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BIOHAZARD

How the Pentagon's Biological Warfare Research Program Defeats Its Own Goals

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THE CENTER FOR PUBLIC INTEGRITY

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"A defensive [Chemical and Biological Warfare] program not supported by an offensive program can well be worthless. You cannot know how to defend against something unless you can visualize various methods which can be used against you, so you can be living in a fool's paradise if you do not have a vigorous munitions and dissemination-type program."

General William Creasy,
Commander, U.S. Army Chemical Corps, 1958

"[B]iological warfare defense has gained unparalleled interest and support within the [Defense] Department."

Dr. Billy Richardson,
Deputy Assistant Secretary of Defense for Chemical Matters, 1992

"The military officers in charge [of the Army's biological defense research] have little experience in the field and are very easily fooled by 'scientific salesmen.' During my years at the program I saw gigantic contracts funded that I never would have seen funded at NIH [the National Institutes of Health] or NSF [National Science Foundation]--military officers with relatively little research experience with millions of dollars of contract money. Because of the cozy relationship...they don't really have to justify their research priorities to anyone."

Research scientist who formerly worked with the U.S. Army's Biological Defense Research Program, 1992

Seth Shulman has written about scientific and military matters for the past ten years. He is the author of *The Threat at Home: Confronting the Toxic Legacy of the U.S. Military* (Beacon Press, 1992), which exposes the U.S. military's alarming record of environmental contamination. He has authored more than 100 articles for magazines including *Smithsonian, The Atlantic, Discover, The Progressive,* and *Time*; and for newspapers including the *Times of London,* the *Boston Globe*, and the *Los Angeles Times.* From 1988 to 1991 he served as Boston correspondent for the British science journal *Nature,* and is currently a contributing writer for *Technology Review.* Shulman has won numerous awards for his writing. His reporting on military toxic waste was picked as a finalist for the 1991 Livingston Award for the best example of national reporting by a journalist under the age of 35. His previous work on the Army's Biological Defense Research Program was chosen by the Free Press Association as a finalist for an 1988 H.L. Mencken Award for "outstanding journalism in support of liberty," and included in Project Censored's annual list of the "ten best underreported stories" of the year. Shulman received an A.B. from Harvard University and served as a Vannevar Bush Fellow in the Public Understanding of Science and Technology at the Massachusetts Institute of Technology from 1985-1986.

Charles Piller, who edited this report, is a member of the board of directors of the Center for Public Integrity. He is the author of numerous newspaper and magazine articles about science, technology, and military affairs, and has written two books: *Gene Wars: Military Control Over the New Genetic Technologies* (with Keith R. Yamamoto; William Morrow, 1988), and *The Fail-Safe Society: Community Defiance and the End of American Technological Optimism* (Basic Books, 1991).

Charles Lewis is the founder and Executive Director of the Center for Public Integrity. For 11 years, he did investigative reporting at ABC News and CBS News, most recently as a producer for *60 Minutes.*

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EXECUTIVE SUMMARY

Evaluating the Military's Biological Defense Program

This Center study explores the U.S. Army's Biological Defense Research Program (BDRP). After a year of research, we have found a program that is misguided in its aims and poorly managed. These problems are so extreme as to suggest that the BDRP research may actually undermine efforts to control and protect against the heinous threat of biological warfare.

The BDRP has three major goals: It offers U.S. troops medicines, vaccines, and other "medical countermeasures" against germ warfare; it sponsors unclassified, prophylactic research on biological warfare threat agents "for peaceful purposes"; and it keeps abreast of developments in the field that might pose potential risk to U.S. troops. Toward these ends, the U.S. military has spent well over $1 billion since World War II — more than half of that since 1984. Despite those outlays, close scrutiny of the BDRP reveals that the Army's program has fallen far short of all its stated goals.

Over the past decade, The BDRP has:

- spent hundreds of millions of taxpayer dollars on projects of questionable merit and relevance;
- attracted mostly second-tier scientists whose sparsely published research results have most often appeared in obscure, little-known journals;
- failed to fulfill its mandate to respond to existing BW threats as manifest in its lack of vaccines against the most obvious and well-known biological threat agents during the Persian Gulf War;
- failed to offer any effective medical defense against biological warfare;
- failed to fulfill its stated policy and legal obligation to be open and accountable in its efforts;
- and finally, engaged in potentially provocative research that increases, rather than reduces the prospects of an international biological arms race.

Meanwhile, the military has consistently failed to train troops adequately in safety and decontamination procedures on the biological battlefield.

Our report, based on a year-long investigation, reveals a government program that is largely insulated and unaccountable. Under any circumstances, the goal of a medical defense against biological warfare agents is highly questionable. Many leading medical scientists consider it a self-defeating exercise: Intensive research and development on vaccines and drug therapies suggests that protective measures against individual biological weapons can be effective. Yet it is virtually impossible to prepare medical contermeasures to the myriad possible diseases a potential enemy might unleash. The problem is compounded by the prospect that biological warfare agents could be deliberately altered through the tools of genetic engineering. Even with a vaccine or prophylactic treatment, the logistics entailed to inoculate troops and/or civilians far enough in advance to be effective makes

successful medical defense doubtful at best. But the problems presented by the BDRP go far beyond its dubious rationale.

Secrecy

International treaty and U.S. law require the BDRP to be open and unclassified. But we found that biological weapons-related research is easily hidden in related medical and chemical-weapons research programs conducted by the military. Even within the BDRP itself, we encountered public-affairs officials who refused to release rudimentary information about the program.

Perhaps more troubling, the BDRP publishes few research results that could indicate the program's detailed goals and practices. The dozen in-house researchers receiving the most funding (each in excess of $1 million annually) published a combined total of just 19 articles in the open literature in 1991. One researcher, who presided over more than $1.7 million in research funds in 1988 and 1989 alone, co-authored just five articles in the open literature during his nine-year tenure at the BDRP. Notably, his research prior to his work at the BDRP yielded eight published articles in 1980 alone — the year he arrived at the program.

Provocative Research

International and U.S. law prohibit the development or production of biological weapons. Yet at least 25 percent of the research conducted or commissioned by the BDRP is not considered solely defensive in nature by qualified independent scientists. Within the program, we found a predominance of research focused on exotic threat agents — many of which are not even considered legitimate threats by the military's own intelligence data. Furthermore, the BDRP conducted this exotic research at the expense of work on medical defenses against known threat agents. And the Army similarly neglected work on defensive measures with demonstrated efficacy, such as development of protective gear, and detection and diagnostic research.

Some BDRP projects appear to offer little pretense of a defensive rationale. One researcher, for example, has created a highly virulent and antibiotic-resistant strain of anthrax. Another has modified the botulism neurotoxin to yield a deadly form of botulism that would be unaffected by conventional vaccines.

Second-rate research

As for the caliber of research undertaken by the BDRP, we discovered a program that allots research awards without the benefit of a strong, independent peer review system. This may account, in part, for our finding that the BDRP attracts mostly second-tier researchers. The program awards only two percent of its outside contracts to highly respected biomedical-research institutions.

In biomedical research the number of peer-reviewed journal articles published represents a critical measure of productivity. Dollar for dollar, the program's output of published papers runs considerably lower than comparable biomedical-research programs within the National Institutes of Health or research universities. Moreover, BDRP scientists most often publish in obscure journals. We found that some 42 percent of 1991 publications by the BDRP's top twelve in-house researchers appeared in journals not even among the top 1,000, ranked in order of how frequently they are cited by biomedical scientists. While some research projects would

naturally yield fewer articles than others, the failure to publish at anything close to the rate of academic labs conducting related research suggests that either the BDRP's work is not well designed or that it is considered unimportant by the scientific community.

Malfeasance

Program insiders report cases of outright malfeasance within the BDRP. Several full-time researchers are said to have moonlighted on BDRP time — in one case, owning and operating a liquor store. Others allegedly garner millions of dollars for research they know to be far afield from the mandate of the program.

Such allegations of an abuse of taxpayer funds and of the public trust would be troubling in any government department. In the case of the Biological Defense Research Program, however, much more is at stake than a government boondoggle. Given the frightening and dangerous nature of this class of weaponry, special attention must be paid to the U.S. commitment to the 1972 Biological Weapons Convention, which bans not only the stockpiling, but even the possession or development of biological weapons. Any efforts that might even appear to undermine this treaty obligation could have grave, destablizing international implications; any research that even appears provocative may encourage similar work by U.S. adversaries, thereby fostering a biological arms race.

The gravity of these findings suggests that the time may be ripe for a formal re-evaluation of role and activities the BDRP. As a provocative program that does little to allay domestic or international concerns about its mission, the BDRP may actually endanger our national security. This much is certain, however: As currently configured, the BDRP does little to enhance it.

INTRODUCTION

As the world braced for war in the Persian Gulf in the second half of 1990, the public was jolted by the specter of biological warfare: the intentional spread of viruses, bacteria, or toxins to cause death or debilitating illness. In the final days of that year, with hundreds of thousands of U.S. troops massed near the Iraqi border, the U.S. military announced that it would inoculate some of its solders against two of the world's best-known biological warfare agents — Bacillus anthracis (which causes the deadly disease anthrax) and botulinum toxin (which causes botulism, a lethal form of food poisoning.)

The U.S. decision to vaccinate its troops came in response to widespread reports that Iraq's military arsenal included those types of biological weapons. As all-out war loomed, fears mounted that Iraqi President Saddam Hussein might resort to using biological weapons. In recent years prior to this incident, the issue of germ warfare had only occasionally captured the attention of the American public. This was, in part, because biological weapons are the one class of weaponry whose possession is entirely and unequivocally banned by international law. The 1972 Biological Weapons Convention (BWC), an international treaty signed by more than 100 nations, bans the use, stockpiling or production of biological weapons — the first treaty that banned both use and possession of an entire class of weapons.[1]

Like many other nations, the United States has signed the BWC, thereby pledging not to produce harmful biological agents "of types and in quantities that have no justification for prophylactic, protective or other peaceful purposes." The military's lead agency for the medical aspects of biological warfare defense, headquartered at the Army's Fort Detrick facility in Maryland, is the Biological Defense Research Program (BDRP). According to Department of Defense (DOD) figures, the BDRP has been funded recently at a rate of roughly $60 million annually, with many times this amount spent in other, closely related chemical weapons and chemical defense programs (see Appendix A).[2]

In December 1990, however, at the tense and fateful juncture of the Persian Gulf conflict -- despite hundreds of millions of dollars spent and the existence of effective vaccines - U.S. military representatives announced that the Pentagon's supply of vaccines was woefully inadequate even for its own forward-deployed troops, let alone for dissemination to allied troops or threatened civilians.

The revelation was particularly surprising because the two biological-warfare agents in question were so well known. Bacillus anthracis and botulinum toxin -- "old chestnuts," in the words of a senior Congressional staff member — were among the most likely agents to encounter in virtually any hostile biological-weapons program. Both of these agents had been well-known for decades and established vaccines (or in the case of botulinum toxin, a vaccine-like antitoxin drug) existed for prophylaxis against each.

In the case of anthrax, the Pentagon had possessed a vaccine for decades. In addition, the United States had vigorously protested the alleged production of anthrax organisms by the former Soviet Union after an outbreak of anthrax in 1979 in the city of Sverdlosk.[3] Because of the United States' high-profile allegations and millions of dollars spent on anthrax research in recent years, most observers assumed the U.S. military had ranked the dangers of an anthrax attack by the Soviet Union high among its many contingency preparations to defend the military against biological attacks.

The lack of stockpiled vaccines or prophylactic treatments during the Persian Gulf conflict raised many questions about the military's biological defense program. A *New York Times* article on December 29, 1990 quoted the chagrined civilian representatives in charge of the production of each of the two scarce remedies. Kenneth Wilcox, deputy director of the Michigan Department of Public Health — the sole U.S. provider for mass quantities of anthrax vaccine — said only that his agency would do everything it could to increase production. Delbart Glanz, vice president of the Salk Institute for Biological Studies — the lone production facility for an antitoxin treatment against botulism -- said it would "take some time" before a large quantity could be produced. According to the *Times,* the botulinum program "was just getting under way."[4]

Not surprisingly, experts on chemical and biological weapons questioned why the Pentagon had not been better prepared to meet such a well-established and obvious threat. Ironically, despite statements by President Bush that the United States did not enhance Iraq's capability in weapons of mass destruction, a leaked State Department Document from 1990 shows that the White House knew that the Department of Commerce had granted "at least 17 licenses" for "the export of bacteria or fungus cultures either to the Iraqi Atomic Energy Commission or the University of Baghdad," in addition to equipment that could be used in BW development.[5] Elisa Harris, a chemical and biological specialist from the Brookings Institution, expressed a view widely shared among insiders. "Given that we have been aware of Iraq's effort to develop biological weapons for a considerable period of time, the Pentagon should have had effective contingency plans for procuring adequate [vaccine] supplies," she noted, and for "carrying out a prompt vaccination program."[6]

With war imminent, however, the Pentagon found a sympathetic press corps when it declined to comment on such sensitive strategic matters as which troops would be vaccinated. Less easily justified, though, was the officials' refusal to address the failings of the program that had led to the situation. Responding to Harris' critique, an unnamed Pentagon official merely pointed out to *New York Times* reporter Michael Gordon that it was "difficult to ramp up production..." Plus, he added, "very few places are equipped to make this stuff."

As announced by the United States, some vaccinations of military personnel did take place in the early months of 1991. Fortunately, the war ended swiftly and biological weapons were not used. Subsequently, a report to Congress by the General Accounting Office in the spring of 1991 sharply criticized the U.S. military's defensive posture against the threat of chemical and biological warfare (CBW).[7] The study revealed that U.S. soldiers had been inadequately equipped and trained in the use of protective gear against potential CBW threats. Similarly, the vaccination incident had exposed a serious failure on the part of the U.S. military's biological defense program. It revealed an Army program that -- for whatever reasons — was almost completely unable to effectively prepare for Iraq's biological warfare threat — even though most experts considered the Iraqi capability primitive by modern standards.

