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 APES Topic 9 - Toxicology

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FOOLING WITH NATURE

are man-made chemicals in the environment hazardous to humans? what does science know?

William Kistner – PBS Frontline

<http://www.pbs.org/wgbh/pages/frontline/shows/nature/disrupt/envchem.html>

You've seen some of the headlines: 'Sperm Counts are Falling;' 'Breast Cancer Increasing;' 'Attention Deficit Disorder on the Rise. ' Are we all doomed?

Probably not. But subtle, yet significant hormonal changes may be taking place that could have a profound impact on human health and development. New research is focusing on the way man-made chemicals, from banned substances like PCBs to plastic compounds used in all sorts of everyday goods, may impact the developing fetus through a process called endocrine disruption. Experts are particularly interested in how these chemicals impact the endocrine system, a sensitive system of glands and hormones responsible for the development of the brain and reproductive organs, as well as other bodily functions. Many researchers have hypothesized that extremely small doses of toxic compounds may disrupt the hormonal balance of the developing fetus, resulting in permanent changes to the development of the brain, the reproductive organs and the immune system.

Recent studies suggest that traces of persistent chemicals such as PCBs may cause permanent changes in children, resulting in lower IQ levels, attention deficits and other behavioral problems. Researchers say this new data marks a paradigm shift in the way toxic chemicals may be regulated, as scientists begin linking broad human health effects to small doses of chemicals in the environment. Much of this research is still in its early stages, and many questions remain to be answered about how significant these changes are, which chemicals may be causing them, and what mechanism causes these effects. But research linking these chemicals to health effects in children has prompted the director of one federal health agency to raise this alarming question: "Has the fetus become the unfortunate mining canary for human exposure to toxicants in the environment?"

Many scientists are skeptical of jumping to conclusions about human health impacts until more research is done. "I think there is some general scientific consensus that effects on hormones and hormone systems may play a role in some bad things that have happened in the wild," says Linda Birnbaum, acting associate director for health with the National Health and Environmental Effects Research Laboratory of U.S. EPA. "But when it comes to people, are there endocrine effects going on from environmental levels of chemicals in people -- I really don't think we know the answer."

A Push From Congress

Recent concerns about human health effects have driven Congress to push for more research, requiring EPA to come up with a plan this year to screen environmental chemicals for their potential hormonal impacts on health. In 1996, Congress ordered EPA to implement a screening program by mid-1999. A panel of scientists and representatives from industry, academia, government, and public interest organizations has been convening for more than a year to design a hormonal screen for potentially thousands of commonly-used industrial chemicals that have never been tested before. It is a daunting task that has resulted in a new model for environmental regulation.

"This is the first time since the passage of the Toxic Substances Control Act, more than 20 years ago, that Congress has spoken on the issue of testing of chemicals" says assistant EPA administrator Dr. Lynn Goldman. "That's a very fundamental change from the kind of legislation we've had in the past. And I think that it will very much increase the amount of information that we have available on toxic chemicals."

Difference of Opinions

While there is virtual consensus that more studies and research need to be conducted to determine what risk there is to humans, many in industry doubt there is cause for great alarm. "I think that what we know so far indicates that there is no cause for concern," says Jay Vroom, president of American Crop Protection Association, which represents pesticide manufacturers. "I think that it's important that we look not only at laboratory experience but also information from human experience, as well as wildlife. And that's an important factor, one which I think that the public, government, and industry are all committed together to working at exploring and compiling more information and getting a better understanding of what the science is really all about."

Some research scientists also publicly dispute alarms over human health effects. Critics of the endocrine disruption hypothesis say it's one thing to study deformities of alligator penises and bird bills in polluted areas, but they say blaming human diseases and deficiencies on environmental chemicals is a stretch. Stephen Safe, a toxicologist with Texas A&M University, says that until human studies can support these concerns, apocalyptic warnings of health disasters ring hollow. "It is incumbent on the scientists, the media, legislators, and regulators to distinguish between scientific evidence and hypothesis, and not to allow a 'paparazzi science' approach to these problems," Safe wrote in an editorial published last year in the *New England Journal of Medicine*.

That editorial struck a nerve among other researchers who support the hypothesis. "I think that most scientists looking at the totality of data here would certainly not call the concern about endocrine disruption an irrational fear," says Fred vom Saal, a University of Missouri biologist who is studying low-dose chemical effects in lab animals. "I think that that kind of verbiage coming from a scientist is looked at as, in general, inappropriate in the scientific community...any developmental biologist can tell you that humans don't develop differently than these other animals."

