

Conclusions grow up in us like fungus. . . . Woe to the thinker who is not the gardener but only the soil of the plants that grow in him.

Friedrich Nietzsche, *Daybreak* (1881)

FOOD SAFETY

U.S. Rice Serves Up Arsenic

At one point during the reign of King Cotton, farmers in the south central United States controlled boll weevils with arsenic-based pesticides, and residual arsenic still contaminates the soil. Today, rice paddies cover fields where cotton once grew, and a large market basket survey published in the 1 April 2007 issue of *Environmental Science & Technology* now shows that rice grown in this area contains, on average, 1.76 times more arsenic than rice grown in California. With rice consumption increasing steadily in the United States, high-rice diets may be of concern, says principal investigator Andrew Meharg, chair of biogeochemistry at the University of Aberdeen, United Kingdom.

Arkansas produces about half and California about 20% of the total rice grown in the United States. The rest comes from Louisiana, Mississippi, Texas, Missouri, and Florida. The total U.S. rice crop for 2004 was 6.4 million metric tons, or 1.6% of total world production, according to the USDA.

USDA data further show that U.S. rice tends to be milled and packaged close to where it is grown. About 60% of the rice

grown in the United States is eaten here, and this figure has been increasing by about 2–3% a year. Rice is eaten directly or processed into breakfast cereal, rice cakes, package mixes, pet food, and beer. U.S. rice also is exported to South America, Asia, and Europe.

Meharg's team purchased 134 varieties of rice, including brown, white, organic, polished, unpolished, and instant, at grocery stores across Arkansas and California. Meharg traced where the rice varieties originated from information on the packages and by performing a principal component analysis of selenium, cobalt, copper, and other minerals in the grain. "This elemental profile directly relates rice to soil on which it is grown," says Meharg.

Total arsenic levels in the 107 south central rice samples averaged 0.30 µg/g, compared to an average of 0.17 µg/g in the 27 California samples. A white rice sample from Louisiana ranked highest in total arsenic (0.66 µg/g), and an organic brown rice from California ranked lowest (0.10 µg/g). Organic growing conditions, however, do not guarantee low arsenic levels, since any rice growing in arsenic-laden soil soaks up arsenic, says Meharg.

U.S. rice consumption averages about 12 grams daily, but Asian Americans average more than 115 grams daily; Hispanic and black consumers also have higher-than-average

rice intakes. The U.S. EPA, which classifies inorganic arsenic as a group A human carcinogen, sets a daily limit at 10 µg/L from drinking water (the most frequent route of exposure). There is no U.S. standard for arsenic in food. However, Meharg calculated that people who eat more than 115 grams of high-arsenic rice could reach or surpass the drinking water standard.

"High-arsenic" in this instance is based on the Louisiana sample that scored highest in arsenic content, assuming that the arsenic content was 42% inorganic, as measured by Meharg in a study published in the 1 August 2005 issue of *Environmental Science & Technology*. Rice grown in Bangladesh, the world's hot spot for arsenic poisoning, contains about 80% inorganic arsenic, and people there eat 450 grams daily.

Rice is recommended as a substitute for wheat for people with celiac disease, a condition in which the wheat protein gluten damages the intestinal lining and impairs absorption. Celiac disease afflicts 1 in 133 Americans. Gluten-free diets also are promoted for children with autistic spectrum disorders, although no clear scientific evidence supports the use of such a diet. Estimates published in the November 2001 issue of *Pediatrics* put the prevalence of autistic spectrum disorders at 6.7 children per 1,000, with 15% of these children on gluten-free diets.

The arsenic levels in U.S. rice "are possibly cause for concern," says John Duxbury, a soil chemist at Cornell University. He completed a market basket analysis of rice purchased in upstate New York that, like Meharg's, found high levels of arsenic in rice grown in the south central United States. But Duxbury points out that the findings are perhaps less straightforward than they may seem. In contrast to Meharg's calculations, the U.S. rice sample with the highest arsenic in Duxbury's unpublished analysis contained only 22% inorganic arsenic. Moreover, Duxbury's greenhouse experiments show that farmers could significantly reduce rice arsenic levels by applying less water to the plants. Other researchers are designing rice plants that absorb less arsenic.

