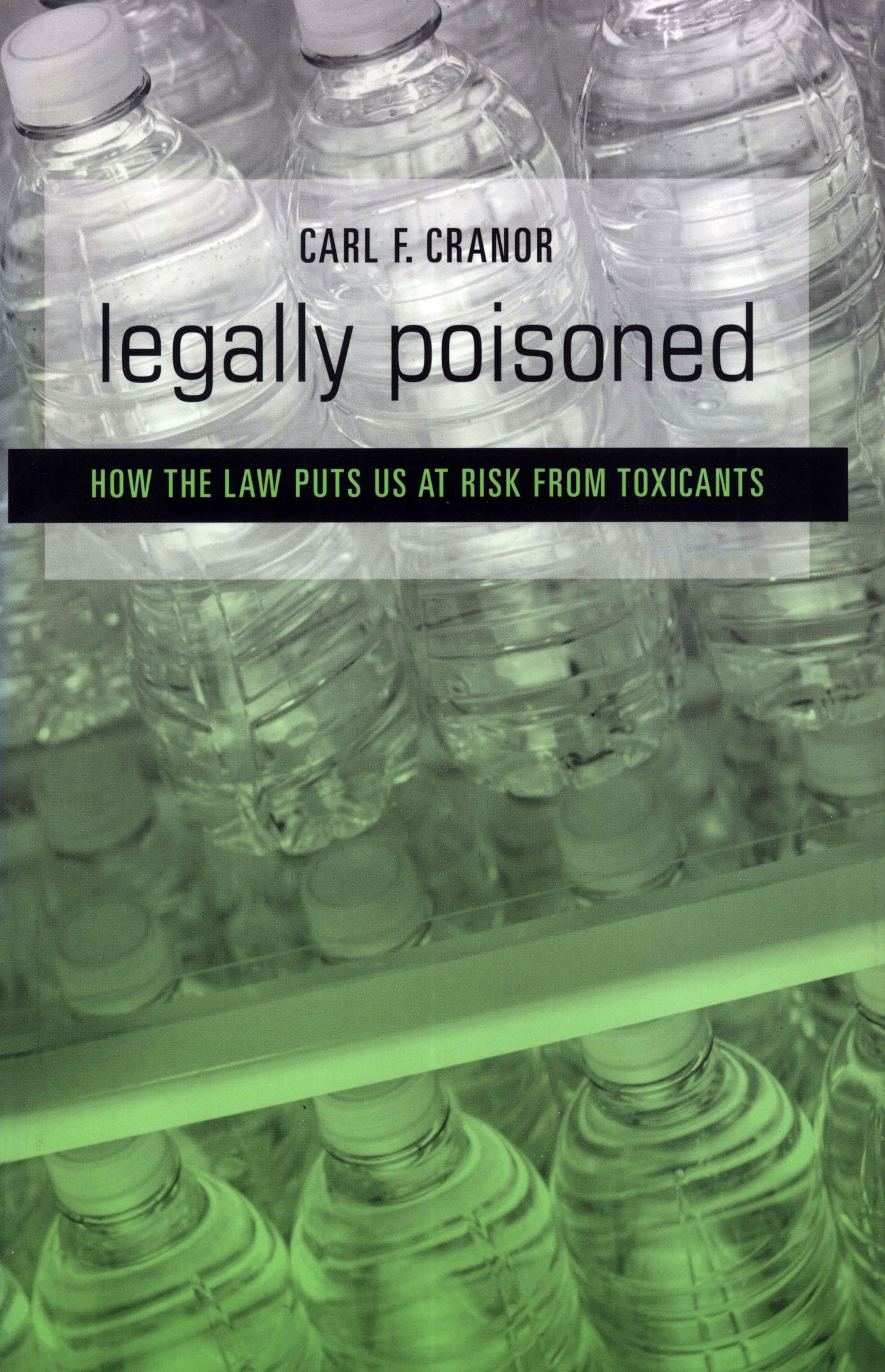
CARL F. CRANOR
legally poisoned
HOW THE LAW PUTS US AT RISK FROM TOXICANTS

