

Pictures show smoking's ill effects on DNA

Scientists generally agree that the first step in the initiation of most cancers is the creation of adducts — DNA changes that occur when a carcinogen covalently binds to genetic material. A husband-wife research team, using a radioactive labeling technique they pioneered, has begun mapping those changes. In the DNA of cancer patients who smoke cigarettes, radiographs show an adduct pattern that intensifies with the amount and duration of smoking. Moreover, traces of this adduct pattern can persist in former smokers for at least 14 years.

DNA is a polymer — a long chain molecule — whose basic units consist of nucleotides. The labeling process developed by Kurt and Erika Randerath, of Baylor College of Medicine in Houston, cleaves DNA into its individual nucleotides, labels each with radioactive phosphorus-32, then uses chromatography — which separates a mix of chemicals into its individual components — to spatially segregate normal nucleotides from those that have been modified by bulky aromatic chemicals, such as benzo(a)pyrene and aromatic amines. To count adducts, the researchers measure radioactive decay in the phosphorus-32 tags.

The Randeraths used DNA separated from healthy tissue excised near cancers during the surgery of 18 people and from three cadavers. While DNA from the lung and heart contained the highest adduct levels, even the bladder, kidney, aorta and liver of longtime smokers showed the same pattern of adducts, report the Randeraths and their co-workers in the March 1 JOURNAL OF THE NATIONAL CANCER INSTITUTE.

In cigarette-smoking cancer-surgery patients, tissue near tumors of the lung, larynx, esophagus and epiglottis typically contained about one adduct per 10 million normal DNA nucleotides. "This

level indicates quite a bit of damage," Kurt Randerath says. "Comparable to what has caused cancer in animals," it suggests "these levels may well be carcinogenic [in humans]."

The team has also applied the technique to scout for adducts caused by occupational exposure to specific aromatic chemicals. Their unpublished data, he says, show discrete dark points in the radiographs, not the broad-band smears seen among smokers — reflecting smoke's more complex mix of adduct-forming chemicals. More puzzling, he notes, is the finding that discrete aromatic-induced

adducts also showed up in foundry workers' white blood cells, while the adduct pattern induced by aromatics in cigarette smoke was not visible in smokers' blood cells.

Though the Randeraths' technique is still in its infancy, "it's by far the most sensitive DNA-adduct detection technique, and as such is very exciting," says Stephen Hecht, who studies cigarette smoking and cancer at the American Health Foundation in Valhalla, N.Y. Hecht suspects it will not only reveal new clues to cancer causation, but will also indicate a way "to measure DNA adducts in a person the way we now measure cholesterol. It could give an indication of cancer susceptibility." — J. Raloff

Young research scientists win scholarships

Carrying on the tradition of ancient Greek mathematician Diophantus, 16-year-old Christopher McLean Skinner won first prize in the 48th annual Science Talent Search this week. Skinner studied a general diophantine equation and found methods for determining the upper bounds on its integral solutions. First in his senior class at Hall H.S. in Little Rock, Ark., Skinner received a \$20,000 scholarship.

Jordan S. Ellenberg, 17, captured second prize in the competition, which is administered by Science Service, Inc., and sponsored by Westinghouse Electric Corporation. Ellenberg's mathematics project identifies sets of positive integers satisfying certain symmetric systems of congruence. He won a \$15,000 scholarship and ranks at the top of his class at Winston Churchill H.S. in Potomac, Md.

Third place went to Richard Hawkins Christie, 15, who also won a \$15,000 scholarship. A senior at Penfield (N.Y.) H.S., Christie studied the interaction between the immune and nervous systems by looking at the distribution of nerve fibers in rat spleen. Christie says his interest in science was piqued at age 10, when he took a college course on the brain.

Other awards announced this week include \$10,000 scholarships for fourth-place winner Stacy Elisabeth Benjamin of Francis Lewis H.S. in Flushing, N.Y., who studied the influence of race on the perception of crime severity; fifth-place winner Sharon Celeste Posey of North Carolina School of Science and Mathematics in Durham, who developed a method of mapping restriction sites on DNA; and sixth-place winner Allene Marie Whitney of Capital H.S. in Helena, Mont., who found a faster method of detecting toxic algae in water.

Scholarships of \$7,500 went to seventh-place winner Kevin Nelson Heller of Half Hollow Hills H.S. West in Dix Hills, N.Y., who investigated the effects of temperature on a particular "jumping" gene; eighth-place winner Andrew William



Photos courtesy Westinghouse



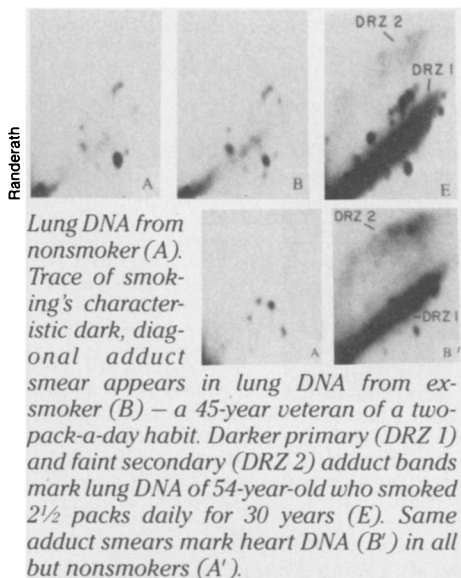
Bush honors finalists. Skinner (inset) won first prize.

Jackson of Roxbury Latin School in West Roxbury, Mass., who made a new kind of spectrograph; ninth-place winner Andrew James Gerber of Midwood H.S. in Brooklyn, who studied the properties of certain psychoactive drugs; and tenth-place winner Divya Chander of Pascack Valley H.S. in Hillsdale, N.J., who proposed a new mechanism by which bacteria invade tissue.

The remaining 30 finalists each received a \$1,000 scholarship. First and second alternates to the top 10 were Daniel Allen Sherman of Hickman H.S. in Columbia, Mo., and Simon Robert Zuckerbraun of the Bronx (N.Y.) H.S. of Science.

The 40 seniors spent five days in Washington, D.C., where they met members of Congress and leading researchers. They also met President George Bush, who urged them to continue their work. "I hope that each student in this room gets a doctorate, or pursues a career of one kind or another in science and technology," Bush told finalists in a March 3 speech at the National Academy of Sciences.

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Randerath

Lung DNA from nonsmoker (A). Trace of smoking's characteristic dark, diagonal adduct smear appears in lung DNA from ex-smoker (B) — a 45-year veteran of a two-pack-a-day habit. Darker primary (DRZ 1) and faint secondary (DRZ 2) adduct bands mark lung DNA of 54-year-old who smoked 2½ packs daily for 30 years (E). Same adduct smears mark heart DNA (B') in all but nonsmokers (A').