"Until this all gets sorted out, consumers shouldn't be overly concerned," Duxbury says. Nevertheless, rice fanciers might note that both Duxbury and Meharg found basmati rice imported from India and Pakistan and jasmine rice from Thailand to contain the least arsenic. —Carol Potera



Arsenic and new rice. Cotton pesticides still contaminate fields now used for food crops.

MOLECULAR BIOLOGY

Estrogens Shield Breast Cancer Cells

Among the more insidious aspects of cancer is its capacity for escaping the anti-cancer defenses of the host. New research suggests that some estrogens may further reinforce this evasion of host immunity, even as those same hormones stimulate the growth and spread of hormone-responsive cancers. According to David Shapiro, a medical and biochemistry professor at the University of Illinois at Urbana-Champaign, the new findings highlight the role that estrogen-related interference with immune cell function may play in the development and progression of breast cancer.

Shapiro and his colleagues, reporting in a paper posted 22 January 2007 ahead of publication in *Oncogene*, observed that estrogen induces the expression of a newly discovered gene in humans for proteinase inhibitor 9 (PI-9). When estrogen binds to receptors in the cancer cell, the resulting complex promotes production of the PI-9 protein, which in turn binds granzyme B, the primary protease used by natural killer (NK) cells to kill off transformed or infected cells.

NK cells normally play a central role in immune surveillance against the metastatic spread of cancer. Previous research out of Leiden University Medical Center in the Netherlands, published in the 25 September 2001 issue of *Proceedings of the National Academy of Sciences*, had shown that increased levels of PI-9 in some tumors and tumor-derived cell lines may enhance these tumors' ability to evade apoptosis mediated by NK cells and cytotoxic T cells.

In the current paper, the researchers linked increasing concentrations of estrogen with increasing levels of PI-9 and progressively blocked cell death by NK cells. "The levels of estrogen required to induce [PI-9] in breast cancer cells are extremely low," says Shapiro. Moreover, at elevated levels of epidermal growth factor and estrogen receptor- α , the induction of PI-9 by either estradiol or the breast cancer drug tamoxifen effectively blocked the killing of cancer cells by NK cells. Levels of epidermal growth factor are elevated in many women with breast cancer, and this adversely affects the prognosis. The presence of estrogen receptor- α at the time of diagnosis is an indication

for using tamoxifen or other forms of endocrine therapy.

Tamoxifen is known to have mixed agonist/antagonist effects on estrogen, stimulating uterine cancer at low doses while inhibiting this and other estrogen-responsive cancers at higher doses. In contrast, the drug raloxifene, which is commonly used to prevent osteoporosis and has also been shown to reduce the risk of some breast cancers, had no immune-disrupting effects.

Shapiro's findings come with the following caveat: most estrogen-responsive breast tumors contain low to moderate levels of estrogen receptors, and in these tumors tamoxifen will not induce a level of PI-9 that enables the breast cancer cells to evade killing by immune cells. Only in the relatively small subset of breast tumors that contain very high levels of estrogen receptors will tamoxifen have an effect that could effectively shield the cancer from attacking immune cells.

Indeed, a 21 June 2006 *JAMA* study—a prospective, double-blind, randomized clinical trial conducted in nearly 200 cancer treatment centers throughout North America—directly compared tamoxifen and raloxifene, and found both drugs to be chemopreventive. "In that large trial, tamoxifen even [seemed to perform] better in the control of noninvasive breast cancers," says V. Craig Jordan, scientific director for the Fox Chase Cancer Center Medical Science Division. "So while these [University of Illinois] data are important and insightful, we should not lose sight of what the clinical data are telling us."