Following the Persian Gulf War, in the spring of 1991, Dr. Billy Richardson, deputy assistant secretary of defense for chemical matters, testified before the Senate Armed Services Committee on behalf of the Pentagon's request for some $600 million in chemical and biological weapons defense appropriations for the coming fiscal year. In light of the Gulf War experience, Richardson said, "more emphasis must be placed on biological defense." In fact, in response to a question from Senator Sam Nunn, Richardson made the revealing disclosure that "biological warfare defense has gained unparalleled interest and support within the [Defense] Department."[8]

Richardson, the military's top-ranking official with direct responsibility for chemical and biological weapons defense, reiterated the importance the Defense Department attaches to biological weapons-related research in May 1992 before the Senate Appropriations Committee when he testified to garner support for chemical and biological weapons-related programs for FY 1993. Due to advances in biotechnology and fears of proliferation, he said, "The Chairman of the Joint Chiefs of Staff and the Deputy Secretary of Defense have designated biological warfare defense as a priority requirement."[9] In addition, Richardson has noted, "the senior leadership clearly recognizes that we must aggressively address the shortfalls identified during Operation Desert Shield/Storm."[10]

To the U.S. military, in other words, a lesson from the Persian Gulf war is that more emphasis needs to be placed upon the United States' biological weapons defense program. This Center Report evaluates the wisdom of that conclusion as an appropriate strategy for responding to the threat of biological warfare.

Long-standing Controversy

The BDRP has long been controversial. Critics have frequently held that medical defenses against biological agents are essentially futile: no program, they have pointed out, can hope to adequately protect threatened soldiers and civilians against the myriad potential biological agents that could be unleashed. There are hundreds of known strains of hazardous biological agents, many of which have frustrated scientists' efforts to find vaccines or cures, despite decades of research. And although few of those agents have all the characteristics necessary to produce an effective weapon, genetic engineering techniques raise the specter that known biological agents can be altered to create more invasive or faster-acting organisms, agents that thwart prophylactic medical defenses, or agents that are hardier and more robust when sprayed into the environment or loaded into munitions. Some military planners believe that wholly new agents with as yet unknown and unpredictable qualities can be created and potentially unleashed as well.

Even if vaccines could be developed for any and all possible diseases, the prospects of using them effectively for troops and at-risk civilians are daunting at best: omniscient military planners would likely need to administer the vaccines to vast numbers of people weeks or months in advance of a conflict in order for the defensive effort to have any effect at all.

Furthermore, as many have pointed out, a military vaccination program risks more than ineffectiveness; it can be provocative as well. Because biological agents can carry disease to both sides of a conflict (not to mention to civilian populations), an aggressor must be able to vaccinate its own troops." A vaccination program therefore lends itself equally to offensive and defensive actions.

The argument points up the troubling double-edged quality of all defensive vaccine research: the division between offensive and defensive work is murky at best, determined primarily by the intent of the party involved. While a vaccine may be produced and stockpiled to guard against a potential biological attack, an attacker must also use the vaccine to protect its own troops and civilians.

The Gulf War experience renewed questions and criticisms regarding the credibility of the concept of medical defense against biological warfare. Since the origin of the Army's biological weapons program during World War II, the U.S. government has spent more than one billion dollars - more than $500 million since

1984 -- to underwrite the Army's secretive work in this area. Yet, if the Army's biological-defense program did not even maintain adequate quantities of vaccines against well-known threats like anthrax and botulism, just what have U.S. taxpayers been paying for all these years?

Especially in light of the Army's failed biological defense in the Persian Gulf conflict, and given the enormous geopolitical changes that have swept the world in recent years, this Center Report offers an examination of the Army's biological weapons research program. We address the following issues:

- What is the Army's Biological Defense Research Program?
- What work has the program undertaken?
- How effective has the program been so far? Has the program made prudent use of taxpayer funds, and does it merit sustained funding?
- And finally, is the program likely to offer a credible defense against biological warfare in the foreseeable future?

For the moment, at least, the U.S. military's program continues apace. If anything, the Pentagon sees a continuing — even growing — biological threat. As Dr. Billy Richardson testified to the Senate, biological weapons research is drawing "unparalleled" attention and support within the military.

Yet there is little doubt that the end of the Cold War has significantly changed military priorities in the United States and abroad. In a vivid example of these changes, 125 nations recently completed a comprehensive and verifiable treaty banning chemical weapons. Leaders of the United States and the former Soviet Union had previously agreed to destroy most of their nations' vast stockpiles of chemical agents.[12] In addition, Russia pledged in April 1992 to end germ-warfare research altogether, ostensibly removing a threat that has for decades served as a central justification for the U.S. BDRP.

These domestic and international circumstances heighten chances for success in strengthening the international regime against biological weapons and preventing biological warfare.

Methodology

To compile this report, we investigated what may be the most thorough collection of research documents ever gathered about the military's biological defense research program by a non-governmental organization. To evaluate the goals and caliber of BDRP's research, we consulted dozens of experts, combed the publication records of the program's top researchers, and interviewed former and current BDRP insiders. We developed a database of the program's research projects for funding year 1989 (the latest year for which comprehensive data could be obtained from confidential official sources), tracked funding over the life of the BDRP, and investigated many of the outside research contracts allotted by the program.

We also made a thorough search of previously published works that provide overviews and historical information about the military's biological defense efforts. Many of these works are listed in the bibliography at the end of the study.

This report represents a comprehensive analysis of what the BDRP has accomplished, and of its stated

and apparently hidden goals. As with any large, secretive government program, the data are not always easy to evaluate. Whenever possible, we have tried to let the empirical information guide our interpretation.

BACKGROUND

This year marks the 51st anniversary of the U.S. military's biological weapons research and development program. The U.S. biological warfare program began in response to fears in the early 1940's that Japan and Germany were developing biological weapons, parallel in many ways to the Manhattan Project, the secret wartime effort that developed the atomic bomb. Like the Manhattan Project, the U.S. biological weapons research effort was deemed an urgent priority. Work was conducted in extreme secrecy and, from the start, the program depended on the efforts of a coterie of American scientists drawn from academia and industry.

At the request of then-Secretary of War Henry Stimson, a special committee appointed by the National Academy of Sciences determined that biological agents disseminated intentionally in war could indeed cause widespread disease and devastation. Acting immediately upon the committee's assessment, Stimson sent a memo to then-President Franklin Roosevelt: "We must be prepared," Stimson cautioned. "And the matter must be handled with great secrecy as well as great vigor."[13]

Stimson's instigation of U.S. efforts in this area commenced the first of three distinct phases of biological weapons development in the United States.[14] While the modern-day program has evolved significantly from the early efforts, this initial period was marked by several important factors that would guide policy to some degree in later years as well.

Phase One: Secret Origins

First among the factors influencing the program's early development was the intense secrecy surrounding its efforts. Stimson appointed George W. Merck, then president of Merck pharmaceutical corporation, to head the program. With Roosevelt's blessing, Stimson concealed the program from public scrutiny within a New Deal welfare agency called the Federal Security Agency — a governmental body that ostensibly oversaw the Public Health Service and Social Security. As he explained to Roosevelt, placing the program within a civilian agency "would help in preventing the public from being unduly exercised over any ideas that the War Department might be contemplating the use of this weaponry offensively."[15]

An equally important factor influencing the U.S. biological weapons program's development in its formative years was the use of a widespread network of scientists and engineers. This practice, in fact, has continued throughout the U.S. government's long-standing dealings with biological weapons research and development. By 1943, the U.S. had established a centralized facility in Maryland called Camp Detrick (now Fort Detrick, still headquarters for the military's biological defense research). At the end of 1943, the program employed some 4,000 people and had begun production of 500-lb. anthrax bombs, botulinum-toxin bombs, and other biological weapons. While Fort Detrick was the program's center, as many as 300 universities, research institutes and corporations took part in the effort — many from the program's inception.[16]

If secrecy and incorporation of outside scientific assistance influenced the program's early development, however, the program's hallmark may well have been continual uncertainty about its precise mission. Of course, in this early wartime period, the U.S. biological weapons program was unabashedly offensive in nature. An overarching goal was to manufacture and "weaponize" biological agents that could be used against an enemy. President Roosevelt pledged in 1943 that the United States would not use chemical weapons except for

retaliation in kind, and many assumed that this "no first use" policy applied for biological weapons as well.

By the same token, as indicated in Stimson's initial memo, the notion of being "prepared" was always of paramount importance to the program. But protecting troops and civilians against biological weapons was an extremely difficult prospect — especially in a medical era when penicillin had only recently been discovered. Because of these problems, the military's early efforts raised serious questions in the minds of some of the program's advisors about the notion of a medical or biological defense against this type of weaponry. Allied troops and civilians, after all, would need to be protected against the effects of any biological weapons planned for use in combat. Few vaccines existed for the dozens of candidate biological-warfare agents. Even if such vaccines had been available, any mass vaccination campaign would have inevitably caused mild-to-serious medical side effects in some percentage of cases; perhaps more importantly, it would alert any potential aggressor.

According to the National Academy of Sciences panel that recommended the creation of the program, there was only one solution: "namely to study the possibilities of such warfare from every angle, make every preparation for reducing its effectiveness and thereby reduce the likelihood of its use."[17]

Confusion over the program's mission heightened at the end of World War II. Two preeminent science advisors, Vannevar Bush and James Conant, anticipated the dilemma. As they wrote to Roosevelt: "If this war ends without the use of biological warfare, the United States will be confronted with a serious problem as to the future. Shall research and development along this line be pushed?...[F]ear and distrust of other countries might be intensified if the rumors spread [of work] on the perfection of this new weapon of destruction."[18]

At the time, Bush and Conant sought some kind of international agreement to diffuse a possible biological arms race. They suggested some mechanism through which knowledge gained by the U.S. program could be shared with an international body or directly with other nations. Similar international controls were closely considered during this period for the United States' emerging nuclear-weapons technology as well. In each case, however, such international controls failed to materialize as the U.S. ultimately chose instead to maximize its technological edge in each area.

As we now know, U.S. suspicions during World War II about enemy interest in biological weapons were partly justified. Although Germany never developed a significant BW capability, the Japanese conducted a large-scale biological-weapons program beginning in 1935. The program, which proceeded throughout World War II, included the development of everything from porcelain bombs holding thousands of infected fleas, to chocolates tainted with deadly anthrax bacteria. Most disturbing, the Japanese used such weapons in their invasion of China and conducted systematic human experimentation on prisoners of war that left at least 3,000 enemy soldiers dead.[19]

The U.S. military knew little of the program during World War II. Rather, fears of biological warfare during this period were spawned largely by more general perceptions at the time that advances in medicine could make biological agents more usable. After all, Japan's military was hardly the first to make use of disease as a weapon of war. The practice dates at least as far back to when ancient Romans fouled the wells of enemies with animal carcasses, and to the Middle Ages when advancing Tartars hurled corpses infected with the bubonic plague over city walls into the midst of the besieged Black Sea port of Caffa.[20] Moreover, until 50 years ago,

infection from wounds has historically claimed the lives of more soldiers than have direct injuries from bullets or bombs.[21]

As World War II came to a close, therefore, the U.S. was forced to make a major decision about the extent to which a full-fledged biological-weapons program should be maintained. As Merck wrote in a report to the Secretary of War in 1946:

> Although remarkable achievements can be recorded, the metes and bounds of this type of warfare have by no means been completely measured. Work in this field, born of the necessity of war, cannot be ignored in time of peace; it must be continued on a sufficient scale to provide an adequate defense.[22]

The view of the program's civilian director would prevail. In the ensuing 23 years, the U.S. military would conduct hundreds of BW tests — in the laboratory, in the open environment, and on human beings, both volunteers and unwitting subjects. In addition, during this period, the U.S. would stockpile a massive arsenal of biological weapons.

Much later, in Congressional testimony in 1958, General William Creasy, then-head of the U.S. Army Chemical Corps, would bluntly make the case for the all-out U.S. biological weapons development program:

> "A defensive [CBW] program not supported by an offensive program can well be worthless. You cannot know how to defend against something unless you can visualize various methods which can be used against you, so you can be living in a fool's paradise if you do not have a vigorous munitions and dissemination-type program."[23]

Yet this defense-only program is the very approach the Army would officially adopt 11 years later.

Phase Two: Renunciation

A significant change in U.S. military strategy came in 1969 when then-President Richard Nixon renounced biological weapons and promised that the United States would unilaterally destroy its biological arsenal.

The dramatic move came in response to mounting domestic and international calls for chemical and biological disarmament. The United Kingdom, for example, had already begun an eighteen-nation disarmament committee with a new convention for the prohibition of microbiological methods of warfare that would supplement but not supersede the Geneva Protocol of 1925 which bans all signatories from first-use of BW. Mindful of criticism at home and abroad, the Nixon administration initiated a review of chemical and biological warfare policy in May 1969. The complete renunciation of biological weapons by the administration came by November 1969, and was explicitly extended to include toxins in February 1970. The move anticipated the Biological Weapons Convention of 1972 — to this day one of the most sweeping disarmament treaties ever achieved — the only multilateral treaty that bans the possession of an entire class of weapons.

The Nixon administration's unilateral renunciation of biological weapons was predicated on the view that biological agents have little or no military value. After reviewing the information available at the time, President Nixon's advisors found biological weapons to be unreliable and unpredictable. Biological agents, the administration realized, could spread out of control and initiate epidemics in civilian populations on either side of an armed conflict and could readily backfire locally.