The Effects on Children

While there is continuing scientific debate about human health impacts of environmental chemicals, some of the most compelling data has been shown in studies of children born to mothers who consumed PCB-contaminated fish from the Great Lakes. The Agency for Toxic Substances and Disease Registry (ATSDR), a small federal research agency affiliated with Health and Human Services, reported this year that "a growing body of animal and human data suggests that many environmentally persistent compounds have the potential to disrupt the normal functions of the endocrine system." The agency reported that these chemicals "may have a serious impact on reproductive and developmental parameters in wildlife and human populations."

ATSDR has been studying human health effects from toxic chemicals in the Great Lakes for the past six years. Last year, the agency put out a little-publicized, yet landmark report that carefully reviewed human health studies conducted so far. The report stated that neurobehavioral and developmental problems can occur in newborns and continue through school-age children following exposure in the womb to persistent chemicals like dioxins and PCBs, which are banned yet still persistent in the lakes. It also issued a call to action to reduce human exposure to these long-lived environmental chemicals.

"If you start to look at all the data together, you start to see a convergence," says Christopher DeRosa, director of ATSDR's division of toxicology. "We have a real sense of concern regarding the impact on human health." Those particularly at risk are unborn children, nursing infants, subsistence and sports fishermen, and the elderly. But it is the fetus that is most susceptible to permanent damage from extremely low, background levels of toxic chemicals in the environment. "The developing fetus is at the greatest risk because of the intrinsic sensitivity in its developing organs," DeRosa says.

Some of the studies have shown dramatic effects in children. ATSDR points out that children born to mothers who consumed Great Lakes fish during their pregnancies are three times more likely to have lower IQs and twice as likely to be two grade levels in reading comprehension behind their peers. Other studies have shown children whose mothers consumed PCB-contaminated fish had lower birth rates, reduced motor reflexes and neuromuscular function, poor short-term and long-term memory, weakened immune systems and greater susceptibility to infections, among other problems. Studies of children exposed to PCBs and other persistent toxic compounds in other areas of the world also have found developmental, reproductive and neurobehavioral abnormalities.

Blown by the Winds

While experts say toxic pollution levels declined dramatically in the Great Lakes since the 1970s, the decline in persistent chemical pollution leveled off in the 1980s. In some cases toxic chemical levels in the Great Lakes have recently risen, as atmospheric deposits of PCBs, DDT and other banned chemicals in the US are blown thousands of miles by winds from countries that still use these compounds. As a result, fresh samples of DDT can be found today in the tissues of Great Lakes fish, even though DDT was banned for use in the US in the early 1970s.

These chemical deposits are not limited to the Great Lakes. EPA reported that fish advisories against eating PCB contaminated fish rose 41% across the US from 1995 to 1996. "Consumers need to educate themselves and make informed decisions," says DeRosa. "They can reduce their exposure to PCBs in fish by the way they cook the fish and avoiding certain types of fish for women of reproductive age." DeRosa says that 95% of human exposure to toxic chemicals comes through the diet, and fish is a major route of exposure since they more readily bioaccumulate toxic compounds. Still, he says, fish advisories are too often ignored by consumers or not enforced by local health agencies.

ATSDR spends about \$2.5 million a year on health studies in the Great Lakes, an area that has had more scrutiny for toxic chemicals than anywhere else. DeRosa says the agency may use the Great Lakes as a model to study health effects from environmental chemicals in other regions such as the Hudson River, the Chesapeake Bay, the Puget Sound and the Gulf Coast. He does not expect the levels of environmental contamination to differ much from what they're finding in the midwest.

Researchers will not know how serious and extensive these effects are until they conduct further human health population studies. "Scientific discovery is rarely a straight line," says EPA's Linda Birnbaum. "It's usually a winding road and it's very hard when you embark at the beginning or even jump in at the middle to know where it's going to lead you in the end."

Concerned health researchers are not certain where the road is taking them, but they worry that changes in child IQ levels and other behavioral differences are serious and costly problems to society at large. While it is unclear if endocrine disruption is the exact mechanism by which these changes are taking place, some health experts say we need to act now to reduce further human exposures to toxic chemicals before future generations are put at risk. "It is time for public health action," says DeRosa, "As someone said in a recent meeting, we may not have a smoking gun, but there are bullets all over the floor."