Estrogenic compounds such as DDT and dioxins may also impede immune protection against breast cancer cells. "The mechanism that this study provides for estrogen-mediated decreases in NK cell function may also be operative in the decreases in NK function that have been observed with certain environmental estrogens, such as DDT," says Margaret Whalen, an associate professor of chemistry at Tennessee State University who has studied the immune-suppressive effects of various organochlorine pesticides. Most human exposures to xenoestrogens involve mixtures at relatively low levels, Whalen adds, and concurrent exposure to multiple chemicals may alter the immunotoxicity of a particular chemical.

Shapiro and his colleagues are now looking into the factors that contribute to regulation of PI-9 in postmenopausal women. "Blocking the production of this protein represents a potential new target for breast cancer therapies," he says.

—M. Nathaniel Mead

Fresh Guidance for Produce Safety

Between 1998 and 2004, the number of produce-related disease outbreaks in the United States doubled, and outbreaks in the past six months have raised awareness more than ever. Now the FDA has called on industry to voluntarily implement the Hazard Analysis and Critical Control Point (HACCP) system throughout supply chains for fresh-cut produce such as shredded lettuce, bagged spinach, and peeled baby carrots. Some consumer groups have argued that HACCP should be mandatory for produce (as it is for meat), but the FDA counters that voluntary measures can be implemented more quickly than mandatory laws and may eventually lead to stricter controls.



Water Prices Surge

Over the past five years, municipal water rates have risen by an average of 27% in the United States, 45% in Australia, 50% in South Africa, and 58% in Canada, according to an Earth Policy Institute report released in March 2007. Yet these price hikes do not affect developed countries only. In Tunisia, for example, the price for irrigation water has increased fourfold over the last decade. The report states that three main factors influence water prices: cost of transporting water from source to consumer, total demand, and price subsidies. The Earth Policy Institute advocates pricing water based on its true value and scarcity, a move the group feels will promote conservation.

White House, Greenhouse

The Supreme Court's 2 April 2007 ruling that greenhouse gases are pollutants does not require the U.S. EPA to regulate the gases, but does direct the agency to study the gases anew and regulate them if they are proven to harm human health. President Bush has said he plans no caps on greenhouse gases, and on 14 May 2007 reiterated his proposal to depend on a fivefold increase in cleaner fuels by 2017 to reduce emissions. The next day, the Senate defeated a proposal requiring the Army Corps of Engineers to consider climate change when designing water resources projects. Proposal sponsor John Kerry (D-MA) was not deterred, saying, "We're making a statement here in the Senate to finally, once and for all, recognize the reality of what is happening with respect to climate change."



LEAD

Dangerous Wait

You think waiting for the cable guy is bad? Some families must wait more than a year for a lead abatement team to remove or contain the lead that is poisoning their children, reports a group led by Kristina M. Zierold of the Wake Forest University School of Medicine.

The team examined housing data collected between 1996 and 1999 from 382 Wisconsin children with first-time blood lead levels between 20 and 40 $\mu\text{g}/\text{dL}$. Getting rid of the lead from these children's homes took a median of 465 days, the team writes in the February 2007 issue of the *American Journal of Public Health*. For 45% of the children, abatement took more than 18 months, whereas for 18% of the children, cleanup occurred within 6 months.

Wisconsin, with its strong public health system, is probably as fast if not faster than other states at performing lead abatement, says Zierold. But little research has documented abatement times, so it's hard to say how fast or slow any state is. If a child has a blood lead level of 20 $\mu\text{g}/\text{dL}$ or higher, an environmental intervention should begin within 10 days, according to the CDC. Zierold says local or state health officials are usually prompt about writing abatement orders, but landlords don't always have the money to do the cleanup.

She and her colleagues found clear racial disparities in the rate of lead abatement. Homes where white children lived were almost twice as likely as the homes of black children to be cleaned up within



6 months (almost 70% of the children in the study were black). Although the authors did not ask participants about socioeconomic status, they note that most black children in Wisconsin live in lower-income urban communities, and that families with lower income tend to reside in rental housing.

