Biomedicine

John Travis reports from Washington, D.C., at the annual meeting of the American Association for Cancer Research

Smoke gets in your cervix and fetus

When a cigarette smoker inhales, thousands of tobacco-derived compounds, many accused of being carcinogenic or otherwise toxic, gain easy access to the human body. Like detectives who document the actions of a suspect before and after a crime, investigators are tracing the steps of these suspicious compounds as they sneak about the body.

Three research groups now present evidence that some of those tobacco compounds enter a woman's cervix, where they may cause cancer, or pass into a fetus, where they may cause respiratory problems or genetic damage that will predispose the child to cancer.

Researchers have shown that the human papilloma virus plays an important role in triggering cervical cancer, but they believe that the virus alone is insufficient. "There must be another factor initially damaging the cervical DNA," says Bogdan Prokopczyk of the American Health Foundation in Valhalla, N.Y.

Epidemiological studies strongly suggest that smoking is one such factor, adds Prokopczyk. Consequently, he and his colleagues recently examined samples of cervical mucus taken from both smokers and nonsmokers. They found that compared to nonsmokers' cervical mucus, that of smokers contains much higher concentrations of nitrosamines, carcinogenic derivatives of nicotine that come from tobacco.

The new results mesh with earlier research by other groups showing that smokers have more DNA damage in cervical cells than nonsmokers do, says Prokopczyk. Previous studies had also established that the cervical cells of smokers contain tobacco-derived nicotine, the precursor of the nitrosamines.

A fetus may also pay a price for the smoking of its mom or the people around her. Babies born to smokers often have low weight at birth and respiratory problems, notes Steven R. Myers of the University of Louisville (Ky.) School of Medicine. Whether the children suffer higher cancer rates remains unclear, however. For many years, says Myers, the placenta was considered an effective barrier to tobacco-derived carcinogens.

To test that assumption, Myers and his colleagues recently obtained a detailed smoking history from 410 pregnant women. When the women gave birth, the investigators took maternal blood samples and samples of fetal blood from the umbilical cord. They then examined the blood for smoking-related adducts, the joining of a carcinogen to DNA or other molecules like hemoglobin.

Myers' group tested for three specific types of hemoglobin adducts that tobacco-derived carcinogens would form and found that the number in the fetus increased with the number of cigarettes its mother smoked. "She's passing a significant concentration [of carcinogens] into the baby," says Myers.

The investigators found that the babies of nonsmoking mothers who spent many hours a day around smokers also have greater than normal numbers of hemoglobin adducts. "The question remains what this all means to the baby," acknowledges Myers. He believes that the fetal hemoglobin adducts serve as markers of the number of DNA adducts that smoking creates in the fetus.

In general, fetal DNA may be more vulnerable than maternal DNA to adduct formation, notes Robin M. Whyatt of Columbia University School of Public Health. In a study examining the effects of air pollution and smoking on 170 newborns from Poland, Whyatt and her colleagues analyzed the DNA in white blood cells taken from blood in the umbilical cord.

The Polish infants, in general, had significantly more DNA adducts than their mothers, Whyatt says. To explain this puzzling result, she suggests that fetal cells, which divide more rapidly than adult cells, expose their DNA more often to adduct formation. In addition, suggests Whyatt, fetuses may not repair their DNA as efficiently as adults do.

Materials Science

Seeing into the body electric

To look around inside the human body for medical purposes, one must be able to distinguish among tissues.

As it turns out, the electric resistance of animal tissues varies enough that appropriate equipment can use that difference to differentiate organs. Now, Peter Metherall, a physicist at the University of Sheffield in England, and his colleagues have devised a system to generate three-dimensional images of a body's interior based on differences in the electrical properties of its tissues.

Called electrical impedance tomography, or EIT, the technique bears some similarity to magnetic resonance imaging (MRI). In both, a computer infers structure from the body's response to a field and constructs a model from that information.

The EIT procedure uses 64 electrodes placed on the surface of the body. Half of them send current, the other half receive it. The system measures voltage changes, from which the computer generates a color picture.

The technique does not yet have such fine resolution as MRI or computerized tomography, but it has "several distinct advantages over existing medical imaging methods," Metherall's team says in the April 11 NATURE. "These include safety, portability, long-term monitoring, cost, and the inherent ability to image physiological function."

Contending that three-dimensional EIT will prove especially useful for lung and brain imaging, the researchers have begun a clinical trial to see how well it detects obstructions in the lungs. "If the trial is successful," they say, "3-D EIT will provide an important alternative to the established radionuclide imaging techniques."

A sharper magnetic window into the body

Though increasingly common in mainstream medicine, magnetic resonance imaging (MRI) has its limitations.

To produce an image, MRI must detect very faint signals arising from the gyrations of atoms in a magnetic field—a phenomenon known as nuclear magnetic resonance (NMR). As atoms align themselves "up" or "down" with respect to the field, they vibrate, creating signals that reveal their location.

Alexander Pines, a chemist at the University of California, Berkeley, and his colleagues have developed a method of amplifying the NMR signal of biological molecules. They use a laser to energize and polarize xenon gas, which they then dissolve in solution. They mix the solution with samples of organic molecules and find that the xenon atoms magnetically polarize neighboring molecules, amplifying their NMR response, the scientists say in the March 29 SCIENCE. To make the technique medically useful, they envision administering energized xenon to patients by inhalation or ingestion.

Solar energy captured in film

Seeking to harness solar energy to drive chemical reactions, Mark E. Thompson, a chemist at the University of Southern California in Los Angeles, and his colleagues have devised a new thin film that can convert sunlight into electric potential. Paying homage to the plant energy collector chlorophyll, they call it chemophyll.

In contrast to silicon solar cells now in use, the new, multilayered thin films of metal biphosphonate behave like chlorophyll, the scientists contend in the April 18 NATURE. Aiming to mimic the high efficiency of plant photosynthesis, Thompson's team fabricated a material that achieves "stable photoinduced charge separation."

Photons cause electrons to travel from donor molecules to acceptor molecules in different layers of the material. Other researchers have recently used sunlight to separate charges in a single molecule (SN: 4/6/96, p. 212).