations of man's inventive mind, brewed in laboratories, and having no counterpart in nature.
>
> To adjust to these chemicals would require time on the scale that is nature's; it would require not merely the years of a man's life, but the life of generations. And even this, were it by some miracle possible, would be futile, for the new chemicals come from our laboratories in an endless stream; almost five hundred annually find their way into actual use in the United States alone [*Note: today it's more like 1,000 annually*]. The figure is staggering and its implications are not easily grasped—500 new chemicals to which the bodies of men and animals are required somehow to adapt each year, chemicals totally outside the limits of biologic experience.[10]

In the 1960s, Carson chose the chlorinated hydrocarbon insecticides such as DDT, chlordane, aldrin, and endrin to make her case. DDT, for example, had been shown by tests from 1947 through Carson's time and beyond to be carcinogenic to animals. Yet it continued to be used, despite its persistence in the environment, long retention in fatty body tissue, and its ability to kill wildlife. It was banned in 1974 after three years of litigation. Today, DDT still shows up in human blood samples.

Throughout the 1970s, lab animal testing and wildlife studies produced revelations about a range of other chemicals. Polychlorinated biphenyls (PCBs)—a family of synthetic chemicals used in electrical transformer coolants, in hydraulic fluids, lubricants, plasticizers, coatings, sealants, and pesticide extenders—were found in the mid-1970s to be entering the human food chain through fish, cheese, eggs, and animal feed. Persistent, bioaccu-

mulative, and "fat-loving"—i.e., stored in fatty tissues and fluids such as breast milk—PCBs were linked to a number of cancers, birth defects, and brain damage. They were banned in 1976, but are still found today in blood samples of the general population.

In 1975 and 1977, the National Cancer Institute (NCI) published evidence that ethylene dibromide (EDB)—a chemical Dow sold for years as a gasoline additive and later as a soil fumigant—induced cancer in lab animals. It was later banned by the EPA. In the 1970s, NCI also found cancer problems with a widely used hair dye compound, 4 methoxy-mphenylenediamen, as well as a bromine/phosphate-based chemical called Tris, used as a flame retardant in textiles, fabrics, clothing, furniture and toys, and infant sleepwear.[11] And so it went, chemical by chemical, battle by battle, decade by decade.

One 1997 survey of supermarket foods found PCBs, DDT, and dioxins present in foods from chicken and pork to butter and ice cream.

By the mid-1980s, chlorofluorocarbons, or CFCs—a family of chemicals initially discovered for use as refrigerants, and subsequently manipulated for an array of others uses, were shown by dramatic satellite photography to be degrading the earth's protective ozone layer. CFCs were later banned. Yet prohibiting harmful chemicals didn't always mean they were removed from circulation. One 1997 survey of supermarket foods, for example, found PCBs, DDT, and dioxins present in foods from chicken and pork to butter and ice cream.[12] Meanwhile, one 1992 study reported that sperm counts in Europe and the United States had declined by about half since World War II. Another found that rates of testicular cancer had soared in the United States between 1973 and 1994. Chemical additives used in the making of plastics, such as phthalates and bisphenol-A, were gaining scientific notice, too: female rats whose mothers were exposed to phthalates gave birth to male pups with single testes or sacs of blood in place of testicles; and pregnant mice given tiny does of bisphenol-A gave birth to male offspring with abnormally large prostates.