"Are these results a surprise? Given the lack of resources we put toward the problem, no," says Bruce P. Lanphear, director of the Cincinnati Children's Environmental Health Center. "The question these findings raise is, why do we wait until children are poisoned in the first place? Why don't we try to identify [contaminated] housing

units before the kids are poisoned?" Nationally, 38 million homes contain lead-based paint, and lead poses a risk in 35% of all low-income housing, according to the CDC. Moreover, studies are now showing that blood lead levels as low as 2–3 $\mu\text{g}/\text{dL}$ harm children's physical and mental development; in the past, levels below 10 $\mu\text{g}/\text{dL}$ were considered acceptable.

Abatement times have improved since the study began. The authors write that by 1999 lead-safety improvements were completed within 6 months in 31% of homes. According to Zierold, since the study began Wisconsin has made a stronger effort to investigate the homes of children with elevated blood lead within two weeks. The Wisconsin Department of Health and Family Services also launched a registry of single-family homes, apartments, and daycare facilities that meet lead-free or lead-safe property standards. This is particularly important as the families of poor children tend to move frequently, and the registry increases their chances of finding lead-free housing. —Tina Adler

REMEDICATION

Ground Zero for Uranium?

By harnessing bacteria that "breathe" uranium the way animals breathe oxygen, Florida State University microbiologist Joel Kostka is working to solidify liquid uranium waste under a 243-acre site adjacent to Oak Ridge National Laboratory. Using bacteria to solidify the waste *in situ* may be the best alternative to dealing with the waste, says Kostka. Other solutions, such as excavating and disposing of it elsewhere, are "just moving the problem, and [don't] get rid of the waste," says Kostka.

Kostka directs a team of microbiologists studying bioremediation as part of a five-year, \$15-million U.S. DOE project led by Oak Ridge National Laboratory. The multidisciplinary project includes geologists, geochemists, and microbiologists, and focuses on waste dumped underground over a 32-year span beginning in 1951. The waste is the result of the uranium enrichment

process in weapons manufacturing. As much as 1 trillion liters of waste were dumped each year.

Kostka, whose work is described in the 1 February 2007 issue of *Geochimica et Cosmochimica Acta*, has isolated *Geobacteraceae* bacteria that turn soluble uranium found in groundwater into an insoluble form. This solidified form clings to geological formations underground and is thus immobilized. But questions remain, says Kostka: "Is the uranium stable? Is it going to remain in the ground? Are natural forces such as rainfall going to affect the stability of the uranium?" Kostka and his colleagues are currently working to answer these questions.

Another aspect of Kostka's work involves providing a carbon source—food—for the bacteria. The research described in *Geochimica et Cosmochimica Acta* evaluates two forms of carbon, ethanol and glucose. "Ethanol is easier to handle on a large scale [although] glucose has also been shown to be effective," he says. These compounds are "fed" to the bacteria through injection wells.

Microbiologist Colleen Hansel of Harvard University says, "Very little is known about these bacteria and the process that is involved in uranium immobilization in sediments and waters, so starting to understand the bacteria and genetically how these organisms do this process is very important. There is still so much we don't know." For example, it is important to learn how to best deliver nutrients to the bacteria. And it's important to pinpoint which bacteria to foster—scientists want to stimulate the growth of those that will immobilize uranium and not others that might interfere with that process.

Still, the idea of using bacteria to treat radioactive waste may have broad and important implications, says Kostka, since DOE facilities that once made nuclear weapons have vast contaminated underground areas. "I think immobilizing [uranium waste] by microbial techniques is a good strategy, because the necessary bacteria are present in the environment already," says Andreas Kappler, a geomicrobiologist at the University of Tübingen, Germany. —Harvey Black

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Doctor Fungus

The Doctor Fungus website, located at <http://www.doctorfungus.org/>, strives to be an online reference source for all things mycological. The nonprofit site is continually revised, updated, and reviewed by an international team of pathologists, mycologists, pharmacologists, and other specialists. Although intended primarily for physicians, the site offers plenty of information for an educated lay audience. The site's resources are searchable by a number of ways: through topic headings down the middle of the homepage, a toolbar at the top of the homepage, a pull-down menu at the top of the homepage, and a sitewide search engine.