Because their effects are inherently uncontrollable, biological agents lack the targeting ability required by the modern military planners. As MIT biologist Jonathan King puts it, "infectious agents recognize neither national boundaries nor uniforms."[24] They are also relatively slow to act compared to other weapons of mass destruction because they usually require hours, days, or weeks to generate disease states within their victims. Equally important to Nixon's military planners was the realization that biological weapons provoke universal repugnance and could well trigger a chemical or nuclear response.

The case against the military utility of biological weapons was so strong that the Nixon administration even felt confident that stockpiles of biological weapons would be useless as a deterrent, and therefore need not be maintained. The rationale for this decision, then, was that neither military capability nor national security would be compromised by the unilateral renunciation of this category of weapons regardless of the policies adopted by other countries. The use of biological weapons would be so risky for any party concerned that the U.S. did not feel threatened by the prospect of giving them up completely.

The view was enhanced by several more strategic lines of thought. First of all, as Pentagon advisor Han Swyter noted plainly at the time, "The proliferation of chemical and biological capability would tend to change the world's balance of power, reducing ours."[25] Harvard biochemist Matthew Meselson, widely considered the driving force for the Nixon renunciation, has since explained the rationale further. It was realized at the time, Meselson told Congress in 1989, that the "[p]roliferation of biological weapons would greatly increase the number of nations to which the populations of the United States and its allies are hostage."[26]

In addition, Meselson noted, "it was realized that our biological weapons program was pioneering an easily duplicated technology and that our program was likely to inspire others to follow suit." The prospect, Meselson says, led to the conclusion "that our biological weapons program was a substantial threat to our own security."[27] A key piece of this calculation comes in the fact that chemical and biological weapons are relatively cheap to produce. A wealthy power has much to gain, therefore, by controlling their spread. In contrast, expensive armaments like nuclear weapons are less likely to proliferate widely, especially to the Third World.

Despite the Nixon administration's far-reaching change in policy, however, the U.S. did not want to give up the program altogether. The administration stated that the U.S. would "restrict our biological program to research for defensive purposes, strictly defined [emphasis added] — such as techniques of immunization, safety measures and the control and prevention of the spread of disease." The policy left the door open for what would become the Army's current BDRP.

While the United States' arsenals of biological weapons were destroyed, a newly commissioned research program was established under the auspices of the Army. Its new mission was couched in purely defensive terms, but it employed many of the same people and retained much of the earlier program's approach. The sense of the program's continuity was heightened in 1969 when National Security Advisor Henry Kissinger penned

Decision Memorandum 35, which stated that the new U.S. biological defense research program "does not preclude research into those offensive aspects of bacteriological/biological agents necessary to determine what defensive measures are required."[28] The notion of a purely defensive program, in other words, was muddy and malleable.

The concerns expressed by Bush and Conant at the start of the nation's biological weapons program lingered. Many continued to worry about the degree to which any military research related to biological weapons might spawn "fear and distrust" among other nations and ultimately lead to a biological arms race. Nonetheless, the program was funded at a relatively modest level at the outset, not exceeding $25 million annually. The BDRP program proceeded relatively quietly for a little over a decade, until the early years of the Reagan administration.

Phase Three: Rekindled Interest

Just slightly more than a decade after Nixon's bold policy decision, the Reagan administration adopted a strikingly different analysis of the dangers of biological warfare. Almost immediately after Reagan took office, the BDRP budget jumped dramatically. Between fiscal years 1981 and 1987, the program's budget more than tripled and the administration publicly began to claim that biological weapons presented a heightened threat to national security. As Assistant Secretary of Defense Douglas Feith informed Congress in August 1986: "The prevailing judgment of years ago that biological warfare is not a militarily significant weapon is now quite unsustainable. Biological warfare can be designed to be effective across the spectrum of combat, including special operations and engagements at the tactical level."[29] Eventually, under the Reagan military buildup, it would grow to a point where it would command a larger annual budget--adjusted for inflation--than the U.S. military offensive biological weapons program had in most funding years.[30]

Particular public concern was raised about the expanding program when, in 1984, the Army tried to slip through Congress a multi-million-dollar aerosol testing facility for biological agents at Dugway Proving Ground in Utah. Submitted on the final day before the summer Congressional recess, the controversial appropriation was sought as a routine "reprogramming" request to bypass the authorization process. Reprogramming requests are usually reserved for minor, non-controversial reallocation of funds.[31]

During this period, judging from the BDRP's rapidly increasing funding, from the accounts given by Feith and others in the administration, and from the military's effort to quickly build an aerosol testing facility for "toxin agent test support," it is clear that the Reagan administration believed something in the equation had changed since the 1969 unilateral renunciation of biological weapons.

Given the advances in genetic engineering, this view would seem reasonable enough at first glance: the Nixon administration's decision to renounce biological weapons just slightly predated the birth of recombinant DNA technology - a virtual revolution in microbiology. In fact, 1972, the year that the Biological Weapons Convention was signed, was also the year that the first gene-splicing experiments were performed. At that time few members of either the military or scientific establishments anticipated the speed and breadth of the far-reaching advances to come in genetic engineering and other areas of biotechnology.

In testimony that laid out the new Reagan administration calculus, Feith warned Congress, "New

technology has exploded the standard ideas about BW that prevailed ten or more years ago." According to Feith, "The technology that makes possible so-called 'designer drugs' also makes possible designer BW."[32]
To be sure, gene-splicing techniques — through which specific genes and the traits they carry are inserted into existing microorganisms — have created the potential for new avenues of exploitation. But experts have been deeply split over the implications of this technological advance.

If genetic technologies increase the potential for novel biological agents, some note, they also diminish the prospects for successful medical-defense measures. This derives from two factors: First, naturally occurring pathogens (disease-causing organisms) are already very difficult to defeat medically - witness the decades of as yet unsuccessful work to conquer influenza or tuberculosis, for example. And the Defense Department has been trying to develop and refine medical countermeasures to organisms that were well defined and designated as biological warfare threat agents since the 1940s. Second, while it is no small matter to create a novel pathogens using the tools of genetic engineering, it is vastly more difficult to defend against the potentially unlimited array of agents that gene splicing could unleash even if such agents could be anticipated — itself a prospect that strains credulity. The new genetic technologies simply favor offense over defense. Furthermore, as Dr. Richard Novick, molecular biologist and director of the Public Health Research Institute of New York, has outlined in detail, in the foreseeable future, new genetic technologies do little to overcome the inherently uncontrollable nature of biological agents that so hinders their military utility.[33]

Despite the apparently fatal logical contradiction inherent in the program's approach to the problem of biological warfare, in its 1980s buildup the BDRP called on some of the strategies the military had used in the 1940s. The program has continued to make ample use of outside researchers. Despite its much-touted commitment to unclassified research, the program continues to obscure much of its work; it fought, for instance, a Congressional initiative in 1989 to issue publicly a complete listing of its research efforts.[34] And finally, like its offense-based predecessor program, the BDRP remains burdened with confusion about how best to implement its role of offering a credible medical defense against biological weapons.

ANALYSIS OF THE ARMY'S BIOLOGICAL DEFENSE RESEARCH PROGRAM (BDRP)

Organizational Structure

The U.S. Army's Biological Defense Research Program is headquartered at Fort Detrick in Frederick, Maryland, a rural town 45 miles northwest of Washington, D.C. The BDRP is part of a complex bureaucracy that draws upon highly sensitive, classified military intelligence information about potential biological weapons development around the world. Consequently, despite frequent claims about the program's openness, it is extremely difficult to get a sense of the scope or scale of the Army's effort. The dilemma can be illustrated by both the hierarchical structure of the program and the funding mechanisms that support it.

The lead facility that undertakes the work of the BDRP is known as the U.S. Army Medical Research Institute of Infectious Diseases (USAMRIID) - a component of the U.S. Army Medical Research and Development Command. The institute has a professional scientific staff of more than 100, including medical doctors, veterinarians, microbiologists, pathologists, chemists, molecular biologists, physiologists, and pharmacologists.[35] These researchers are augmented by a support staff of some 400 military and civilian personnel.

BDRP research is also conducted at related military research institutions, including the Walter Reed Army Institute of Research in Washington, D.C.; the Air Force Aeromedical Research Lab in Fort Rucker, Alabama; the U.S. Naval Medical Research Institute in Bethesda, Maryland; the U.S. Naval Biological Research Laboratory in San Diego, California; and the Uniformed Services University of the Health Sciences in Bethesda, Maryland. In addition to those military institutions, the BDRP allots roughly two-thirds of its research budget to nearly 100 outside contractors, including universities, other government agencies, private firms, and foreign research laboratories (see Appendix C).

In addition, the Armed Forces Medical Intelligence Center -- a highly secret organization at Fort Detrick that serves all three main branches of the armed forces - is responsible, in conjunction with other intelligence agencies, for analyzing classified information about biological agents that might present a warfare threat to U.S. forces. Drawing upon these intelligence data, the military's Academy of Health Sciences establishes the broad requirements outlining what research and development is needed to counter perceived threats. These requirements are intended to guide the BDRP in its unclassified research agenda.

If that picture sounds complex, one need only take note of the way that Col. David L. Huxsoll, the commander of USAMRIID, explained the BDRP's chain of command to a Senate subcommittee in 1989:

> So-called medical defense constitutes approximately two-thirds of the BDRP. The USAMRDC [U.S. Army Medical Research and Development Command] is the medical materiel developer, and develops its programs in response to requirements identified by the Army Medical Department combat developer, the U.S. Army Academy of Health Sciences. Non-medical, combined chemical-biological defense efforts constitute approximately one-third of the BDRP. These efforts are directed by the U.S. Army Armament, Munitions and Chemical Command through its laboratory, the U.S. Army Chemical Research Development and Engineering center

(CRDEC) [located at Aberdeen Proving Ground, Aberdeen Maryland], and by the U.S. Army Test and Evaluation Command at the Life Sciences Laboratory at the Army's Dugway Proving Ground in Utah. Defense materiel is developed by the parent command of both of these organization, the U.S. Army Material Command, in conjunction with the combat developer, the U.S. Army Chemical School.[36]

As Huxsoll puts it, for example, "The BDRP is open and unclassified. Congress, the United Nations, regulatory agencies, scientists throughout the world, public interest groups, and the news media all have ready access to information about the U.S. BDRP."[37]

In reality, information about the scope of the BDRP is exceedingly difficult to obtain. Even Congressional efforts to simply require the publication of an annual listing of biological agents under investigation by the BDRP have failed.[38] One important point highlighted in Huxsoll's comments is the overlap between the BDRP and other related military medical research, as well as some chemical weapons research. Medical research in the chemical warfare budget, such as the development of protective equipment, studies about the effects of nerve gas, and general biomedical and environmental research, includes biotechnology studies directly relevant to the problems of biological warfare. But much of the chemical weapons program is classified secret. And while BDRP researchers do publish in the open literature, the absence of a publicly available research prospectus makes it impossible to know if some research results are being withheld.

Efforts to obtain the most straightforward information for this report about the tenure of specific scientists within the program were first stonewalled and ultimately denied on the grounds that the information was "sensitive." As BDRP spokesperson Charles Dasey acknowledged in a recent interview, the BDRP exercises a "reflexive reluctance to issue information about the program because it has often been misconstrued in the past." Dasey claims "we have done a lot in this program to let the sun shine in. Unfortunately, it hasn't always had the desired effect."

The BDRP's de facto secrecy and the military's overlapping programs make it difficult to compile an accurate picture of the BDRP's goals and funding level. Because chemical weapons R&D is funded at an annual rate roughly four times higher than that of the BDRP itself, it is a factor that can clearly have a great impact on the biological defense effort, depending on the degree to which biological research resides on the chemical side of the ledger.

Furthermore, in both biological and chemical weapons research, a relatively small outlay (compared, for instance, to most military hardware projects) can underwrite a considerable amount of research and development work. The program therefore could be significantly augmented by any secret funding, for example, via the Pentagon's "black budget" -- now estimated to comprise five to ten percent of the military's annual requests for funds.[39] (Such funding, if it exists, would violate the U.S. obligation to the Biological Weapons Convention of 1972 to conduct only open and unclassified research in this area.)

But program overlap and potentially secret budgets are overshadowed by the arcane system through which Congress allots money to BDRP in the first place. No Congressional funding is listed as being appropriated directly to the BDRP itself. Instead, funds are earmarked only for a broader category called "medical research and development" which includes a host of military medical R&D unrelated to biological

agents. As with most other military research and development funding, these funds are then separated into five distinct categories. The BDRP's funding is drawn from each — a subset of the total of these five categories, which are listed as:

6.1: Basic Research (including identification and isolation of infectious agents and characterization of agents);

6.2: Exploratory development (including definition of animal models, preparation of vaccine and drug candidates, improvement of disease diagnosis and agent identification, and epidemiological studies);

6.3A: Advanced nonsystems development (including scale-up production and advanced testing);

6.3B: Advanced systems development (including safety and efficacy testing); and finally

6.4: Engineering development (which includes large-scale field trials and initial product purchases).[40]

To weave our way through the tangled organizations and funding, we compiled a "snapshot" of the program for a single funding year. The following data presents the 1989 funding year (FY 1989, beginning in October, 1989). We chose that year because it is the most current for which we could get a complete set of information and because it allows us to track the status of many of the multi-year projects underway at that time as well as any published research that might have ensued from those efforts. Funding that year for the medical component of the BDRP was $66.5 million, up from $29 million just five years earlier. Current year funding stands at $55.8 million.

[Note: Much of the information used to describe the details of the BDRP's 1989 research was derived from more than 200 Research and Technology Work Unit summaries. These forms, completed by the military for each research project — whether internal or contracted out — include the following information: Funding data, names of the project, investigator, and the sponsoring agencies; description and objective of the project, approach for achieving the objective; and often a progress report. While the forms may be incomplete, cryptic, or vague, they remain the best source of detailed information about the broad sweep of BDRP work. Although these forms are unclassified, they are not easily obtained; in denying access to the forms, the military sometimes has argued that the complete set of unclassified forms, taken as a whole, would offer adversaries a comprehensive portrait of the U.S. program. The Center obtained these forms from a federal government source who requested anonymity.]