Hormonal Havoc

By the mid-1990s, more was being learned about the persistent and invasive nature of chemicals. The *timing* of chemical exposure in human and all biological development began to get more attention, and some new insights and theories were advanced. Only in the last 10 years or so, have scientists discovered that some man-made chemicals are playing havoc with human and animal endocrine systems, disrupting critical hormone messengers, and altering developmental biology in the womb. Researchers have

identified more than 120 chemicals currently found in the environment that are reported to have reproductive and/or endocrine-disrupting effects.[13] Hormone disruptors, as they are also called, include some large chemical families such as the 209 compounds classified at PCBs, 75 dioxins, and 135 furans.[14] Some of these substances can cross the placenta, reaching the unborn, and can be passed along to infants in breastfeeding. Others cause mutations, affect intelligence, or lodge in the DNA. Several studies in Europe and North America have linked reduced intelligence and/or behavioral effects with a child's exposure in the womb to PCBs and co-contaminants. With regard to dioxin and dioxin-like PCBs, the World Health Organization noted in 1998 that subtle effects may already be occurring in the general population of developed countries at current background levels.[15]

More than 120 chemicals currently found in the environment are reported to have reproductive and/or endocrine-disrupting effects.

Immunity Down

New scientific findings in the 1990s were also revealing that contaminated water, food, and air in some locations appeared to be suppressing human immune systems, lowering an individual's resistance to viruses, bacteria, and tumors they would normally fend off. One disturbing report came from the Inuit people of Arctic Canada, far removed from industrial society, but in a location where pollution is circulated and deposited by global air and ocean currents. The contaminants had migrated into the Arctic food chain, resulting in dangerously high levels, particularly in marine mammals and other creatures the Inuit used for food. As a result, Inuit women's breast milk built up contaminants like PCBs to very high levels—measured at 1,052 ppb in one Quebec Public Health report, nearly twice that of the seal blubber they ate (527 ppb) and ten times that of arctic fish (152 ppb)—a classic food chain-biomagnification effect. Pregnant and nursing Inuit women passed these high doses of magnified poisons directly and unknowingly on to their children, born with depleted white blood cells and doomed to life of suppressed immunity. Some Inuit children have suffered excessive bouts of disease, including a 20-fold increase in life-threatening meningitis compared to other Canadian children. The findings in the Inuit community provide a powerful message to the rest of the world.

"We're probably all—and I mean the whole . . . planet—immunosuppressed," says Steve Holladay, an immunotoxicologist at Virginia-Maryland Regional College of Veterinary Medicine in a 1996 interview. "Simply, it means we're not quite as healthy as we could or would be. Our risk of devel-

oping (diseases) is slightly higher."[16] British scientist, Dr. John McLaren-Howard of Biolab agrees, noting "we are all blitzed with a load of toxic chemicals," the effects of which we don't fully understand." He also believes toxic chemicals hamper the immune system making individuals more susceptible to colds and other bugs. "The toxic chemicals in our system put a burden on us because our body has to work hard to get rid of them," he says. "So fighting off a cold will be much harder, because it's yet another thing for the body to have to cope with."[17]

"We're probably all—and I mean the whole planet—immunosuppressed."

Dr. Steve Holladay

In addition to suppressing immunity, toxic chemicals are also implicated in stimulating the immune system in the wrong way; in effect, triggering human immune cells to attack the body's healthy tissue as if it were a foreign agent, giving rise to various auto-immune disorders. Among chemcials that have been linked to various auto-immune conditions, for example, are carbon tetrachloride, mercury, perchloroethylene, PCBs, silica, trichloroethylene, and vinyl chloride. In fact, in recent years, lupus and other auto-immune diseases have increased internationally and appear to be popping up in clusters within communities tainted with toxic chemicals.

Cleaned Up?

Today, the general perception, in the United States and Europe at least, is that pollution is being cleaned up and that exposure to toxic chemicals is lower than it used to be. But other data suggest the clean-up might be somewhat superficial, or at least not reaching the larger universe of what's out there. For example, the U.S. Geological Survey released a study in March 2002 of 139 U.S. waterways that found trace amounts of many chemical and pharmaceutical products in those streams. Among the findings, 74 percent of the streams had residues of the insect repellent DEET; 69 percent had degraded detergent residues, 66 percent had disinfectants, 60 percent had residues of fire retardant chemicals; 45 percent had insecticide residues, and 24 percent had residues of the solvent tetrachloroethylene. Prescription drug residues and steroidal compounds were found in more than 80 percent of the streams.[18] Although there has been apparent progress over the last decade in reducing reported chem-

