

# Rachel's Environment & Health News

## #414 - Potent Immune System Poison: Dioxin

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The immune system is a complex set of specialized cells and organs that defends the body against attack by "foreign" invaders. When it functions properly, the immune system fights off diseases caused by bacteria, viruses, fungi, parasites, and cancer cells. "When it malfunctions, however, it can unleash a torrent of diseases, from allergy to arthritis to cancer to AIDS," according to the federal National Institutes of Health (NIH).[1]

At the heart of the immune system is the ability to distinguish between self and nonself. A healthy immune system protects the "self" and attacks only the "nonself." Virtually every cell in your body carries distinctive molecules that identify it as self. Cells lacking a "self" marker are quickly perceived as "foreign," attacked, and eliminated by the immune system.

The National Institutes of Health (NIH) describes the immune system this way: "The immune system, which equals in complexity the intricacies of the brain and nervous system, displays several remarkable characteristics. It can distinguish between self and nonself. It is able to remember previous experiences and react accordingly: once you have had chicken pox, your immune system will prevent you from getting it again. The immune system displays both enormous diversity and extraordinary specificity: not only is it able to recognize many millions of distinctive nonself molecules, it can produce molecules and cells to match up with and counteract each one of them. And it has at its command a sophisticated array of weapons.

"The success of this system in defending the body relies on an incredibly elaborate and dynamic regulatory-communications network. Millions and millions of cells, organized into sets and subsets, pass information back and forth like clouds of bees swarming around a hive. The result is a sensitive system of checks and balances that produces an immune response that is prompt, appropriate, effective, and self-limiting."[1]

The immune system can fail in two ways: if it is damaged, it can fail to attack foreign invaders, and can thus allow infections or cancers to develop. On the other hand, if the immune system fails to distinguish self from nonself, it can overreact and attack the self, causing "autoimmune" diseases such as arthritis, asthma, lupus, or Type I diabetes (insulin-dependent diabetes mellitus). Other autoimmune diseases include scleroderma, Graves' disease, Addison's disease, Hashimoto's disease, myasthenia gravis, lymphocytic adenohypophysitis (also called Sheehan's syndrome), mucocutaneous candidiasis, Schmidt's syndrome, and autoimmune thyroid disease.

### Dioxin: Potent Immune System Poison

U.S. Environmental Protection Agency's (EPA's) 1994 draft reassessment of dioxin emphasized that dioxin damages the immune system directly and indirectly. From studies of rats, mice, guinea pigs, rabbits, cattle, marmosets, monkeys, and humans, EPA concludes that even low doses of dioxin attack the immune system. Dioxin directly reduces the number of B cells (immune cells that develop in the bone marrow, then circulate throughout the blood and lymph, fighting off invaders). And it reduces the number of T cells (immune cells that develop in the thymus, then circulate throughout the body, attacking invaders), but dioxin's attack on T cells seems to be indirect. EPA says, "One potentially important indirect mechanism is via effects on the endocrine system. Several endocrine hormones have been shown to regulate immune responses, including glucocorticoids, sex steroids, thyroxine, growth hormone, and prolactin. Importantly, TCDD [dioxin] and other related compounds have been shown to alter the activity of these hormones."[2,pg.9-49]

EPA goes on to say, "It is important to consider that if an acute exposure to TCDD even temporarily raises the TCDD body burden at the time when an immune response is initiated, there may be a risk of adverse impacts even though the total body burden may

indicate a relatively low average TCDD level." In other words, a single dose of dioxin at the wrong time may damage your immune system's ability to protect you.

EPA then says, "Furthermore, because TCDD alters the normal differentiation of immune system cells, the human embryo may be very susceptible to long-term impairment of immune function from in utero [in the womb] effects of TCDD on developing immune tissue." In other words, dioxin can prevent the immune system from developing properly in an unborn child, with lifelong consequences, EPA believes. "Animal studies suggest that some immunotoxic responses may be evoked at very low levels of dioxin exposure," EPA says.[2,pg.9-50]

Linda Birnbaum, director of research at the U.S. EPA Health Effects Laboratory in Research Triangle Park, N.C., was the leader of EPA scientific team reassessing dioxin. She says, "Dioxin appears to be a carcinogen in fish, rodents, and other mammals, including humans. But dioxin can also modulate [modify] the immune system resulting in an inability to fight disease. It is a very powerful immunosuppressant. But it can also upregulate [excite] the immune system so that you start becoming hypersensitive, developing autoimmunity and allergies. Depending upon the stage [of growth] of the animal and the species, sometimes you observe immunosuppression and in other cases you observe upregulation."[3,pg.4]

Birnbaum goes on to describe Taiwanese children, exposed to dioxin-like chemicals, who had unusually frequent respiratory infections and ear infections (otitis). Further, she described an Inuit population in Quebec with elevated levels of dioxin in their bodies from eating the fat of marine mammals (seals); their children have "very high incidences of respiratory infections and otitis [ear infections], and also a very decreased take of vaccinations," Birnbaum says.[3,pg.11] In other words, vaccinations don't work well in these children, perhaps because their immune systems have been damaged.

Birnbaum says there is no threshold for immunotoxic responses to dioxin;[3,pg.14] in other words, there is no level of dioxin below which the immune system is not affected. Put another way: any amount of dioxin seems to do some damage to the immune system, at least in animals; there is no "safe" dose.