# LEGALLY POISONED

## HOW THE LAW PUTS US AT RISK FROM TOXICANTS

Carl F. Cranor



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# LEGALLY POISONED

To Crystal, Chris, and Taylor

# ABBREVIATIONS

| | |
|---|---|
| ADHD | attention deficit hyperactivity disorder |
| Ah receptor | aromatic hydrocarbon receptor |
| ATSDR | Agency for Toxic Substances and Disease Registry |
| BPA | bisphenol A |
| CAA | Clean Air Act |
| CDC | Centers for Disease Control and Prevention |
| CNS | central nervous system |
| CPSA | Consumer Product Safety Act |
| CPSC | Consumer Product Safety Commission |
| CWA | Clean Water Act |
| DDE | dichlorodiphenyldichloroethylene |
| DDT | dichlorodiphenyltrichloroethane |
| DEHP | di(2-ethylhexyl)phthalate |
| DES | diethylstilbestrol |
| DOHaD | Developmental Origins of Health and Disease |
| ED | endocrine disrupter(s) |
| EPA | U.S. Environmental Protection Agency |
| FDA | U.S. Food and Drug Administration |
| FDCA | Food, Drug, and Cosmetic Act |
| FIFRA | Federal Insecticide, Fungicide, and Rodenticide Act |
| HD | Helsinki Declaration |
| IARC | International Agency for Research on Cancer |
| MTBE | methyl tertiary butyl ether |
| MeHg | methylmercury |
| MPTP | methylphenyltetrahydropyridine |
| NRC | National Research Council |

| | |
|---|---|
| NIEHS | National Institute of Environmental Health Sciences |
| NC | Nuremberg Code |
| OSH Act | Occupational Safety and Health Act |
| OSHA | Occupational Safety and Health Administration |
| PAH | polycyclic aromatic hydrocarbons |
| PBBs | polybrominated biphenyls |
| PBDEs | polybrominated diphenyl ethers |
| PCBs | polychlorinated biphenyls |
| PD | Parkinson's disease |
| PFCs | perfluorinated compounds |
| SDWA | Safe Drinking Water Act |
| tOP | 4-tertiary-octylphenol (a degradation product of BPA) |
| TCA | trichloroacetic acid, a breakdown product of trichloroethylene |
| TCE | trichloroethylene |
| TSCA | Toxic Substances Control Act |
| TURI | Toxic Use Reduction Institute |

# LEGALLY POISONED

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# 1

# INTRODUCTION

Take a random walk through your life; it is awash in industrial chemicals, many toxic. Of course, we can all be aware that we are exposed to smog in the Los Angeles Air Basin or to a fog of pesticides being sprayed from a crop duster or to probably unhealthy water from a river contaminated with factory wastes. Most exposures are not obvious, however.

Our exposures, understood as substances reaching the boundaries of our bodies, are often much more subtle, invisible, and otherwise undetectable. Drink water or soda from a plastic bottle or eat canned refried beans or soup, and you ingest bisphenol A (BPA). When a dentist uses a plastic dental sealant for your children's teeth to prevent decay or a composite product to fill their cavities, each likely contains BPA. This compound was created in 1891, proposed as a synthetic estrogen in the 1930s (but not pursued), and eventually used to harden many plastics.[1] More than ninety-percent of us have been exposed to BPA. One serving from some cans of food has sufficient BPA to cause adverse health effects in experimental animals.

If you use cosmetics or body lotions, you may absorb lead (in some lipsticks), phthalates, or other products through your skin. Phthalates enter the womb and they have been found in amniotic fluid. Children have higher concentrations in their bodies than adults. Phthalates may contribute to premature breast development, as well as reproductive effects in males, including feminization (retained nipples), infertility, and undescended testes. Lead is a potent neurotoxicant, adversely affecting learning, IQ, and even behavior. It also contributes to cardiovascular disease.[2]

Prepare your dinner in a nonstick frying pan, and you are exposed to perfluorinated compounds (PFCs) from Teflon. Spray your furniture with Scotchgard and produce a similar result. Ninety-eight percent of the U.S. population is exposed to these substances. The PFCs are quite persistent and may stay in your body for most of a decade and much longer in the environment, from which you can be reexposed. Perfluorinated substances were once thought to stable for hundreds of years, but recent research suggests that they may breakdown more rapidly, releasing toxic by-products.[3] They appear to affect neurological development and are a likely human carcinogen.

