

# The Dark Side of Biotechnology

*Experts say that recent scientific achievements threaten an international treaty banning biological warfare*

Recent scientific progress in biotechnology has unavoidably undermined a 1972 treaty banning the development and use of biological weapons, according to a group of scientists, military analysts, and arms control experts appearing at the recent annual meeting of the AAAS in New York City.

By sharply reducing the potential cost of weapons development, as well as the potential risks of its use, new developments in biotechnology have dramatically increased the military usefulness of biological weapons, the experts said. As a result, the 1972 treaty is outdated and requires substantial modification if a biological arms race is to be averted. "Once the Biological and Toxin Weapons Convention was signed in 1972, many thought the problem of banning such weapons had been solved forever. But that is now clearly not so," said Robert Mikulak, a chemist who specializes in biological and chemical matters at the Arms Control and Disarmament Agency.

The treaty, which was negotiated by President Richard Nixon partly as the result of lobbying by the scientific community, bars the development, production, and stockpiling of microbial or other biological agents "of types and in quantities that have no justification for prophylactic, protective, or other peaceful purposes." But it has been interpreted by the United States, and apparently by the Soviet Union as well, in such a manner as to permit the maintenance of toxin seed stocks and the continuation of defensive research. As former Secretary of State Henry Kissinger once explained to the National Security Council, "This does not preclude research into those offensive aspects of . . . biological agents necessary to determine what defensive measures are required."

Consistent with this interpretation, the Department of Defense (DOD) now sponsors more than 30 research projects involving recombinant-DNA techniques, including 11 at in-house laboratories and 25 at major universities. Thomas Dashiell, a molecular biologist in the Pentagon's research and engineering office, explains that most of these projects involve the development of vaccines against diseases such as anthrax, malar-

ia, dengue, encephalitis, trypanosomiasis, and Rift Valley fever. Pentagon-funded researchers are also trying to develop an antidote to nerve gas and a generic biological warfare detection and identification system. Although the existence of this work is openly acknowledged, not all of the research results are publicly available.

A fear expressed by many of those in the audience and on the podium at the AAAS symposium is that projects such as these could be diverted, either by the United States or the Soviet Union, to the production of relatively efficient, inexpensive new biological weapons tailored for relatively controlled applications. Referring to research in the Soviet Union, John Birkner, an environmental

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biologist who works as a foreign technology analyst for the Defense Intelligence Agency, said that "recombinant DNA techniques could open a large number of possibilities. Normally harmless, non-disease-producing organisms could be modified to become highly toxic and produce effects for which an opponent has no known treatment. Other agents, now considered too unstable for storage or biological warfare applications, could be changed sufficiently to become effective. What concerns us is that biotechnology R & D applied to such purposes would be very easy to conceal. Unlike high energy physics experiments or the construction and testing of weapons delivery vehicles, new biotechnology research efforts devoted to military objectives would tend not to reveal themselves. Facilities, equipment, and personnel devoted ostensibly to food or

drug production could easily be turned to military biotechnology R & D tasks."

To Jonathan King, a molecular biologist at the Massachusetts Institute of Technology, virtually all defensive biotechnology is of dubious credibility. "The notion of an R & D program that is strictly defensive is a fundamental misrepresentation," he said. Scientific skills needed for the development of biological defenses are virtually identical to those needed for the preparation of offensive weapons. A successful defense is also an important tactical ingredient of any biological attack, he noted.

King and Richard Falk, a professor of law and political science at Princeton University, argued that so-called defensive research is not only politically destabilizing but also militarily fruitless, because the tools of biotechnology make a virtually limitless menu of viruses available to any aggressor. As a result, they suggest that relevant provisions of the 1972 treaty be tightened. Falk, in particular, proposed that an "intergovernmental select body of experts . . . be established to investigate the general directions of biological research and to set forth guidelines to sustain the prohibition on military development." The problem, he says, is that under the present treaty, offensive and defensive research are distinguished only by intent, not substance, a policy that both invites and conceals abuses.

Not surprisingly, Dashiell of DOD disagreed, arguing that a better definition of defensive biological research "would be extremely difficult—if not impossible—to develop." One difficulty is that much of the Pentagon's research in biotechnology has more than one application. Vaccines, for example, can obviously be used to inoculate troops against natural diseases as well as biological agents. Some of the gene-splicing work can be applied to chemical, as well as biological, defenses. A dozen or so biotechnology projects are under way to develop militarily useful fabrics, superadhesives, surfactants, and fuels.

If anything, the Pentagon wants to increase, not limit, its defensive research. According to a Defense Department spokesman, the budget for such

work is slated to increase by 40 percent next year, to \$42.8 million. (By including related programs, King and Falk estimate that the actual budget is more than \$120 million.) The new funds are intended partly for the "engineering development" of a new Rift Valley fever vaccine by the Salk Institute and partly for intensified research on a biological weapon detection system.