In laboratory mice, a single tiny dose of dioxin causes increased deaths when the mice are challenged with an influenza virus.[4] It is worth emphasizing that the effective dose of dioxin is very small: 10 nanograms of dioxin per kilogram of bodyweight (10 ng/kg) harms the mouse immune system enough to increase the death rate from influenza virus. To get 10 ng/kg into perspective, consider that a single 5-grain aspirin tablet taken by a 150-pound adult is a dose of 4.7 MILLION nanograms of aspirin per kilogram of bodyweight (4,761,936 ng/kg). For an adult human to get a dose of aspirin equivalent to the dose of dioxin that harms the mouse immune system, you would have to divide a single aspirin tablet into 470,000 pieces (nearly half a million pieces) and eat only one piece. Is the human immune system as sensitive to dioxin as the mouse's? No one yet knows.

What about animals more human-like than mice? Tom Webster of the Boston University School of Public Health cites evidence that the number of immune cells in rhesus monkeys is changed by a dioxin body burden of 270 ng/kg; in marmosets, the number of immune cells is changed at only 6 to 8 ng/kg of dioxin. "While the medical implications of this effect are unknown, it appears to occur at about the average human body burden of dioxin-like compounds," he says. In other words, average residents of North America carry 7 to 9 ng/kg in their bodies now, and 6 to 8 ng/kg alters the immune systems of marmosets.[4,pg.8] "Similar effects [immune cell alterations] were seen in the children of mothers who lived in dioxin-contaminated Times Beach, Missouri during and after pregnancy," Webster notes, citing work by Gerson Smoger

and others. [4,pg.7]

This past summer, German researchers published a study of the health of 158 chemical workers who had been exposed to dioxin in 1953 during an industrial accident at a BASF chemical plant.[5] The 158 exposed workers were compared to 161 unexposed workers. The dioxin-exposed workers experienced more frequent infections and parasitic diseases during the 36 years after exposure, consistent with immune system damage. Especially noticeable were increases in respiratory infections, thyroid diseases, disorders of the peripheral nervous system, and appendicitis. Mental disorders were also increased. All together, the highly-exposed group had 18% more recorded episodes of illness than the control group.

Ironically, the largest source of dioxin entering the environment today is medical incinerators. Together, medical incinerators and municipal solid waste (msw) incinerators account for 95% of all dioxin emissions into the air of the U.S., according to U.S. EPA.[6,pg.2] The good news is: these technologies are not needed and could be phased out rapidly, if public health authorities began to take their DISEASE PREVENTION responsibilities seriously. Plans for new incinerators could be easily abandoned. For both medical wastes and municipal wastes, alternatives already exist that are cleaner, safer, and less expensive. (The chief appeal of incinerators is political: massive campaign contributions by the waste industry.)

Unfortunately, instead of planning to phase out incinerators, EPA has announced plans to "regulate" incinerator emissions more tightly by requiring air pollution scrubbers. Scrubbers will not decrease dioxin production, but will move dioxin from the air emissions into the incinerator ash, which gets buried in shallow pits in the ground. Thus, current public health policies are creating a legacy of unpleasant surprises for our children.

--Peter Montague

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[1] Lydia Woods Schindler, UNDERSTANDING THE IMMUNE SYSTEM [NIH Publication No. 88-529] (Bethesda, Md.: National Institutes of Health, July, 1988), pg. 1.

[2] U.S. Environmental Protection Agency, HEALTH ASSESSMENT DOCUMENT FOR 2,3,7,8-TETRACHLORODIBENZO-p-DIOXIN (TCDD) AND RELATED COMPOUNDS. VOL. III OF III. [EPA/600/BP-92/001c] (Cincinnati, Ohio: U.S. Environmental Protection Agency, August, 1994.) This is the official draft of "Chapter 9" of the EPA dioxin reassessment, also known as the "risk characterization chapter." Available free while supplies last; telephone (513) 569-7562 in Cincinnati.

[3] Linda Birnbaum, GREAT LAKES WATER QUALITY BOARD 102ND MEETING, CHICAGO, ILLINOIS, JULY 15, 1993, PRESENTATION BY LINDA BIRNBAUM, U.S. EPA (Washington, D.C.: International Joint Commission, Great Lakes Water Quality Board, Dec. 21, 1993), pg. 4. Available from us for \$4.00.

[4] Tom Webster, DIOXIN AND HUMAN HEALTH: A PUBLIC HEALTH ASSESSMENT OF DIOXIN EXPOSURE IN CANADA (Boston: Boston University School of Public Health, 1994), pg. 7, citing unpublished work by Linda Birnbaum and others. Available from us for \$4.00.

[5] Andreas Zober and others, "Morbidity follow up study of BASF employees exposed to 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) after a 1953 chemical reactor incident," OCCUPATIONAL AND ENVIRONMENTAL MEDICINE Vol. 51, No. 7 (July 1994), pgs.

479-486.

[6] Lynn Goldman, STATEMENT OF LYNN GOLDMAN, M.D., ASSISTANT ADMINISTRATOR FOR PREVENTION, PESTICIDES AND TOXICS, U.S. ENVIRONMENTAL PROTECTION AGENCY, SEPTEMBER 13, 1994 (Washington, D.C.: U.S. Environmental Protection Agency, September 13, 1994).

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