Many of your couches, chairs, carpet pads, drapes, car seats, televisions, and computers have a brominated flame-retardant (polybrominated diphenyl ethers, or PBDEs) in them. The PBDEs entered the market only in the 1970s, but already millions of pounds are used in the United States. We are all in contact daily with them. Little is understood about their health effects, because legally they could enter commerce without toxicity testing. However, recent studies suggest PBDEs delay neurological development in children and affect the reproductive system by delaying pregnancy. PBDEs' persistence and adverse effects in animals raise many concerns.[4]

Quite ordinary activities bring you into contact with industrial chemicals. When you drink tap water, you likely ingest methyl tertiary butyl ether (MTBE), a gasoline additive. A high percentage of us has detectable body levels.[5] Its toxicity has not been fully determined, but animal studies show it causes several cancers, which should be of concern.[6]

Eat steak for dinner and ingest up to six hormones used to accelerate weight gain in beef. Twelve percent of cattle contain these residues. The European Union (EU) found that there is no safe level of these substances for fetuses. A serving of steak also contains fat-soluble toxicants—long-banned pesticides (DDT (dichlorodiphenyltrichloroethane), chlordane, dieldrin and others), industrial fluids (polychlorinated biphenyls, (PCBs)), and dioxins (contaminants from industrial processes), as well as the more recent PFCs and PBDEs. Concentrations of individual contaminants are low, but their toxic effects can be additive.[7]

We are not merely exposed to most of these compounds, however. Each of us is in reality contaminated by hundreds of substances. That is, industrial chemicals, pesticides, cosmetic ingredients, and other products enter our bodies and then reach and infiltrate our tissues, organs, and blood. They become part of our body burden of chemicals. The Centers for Disease Control (CDC) has developed techniques for detecting them by measuring the amounts in our blood or urine; this process is called biomonitoring.

To date, the CDC can reliably identify about 212 substances in our bodies; this number will only increase as protocols for detecting them are developed and refined. The CDC is investigating these compounds because they represent substantial exposures or are known or suspected to be toxic hazards. That is, most have intrinsic toxic properties, or what experts have called "built-in abilit[ies] to cause an adverse effect."[8] (Whether they will pose risks depends upon their concentrations and other factors.)

These substances include, among other compounds, fire retardants (the PBDEs), industrial insulating and cooling compounds (PCBs), gasoline additives (MTBE), discarded rocket fuel components (perchlorate), lead, arsenic, many pesticides, and perfluorinated compounds, as well as plastic-hardening agents and plastic-softening agents. All of these chemicals have penetrated our kidneys, lungs, liver, bones, and in some instances even our brains. The CDC's list includes known or probable human carcinogens; estrogen-mimicking substances; other hormone-disrupting chemicals; thyroid disrupters; developmental toxics; neurotoxicants, which can damage the nervous system and brain; and immunotoxicants, which can damage the immune system.

We cannot escape contamination. Kim Radtke, a pregnant mother-to-be, was determined to do everything right to protect her developing child from worrisome toxicants. She had eaten organic foods for some time, avoided deodorants and scented lotions, and exercised regularly. Yet when she was tested for twenty-three industrial chemicals in a study of ten pregnant women, she was shocked that many of them burdened her body. She was the most contaminated among the small group tested.[9]

Radtke's son, Karson, entered the world already tainted with industrial chemicals. Radtke nursed him because of breast feeding's importance to his development, but in the process she off-loaded some of her hazardous body burden into him.[10] Unfortunately, nursing one's child has become much more of a risk-benefit calculation than it should be. Yet her contamination is not unusual but routine.

Some invaders are naturally occurring elements, for example, lead and mercury, to which humans have been exposed for centuries. Other substances were not present before they were deliberately synthesized for better living through chemistry, such as PCBs, PBDEs, MTBE, DES (diethylstilbestrol), BPA, PFCs, and many pesticides. Sometimes products directly contaminate us; at other times we receive secondary contamination from the environment.

Some industrial chemicals are persistent, likely to remain in our bodies for years. The flame retardants can reside in fatty tissues for several years. There they unite with long-banned PCBs. Only about half of the PCB bodily contamination disappears in eight years. In addition, perfluorinated substances have joined the club of long-lasting substances in our bodies with a half-life of up to seven years.[11] This team of three can jointly contribute to similar adverse effects and has considerable time to affect our health adversely.

Bisphenol A and other substances can be quite transient in our bodies. Nonetheless, the CDC found that about 93 percent of people older than six were contaminated by BPA. Children have the highest exposures.[12] This suggests that we have near continuous exposure from numerous sources. Solvents, such as MTBE, or plastic additives such as phthalates, also have a short half-life. Length of residence in our tissues, however, does not determine the risks from these substances.