The U.S. Geological Survey recently found trace amounts of chemical and pharmaceutical products in 139 U.S. waterways.

ical pollution and wastes under various environmental laws, these laws fall short in covering the vast universe of chemicals now used in daily commerce. Thousands of chemicals are still not reported or regularly tracked in the environment. And the chemicals that are tracked haven't gone away. In October 2003, for example, the Virginia Department of Health issued fish consumption advisories after mercury and PCBs had been found in several of the state's rivers and swamps.[19] Given the large number of regulated and unregulated chemical substances still found in the environment—in soil, air, water, waste emissions, not to mention those leaching out of products themselves—it's no wonder they are routinely found in the human body.

Body Burden

Although various government health agencies have collected human chemical exposure data in the past, such efforts have typically been sporadic, not well funded, and focused on one or two substances at a time. In addition, such information has not been routinely presented to the public. But that changed in March 2001, when the U.S. Centers for Disease Control

In Bill Moyers' Blood

Dioxins & Furans	**Bill Moyers** (in picograms per gram, pg/g, or parts per trillion)	**U.S. Average**
2,3,7,8-TCDD (tetra dioxin)*	5.38*	5.38
1,2,3,7,8-PeCDD (pentadioxin)	11.60	10.70
1,2,3,4,7,8-HxCDD (hexadioxin)	9.26	75.10
1,2,3,7,8,9-HxCDD (hexadioxin)	7.32	11.70
1,2,3,6,7,8-HxCDD (hexadioxin)	58.30	—
1,2,3,4,6,7,8-HpCDD (heptadioxin)	125.00	110.00
1,2,3,4,6,7,8,9-OCDD (octadioxin)	1,104.00	724.00
2,3,4,7,8-PeCDF (pentafuran)	9.76	9.70
1,2,3,4,7,8-HxCDF (hexafuran)	7.43	7.42
1,2,3,6,7,8-HxCDF (hexafuran)	7.54	5.78
2,3,4,6,7,8-HxCDF (hexafuran)	3.76	0.54
1,2,3,4,6,7,8-HpCDF (heptafuran)	18.90	15.30
1,2,3,4,7,8,9-HpCDF (heptafuran)	1.84	0.73
1,2,3,4,6,7,8,9-OCDF (octafuran)	30.50	2.28

Source: PBS, Trade Secrets—"Bill Moyers' Test Results"

*The sample volume was insufficient for analysis of TCDD levels. The value given is the average that EPA has found in U.S. citizens. TCDD is not included in the total of 84 chemicals counted in Mr. Moyers' results.

and Prevention (CDC) in Atlanta committed to more regular reporting of chemicals found in the human body. At that time, CDC reported that most Americans carried detectable levels of plastics, pesticides, and heavy metals in their blood and urine. Health officials cautioned, however, that just because people had chemicals in their blood or urine did not necessarily mean those levels would cause disease. Still, some scientists believe that any level of industrial chemicals in the body is unacceptable. "For human beings to carry the burden of industrial chemicals is commonplace, but it's not normal," said Michael McCally, vice chairman of the Department of Community and Preventative Medicine at Mount Sinai School of Medicine, "...and we shouldn't accept it as normal. It represents a mass experiment by the chemical industry on us."[20]

"It represents a mass experiment by the chemical industry on us."

Michael McCall, Mount Sinai School of Medicine

In addition to the CDC, some prominent journalists and citizens, with the help of recognized public health agencies, also began preparing and reporting on the "body burden" issue. Nationally-known journalist Bill Moyers—a former speech writer for President Lyndon Johnson—had his body burden measured for a March 2001 PBS television special he hosted on the chemical industry. Those tests revealed that Moyers had 84 chemicals in his blood and urine—many of them carcinogens and worse.[21] (See sidebar, opposite.)