Dashiell says that the Pentagon also intends to monitor the field of commercial biotechnology more closely for inventions of military significance. "We've had some discussions with industry already," he says, and contracts may be signed soon. The purpose, he says, is "to assess the difficulties in the application of these technologies to biological weapons. I have to know what is possible. If we run into insurmountable difficulties, then I have a reasonable basis for concluding that the Soviets cannot get there either." Birkner added that "specifically, DOD would like counsel from the industrial and academic communities on such topics as . . . how to improve DOD access to militarily useful applications, and how DOD can ensure that we remain in a position of innovative biotechnology leadership."

The treaty changes they have in mind primarily involve compliance verification. In the 1984 edition of its annual publication, *Soviet Military Power*, the Pentagon alleges for the first time that the Soviets' research in this area directly violates the 1972 treaty. As a result, both the Pentagon and the State Department favor a treaty amendment that would permit inspections of suspect military installations by an international team of experts on extremely short notice. A similar proposal, included in the Administration's draft chemical weapons treaty (*Science*, 4 May, p. 474), was rejected by the Soviets in May as unnecessarily intrusive. Additional proposed U.S. amendments call for the establishment of a U.S.-Soviet consultative committee and the reporting of various data on biological research.

Noting that "suspicions are extremely corrosive of existing constraints" on biological weapons, Mikulak said that these amendments are necessary to restore the treaty's credibility, and will be formally proposed during a U.S.-Soviet review conference to be held next year.

Most of the panelists sharply challenged the Pentagon's claim that biological weapons are being developed by the Soviet Union. Under questioning, Birkner acknowledged that it was no

more than a working "hypothesis" and at one point stated flatly that "the U.S. government admits to not knowing" if the hypothesis is true. All the Administration knows for sure is that relevant equipment and reagents have been imported by the Soviet Union, that key Soviet researchers have not recently published in the open scientific literature, and that several research centers are under military control. "It's not that we have affirmative evidence," Dashiell says. "It's just that we don't know what's going on at certain laboratories."

Several of the panelists expressed concern that the Pentagon would soon use its allegations of Soviet biological weapons development to justify its own weapons development. But the idea was firmly denied by Dashiell and by an agency spokesman, who both said that no significant policy changes are contemplated. They claimed instead that the government's principal response will be additional limitations on exports of biotechnology equipment and know-how.

Various bacteria, fungi, protozoa, and viruses already cannot be shipped to Eastern bloc countries. In addition, seven types of genetic engineering equipment are listed on the Commerce Department's Militarily Critical Technology List, which serves as an overall guide to restricted exports. The list includes containment and decontamination equipment for large production facilities; high capacity biological reactors, separators, extractors, and dryers; and nozzles capable of disseminating biological agents in a fine mist. "This is a beginning," Birkner said.

He warned of a serious industry-government clash over new limitations if firm evidence of Soviet weapons production is uncovered. "In such a contest, [the] government would probably prevail," he said. But he endorsed a recent proposal by the White House Office of Science and Technology Policy to establish a new industry-government advisory committee, so that serious acrimony will be curtailed.—R. JEFFREY SMITH

### High Energy Physics

## U.S., Europe at Odds

A potentially significant split is beginning to emerge between the high energy physics communities of Europe and the United States over the optimal strategy for ensuring proper international collaboration on the construction and use of

the next generation of particle accelerators.

At the heart of the debate, according to Herwig Schopper, director general of the European Organization for Nuclear Research (CERN) is disagreement over whether the Superconducting Supercollider (SSC) being planned by American physicists should be considered the principal international focus of high energy physics in the early 1990's, or whether it should be complemented by new facilities at CERN's laboratories in Geneva, Switzerland.

Schopper told a session of the AAAS meeting that a second ring of magnets placed in the same tunnel as that currently under construction for CERN's new electron-positron collider (LEP), which is scheduled to start operating by the end of 1988, could produce proton-antiproton collisions with a center of mass energy of about 10 TeV and at a cost of \$500 million.

Furthermore, if research into a new generation of superconducting magnets turns out to be successful, this energy could be raised to about 18 TeV. Although still considerably less than the 40 TeV planned for the SSC, this would nevertheless be sufficient to explore much of the same region of particle physics as the American machine at significantly less than the latter's estimated \$3 billion cost.

If the United States proceeds with the construction of the SSC, he added, there were various options available to CERN. One would be to make use of its current 450 GeV superproton-synchrotron and of the electron ring to produce electron-proton collisions for experiments complementary to those planned for the SSC. Among the attractions of such a project, said Schopper, was the fact that "there exists a considerable experience with high intensity proton beams at CERN."

Leon Lederman, director of the Fermi National Accelerator Laboratory, told the same session that there was still considerable uncertainty over the prospect for success of the current research into the new generation of superconducting magnets, raising doubts about whether a new ring in CERN's LEP tunnel could reach sufficiently productive energies to make the effort worthwhile when compared to the American proposal.

Furthermore, the cost of the American machine had been conservatively estimated and could well be significantly less. Building two separate machines would be a "mistake," says Lederman,

well aware of the growing interest in Congress to see substantial international cost-sharing on the SSC.