As we will explain in detail below, certain aspects of the program have been altered since the time period we examine. In most respects, though, the program remains fundamentally unchanged. In fact, because of the long-term nature of much of the BDRP's research, many of the projects described in this report are still underway today.

Program Mission

As an unusually candid Army assessment of the BDRP from 1985 explains:

> The BDRP is directed against agents of biological origin which are potential military medical threats. Primary concern is on the development of prophylactic and therapeutic drugs, immunotherapies, diagnostics, vaccines, antitoxins, and toxoids against agents of biological origin, and includes proposals dealing with novel and traditional approaches. Infectious agents of interest include anthrax, tularemia, Q fever, and human pathogens of Alphaviruses, Flaviviruses, Bunyaviruses and Arenaviruses. Toxins of major interest include blue-green algal toxins (microcystin, anatoxin A), dinoflagellate toxins...vertebrate toxins...protein and peptide toxins of other biological origin including pre and post synaptic neurotoxins, and membrane active substances.[41]

Although such a description can be surmised from publicly available documents, few Army statements give as clear and concise an accounting of the program's specific research goals as the one above. Of particular note is the way certain diseases and toxins discussed above are described simply as infectious agents "of interest" to the program. What does this mean with regard to BDRP mandates and priorities? According to the Pentagon, a bonafide "biological warfare threat" can consist only of a biological agent known (or presumably strongly suspected) by the U.S. military's intelligence community to be under development or in production as a weapon by a foreign government. Pentagon officials now say that, aside from the former Soviet Union, they believe at least ten nations currently conduct some kind of biological weapons program.

As explained in the previous section, the Pentagon's elaborate organizational structure in the area of biological defense research is intended to allow intelligence information about alleged biological weapons threats to filter through to the unclassified BDRP, guiding the BDRP's research agenda. Of course, aside from specific preventive vaccines, drugs, therapeutic measures, and patient-treatment and management procedures, the BDRP has also traditionally engaged in more-broadly focused medical research (such as the attempted development of broad-spectrum antiviral drugs) that does not precisely target specific, known threat agents. Nonetheless, despite the above overview, the BDRP has never been given the mandate — either from Congress or from the Pentagon — to investigate any infectious disease it deems to be "of interest." And yet, as a recent evaluation by the General Accounting Office (GAO) shows, this is precisely how the BDRP has functioned for years.[42]

According to the GAO report, only half (51.4 percent) of BDRP projects in 1990 were specifically directed towards research on biological threats validated by intelligence information. The GAO determined that 48.6 percent of BDRP research that year was unrelated to any validated biological threat agent. The GAO said the BDRP had, in essence, squandered some $47 million in 1990 alone on projects that fell outside the military program's own stated mission. As the GAO learned, while the BDRP's projects are subject to an in-house technical review by Medical Command personnel, neither the Command nor any of the independent organizations affiliated with the BDRP — not even the Armed Forces Medical Intelligence Center, provider of the threat assessments — ever examined projects to ensure they were directed at so-called validated threat agents.

The GAO estimates that 43 percent of the funds the Army has spent since 1965 toward the development of some 16 vaccines or other drugs - an amount totaling several hundred million dollars — has been directed towards products that do not coincide with the U.S. military's own assessment of biological agents that pose a valid threat to U.S. security.[43]

Our analysis corroborates the thrust of the GAO findings. As we will discuss later in more detail,

interviews with current and former BDRP researchers revealed a program that has become insulated and unaccountable. Program managers seem more interested in pursuing the latest high-tech virus research--however far-removed from the BDRP's mission - than in fulfilling their prescribed mandate.

Embarrassed by the U.S. military's lack of a meaningful defense against the perceived biological threat in the Persian Gulf War, and frustrated by the findings of the GAO, the Senate attempted in 1991 to rein in some of the BDRP's excesses by stipulating that BDRP researchers must receive special permission from the Senate Armed Services Committee to research any threat agents that were not validated by the BDRP's intelligence data. In addition, Congress required that such research on exotic threats could under no circumstances exceed 20 percent of the program's funding.

Today, BDRP officials and researchers alike bemoan these restrictions. BDRP spokesperson Dasey, for instance, stresses the importance of allowing exploratory research within the program to anticipate any "technological surprise" that might materialize in the biological-weapons arena. In reality, many in the program acknowledge that the Senate's stipulations have made little functional difference in the military's biological research efforts. Dasey, for example, notes that only one area of research within the BDRP has actually been stopped to date by the Congressional mandate — work on broad-spectrum anti-viral drugs, a program area that received a fair amount of funding in our snapshot 1989 year (see Tables 1 and 2). Other research on non-validated threat agents, Dasey says, has often been shifted to other branches of the military's complex medical-research apparatus.[44]

The GAO report and subsequent, largely ineffectual efforts to force greater accountability upon the BDRP's research agenda highlight lingering contradictions about the program's mission. First, while the program officials adamantly maintain that the intent of their efforts and content of their work is purely defensive, BDRP scientists continue to engage in a considerable amount of work that goes well beyond the program's own "strictly defined" bounds of defensive research.

BDRP representatives dismiss concerns about offensive applications simply by maintaining that all research in the program is purely defensive in nature and, furthermore, that a clear difference exists between offensive and defensive research. Col. David Huxsoll, for example, former commander of the U.S. Army Medical Research Institute of Infectious Diseases, has claimed that "[f]rom the outset, defensive research is based on different postulates and hypotheses than is research directed toward 'offensive' ends."[45]

And yet, it has long been understood that any vaccine research can have an offensive component. This fact was actually articulated by some of the United States' earliest BW planners. As a 1949 report on biological weapons put it:

> [T]he offensive employment of BW is predicated upon the ability to immunize our troops, those of our allies, or other personnel likely to come within range of infection by our own BW weapons. Information obtained from research on the defensive aspects of BW is, in the greater part, applicable to offensive problems as well.[46]

The difficulty in distinguishing offensive from defensive research was brought home in the aftermath of the Persian Gulf War, when a team from the United Nations tried to find evidence of an offensive biological

weapons program in Iraq. The investigators found that Iraq did possess cultures including Bacillus anthracis and botulinum toxin which they had received from the American Type Culture Collection. Furthermore, U.N. investigators found evidence that Iraqi researchers had undertaken toxicity studies of these agents that, the investigators believed, might indicate that they were seeking an offensive capability.

Kurdish rebels produced one document that they describe as an official Iraqi army memo calling for an inventory of biological materials, but its authenticity could not be verified. Neither U.N. nor U.S. investigators have presented evidence to indicate the presence of delivery systems, clear documentation, appropriate munitions, or production facilities that might have established that Iraq had an offensive capability. In this respect, other than the perception of offensive intent, the Iraqi research did not differ in form from research long since undertaken by the U.S. BDRP.[47] In fact, comparable U.S. research efforts have always been far more elaborate and sophisticated.

The BDRP's openness policy is riddled with similar contradictions. BDRP officials understand that an avowedly secret program would be seen as provocative by other nations. Yet, BDRP officials resist a truly open program even in theory. As BDRP spokesperson Charles Dasey contends, for instance, offering too clear a catalogue of the program's activities might reveal gaps to a potential adversary. "You'd communicate a vulnerability," he states, offering the program's underlying rationale for keeping the full scope of its activities secret.

Finally, the BDRP exhibits a contradictory message by repeatedly propounding the view that effective medical defense against biological warfare (namely, vaccines or other prophylactic treatments) is possible while doing relatively little to amass a storehouse of proven vaccines against known threat agents. The outcome of the BDRP's questionable emphasis on exotic, high-tech virus and toxin research can be seen clearly in the absence of stockpiled vaccines during the Persian Gulf War.

Especially in light of the GAO's research, there is little question that the BDRP has frequently chosen to favor diverse and exotic research over the production of vaccines or other prophylactic treatments against validated threat agents. Aside from its other drawbacks, such an emphasis undermines the program's stated adherence to the notion of a medical defense by failing to offer such a defense in those few cases where it might actually show some efficacy: namely, in the case of proven vaccines against well-known threat agents like Bacillus anthracis.

Research Overview

As stated above, in FY 1989 Congress allotted a total of $66.5 million to the BDRP's medical component. (As noted, this figure does not include funding for related projects in equipment testing, and projects that are funded through the Chemical Weapons program that pertain to problems of biological warfare.) In that funding year we found a total of 194 projects underway within the program. Given the multi-year nature of many of the projects, we determined a cumulative funding total of $134.4 million. In other words, ongoing research projects costing a total of $134.4 million were in the pipeline at this time.

From that total amount, $49.6 million (roughly 37 percent) was earmarked for 59 in-house research projects, conducted at one of several branches of USAMRIID at Fort Detrick. The remaining $84.8 million (63

percent) was awarded in 135 separate outside contracts.

Of the in-house component of the BDRP, we identified sixteen researchers who presided as principal investigators over projects allotted more than $1 million each. Similarly, at least 16 outside institutions received contracts with cumulative funding totals (over the project lifetimes) worth in excess of $1 million each. Of the 135 outside contracts in 34 states, 47 separate universities were represented, as were 16 private firms and 16 separate government agencies — including the U.S. Department of Agriculture and the Food and Drug Administration. Also represented were contracts awarded to 10 separate foreign research institutions — located in Argentina, Britain, The Central African Republic, Israel, Scotland, South Korea, and Sweden. (See Appendix B for a full list of in-house BDRP projects; see Appendix C for a list of BDRP research contracts to outside institutions.)

Just what kind of projects were funded? As might be expected, the program covered a wide breadth of topics. Researchers were involved in determining the molecular structure and overall biological effects of an array of toxins, including crotoxins obtained from rattlesnake venom and saxitoxins derived from shellfish. Many research projects were involved in the development of vaccines — against such scourges as tularemia, a deadly, plague-like disease caused by the bacterium Pastuerella tularensis;[48] or chikungunya, a debilitating tropical virus endemic in parts of Africa and Southeast Asia.

Other research sought to understand basic disease processes, such as biological mechanisms that allow certain types of viruses to invade cells. Similarly, diagnostic tools were under development to allow for rapid detection of potential biological agents in the field. In addition, the BDRP program conducted a sizable effort--some $4 million of in-house funds alone by our calculations — to explore the prospects for a so-called "broad spectrum" anti-viral drug that might be effective against numerous virus-borne diseases.

In a functional sense, the research funded during this period ran the gamut from basic laboratory studies to numerous projects using animal models - including mice, guinea pigs, monkeys, dogs and many other species. In fact, a number of research projects even included a human component. In one in-house project, for instance, an experimental tularemia vaccine was administered to nine volunteers — only to be suspended when three of them suffered from "transient liver dysfunction."[49]

Perhaps more descriptive of the breadth of the BDRP, though, is a sampling of the titles of the research projects themselves. In our snapshot year, 1989, U.S. taxpayer funds were supporting research efforts including, "Studies of Microbial Toxins and Venoms of Military Importance: Basic Mechanisms of Toxicity," in which researchers infected rabbits with various snake and/or spider venoms to study blood coagulation; "Freshwater Cyanobacteria Blue-Green Algae Toxins: Isolation and Characterization," which made use of "large-scale culture methods" to grow and distill various strains of these potent algae toxins; "Mode of Action of Membrane Perturbing Agents: Snake Venom, Cardiotoxins and Phospholipases;" and "Toxins and Physiologically Active Compounds as Potential Biological Agents," in which, among other things, researchers screened cholera and pertussis toxins for their abilities to affect cell tissue.

To provide a rough overview, the following tables (Table 1 and Table 2) divide in-house and out-of-house projects during this funding cycle into broad topic categories. As they show, by sheer numbers of research projects, the thrust of the research endeavor is roughly comparable in each case.

Table 1

In-House BDRP Research Projects By Topic Area

Research Category	Number of Projects	Percent of Total
Vaccine Research	12	20%
Clinical Treatments/Drug Delivery	3	5%
Cellular Disease Mechanisms	4	7%
Broad Spectrum Anti-viral research	4	7%
Toxin Characterization	15	25%
Diagnostic Research	8	14%
Immunotherapy/immunoregulators	7	12%
Other	6	10%

Source: DOD Research and Technology Work Unit Summaries, FY 1989.

Table 2

Outside BDRP Research Contracts By Topic Area

Research Category	Number of Projects	Percent of Total
Vaccine Research	26	19%
Clinical Treatments/Drug Delivery	7	5%
Cellular Disease Mechanisms	25	18%
Broad Spectrum/Anti-viral research	12	9%
Toxin Characterization	32	24%
Diagnostic Research	10	7%
Immunotherapy/immunoregulators	6	4%
Vector Research/Epidemiology	9	7%
Other	8	6%

Source: DOD Research and Technology Work Unit Summaries, FY 1989.

Much of the bureaucratic accounting for both in-house projects and outside contracts sponsored by the BDRP is accomplished through so-called Work Unit Summaries as noted above. Yet these forms — the principal way the system tracks its vast array of work on a regular basis - often obfuscated the focus of the particular research efforts. Many of the Work Unit Summaries in this funding year, including research commanding some of the largest dollar amounts, contained only vague titles and obtuse references to the work in question. Consider, for example, the titles for the three in-house projects with the largest cumulative funding totals:

1) "Exploratory Studies for the Development of Medical Defensive Countermeasures to Infectious Agents of Biological Origin,"

2) "Basic Studies on Infectious Agents for the Development of Medical Defensive Countermeasures,"

3) "Exploratory Studies for the Development of Vaccines Against Infectious Agents of Potential BW Threat."[50]

These three projects alone commanded nearly $13 million of the BDRP's total funding -- almost 10 percent of the program's cumulative allotment and a full quarter of the program's in-house funds. The actual nature of this research could be inferred only obliquely from the Work Unit Summaries. A review of the publication records of the researchers involved in these projects helped us form a clearer picture.

