Mutagens in air: They may be a gas

While the release of chemical pollutants into the air poses a health threat, the greater danger may lie in the by-products of the subsequent interaction of those chemicals in the presence of sunlight. Or at least that's what is suggested by a mutagenicity study appearing in the March ENVIRONMENTAL SCIENCE AND TECHNOLOGY. It shows that toluene, a fairly simple and nonmutagenic hydrocarbon found in virtually all urban air, can be converted photochemically into gas-phase mutagens.

Paul B. Shepson of Northrop Services Inc. in Research Triangle Park, N.C., says that to date almost all mutagenicity studies of urban air pollutants have focused on compounds known as polynuclear aromatic hydrocarbons (PAHs), which are adsorbed onto airborne particulates. "But there's no evidence that this [research focus] is justified," he says. "Though we know PAHs are mutagenic, no one has really addressed the question of the extent to which gas-phase hydrocarbons contribute to the overall mutagenic activity of urban air."

The Ames test performed by Shepson and colleagues at Northrop, together with researchers at two local Environmental Protection Agency laboratories, examined the ability of toluene and its breakdown products to induce mutations in bacteria. The test is widely used as a preliminary gauge of a material's potential hazard as a cancer-causing agent.

Because the chemistry of an urban atmosphere changes greatly over the course of a day, the researchers focused on the mix of hydrocarbons that would exist at both 3 hours and 6.7 hours after a typical atmospheric mix of toluene, oxides of nitrogen (NO_x), water and clean air was pumped into closed reaction chambers and allowed to react in the presence of light. These particular temporal snapshots of toluene photochemistry were selected, Shepson says, because the mix of photochemical products present "was as different in the two cases as possible." That's because at 6.7 hours, reactive nitric oxide was no longer present.

To do the Ames test, these chemical mixes had to be held in a constant steady-state rate of reaction for 18 hours, something not possible in the ambient atmosphere. In each test, bacteria were exposed to: (1) "clean air" only; (2) the initial mix of toluene, nitrogen dioxide, nitric oxide and water—but no light; (3) the irradiated mix of hydrocarbons that would be present at 3 or 6.7 hours; and (4) that latter mix minus any solid particles.

The first two exposure regimes were not mutagenic. Like the third test atmosphere, however, the gas-only reaction products showed strong mutagenic activity. Further analysis suggested that formaldehyde and peroxyacetyl nitrate (PAN) contribute to this gas-phase mutagenic activity. That in itself is important, Shepson says, "because there are a large number of hydrocarbons in the atmosphere that produce both PAN and formaldehyde in photooxidation processes."

More surprising, he says, is his group's subsequent finding of a similar photochemically induced mutagenicity among the breakdown products of an even smaller organic chemical, propylene (C_3H_6). And when the researchers studied wood-smoke mixtures, "we got a large mutagenicity response there with gas-phase products," he says.

However, with potentially thousands of photooxidation products present in the irradiated wood-smoke mixture, "it's absolutely hopeless to try and determine what caused the response," he says. That's one reason his team plans to focus more attention on propylene. Explains Shepson, "We feel we should start with the simplest case and try to understand that before we move on to more complex ones."

In any case, concern remains that important and largely unrecognized gaseous mutagens may be prevalent in urban air.

— *J. Raloff*

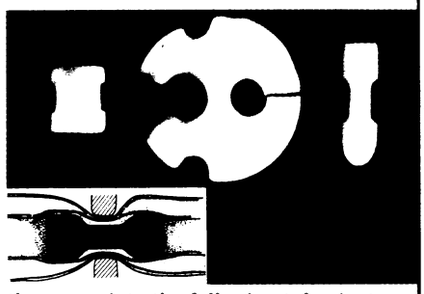
Pulling the plug on sterilization

When a woman has her fallopian tubes "tied," the sterilization effected can be forever. Contraceptive counselors do not recommend tubal sterilization to women seeking a reversible form of contraception, because reversal, which requires removal of the damaged section of the tube and exacting microsurgery to reconnect it, frequently doesn't work.

C. Irving Meeker of the Maine Medical Center in Portland and Wilfred Roth of the University of Vermont in Burlington set out to develop a device to make sterilization more reversible, and have come up with the gizmo at right. The idea is to protect the fallopian tube (see inset) from being crushed, so that no microsurgery is required for reversal.

They have implanted the device in 18 baboons for 6 to 18 months. Within a year of removal, 10 of the 18 got pregnant. This 56 percent conception rate compares to a 65 percent rate in unsterilized baboons, representing "a high degree of reversibility for the method," they report in the March OBSTETRICS & GYNECOLOGY.

For insertion, a small slit is made in the abdomen and the plug (far right) is threaded into the fallopian tube through its open end near the ovary. The clip (center) is placed around the plug and tube, and the lock (near right) fits into the clip to hold it shut. The egg, released from the ovary into the fallopian tube, is stopped by the plug and reabsorbed by the body.



To reverse the procedure, the lock and clip are removed and the plug is either eased out of the tube or taken out through a small slit. The researchers plan to start testing in humans when they receive Food and Drug Administration approval.

Meeker says he hopes the device will prove useful for women in their 20s who are not planning to have more children but may change their mind. He anticipates it could also be valuable in underdeveloped countries like China, where strong political pressure for sterilization is resisted by couples with one child who worry that something may happen to their only offspring. "For them," says Meeker, "the possibility of reversal becomes extremely important."

— J. Silberner

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Do kinks and twists denote DNA damage?

Radiation and chemicals often damage a cell's DNA. Fortunately, there is a natural repair mechanism to undo most of that damage. But what is it that these enzymes must repair? And how do dispatched repair squads find the damage? Using computers to model the most likely stable structure of two types of photochemically induced damage, chemists in Berkeley, Calif., think they may have spotted the answers — bends and a partial unwinding of the DNA's characteristic double helix in the damaged cells. A report of their work appears in the March 15 SCIENCE.

Creation of certain dimers, bound pairs of identical subunits, is the most widely studied radiation-induced DNA change. Upon irradiation with ultraviolet (UV) light, two adjacent structures — thymines — along a strand of DNA may fuse into a thymine dimer. These dimers present roadblocks to normal DNA synthesis and are likely to spawn mutations if they are not repaired before the cell's DNA undergoes replication.

Another well-studied DNA lesion occurs when cells exposed to the drug psoralen (often used for treating the skin disease psoriasis) are subsequently irradiated with long-wavelength UV light. Here the psoralen molecule chemically binds to a