He suggested that a better strategy would be to adopt an international consensus that the SSC should become the principal focus of Western physicists after the current generation of accelerators has been completed—and that in return Europe might eventually play host to any facility that was proposed after that.

Schopper said later that he disagreed with this strategy, since concentrating all international efforts in a series of individual machines reduced the advantages to be gained from competition, and increased the ease by which the whole international research program in high energy physics could, at some time in the future, be brought to a halt by governments.—**DAVID DICKSON**

## Science Education

### Misplaced Concern?

Preliminary results of a survey carried out last year of almost 5000 fifth-grade and ninth-grade children in 200 public and private schools across the United States suggests that the general level of ability in science subjects has increased significantly over the past decade, and may not be as low as widely feared, the AAAS meeting was told.

When compared to the results of a similar survey conducted in 1970, the children revealed less knowledge about space travel (the first test was made in the year following the Apollo moon landing) and scored lower on some purely factual questions, such as why a dropped ball falls to the earth.

However, these results were more than compensated for by improvements on "process" questions, such as those requiring the ability to read a thermometer and correlate reading with data on a chart. Comparing the results of fifth-graders on 26 separate items raised in both the 1970 and 1983 tests, for example, researchers from the Teachers College of Columbia University, New York, calculated that the average test score had risen from 56 to 62.5 percent, with better results on 20 items and worse results on only three; that of ninth-graders measured on 33 common items rose from 54.3 to 59.5 percent, with improvement on 24 items and a drop on five.

"These results show that, whatever the weaknesses of science education in our schools, teachers seem to be doing

something right," says Rodney Doran, professor of science education at the State University of New York at Buffalo and associate research coordinator for the survey. "They also suggest that much of the current debate about the failures of science education may turn out to be a house of cards," he adds, pointing out that questions on which the schoolchildren did well were those which had been emphasized in new curricula introduced, partly as a result of initiatives taken by the National Science Foundation, in the late 1960's and 1970's.

Doran points out that the findings, which formed part of the U.S. contribution to a 25-nation comparative study being organized by the International Association for the Evaluation of Educational Achievement and due for completion in 1986, are still preliminary.

Nevertheless, according to the U.S. coordinator for the study, Willard J. Jacobson, the results appear to suggest that recent changes in teaching methods have led to a situation in which "children do understand more about the processes of science, and are better able to apply what they know."—**DAVID DICKSON**

## Polygraph Tests

### Dubious Validity

The polygraph test, an increasingly common ingredient of criminal investigations and employment interviews, came under vigorous attack during the AAAS annual meeting. David Lykken, a professor of psychiatry and psychology at the University of Minnesota, asserted that the polygraph rested on a thin scientific foundation and that its central psychological assumption—that guilt can always be inferred from emotional disturbance—is "wildly implausible."

"It is both curious and disturbing that a technique based on such implausible assumptions has managed to become entrenched in American mythology," said Lykken, who has been a consultant to the Defense Department, Congress, and numerous private litigants confronted with adverse polygraph results. "The field of polygraphy is shot through with a degree of psychological naïveté that would be funny if it didn't result in so much harm."

Specifically, Lykken said that the validity of the polygraph rests on a false assumption that a polygrapher can construct questions about previous mis-

deeds that will be answered deceptively—questions that are used as controls during the polygraph analysis. "It seems to me the height of arrogance" for a polygrapher to believe that such questions can be devised, he said, and without them, the test will fail. Most studies of polygraph accuracy are methodologically flawed, he said, and the others have a high incidence of falsely positive results.

Gordon Barland, a psychologist who owns a prominent polygraphy firm in Salt Lake City, challenged Lykken's assessment. "I would be the first to say that such studies have a number of serious problems. . . . No one is persuasive by itself. But each one is only a stone in a mosaic, and you need to try to look at the big picture, the whole mosaic." By grouping various studies that Lykken faulted, Barland concluded that polygraphs were on the average 90 percent accurate. He also noted that criminal investigators who use the polygraph "are very convinced that it is highly accurate."

Leonard Saxe, an assistant professor of psychology at Boston University and the author of a recent study on polygraphy by the congressional Office of Technology Assessment, said that he agreed that the polygraph had "some utility," but cautioned that it was fairly limited and that use of the test had far outstripped any legitimate need. Twenty-one thousand examinations are already conducted each year by the Department of Defense and the National Security Agency alone, roughly half during criminal investigations and half during preemployment screening. The Pentagon wants to double the number of preemployment tests, and along with other agencies, wants the right to test more than 100,000 employees for evidence of unauthorized disclosures of classified information, and the right to demote or fire employees that refuse to be tested.

These plans have aroused sharp controversy in Congress, primarily because, as Saxe says, "there is no scientific evidence that the kinds of polygraph tests used for screening are valid." He also notes that the usefulness of tests during criminal investigations depends on voluntary cooperation, and that coercive measures such as threats of demotion may skew the results. Congressional critics are watching nervously for a final Administration decision, because a legislative ban on the use of tests for preemployment screening expired on 15 April.—**R. JEFFREY SMITH**