chromosomes, cell membranes, cytoplasm—are run through the AMS to determine just where the compound wound up, how it was metabolized, and which macromolecules it interacted with. That kind of information offers no clear verdict on cancer risk, acknowledges Turteltaub: "We can't make the direct connection between a chemical and a tumor." But it does give a picture of how a chemical behaves in the body at doses 1000 times smaller than those traditionally administered to laboratory animals, says John Vogel, an LLNL physicist who pioneered the field of bio-AMS with Turteltaub in the late 1980s.

Data are pouring out of such studies, says Snorri Thorgesson, chief of NCI's laboratory for experimental carcinogenesis, and he adds that "at the technical level, there's no question [that] the data are valid." Among other things, the AMS has shown that even low levels of benzene bind to the proteins that form the scaffolding of chromosomes, suggesting that the compound may interfere with chromosomal replication, and that even the smallest detectable amounts of the pesticide malathion latch onto brain-cell DNA. "We are getting mind-boggling results," Vogel says, as he shuffles through a pile of yet-to-be-published data.

Pharmaceutical companies are also exploring AMS as a means of tracing how potential new drugs are metabolized. Chiron, of Emeryville, California, has just begun such a project with the LLNL group. Gavin Dollinger, Chiron's principal scientist on the project, gives an example of the technique's appeal: To see whether a compound crosses the cell membrane—a prerequisite for many drugs—he would ordinarily lace it with a highly radioactive tracer and feed it to a rat at high doses. If it didn't cross the membrane, he would alter it slightly and try again. "It's not only trial and error, but it's a very slow process with a lot of radioactivity and a lot of rats," Dollinger says.

AMS, in contrast, lets him test many compounds at once, because the doses can be much lower and the radioactive tags more subtle. The idea, Dollinger explains, is to give a rat, say, 100 C^{14}-tagged compounds that share a common trait like molecular weight. If the AMS analysis reveals that several different members of that group penetrate the cell membrane, the scientists will have some idea of the property responsible. By studying the behavior of other sets of compounds with other common properties, he and his colleagues are building up "personality profiles" of potential drugs.

The next step for the pharmaceutical makers is to use AMS to test actual drug products, to see exactly how they fare within the cell. But Dollinger says that he and his colleagues won't be working with proprietary substances anytime soon. Even large pharmaceutical companies would likely balk at the cost of having their own AMS lab, at least for now, he says. "That to me is the biggest issue so far," Turteltaub concedes. "How do you move it out of Livermore?" The sprawling LLNL machine is already oversubscribed and running around the clock, and new AMS facilities don't come cheap, costing anywhere from $1 million to $4 million.

What's more, most of the roughly 35 AMS centers in the world have shunned biological research. The levels of C^{14} needed to trace compounds in biological tissues, while low, are still 10 to 1000 times higher than those typical of archaeological materials, and operators fear that residual C^{14} left from bio-AMS might confound later archaeological studies. Indeed, that happened after the very first published biological experiment on an AMS, done in 1988 at McMaster University in Hamilton, Ontario, in conjunction with LLNL biochemists. Says Vogel, "Everyone else is still making their money from carbon dating, and they're still terrified of us."

Still, there are signs that this nascent field of bio-AMS is beginning to catch on. One AMS maker, High Voltage Engineering Europa, is building a prototype AMS specifically for biological studies, while the U.K.'s Wellcome Trust recently purchased an NEC accelerator for Oxford University to study the link between aluminum and Alzheimer's disease. Japan now has six AMS centers, and at least one of them is planning to run biological experiments. And at Beijing University in China, a team is gearing up for bio-AMS studies, Vogel says. The Livermore work, boasts Ivan Proctor, the acting CAMS director, "is way in front of a wave that's just beginning to ripple."

–Jonathan Weisman

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HUMAN GENETICS

New U.K. Committee Draws Fire

LONDON—Last week the British government announced what it believes to be a world first: a new committee to advise it on genetic testing. But far from drawing praise, the announcement instantly prompted a storm of protest from the House of Commons' science and technology committee, the body that originally suggested a new commission. Members of Parliament (MPs) complained that the government had thoroughly diluted their proposals. "The government's response is very complacent, and there is unanimous disappointment among us," says Labour MP Lynne Jones.

Last year, the parliamentary committee carried out a wide-ranging inquiry into human genetics—the largest it has undertaken since being set up in 1992. The MPs urged the government to set up a Human Genetics Commission, with statutory powers, to cope with the impact of genetics research, which is likely to identify many important human disease genes by the end of the decade. "The scale of the potential problems is enormous, and the right structures are needed now," says Conservative MP Giles Shaw, chair of the committee. The proposed commission was to span issues from regulating genetic medicines to offering advice on screening, insurance, patenting, research, and public education. "It was well received by patient interest groups, medical researchers, and the pharmaceutical industry in this country and abroad," says Labour MP Jeremy Bray.

But the committee announced last week, to be chaired by physicist John Polkinghorne, president of Queen's College Cambridge and a member of the Church of England's doctrine commission, will only provide advice on developments in testing for genetic disorders, testing individuals, and establishing requirements for manufacturers of genetic tests. This limited scope means that many issues raised by the inquiry have not been dealt with, says Jones. "All sorts of concerns, including insurance and employment, are not there," says David Shapiro, secretary of the independent Nuffield Council on Bioethics, which has explored many issues raised by genetics research. Researchers are also unhappy. Clinical geneticist Peter Harper at University College Hospital in Cardiff says that it looked like a "thorough watering down" of the parliamentary committee's proposals.

The new committee will report to the Department of Health along with two other bodies, the Human Fertilisation and Embryology Authority and the Gene Therapy Advisory Committee. But, says Bray, the field is moving too fast for the strategy of setting up ad hoc committees as problems arise to be successful. "There's also real concern that it's linked to the Department of Health, when there are many concerns outside that department's remit," says Harper. The parliamentary committee now plans to recall key researchers and other experts who gave evidence to its original inquiry to consider its next moves.

Health Minister John Horam, announcing the new committee, said he was confident that its purpose would be widely understood and accepted and its work would be reviewed after 2 to 3 years. But pressure will now be on to widen its purview, says Shapiro: "The government may need to look at it much sooner."

–Nigel Williams