The top grossing in-house research project (listed first above) received a cumulative funding total over two years of more than $4.7 million -- a vast sum by the standards of biomedical research. It is certainly enough to finance the labs of a couple of Nobel-laureate biochemists over a comparable period. As required, in the Work Unit Summary, K.J. Linthicum, the BDRP's principal investigator for this particular project, outlined the objective, approach, and progress of his research. But, like the research title, many of the form's descriptions are written in vague jargon. "Ecologic and genetic factors relating to vector and reservoir competence are studied under controlled conditions," Linthicum writes, for example.[51]

Using the work unit summary as a key, however, several articles published in 1990 and 1991 offer a much fuller sense of this research effort. It seems that, at least during this time period, Linthicum's efforts were concerned particularly with two insect vectors (sources of disease transmission): ticks and mosquitoes. In the *Journal of Medical Entomology,* Linthicum and some ten co-authors assess the "possible role of ticks as the maintenance host for epizootic strains of Venezuelan equine encephalomyelitis (VEE) virus."[52] Linthicum, et al. inserted the VEE virus into ticks and demonstrated that it could replicate in the insect vector.

Another striking article, published in the *Journal of the American Mosquito Control Association*, recounts the findings of an effort that Linthicum presided over during this funding cycle in which mosquito breeding habitats were sequentially flooded in a part of central Kenya where the deadly virus Rift Valley fever is endemic.[53] The goal of the effort, according to the article abstract, is "to determine the numbers of mosquito eggs hatching during each flooding." A related article published several months earlier in the *American Journal of Tropical Medicine and Hygiene* includes Linthicum as a co-author. This research addresses the "transmission of Rift Valley fever virus [a strain that cannot cause the disease] by adult mosquitoes after ingestion of the virus as larvae."[54]

Having pieced together a fuller picture of what the U.S. government purchased in Linthicum's case with taxpayers' $4.7 million, how can one assess such a research effort? In the ensuing analysis, we attempt to evaluate research like Linthicum's in a number of different ways. First, we look at how a given project corresponds to the BDRP's stated mission. In the case of Linthicum's research, for instance, were the VEE virus and Rift Valley Fever legitimately conferred upon the program as threat agents worthy of study?

While the VEE virus does constitute a validated threat agent according to the military's own assessment, Rift Valley Fever is not considered a biological threat agent under development by any nation, but rather a deadly, naturally occurring disease particularly prevalent in Africa. According to the GAO, more than $12 million in taxpayer funds has been spent in the quest for a vaccine against Rift Valley Fever.[55] The development of such a vaccine might, in itself, be a worthy goal, but it is of questionable value and arguably provocative in a program concerned with offering a defense against biological-weapons agents.

Next, we evaluate the program's adherence to its mandate to be "strictly defensive" in nature. In the Linthicum case, research into insects that transmit VEE virus and Rift Valley Fever does not technically violate the provisions of the Biological Weapons Convention; there are legitimate prophylactic purposes for learning more about such disease-transmission pathways. Nonetheless, replicating even a "disarmed" strain of a virulent disease in insects is itself likely to stimulate concern, particularly when the disease involved is not believed to be a threat agent. Such research is an essential first step to weaponizing a biological organism.

In this case, clear patterns emerge that cast serious doubts on the program's stated goals and capabilities. The BDRP continues to sponsor a good deal of research with clear offensive value, but without clear defensive utility. Linthicum's research was conducted in-house, but the provocative nature of many BDRP projects can be seen as well in the contracts that the BDRP awards to outside institutions.

A 1988 assessment by journalist and Center for Public Integrity board member Charles Piller and molecular biologist Keith Yamamoto, a member of the National Academy of Sciences, determined that a full one third of the BDRP's in-house research from 1979-1986 fell into a category they considered to be offensive in nature.[56] Consulting with several well-established biomedical scientists to try to conduct a similar assessment for the 1989 overall program, we found that only a relatively small portion of BDRP work could be construed as purely defensive. This included studies on the diagnosis of biological-weapons related illness, the detection of biological agents in the environment or in the body, and studies seeking clinical treatments. The vast bulk of the program -- including much of the BDRP's toxin and vaccine research and development — fell into a gray area, yielding research results of interest to either a defensive or an offensive program. These studies included the manipulation of organisms in ways that could increase their virulence or potency, or could increase their utility as biological weapons; any research dealing with insect vectors, aerosols or other dissemination methods; the study of exotic threat agents; and research involving the production of significant quantities of dangerous organisms or toxins.

Finally, we determined that at least one quarter of the research projects in our FY 1989 snapshot year - 50 or more studies — could not be considered to be solely defensive in nature. This included BDRP contracts to outside research institutions. Some examples are given below.

In one particularly controversial BDRP contract with the University of Massachusetts, for example,

biologist Curtis Thorne used genetic engineering to create a new highly virulent and antibiotic-resistant strain of anthrax.[57] Microbiologist Richard Novick, director of the Public Health Research Institute of New York, says that after close review he believes Thome's research violates the Biological Weapons Convention of 1972. As Novick puts it, "I can see absolutely no defensive reason for this research." Novick says he considers Thome's research an extreme example, but that based on his review of documents obtained for this study, many BDRP research projects support offensive applications.

In a similar example, Yamamoto points to a BDRP project in which researchers modified the botulism neurotoxin so that its toxicity was conserved, but its antigenicity — the ability of a virus or other substance to invoke an immune response in a victim — was altered, thus yielding a form of botulism that would be unaffected by a conventional vaccine.[58]

According to our BDRP data, these two highly provocative projects alone will cost U.S. taxpayers more than $1 million over their combined project lifetimes.

One research project at Harvard University investigated "pathogen maturation and infectivity" of infected ticks at a cost of nearly $400,000 in the 1988-89 funding year alone. Another at the University of Ohio, in Athens, Ohio, studied the ability to infect rodents using mosquito vectors. Several other research projects, amounting to millions of dollars worth of funding, investigated novel and potentially provocative toxins, such as crotoxins from snails, and snake neurotoxins. In one such project conducted at the private firm SRI International in Menlo Park, California, researchers tried to synthesize a key component of blue-green algae toxins. An in-house BDRP project involved detailed explorations of the genetic and biological character of the venom of the Australian red-bellied snake. We judge all of these projects as particularly provocative because they involve exotic agents or could be used to enhance the ability to disseminate biological weapons.[59]

Research Caliber

As USAMRIID Commander David Huxsoll testified before Congress in 1989:

> There are those who claim that USAMRIID and its scientists are second-rate. This claim is not consistent with the demonstrated performance of these individuals. Both in-house and contract BDRP scientists publish regularly in peer-reviewed journals, and present their work at national and international symposia.[60]

Huxsoll's comment — part of his prepared statement to a U.S. Senate committee rather than a response to hostile questions by committee members — is most noteworthy for its defensiveness. The USAMRIID commander clearly felt the need to address directly on the widespread sentiment that the BDRP was attracting mostly second-tier researchers.

To some extent these sentiments date back to the earliest phases of the military's program. As several historians have noted, the military's biological weapons program never had the kind of support from the top biomedical scientists enjoyed by the Manhattan Project, which drew most of the nation's top physicists.

One aspect that has long rankled scientists and policy makers alike is that the BDRP makes little use

of peer review for the allotment of its research awards. While the program does take some advantage of a network of outside consultants, no significant independent appraisal is included in the normal award procedure.[61] As Huxsoll notes, of course, many of the program's published articles are eventually peer reviewed, but the research projects themselves are not determined by a peer group's independent assessment as is the case in almost all comparable government research programs.

To more fully settle the issue of the caliber of the BDRP's research, we sought a more empirical assessment. To accomplish this, we scrutinized the publication records of the in-house researchers who presided over the largest ongoing projects. We looked at the top twelve of these researchers--all of whom presided over research projects with cumulative funding in the vicinity of $1 million or more, and together controlled some $33.2 million in BDRP research in 1989 -- and surveyed the number of publications they produced individually and cumulatively.

Sheer numbers of publications generated can have special significance in light of the highly sensitive nature of the BDRP's subject matter. For example, H.W. Lupton, a pharmacologist who worked in the BDRP for nine years through 1989, co-authored just five articles in the open literature during his entire tenure at the BDRP. Yet in the 1989 funding year alone he presided over a cumulative total of $1.7 million of research. Notably, Lupton's research prior to his work in the BDRP yielded eight published articles in 1980 alone--the year he arrived at the BDRP. One can only sumise that some of his research results never made their way into the open literature. Lupton — who now works at the Salk Institute in Pennsylvania, a major contractor to the BDRP — made no defense of his publication record when asked about it. He said only that he felt lucky to have been involvedin the BDRP in "the good times" prior to discussion of validated threat agents and other "constraints" that he sees as currently "killing the program." To Lupton, the BDRP's flexibility and ample support made it a strong research program during the 1980s.

The work of two other researchers, J.F. Hewetson and R.W. Wannemacher, tend to support the hypothesis that only a fragmentary picture of the BDRP's work can be gleaned from the open literature. During FY 1989 Hewetson and Wannemacher were key researchers in the BDRP's efforts to study mycotoxins — the same toxins that the U.S. had charged the Soviet Union and its surrogates of having disseminated in Southeast Asia and Afghanistan during the late 1970s and early 1980s.[62] Despite the fact that such U.S. allegations had been conclusively debunked by the mid-1980s, Wannemacher and Hewetson oversaw a cumulative total of some $3.7 million for in-house research — much of it devoted to mycotoxins.[63]

Wannemacher's record is particularly noteworthy. In 1989, Wannemacher himself presided over $1.2 million in in-house research.[64] Between 1989 and 1991, however, our review found only three articles even listing Wannemacher as a co-investigator. Each of the three articles described relatively straightforward research which chronicled the lethal effects of mycotoxins on rats: one by injecting rats, one charting effects from inhalation, and one from absorption through the skin.[65]

Considering the scale of the research effort Wannemacher oversaw, the publication record was lower than would be seen as acceptable by nearly any university or civilian funding agency. Notably, like Lupton, Wannemacher shows a far more productive publication record before his arrival at the BDRP in 1988; averaging about three papers per year before joining the program, one per year afterward.[66] (BDRP officials would not release a list showing the dates individual researchers joined the program, so we established those dates based

on publication records. The BDRP also refused our requests for biographical information on its key researchers.)

What about overall productivity of the BDRP program? According to Thomas Dashiell, former Director of Environmental and Life Sciences for the DOD, in-house BDRP researchers produce roughly 150 scientific papers per year with a budget of approximately $30 million -- $200,000 per published paper.[67] Even accepting Dashiell's figures, which reflect far higher productivity that we could detect in the open literature, this record is hardly grounds for boasting. Dollar for dollar, it is not uncommon for even undistinguished academic programs to have twice that output. By way of comparison, in testimony before a Senate Committee in 1989, Keith Yamamoto noted that his (highly regarded) biology department at the University of California generated some 165 published papers in 1987, receiving a total of just $7 million in federal support — about $42,000 per published paper.[68] Based on figures from Dashiell and Yamamoto, the University of California department's productivity, based on published work, is nearly five times as great as the BDRP's.

But what about the productivity of the program's leading investigators? During 1991, the 12 BDRP researchers with the highest funding totals contributed to the publication of just 19 articles in the open literature — at $33.2 million in total funding, this amounts to $1.75 million per paper — an extremely expensive product for any healthy research program. And this is actually higher than that elite group's average output of slightly more than 16 papers per year from 1985-1989 (see Appendix D). Many BDRP studies fall within the mainstream of academic interests in virology and molecular genetics. Others, such as the more obscure subjects related to diseases of particular military interest, would logically yield fewer published results than studies conducted in an academic department more tightly focused on topical research of wide interest. But based on number of published papers, Yamamoto's department can claim 42 times the productivity of this group — a disparity that goes well beyond expected variations in topic areas.

Quantity of published work is a limited way of assessing a program. We expanded our analysis to publication quality by using the Science Citation Index published by the Institute for Scientific Information (ISI) in Philadelphia, Pennsylvania. ISI combs virtually all scientific publications and tracks all citations. On the basis of these raw numbers of citations, journals are assigned so-called impact factors. Journals whose articles are frequently cited receive a higher impact factor; the index also considers the longevity or "half-life" of articles. Ultimately, journals are ranked against each other to assess which have the most impact on their fields. It is the only such service available, and is used throughout the world.

While this kind of evaluation cannot be considered an absolute measure of the value of a particular study or journal, it neverless provides one of the most respected yardsticks for judging the usefulness of scientific research to scientists themselves. For our purposes, the journal impact ranking system offers a clear benchmark to assess the reputation of journals in which BDRP researchers tend to publish. Again, we have surveyed most closely the publication records of the researchers the largest BDRP projects. If anything, these senior researchers would normally be expected to publish their work more prominently than most of their colleagues.

The results presented in Table 3 illustrate the publication record and impact assessment for the year 1991. (For a complete accounting of the publication record of these researchers over the course of several years, see Appendix D.)

Table 3

1991 Publication Record of 12 Top BDRP Researchers

Journal	# of articles (1991)	Overall Impact Rank*
Journal of Medical Entomology	3	1,477
Antiviral Research	3	363
Journal of Infectious Diseases	2	110
American Journal of Tropical Medicine and Hygiene	1	594
Toxicon	1	864
Journal of the American Mosquito Control Association	1	2,047
Infection and Immunity	1	213
Virology	1	181
Toxicology and Applied Pharmacology	1	528
Journal of Clinical Pathology	1	434
Chinese Medical Journal	1	3,862
Immunopharmacology	1	1,069
Proceedings of the National Academy of Sciences, USA	1	30
Protein Chemistry	1	791

TOTALS: 19 Articles in 14 Journals

Source: Raw data from Medline, impact analysis from Insitute for Scientific Information.