The Think You Have a Fungal Infection? section of the site has information on fungal infections in people, animals, and plants, plus a separate section devoted to yeast infections. The human portion has links to information on nine common fungal infections and a

section on miscellaneous infections that can be caused by more than one type of fungus. Each disease is defined and described, color images of the fungus are available, and readers can learn about prognosis, therapy, histopathology, and laboratory tests used to confirm the presence of the fungus. Other information includes an overview of the

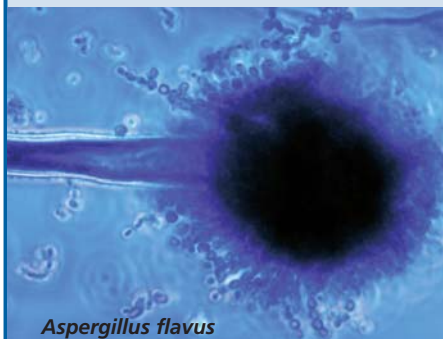
natural habitat of each fungus and susceptibility testing where relevant. Links to other sites with information on the fungus are listed along with access to PubMed for searching for further research articles on the topic.

The Think You Have a Sick Building? section offers instructions on how to look for mold in buildings, both on surfaces and in the air. Overviews of the three primary tools for air analysis are provided. Also within this section are pages on mold remediation and lists of frequently asked questions for homeowners and physicians.

The Learn About Fungus section has two overviews of mycology, one for the general public and one for those with more extensive scientific expertise. Descriptions of the most prevalent types of fungi are also available in this section. Each description contains links to images and information on susceptibility. Also featured are the taxonomic classification of the fungus selected, information on pathogenicity, clinical significance, and macro- and microscopic features. There is also a page of fungal names and synonyms.

The Antifungal Agents section addresses drugs used to treat fungal infections. The Introduction page of this section has links to the six available classes of agents used in treating such infections. A page on antifungal pharmacology discusses the fungal cell structure and targets. Additional pages within this section address nephrotoxicity, drug dosing in renal and liver dysfunction, and drug interactions.

—Erin E. Dooley



Aspergillus flavus

National Children's Study Receives More Funding

In February 2007 Congress earmarked \$69 million for the National Children's Study. These funds will expand the study by 15 to 20 new study centers and will allow the 7 existing centers to begin recruitment. The study, under the auspices of a coalition of federal agencies, will eventually include 100,000 children from a total of 105 communities across the United States, following the children from before birth until age 21. Study researchers will focus on a wide range of health issues including birth defects, asthma, obesity, behavior, and environmental and dietary impacts on health. Findings should guide new disease prevention strategies and health and safety measures, as well as provide the impetus for potential disease treatments and cures.



Urban Environment Report

The Earth Day Network released its first *Urban Environment Report* in February 2007, ranking the 72 largest cities in the United States by more than 200 environmental, health, and quality of life indicators. The indicators cover eight main subject areas including vulnerable populations, toxics and waste, air quality, drinking and surface water, human and public health, and climate change. The five cities ranking the lowest are Detroit, Miami, Cleveland, El Paso, and Houston, while the five highest-ranking cities are Fargo, Burlington (Vermont), Portland (Oregon), Colorado Springs, and Sioux Falls. The full report is available at <http://www.earthday.net/UER/report/>.

The Great Lightbulb Switch

A group of industry players, environmental advocates, and energy specialists is working to phase out incandescent lightbulbs by 2016 in favor of new technologies including compact fluorescent lamps (CFLs) and light-emitting diodes, which are up to six times as efficient as incandescents and last much longer. About 150 million CFLs were sold in 2006. A complete changeover could save \$18 billion in electricity annually and save the amount of power generated by as much as 80 coal-fired plants' worth. What's the rub? CFLs contain an average of 5 mg of mercury each. On the bright side, some retailers, such as IKEA, already have takeback programs in place, and advocacy groups are urging big retailers such as Wal-Mart to join the effort.