In March 2003, CDC released the second *National Report on Human Exposure to Environmental Chemicals*, the largest and most extensive assessment of the U.S. population's exposure to environmental chemicals. The report presented human exposure information for 116 environmental contaminants—ranging from lead and tobacco smoke, to pesticides and heavy metals.[22] As the CDC released its report, another "body burden" blood and urine study was made public, this one led by Mount Sinai School of Medicine in New York, and completed in collaboration with the Environmental Working Group in Washington, D.C. and Commonweal, a California-based public health organization. Using a small group of nine environmental health professionals as volunteers, this study found an average of 91 industrial compounds, pollutants, and other chemicals in the volunteer's blood and urine. None of the volunteers worked with chemicals in their job or lived near an industrial facility. In total, some 167 chemicals were found in the volunteers. Of these, 76 were known

"This was completely outside my control. Dow put this chemical into me without any assistance on my part."

Charlotte Brody on her blood test

to cause cancer in humans or animals, 94 were toxic to the brain and nervous system, and 79 caused birth defects or abnormal development.[23] Some of the chemicals were specifically traced to the Dow Chemical Company.

Charlotte Brody, executive director of the Boston-based nonprofit group, Health Care Without Harm, was one of the public health professionals participating in the Mount Sinai-led survey. In Brody's blood and urine, the Mount Sinai researchers found 85 chemical contaminants, including more than two dozen types of PCBs, seven dioxins and the Dow Chemical insecticide *Dursban*. *Dursban*, whose active chemical agent is chlorpyrifos, is known to cause neurological damage at high doses in animals and humans, and the federal Environmental Protection Agency has banned its indoor use.* Brody, a nurse, activist and gardener, has taken great pains to avoid commercial pesticides in her gardening and tries to eat organic produce. Which is why she was quite surprised to find *Dursban* in her blood. "It was the biggest insult of all," she said, after learning the results. "This was completely outside my control. Dow put this chemical into me without any assistance on my part."[24]

Chemical Trespass

So these are the chemicals—the *Dursbans,* the POPs, the PBTs, the endocrine disruptors, the carcinogens, and mutagens. They are the chemicals that the dissident Dow shareholders in Midland, Michigan were talking about on May 8, 2003. They are also the chemicals that Dow workers, Dow neighbors, and Dow activists have questioned and continue to question.

On one level, the questions are not new. Yet the way they are being framed *is* new. For the basis of the charge today is *chemical trespass*: that "body burden" chemicals are an invasion of personal property; a transgression on inherent rights to health. Such invasive chemicals are causing biological and/or genetic damage to persons and life processes. Dow, a global corporation with more than 200 plants operating in 38 countries, has a specific chemical burden in many living things, say its critics; burdens that result in real costs and damages. For these, Dow is a responsible party, and may soon face a new kind of legal and social liability that will profoundly affect its bottom line.

In the meantime, "the writing is on the wall," say Dow's critics. A global consensus is emerging on toxic chemistry. The U.S. and Canadian governments have signed the Great Lakes Water Quality Agreement, establishing a goal to "virtually eliminate" the discharge of persistent toxic substances into Great Lakes. And more than 150 nations have signed the

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* For more on *Dursban* see Chapter 5.

Stockholm Convention on Persistent Organic Pollutants (POPs), an international agreement ratified in February 2004 that commits ratifying nations to eliminate certain "bad actor" POPs and their byproduct chemicals. A dozen of the dirtiest chemicals are now listed, with more to follow. Dow should heed these messages.

The charge today is *chemical trespass*: that "body burden" chemicals are an invasion of personal property; a transgression on inherent rights to health.

The goal for Dow—for the good of its business, its shareholders, and society—should be to move away from the chemistry that makes POPs, PBTs, endocrine disruptors, and other such substances. Yet the resistance to that course within the company has been striking, demonstrated repeatedly in the chemical-by-chemical fighting of the last three decades—a resistance rooted in Dow's founding chemical trove and its corporate culture. That part of the story is next.