*The impact ranking number is based upon citation impact factors determined by articles published in 4,291 journals tracked during the year 1989. A rank of "1" would mark the most frequently referenced journal.

According to these data, the 12 high-profile researchers within the BDRP published just one article ranked in the top 100 journals. Only four articles (roughly 21 percent) were placed in publications that ranked in the top 200 journals. And seven articles (some 37 percent) were published in what would have to be judged as more obscure journals that did not rank among the top 800 in citation impact factor.

Linthicum's work, for instance, was published in the *Journal of Medical Entomology*, the *Journal of the American Mosquito Control Association,* and the *American Journal of Tropical Medicine and Hygiene*.[69] Only one of the three publications even ranked in the top 1,400 journals in terms of overall impact, according to our empirical ranking system. In Linthicum's case, the publications in question received impact ranks of 1,477;

2,047; and 594 respectively out of 4,291 scientific journals.

Anecdotal accounts we gathered in interviews shed light on this apparently inferior publication record. Past and current BDRP researchers described a slack research environment insulated from other biomedical institutions and largely unaccountable even within the military. Two sources who requested anonymity said that several full-time BDRP researchers ran businesses on the side: one owned and managed a liquor store in town; another ran a delicatessen; still another full-time employee moonlighted selling computer equipment.

The testimonial of one researcher, who spoke on the condition of anonymity, was particularly candid and instructive. This researcher, who worked in the BDRP in the early 1980s and then again more briefly before and during the Persian Gulf War, described the BDRP as an "insulated, country club environment," emphasizing that Army officers hold all key administrative positions. The result, he said, is "funding by administrative [fiat]; there is basically no peer review." In the BDRP, he says,

> the military officers in charge have little experience in the field and are very easily fooled by 'scientific salesmen.' During my years at the program I saw gigantic contracts funded that I never would have seen funded at NIH [the National Institutes of Health] or NSF [National Science Foundation] — military officers with relatively little research experience with millions of dollars of contract money.
>
> Because of the cozy relationship, because they don't really have to justify their research priorities to anyone, you see many researchers [in the BDRP] getting off track from the program's mission to do things that are more fun than necessary. A lot of the work - like some of the stuff on exotic marine toxins and snake venoms — is really just driven by scientists who want to do the latest up-to-date things - who want to look like they are involved in high-tech genetic technology.

Contract Research Quality

While the emerging picture of the BDRP's in-house research raises questions about the program's priorities and caliber, roughly two thirds of the BDRP's funds are allotted in contracts to outside research institutions. A full evaluation, therefore, requires consideration of this component as well.

Interviews with many biomedical researchers show that they hold the BDRP in relatively low esteem. Many contracting scientists for the BDRP freely acknowledged that they would prefer to receive funding from more prestigious government agencies like the National Institutes of Health or the National Cancer Institute. Several researchers told us, in fact, they accepted work with the BDRP only after having been turned down elsewhere for research funds — an increasingly common experience in the biomedical sciences in recent years, as federal spending has tightened. Take, for example, the case of Donald Robertson, a researcher at Brigham Young University in Utah. During funding year 1989 and for several prior years, Robertson received funding from the BDRP for research on anthrax, but he concedes that he would rather have been doing other work. He notes that his grant from the National Science Foundation expired and that he'd had difficulty obtaining funding for his cancer research. He shifted his research agenda and took a contract from the BDRP. As he explains, "I wouldn't be working on this particular project if it weren't funded by the military."[70]

For more of an overview of the BDRP's outside contract institutions, however, we consulted with a range of leading biomedical researchers. Quite simply, they concluded that the BDRP's outside contracts were concentrated in institutions that have little or no history of excellence in biomedical research. While some individual researchers under contract with the BDRP may undoubtedly conduct solid, competent research, in general the BDRP does not attract the best talent.

Of the $84.8 million awarded to ongoing contracts during in the 1989-90 funding period, only $2.6 million (or roughly 3 percent of total funding) found its way to researchers at top-ranked institutions for biomedical research, such as Harvard, Stanford, MIT, and Johns Hopkins. Top-ranked institutions received 7 out of 135 total contracts.

The majority of research money, in fact, went to schools and research institutions with little or no reputation for biomedical research. For example, the little-known Southern Research Institute in Birmingham, Alabama, received about $8 million in BDRP funds. The program gave sizable contracts (over $1 million each) to researchers at an obscure private institution called the Hawaii Biotechnology Group in Aiea, Hawaii, and at Miami University in Coral Gables, Florida. Many other contracts went to larger universities, such as the University of Tennessee in Knoxville, and Auburn University in Auburn, Alabama, that have little reputation for biomedical research.

CONCLUSION

As this report has illustrated, the BDRP has a poor record of upholding the public trust. The Army program has wasted hundreds of millions of dollars on far-flung, exotic, and often provocative research — in direct conflict with its stated mission. It has failed to respond in a timely fashion to existing biological threats, nor has it yielded a strong track record of products in its 23 years of operation. It has, without question, failed to attract top talent in the field and has often sponsored second-rate research, with a poor publication record both in the number of publications by its top researchers and in the prominence of the journals in which they publish.

Perhaps most disturbing, despite its many statements to the contrary, the BDRP has consistently failed to proceed in a fully open and accountable manner. This has not only hurt the program's credibility, but has arguably proved provocative in the international arena.[71]

The central dilemma about the program's pledge to be open and unclassified is captured well in the commentary of two outside observers, Robert J. Rutman and Harry J. Disch, writing in the journal *Politics and the Life Sciences:*

> [T]he essential question is, 'what is a credible BDRP' which would deter development of BW capability? If the credibility is based on secret research, its deterrent value is questionable. If the BDRP is public, any enemy could concentrate on areas not covered by the public BDRP which again would not act as deterrent.[72]

Neither secrecy nor openness on the part of a biological defense program, in other words, serves as a credible deterrent to, biological warfare. To be sure, the BDRP's current policy - pledging but failing to live up to a commitment to openness — does little to solve the dilemma.

The BDRP's problems — misdirected resources, poor-quality science, muddled goals, secrecy, and allegations of malfeasance — reflect the central contradiction of the BDRP: Because a credible medical defense for biological warfare defies scientific logic in the age of genetic engineering, the program offers a false sense of security. Meanwhile, the emphasis on exotic diseases not recognized as threats suggests to adversaries of the United States that the BDRP's motives may be suspect - encouraging adversaries or potential adversaries to doubt the unequivocal U.S. policy prohibiting the development or production of an offensive biological weapons capability. Those adversaries may well be encouraged to increase their own efforts pertaining to biological warfare. Indeed, in recent years U.S. intelligence agencies have continually upgraded the number of nations estimated to have active biological weapons research programs.

How can these problems be approached? First, greater openness and accountability in the BDRP are required. Not only has the program's caliber suffered as a result of its insulation and isolation; our democratic processes and the program's legal mandate require fuller disclosure. In this sense, any and all Congressional efforts to bring more oversight to the program are potentially useful.

Because, as we have shown, there is no hard distinction between offensive and defensive research in the area of biological agents, the issue of intent on the part of the program's military leaders and its researchers

cannot be escaped. For this reason, several Members of Congress and other observers have recommended that the vaccine and disease-related research now conducted by the BDRP be shifted under the auspices of a civilian agency, such as the National Institutes of Health (NIH).[73]

If the central goal of the BDRP is to create vaccines and other prophylactic treatments against rare and potentially threatening diseases, it makes sense to move this research to an agency with a stellar track record in those areas, an agency with a widely admired peer-review system, and one with no hint of military intent. NIH fills all those requirements.

Several observers have suggested that, following a model currently being developed for chemical weapons, an international agency such as the World Health Organization (WHO) establish a biological defense research program with participants from many nations. Such an international effort, if established, would appear to resolve many of the problems presented by the BDRP.[74]

Because it would be international, a biological defense program at an agency like WHO would not be seen as provocative; it would not risk escalating a biological arms race. Because it would be located in a civilian agency (as is the case in the NIH proposal above), the defensive motives of such a program would be above reproach. Furthermore, such an international agency would be well positioned to help enforce the strict international treaty that bans biological weapons entirely. International teams under the auspices of this agency could inspect and verify adherence to the treaty and they could be called upon to resolve allegations of treaty violations that might arise.

Meanwhile, the military should redirect its biological-defense efforts to training, protective battlefield suits, vehicle and building filtration systems, and decontamination methods. Unlike medical defense measures, all of those techniques have proven effectiveness against both biological and chemical weapons. As the Gulf War experience demonstrated, training and personal protective devices have been sorely neglected by DOD.[75]

The specter of biological warfare is surely terrifying. But there are only two sure ways to reduce the threat. Troops can be protected, at least in a crisis, by well-designed protective gear, and by reliable detection and diagnostic methods that can help to identify — and thereby avoid and even contain--the presence of hazardous biological agents. Nations, on the other hand, can be protected only by upholding and strengthening the international regime that outlaws this heinous class of weapons. In a new, rapidly changing international order, any and all steps toward this end -- including a thorough reassessment of the continuation of the U.S. Army's Biological Defense Research Program — seem well advised.

Appendix A: Program Funding and Funding History in Current Dollars

Fiscal Year	*Biological Defense (in millions of dollars)*
1974	14.4
1975	11.5
1976	15.9
1977	15.9
1978	7.6
1979	16.5
1980	16.0
1981	15.1
1982	21.6
1983	38.8
1984	62.5
1985	68.5
1986	90.6
1987	62.5
1988	50.86
1989	66.49
1990	60.29
1991	68.65
1992	50.09
1993 (requested)	59.7

Appendix B
Military Projects 1989-90:
Ranked by cumulative $ amounts

Performing Organization	Principal Investigator	Title	Objective	Start Date	End Date	Cumulative Funding	Sponsoring Agency	Sponsor Name	Project Number	Program Element
Detrick1, Disease Assessment Div.	Linthicum, KJ	Medical Defense Countermeasures to BW agents	Define disease spectrum of arboviruses to include vector and reservoir competence.	2-Oct-84	2-Jan-93	$4,723,000	Detrickl	Huxsoll, DL	DAOG3810	0602770A
Detrick1, Virology Division	Dalrymple, JM	Basic Studies on Infectious Agents	To elucidate antigenic composition, replicative strategies and specific gene function for viruses (including togaviruses, flaviviruses, bunyaviruses, arena viruses, anthrax).	2-Oct-85	2-Jan-93	$4,540,000	Detrickl	Huxsoll, DL	DAOG1522	0601102A
Detrick4	Jahrling, PB	Exploratory Studies for the Development of Vaccines	Isolate, study and characterize potential BW threat agents using animal models.	2-Oct-92	2-Jan-93	$3,596,000	Detrickl	Huxsoll, DL	DA303912	0602770A
Detrick1, Virology Division	Kende, M	Advanced Study for Anti-Agent Drugs	Assess efficacy of antivirals for Rift Valley Fever and VEE in rodents, evaluate other drugs.	2-Oct-87	2-Jan-93	$2,927,000	Detrickl	Huxsoll, DL	DA302664	0603763A
Detrick3	Wannema-Cher, RW	Development of Immunotherapy Against Toxins	Develop ability to detect toxins in biological samples (including development of technology for fermenter-type production of sufficient toxin for isolation, purification).	2-Oct-92	2-Jan-93	$2,625,000	Detrickl	Huxsoll, DL	DA302650	0602770A
Rsch. Inst. of Chem. Defense	Moore, DH	Maintain Pathophysiology Technologic Capability to Meet and Counter BW Threat AGents	Identify sites of physiological disruption caused by BW agents in intact animal models.	2-Oct-92	2-Oct-96	$2,445,000	Aberdeen/ Chem	Dunn, MA	DA320474	0602770A
Rsch. Inst. of Chem. Defense	Moore, DH	Maintain Advanced Pathophysiology Technologic Capability to Meet and Counter BW Agent Threats	Identify and screen potential diagnostic tools for BW agents.	2-Oct-92	2-Oct-94	$2,414,000	Aberdeen/ Chem	Dunn, MA	DA320473	0603002A
Rsch. Inst. of Chem. Defense	Moore, DM	Maintain Basic Pathophysiology Technologic Capability To Meet and Counter BW Agent Threats	Identify mechanisms of action of biological agents (guinea pigs, doses and site of application are varied).	2-Oct-92	2-Oct-96	$2,246,000	Aberdeen/ Chem	Dunn, MA	DA320472	0601102A
USN Naval Research Lab	Ward, KB	Molecular Modeling of Protein Toxins, Mojave Toxin	Model toxin-active sites and binding sites.	2-Mar-92	2-Feb-97	$2,144,026	Detrickl	Middle-brook, JL	DA314432	0603002A