Both persistent and short-lived substances can pose live or heightened risks to each of us during development. These risks are "live" because of children's contamination by known *toxicants* and their greater vulnerability during development. Most substances in a pregnant woman's body will cross the placenta and defile her developing child. Many compounds will enter her breast milk, be transmitted to her nursing child, and, as Kim Radtke worried, be off-loaded from mother to child. This points to a broader concern. A study of ten newborn babies found more than 200 industrial chemicals in their umbilical cords. Some news reports suggest even greater contamination. Children begin life sullied by industrial compounds and immediately add to them from external exposures.[13]

Moreover, developing children are particularly susceptible to disease, dysfunction, or premature death as a result of prenatal or early postnatal contamination. They also tend to be more highly exposed than adults and have lesser defenses against toxicants. Children are, thus, at live risk for adverse effects and at greater risk than adults.

Lead, mercury, diethylstilbestrol, thalidomide, pesticides, anticonvulsive drugs, sedatives, arsenic, tobacco smoke, alcohol, and radiation are known developmental toxicants. Two hundred known human neurotoxicants are likely toxic to developing children as well. Numerous other products are of considerable concern, based on experimental animal studies on substances such as PBDEs, BPA, phthalates, pesticides, and cosmetic ingredients. There could be as many as one thousand additional neurotoxicants that could pose health problems. No lowest concentration level appears to be safe for many carcinogens, lead, tobacco smoke, and radiation.[14]

Some developmental toxicants—such as thalidomide and anticonvulsive drugs—cause immediate and noticeable effects, such as birth defects. Others have long-delayed, often less visible adverse consequences—lead can lessen children's IQ and contribute to aggressive behavior. In utero exposures to neurological toxicants, such as some pesticides, appear to hasten Parkinson's disease (and perhaps dementia) after a delay of forty to fifty years. Lead appears to have similar effects. Estrogen-mimicking substances may lead to early onset of cancer, increase the chances of its occurring, or contribute to other diseases, but years after exposure. BPA, for instance, can cross the placenta, become more toxic in the fetal environment, change how important genes are expressed, and damage placental cells. Experimental studies indicate that it can contribute to breast, uterine, and prostate cancer as well as obesity and diabetes.[15]

These contributors to disease are newly being understood. Many of the diseases that once ravaged the United States have disappeared. Public health measures eliminated numerous scourges—for example, cleaning up water and sewage reduced cholera and typhoid fever—while vaccinations reduced or eliminated others, such as smallpox, polio, measles, and mumps. Children born today are likely to live up to two decades longer than recent ancestors.[16]

However, there remain noninfectious illnesses of increasing concern, including, as Bruce Lanphear points out, "cardiovascular disease, diabetes, obesity, respiratory ailments, and injuries." And various morbidities affect children—"intellectual impairments" like lowered IQ, poor memory, mental retardation, autism, attention deficit hyperactivity disorder (ADHD), and "behavioral problems, asthma, and preterm birth—[that] are linked with remarkably low-level exposures to . . . noninfectious environmental factors or gene-environment interactions."[17] These must be addressed with better public health protections.

Since diseases typically result from a combination of environmental and genetic influences, and since our genetic sequences do not change rapidly, researchers are looking much more closely at environmental influences, especially molecular contributions. This research focuses on what is called the "developmental origins of health and disease." Scientists believe that some contaminants, while not changing a person's genome, modify how it functions, or "expresses itself," thus leading to disease. These are "epigenetic" effects.[18]

Although some activities like smoking, drinking, using illegal drugs, and working in industries with toxicants create obvious developmental exposures, we largely do not knowingly and deliberately invite toxicants into our bodies. Rather, even if we seek to avoid them, industrial chemicals and pesticides still invade us; that is a matter of biology and chemistry. Our laws and institutions permit our contamination by toxic substances and add to our risk of disease.

Many people believe that public health agencies protect them from toxicants, that indeed they have a moral duty to do this. They likely believe that most public health laws require product testing and then review of the tests and products for toxic risks before citizens are exposed, just as the Food and Drug Administration requires testing and review of pharmaceuticals. Unfortunately and sadly, this is mistaken. In fact, the vast majority of substances are subject to "postmarket laws." These laws do not require testing or a public health agency's reviewing of industrial compounds for toxicity before they enter the market. Thus the substances governed by such laws are not necessarily free of risks, especially for the most biologically sensitive among us.