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Performing Organization	Principal Investigator	Title	Objective	Start Date	End Date	Cumulative Funding	Sponsoring Agency	Sponsor Name	Project Number	Program Element
Detrick1. Pathology	Middlebrook, JL	Basic Studies ot Countermeasures	Identify and characterize all aspects of any toxin threat (guinea pigs, low molecular weight toxins, botulinum, mycotoxins, marine toxins).	2-Jan-85	2-Jan-93	$1,990,000	Detrickl	Huxsoll, DL	DAOG1519	0601102A
Detrick1, Virology Div.	Huggins, JW	Antiviral Drug, Ribavirin	Develop the drug ribavirin.	2-Apr-89	2-Jan-93	$1,726,000	Detrickl	Huxsoll, DL	DA308927	0604758A
Walter Reed, Wash DC	Meltzer, MS	Immunomodulators for Defense against BW agents	Test efficacy of immunoregulatory cytokines.	2-Mar-89		$1,484,000	Walter Reed	Tyner, CF	DA310365	0602770A
Detrick4	Leduc, JW	Rapid Diagnostic Procedures	Test and perfect assays to rapidly detect agents	2-Oct-87	2-Jan-93	$1,358,000	Detrickl	Huxsoll, DL	DA302669	0603763A
Detrick6	Williams, JC	Rickettsia Vaccine	Evaluate a choloroform-mehthanol extracted residue vaccine; seek new subunit vaccine.	2-Oct-87	2-Jan-93	$1,197,000	Detrickl	Huxsoll, DL	DA302650	0603763A
Detrick3	Hewelson, JF	Mycotoxins	Develop methods for field detection and therapeutic, prophylactic agents (involves monkeys, mice, T-2 Metabolites, saxitoxin, goat antisera to brevetoxin).	2-Oct-88	2-Jan-93	$1,113,000	Detrickl	Huxsoll, DL	DA305650	0603763A
Detrick1, Virology	Lupton, HW	Vaccine Argentine Hemorrhagic Fever (Junin)	Develop and test live attenuated junin virus.	2-Jan-87	2-Jan-93	$1,101,000	Detrickl	Huxsoll, DL	DA313525	0604807A
Walter Reed Inst. of Research, Division of Biochemistry	Gemski, P	Molecular and Cell Biology of Bacterial Toxins	Study virulence factors of bacteria primarily staphylococcal enterotoxins (involving recombinant DNA; cell culture systems; chromographic; physical, chemical and immunochemical techniques).	2-Oct-90		$1,066,000	Walter Reed	Tyner, CF	DA314584	0602770A
USN Naval Medical research and Development Command	Oprandy, J	Advanced Development Rapid Diagnostic Procedures	Produce enzyme-labeled immunoassays for specific antigens and antibodies, nucleic-acid probes.	2-Oct-86	2-Sep-95	$990,000	Detrick6	Robinson, D	DA301600	0603763A

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Performing Organization	Principal Investigator	Title	Objective	Start Date	End Date	Cumulative	Sponsoring Agency	Sponsor Name	Project Number	Program Element
Detrick2	Friedlander, AM	Toxin Effects Determination Studies	Determination of the sequence of events leading to intoxication and immunity.	2-Oct-92	2-Jan-93	$968,000	Detrickl	Huxsoll, DL	DA302630	0602770A
Detrickl, Virology Div.	Ussery, MA	Medical Defense Countermeasures to BW agents	Develop novel antiviral drugs (against Rift Valley Fever).	2-Oct-85	2-Jan-93	$898,000	Detrickl	Huxsoll, DL	DA0G3815	0602770A
Detrickl	Huggins, JW	Antiviral Drug, Ribavirin	Develop the drug ribavirin.	2-Oct-88	2-Jan-93	$805,000	Detrickl	Huxsoll, DL	DA305993	0603750A
Detrick2	Anderson, AD	Immunomodulators/ Enhancers	Define and quantify changes that occur in vaccinated animals when exposed to agents.	2-Oct-88	2-Jan-93	$805,000	Detrickl	Huxsoll, DL	DA308926	0603763A
Detrick1, Disease Assessment Div.	Leduc, JW	Rapid Diagnostic Procedures against BW agents	Rapid diagnosis of BW agents.	2-Oct-85	2-Jan-93	$715,000	Detrickl	Huxsoll, DL	DAOG3811	0602770A
Detrickl	Lupton, HW	Vaccine Chikungunya	Develop and test a live attenuated chikangunya vaccine.	2-Oct-90	2-Jan-93	$640,000	Detrickl	Huxsoll, DL	DA311563	0603750A
Veterans Administration, Tuscon, AZ	Katz, MA	Responses of Guinea Pigs to Experimental Arenavirus Infection	Identify the microvascular defects caused by arenavirus (pichinde virus)	2-Jul-91	2-Jun-94	$564,717	Detrickl	Liu, CT	DA313197	0602770A
Walter Reed Inst. of research, Division of Pathology	Tseng, J	Polyvalent Immunities in Mucosal Tissues	Generation of immunities to staphylococcal entertoxins; develop monkey model.	2-Oct-92		$540,000	Walter Reed	Tyner, CF	DA330858	0602787A
Uniformed Services University of Health Sciences, Bethesda, MD	Siren, AL	Marine Toxins	Characterize the autonomic effects (on rats) of marine toxins evaluate possible theraputic, prophylatic agents.	2-Mar-91	2-Feb-94	$520,867	Detrickl	Brunner, DL	DA312820	0601102A

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Military Projects 1989-90:
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Performing Organization	Principal Investigator	Title	Objective	Start Date	End Date	Cumulative Funding	Sponsoring Agency	Sponsor Name	Project Number	Program Element
Veterans Administration Medical Center	McCarley, RW	Effects of Antichlorinesterase on Synaptic Transmission	Study the actions of organophosphorous agents (soman) on synaptic transmission in rats	2-Jan-91	2-Jul-94	$508,924	Detrick1	McMaster, SB	DA319875	0602770A
USN Naval Medical Research and Development Command	Sieckmann, D	Basic Studies on Toxins	Develop broadly cross-reactive anti-idiotypic reagents and test them.	2-Oct-88	2-Sep-98	$495,000	Detrick6	Robinson, D	DA305721	0601102A
Detrick1	Williams, JC	Q Fever Vaccine	Transfer vaccine production technology from research to pilot scale facility	2-Apr-88	2-Jan-93	$475,000	Detrick1	Huxsoll, DL	DA303917	0603750A
USN Naval Research Lab	Ross, MM	Rapid Scrrening and Structural Characterization of Toxins	Develop new techniques in mass spectrometery to analyze various toxins (involving chemical ionization; saxitoxins, blue-green algal toxins, peptide toxins).	2-Mar-90	2-Feb-93	$446,000	Detrick1	Hines, HB	DA310642	0601102A
Detrick1	Leduc, JW	Rapid Diagnosis system for Potential BW agents	Develop, standardize, and conduct field tests of developed, rapid diagnosis assays. (Assays tested for Korean hemorrhagic fever, chikungunya and Argentine hemorrhagic fever)	2-Mar-88	2-Jan-93	$427,000	Detrick1	Huxsoll. DL	DA303505	0603750A
Detrick1	Cosgriff, TM	Vaccine, Clinical Study	Monitor immunizations of staff at risk of exposure; maintain emergency and containment facilities. (Computer data for the special immunization program goes back to before 1983.)	2-Oct-88	2-Jan-93	$420,000	Detrick1	Huxsoll, DL	DA305651	0603750A
Detrick2	Williams, JC	Advanced Studies (non-System Dev) Against Infectious Agents	Define and quantify changes that occur in vaccinated animals when exposed to agents.	2-Oct-88	2-Jan-93	$418,000	Detrick1	Huxsoll, DL	DA086410	0603763A
Walter Reed Inst. of Research, Division of Experimental Therapeutics	Lovelace, JK	Biochemical Mechanisms of Biological Toxin Binding	Study binding action of toxins botulinum, ricin, and modeccin and test possible protectants.	2-Oct-92		$406,000	Walter Reed	Tyner, CF	DA320746	0601102A
Detrick1	Saviolakis, GA	Countermeasures to Bioregulators	Study effects on host vital systems of mammalian low molecular weight peptides like neurohormones	2-Oct-85	2-Jan-93	$400,000	Detrick1	Huxsoll, DL	DAOG1526	0601102A

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Uniformed Services University of Health Sciences, Bethesda, MD	Feuerstein, G	Demorphin as Behavioral and Autonomic Modulator	Characterize the effects of demorphin, a recently discovered opiod-like peptide.	2-Feb-90	2-Jun-93	$398,830	Detrickl	Saviolakis, G	DA309369	0601102A
Uniformed Services University of Health Sciences, Bethesda, MD	Millington, WR	Acetyltransferase: Modifying Neural and Endroncrine Peptides	Investigate regulation of the enzyme in biological potency of endocrinous opiod peptide	2-Feb-90	2-Sep-93	$368,537	Detrickl	Saviolakis, G	DA310523	0601102A
Detrick1, Airborne Diseases Div.	Anderson, AO	Development of Toxoids against BW toxins	Define threat and countermeasures to natural toxins and develop vaccines.	2-Oct-92	2-Jan-93	$306,000	Detrickl	Huxsoll, DL	DA302546	0602770A
Detrickl	Galloway, AK	Tularemia Vaccine	Test experimental vaccines for tularemia.	2-Jun-92	2-Jan-93	$300,000	Detrickl	Huxsoll, DL	DA014901	0603807A
Detrick4	Jahrling, PB	Immunotherapy Against Viral Agents	Select, acquire, and test immune plasma for protective efficacy for hemorrhagic fever virus (involves monkeys, plasma from patients after natural infections with Lassa fever, junin, Ebola virus).	2-Oct-87	2-Jan-93	$297,000	Detrickl	Huxsoll, DL	DA302668	0603763A
Uniformed Services University of Health Sciences, Bethesda, MD	Tsokos, GC	Development and Evaluation of Immunomodulators	To identify immunomodulatory substances to treat viral desease or enhance vaccine efficacy	2-Jun-91	2-Nov-93	$280,725	Detrickl	Kende, M	DA313258	0602770A
Veterans Administration Medical Center, Pittsburg, PA	Sax, M	Diarrheal-Causing Bacterial toxins	Determine the 3-d structures of protein toxins.	2-Jul-91	2-Jun-96	$271,609	Detrickl	Crumrine, MH	DA313880	0602770A
Walter Reed, Div. of Medicine	Rayburn, DB	Lung Injury Etiology by Mediator-Specific Waveforms	Define and decode signal patterns of lung injury.	2-Oct-92		$249,000	Walter Reed	Tyner, CF	DA330854	0601102A
MDRDC Aeromedical Research Lab, Ft Rucker, AL	Kirby, AW	Low Molecular Weight Toxins	Determine effects of selected neurotoxins on neural visual mechanisms.	2-Oct-93	2-Oct-94	$241,000	MDRDC Aeromedical, Ft. Rucker	Karney, DH	DA317765	0602770A

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Chemical Research and Development Center	Krishna-murthy, T	Toxins and Venoms	Determine structures of several venoms and toxins.	2-Apr-92	2-Sep-93	$238,204	Detrick1	Hines, HB	DA314495	0601102A
USN Naval Research Lab, Wash DC	Ward, KB	Antiviral Drugs Molecular modeling and QSAR	Develop new antiviral drugs.	2-Mar-92	2-Apr-93	$227,500	Detrickl	Huggins, JW	DA314675	0603002A
Uniformed Services University of Health Sciences, Bethesda, MD	Feuerstein, G	Acute T-2 Intoxication	Study approaches to therapy of T-2 mycotoxin shock to the autonomic nervous and cardiovascular systems.	2-Jan-90	2-Dec-90	$209,502	Detrickl	Templeton, CB	DA309254	0602770A
Walter Reed, Div. Communicable Disease, Wash DC	Eckels, KH	Gene Cloning of Bacteria	Characterize bacterial strains.	2-Oct-92		$194,000	Walter Reed	Tyner, CF	DA320753	0603002A
Walter Reed, Div. of Communicable disease	Sadoff, JC	Active and Passive Vaccines against BW Agents	Produce active peptide and live salmonella and passive monoclonal vaccines (involves monkeys, volunteers; recombinant salmonella vaccines to induce local pulmonary humoral immunity).	2-Oct-92		$178,000	Walter Reed	Tyner, CF	DA330857	0602787A
Walter Reed	Kopecko, DJ	Rapid Diagnostic Procedures	Develop genetic probes to identify disease-causing microorganisms (involves cloning to develop typhoid fever bacillus probe and virulen shigella).	2-Mar-89		$170,000	Walter Reed	Tyner, CF	DA305809	0603750A
Walter Reed Inst. of Research, Division of CD&I	Meltzer, MS	Immunoregulatory Cytokines	Determine which immunoregulatory cytokines control infection in the lung to develop a broad vaccine.	2-Oct-92		$159,000	Walter Reed	Tyner, CF	DA320748	0601102A
Waller Reed, Div. of Medicine	Wright, DG	Military Hematology: Host Defenses against Bacterial Infections	Understanding and manipulating host defenses against infections via neutrophils.	2-Oct-89		$153,000	Walter Reed	Tyner, CF	DA309372	0601102A
MDRDC Inst. of Dental Rsch USAIDR, Wash, DC	Miller, RA	Saliva as a Diagnostic Tool for Presence of lethal agents	Determine if saliva is a useful specimen for evaluating exposure to neurotoxins.	2-Oct-93	2-Oct-96	$149,000	MDRDC Inst. Dental Research	Plank, HE	DA0G0717	0602770A

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Walter Reed Army Inst.	Chiang, PK	Toxins and Physiologically Active Compounds as Biological Agents	Study toxic action of peptides, toxins and physiologically active compounds.	2-Oct-88		$140,000	Walter Reed	Tyner, CF	DA314412	0602770A
Detrick1, Pathology Division	Siegel, LS	Toxoids Against Botulinal Nuerotoxins	Evaluate Toxoids prepared from highly purified botulinum toxin seratypes A-G.	2-Oct-87	2-Jan-99	$112,000	Detrick1	Huxsoll, DC	DA302670	0603763A
Detrick5	Perich, MJ	Control of BW Threat Vectors	Provide lab and field data on efficacy of pesticides and applications (involving literature search; Rift Valley fever vector in Kenya studied).	2-Oct-91	2-Oct-96	$109,000	Detrick5	Hembree, SC	DA313540	0601102A
USN Naval Research Lab, Wash DC 20375	Ward, KB	Small Molecular Toxins: Crystallization, X-ray Analysis and modeling	Purify and conduct x-ray structural analyses of small molecular toxins.	2-Feb-92	2-Mar-93	$100,830	Detrick1	Hines, HB	DA314433	0603002A
Walter Reed inst. of Research, Division of Medicine	Wright, DG	Basic Mechanisms of Microbial Toxins and Venoms	Identify and understand basic mechanisms for systemic and cellular toxicities.	2-Oct-92		$100,000	Walter Reed	Tyner, CF	DA320758	0602787A
Walter Reed Inst. of Research, Division of Medecine	Wright, DG	Basic Mechansims of Cellular Toxicity	Basic action T-2 mycotoxins, peptides ionophores, marine and snake venoms, ricin.	2-Oct-92		$100,000	Walter Reed	Tyner, CF	DA320747	0601102A
Walter Reed, Div. of Communicable disease	Kopecko, DJ	Development of Vaccines and Diagnostic Methods	Test novel strains of salmonella, deleting specific virulence properties (involves lab animals; volunteers; recombinant DNA techniques, and tests on animals and humans).	2-Oct-92		$100,000	Walter Reed	Tyner, CF	DA330859	0602787A
Walter Reed Inst. of research, Division of Communicable Disease and Immunology	Kopecko, DJ	Diagnosis of Enteric Infections	Identify bacterial disease agents of GI Tract; typhoid fever, bacillary dysentary.	2-Oct-92		$100,000	Walter Reed	Tyner, CF	DA320745	0601102A
Detrick5	Bunner, BL	Toxin Decontamination Unit	Modify existing pesticide equipment for use as a personal decontamination unit.	2-Feb-90	2-Jan-93	$95,000	Detrick5	Hembree, SC	DA311263	0601102A