The predictable result is that little is known about large percentages of chemical products in commerce.[19] Only about two percent of 62,000 substances in commerce before 1979 have been reviewed at all for their toxicity by the U.S. Environmental Protection Agency (EPA). Of the approximately 50,000 new substances introduced since 1979, about eighty-five percent had no data concerning health effects; even the chemical identity of a majority of them is veiled by claims of confidential business information. At current rates, testing these products after they are already in commerce could take hundreds of years.[20] At the same time it appears that many industrial chemicals are more toxic than might appear. For instance, for most new substances proposed for manufacturing the EPA has no data on their ability to cause genetic mutations, which can be determined by a relatively simple and reasonably accurate test. Yet a sampling of one hundred chemicals in commercial use and a sampling of forty-six chemicals produced in more than a million pounds revealed that about twenty-percent of each group were mutagenic. When a substance is mutagenic it is also highly likely to be a mammalian carcinogen.[21]

For the overwhelming number of substances, the doors from the factories into commerce are wide open, permitting possibly toxic products to contaminate us. For instance, PBDE flame retardants began to be used in commerce in the 1970s without any review of their toxicity. Before that date Americans essentially had no PBDEs in their bodies. Yet there are now millions of pounds in commerce, and U.S. citizens have the highest bodily concentrations in the world.[22] Moreover, PBDEs are remarkably similar in chemical structure and toxicity to long-banned PCBs. This similarity was not noticed or was ignored, or their use was mistakenly "grandfathered in." Such an outcome is not surprising, since the pertinent laws required no toxicity data about new substances or those in commerce.

As new kinds of technologies are created, there will be even more compounds of unknown toxicity under existing laws. For instance, there is a burgeoning industry in nanotechnology. It seeks to develop products for electronics, medicine, and even pollution control with new chemical structures that are larger than a molecule but smaller than a biological cell. They range in size from one to one hundred nanometers in size (a nanometer is $1x\ 10^{-9}$ meters). A PCB molecule is about 1 nanometer. From 2005 to 2009 the number of such products increased from about fifty-four to more than one thousand. Some are long, rigid, fiber-like tubes similar to asbestos, while others can be tiny particles. Both nanotubes closely resembling asbestos and some small particles have exhibited worrisome toxicity properties. Some nanoparticles have been found to cross the placenta and titanium oxide nanoparticles have been found to cause genetic and chromosomal damage in experimental studies.[23]

Postmarket laws, thus, are reckless and permit companies to be reckless toward adults and children. That is, these policies appear to disregard possible undesirable consequences. And they permit the creation and commercialization of products without sufficient attention to undesirable consequences.

In addition, under postmarket laws a public health agency must carry a considerable legal and scientific burden of proof to secure better health protections once products are suspected of being toxic. The science must be found or generated and must be legally sufficient to support better health protections. Public health officials must have the political will, sufficient staff and adequate resources to act on the science. All can be in short supply. These laws in effect put us at risk because no toxicity data is required about substances, and they then erect substantial barriers to making us safer if there are concerns about the risks of products. And they can be manipulated to forestall health protections. If substances pose risks, any science seeking to reveal them begins well after contaminations have occurred, leaving the public at risk while the science is developed.

The features and the use of scientific studies thus become an essential part of the story that follows. It takes considerable time to detect many diseases considered here. Establishing threats is even more complicated because we obviously cannot test unknown substances on people in labs, but of course we are the guinea pigs right now. Animal studies, early and good indicators of risks, are likely to be denigrated, further delaying health protections. Long lag times to identify risks invite parties responsible for the exposures to exploit these issues to disavow responsibility for them. As a result, legal efforts to protect the public typically become mired in procrastination, obfuscation, and endless disputes about the science and law.

The law permits these problems, but it also holds the answer. Laws governing pharmaceuticals and pesticides do not permit human exposures, even for volunteer subjects, without appropriate testing for the risks of these products. The ethics of medical experiments do not permit people to volunteer before sufficient preparatory research has identified risks and ensured that any risks are reasonable. It is forbidden to experiment on children, unless the data is essential to their well being and there is no other way to obtain it.

In sharp contrast, exposures to the vast majority of chemicals have none of these protections. People, and worse their children, become experimental subjects for industrial chemicals. If substances pose significant or subtle risks, their discovery will likely occur long after exposure has occurred and after some damage has been done.

Moreover, no matter how careful we are about our contamination and our health, the actions and products of others beyond our control can affect us. Atomistic self-help based on individual choices—independent actions on which Americans may pride themselves—cannot solve these problems. It can do little to protect those who try to avoid contamination.

We can, however, design and create a less risky world with sensible legal and regulatory safeguards to protect our health. Those who invent and manufacture industrial chemicals should be legally required to conduct their activities with greater foresight, responsibility, and prudence. They should fund toxicity testing of their products before they are manufactured and commercialized. Such research should focus on developmental and other adverse risks during sensitive life stages. Testing should also aim to identify early the risks of cancers, neurological disorders, lifelong illnesses from impaired immune systems, heart disease, various morbidities due to ill-timed toxicants, and so on. Tests should address the