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Detrick1	Monath, TP	Antiviral Drug, Ribavıran	Develop the drug ribavirin.	2-Sep-93	2-Jan-95	$80,000	Detnckl	Huxsoll, DL	DA320502	0604807A
Walter Reed Inst of Research, Division of Biochemistry	Chiang, PK	Cellular Action of Physiologically Active Compounds and Synthetic Analogs	Study cellular basis of the biological action of peptides, physiologically active compounds.	2-Oct-92		$80,000	Walter Reed	Tyner, CF	DA330858	0602787A
Uniformed Services University of Health Sciences, Bethesda, MD	Engler, RJM	Lassa Fever and VEE: Natural Infection and Immunization	Immunoglobulin responses to VEE and Lassa fever determined.	2-Nov-91	2-Mar-94	$76,400	Detrick1	Peters, CJ	DA313895	0603002A
Detrick5	Burrows, WD	Disinfection and Treatment Residual for Biological Agents in Water	Assess the safety of drinking water, initially contaminated by with biotoxins, after treatment (involving aqeous samples of saxitoxin, ricin, T2, and SEB treated with chlorine and other methods)	2-Oct-93	2-Sep-97	$75,000	Detrick5	Hembree, SC	DA330872	0601102A
Rsch. Inst. of Chem. Defense	Solana, RP	Maintain Pharmacology Technologic Capability to meet and Counter BW Threats	Study changes in neurotransmitter substances in guinea pig brain area related to respiration (involving guinea pigs; observe response of transmitters when challenged with low molecular weight neurotoxins).	2-Oct-93	2-Oct-96	$74,000	Aberdeen/ Chem	Dunn, MA	DA320475	0602770A
Walter Reed Inst. of Research	Lovelace, JK	Botulinum Toxin	Investigate effects of toxin on calcium channel and determine efficacy of certain inhibitors (in mice).	2-May-92	2-Sep-92	$66,000	Walter Reed	Tyner, CF	DA314648	0602770A
Defense Electronics Supply Center	Clark, DN	Biotoxins in Water	Review reactions of biotoxins in natural waters to assess what risk they might pose if consumed	2-Dec-93	2-Aug-94	$49,989	Detrick5	Burrows, WD	DA320738	0601102A
Walter Reed Inst. of Research, Division of Biochemistry	Alving, CR	Delivery of Drugs to Skin	Develop liposomes or other carriers with substantial residence time in the skin.	2-Oct-92		$49,000	Walter Reed	Tyner, CF	DA320758	0602787A
Detrick1	Cosgriff, T	Vaccine, Clinical Study	Determine the safety of various vaccines.	2-Oct-88	2-Jan-93	$43,000	Detnckl	Huxsoll, DL	DA305652	0604758A

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Detrickl	Friedlander, AM	Q Fever Vaccine	Improve current vaccine and produce quantities for tafety testing.	2-Oct-89	2-Jan-93	$34,000	Detrick1	Huxsoll, DL	DA308911	0604758A
Detrick1, Division of Virology	Dalrymple, JM	Vaccines Vectored	Indentification and characterization of immunogenic proteins as possible vaccines (involving characterization of genes responsible for important epitopes, which are then cloned, sequenced, and vectored).	2-Jul-93	2-Jan-95	$21,000	Detrickl	Huxsoll, DL	DA320501	0603807A
ARI USAREUR Field Unit, Heidelberg, Germany	Campbell, RJ	Peptide Analysis Using Tandem Mass Spectrometry	Continue post-doc support at LAIR Nation Research Council (studying regulatory peptide ubiquitin).	2-Nov-92	2-May-93	$18,000	Walter Reed	Nyquist, J	DA318077	0603002A
Brooke Army Medical Center, Fort Houston, TX	Bucknell, AL	Evaluation of Orthopaedic Drainage/ Reinfusion System in Reducing Whole Blood Transfusion Need	Evaluate efficacy of reinfusion of postoperative wound drainage in decreasing transfusion need.	2-Dec-93	2-May-94	$4,768	Detrick6	George, DT	DA320739	0601102A

Source: DOD Research and Technology Work Unit Summaries.

Legend for Agency Names:
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Southern Research Institute, Birmingham, AL	Shannon, WM	Drug Development against Viral Diseases (Biological Testing)	In vitro and in vivo screening program for compounds against high-hazard viruses (involving mice, hamsters; over 2800 compounds received for in vitro evaluation and 8000 assays performed).	1-Nov-85	1-Nov-90	$8,035,219	Detrick1	Huggins, JW	DA308943	0503763A	Contract
Technassociates, Inc., Rockville, MD	Stephen, EL	Identification and Aquisition of Chemicals and Drugs for Antiviral therapy	Analysis and compound selection and acquisition systems and databases to aid orderly procurement.	1-Jul-85	1-Dec-90	$3,466,029	Detrickl	Huggins, JW	DA307820	0603002A	Contract
Jefferson Medical College, Philadelphia, PA	Simpson, LL	A Core facility of the Study of Neurotoxins	Determine likely site and mechanism of action of various neurotoxins. (This involved mice, rats, efforts to grow botulinum and isolate serotype B, to sequence gyroxin, and to develop vaccines)	1-Mar-86	1-May-91	$3,090,868	Detrick1	Bunte, RM	DA310385	0602770A	Contract
Southern Research Inst. Birmingham, AL	Secrist, JA	Synthesis Laboratory for USAMRIID Selection Panel	Large-scale synthesis of selected potential antiviral compounds.	1-Dec-85	1-Nov-90	$2,124,974	Detrick1	Gabrielsen, BJ	DA309084	0603002A	Contract
SRI International, Menlo Park, CA	Lim, P	Shelf-Life Stability of Organic Chemicals, Drugs	Analyze bulk chemical lots, drugs, for purity and stability, availability.	1-Apr-85	1-Sep-90	$1,796,152	Walter Reed	Engle, RR	DA307121	0603002A	Contract
Biological Research Faculty and Facility Inc., Ijamsville, MD	Stephen, EL	Antiviral Drug Development	Identification and selective acquisition of chemicals and drugs for antiviral therapies	1-Jun-89	1-Dec-90	$1,713,613	Detrick1	Huggins, JW	DA318667	0603002A	Contract
Korea University, Seoul, South Korea	Lee, H	Leptospirosis, Scrub Typhus and Colorado Tick Fever-Live Disease in Korea	Field and lab investigations of these viruses	1-Sep-88	1-Oct-91	$1,698,612	Walter Reed	Diggs, CL	DA315678	0603807A	Grant
Minnesota University-Duluth	Drewes, LR	Organophosphate Exposure	Metabolism, seizures, and blood flow in brain after exposure to sarin and soman (in dogs).	1-Oct-85	1-Oct-89	$1,353,989	Aberdeen/ Chem	Hanke, D	DA308772	0602770A	Contract
University of Maryland, Baltimore	Albuquerque, EX	Molecular Targets of Organophosphorous Compounds and Antidotal Agents	Determine the impact of agents and antidotes on nicotinic, muscarinic, and other receptors (in vanous animals)	1-Aug-88	1-Aug-91	$1,350,315	Aberdeen/ Chem	Werrlein, RJ	DA315250	0601102A	Contract
University of Illinois, Urbana	Beasley, VR	Blue-Green Algae Intoxication	Determine the lethal and sub-lethal doses; study mechanism of action (of toxins in swine).	1-Sep-85	1-Dec-89	$1,334,778	Detrickl	Mereish, KA	DA308045	0601102A	Contract

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Southwest Research Institute, San Antonio, TX	Chanh, T	Identification and Development of Toxin vaccines	Use biochemical techniques to produce toxin-carrier conjugates for low molecular weight toxins.	1-Dec-86	1-Dec-89	$1,226,407	Detrickl	Hewetson, JF	DA311717	0601102A	Contract
Hawaii Biotechnology Group, Aiea, HI	Vann, DC	Palytoxin Production and Immunoassay Development	Produce research quantities of highly purified palytoxin and develop immunoassay methodology.	1-Mar-87	1-May-91	$1,198,689	Detrickl	Hewetson, JF	DA312321	0602770A	Contract
Southern Illinois University, Carbondale, IL	Miller, DM	Dinoflagellate Toxin Responsible for Ciguatera Food Poisoning	Grow mass cultures of three strains of dinoflagellates and purify 10 specific toxins from the cultures (inlcudes plan to scale up existing technologies for growth of cultures and purification).	1-Dec-86	1-Nov-90	$1,197,918	Detnckl	Pace, JG	DA311707	0602770A	Contract
Korea University, Seoul, South Korea	Lee, HW	Hemorrhagic Fever with renal Syndrome (Korean H.F.)	Conduct seroepidemiological survey of Hantaan viruses in Korea	1-Feb-86	1-Feb-91	$1,178,824	Detrickl	Dalrymple, J	DA309631	0602770A	Grant
Southern Research Inst. Birmingham, AL	Tice, RE	Staphylococcal Enterotoxin B	Develop a microcapsule-based system for oral immunization and lest this system in mice.	1-Sep-86	1-Mar-91	$1,115,767	Detrickl	Crumrine, MH	DA311708	0602770A	Contract
Washington University, St Louis, MO	Rice, CM	Expression of Yellow Fever Antigens	Assess the feasibility of vaccinia/flavivirus recombinants as live vaccine strains (including work on monkeys and rats).	1-Jun-87	1-May-91	$1,048,068	Detnckl	Dalrymple, JM	DA312958	0602770A	Contract
State University of New York Research Foundation, Albany, NY	Kao, CY	Site-Specific Antagonists to Tetrdotoxin and Saxitoxin	Develop means or agents which will prevent ttx/stx from binding sites in various animals.	1-Apr-87	1-May-90	$992,110	Detrickl	Wannema-cher, RW	DA312539	0602770A	Contract
Minnesota University, Miami, FL	Baden, DG	P. Brevis Polyether Neurotoxin	Culture, purify this toxin and characterize its binding component in rat membranes.	1-Aug-88	1-Jan-92	$951,340	Detrickl	Wannema-cher, RW	DA315082	0602770A	Contract
University of Washington	Catterall, WA	Paralytic Neurotoxin Action	Characterize purified toxins; isolate purity, establish peptide sequences, develop monoclonal antibody.	1-Sep-84	1-Sep-89	$950,011	Detrickl	Mereish, KA	DA305250	0601102A	Contract
Cinecom Corporation, Cambridge, MA	Shipley, M	Neurobiology of Soman	Determine effects of soman on acetylchlonnesterase, blood brain barrier, etc. in rats.	1-Nov-85	1-Oct-90	$940,229	Aberdeen/ Chem	Kirby, A	DA308991	0602770A	Contract

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Scripps Clinic and Research Foundation, La Jolla, CA	Buchmeier, MJ	Synthetic vaccines for Arenavirus	Identify antigenic peptides for arenavirus	1-Aug-86	1-Jul-91	$907,400	Detrick1	Jahrling, PB	DA310904	0602770A	Contract
Minnesota University, Miami, FL	Mirocha, CJ	Trichothecene Mycotoxins	Determine structure of toxins and identify metabolites and distribution in animals.	1-Jul-85	1-Dec-89	$879,657	Detrick1	Wannema-cher, RW	DA307561	0603763A	Contract
University of South Carolina, Columbia, SC	Gangemi, JD	Targeting Antiviral Agents for Arena-Bunya Flavi- and Retroviruses	Develop cell targeted and combination chemotherapy approaches in animals.	1-Dec-87	1-May-91	$854,592	Detrickl	Kende, M	DA313999	0602770A	Contract
University of California at San Diego	Montal, M	Modulation of Ionic Channel Function by Protein Phosphorylation	Determine whether or not the NA+ channel is open due to phosphorylation (involving rats, electric eels, cell culture, brains; using saxitoxin, anatoxin A)	t-Mar-89	1-Aug-92	$832,409	Aberdeen/ Chem	Adler, M	DA318142	0601102A	Contract
SRI International, Menlo Park, CA	Dawson, ML	Monoclonal antibodies for Targeted Delivery of Antiviral Compounds	Improve efficacy of antirviral drugs by targeting delivery.	1-Apr-86	1-Dec-89	$804,174	Detrickl	Kende, M	DA309806	0603002A	Contract
Johns Hopkins University, School of Hygiene and Public Health, Baltimore, MD	Childs, JE	Epidemiology of Hantavirus in the UniversityS	Determine extent of hantavirus infections, association with chronic renal failure (involving volunteers).	1-Jun-89	1-Nov-93	$800,733	Detrick6	Leduc, JW	DA318407	0602770A	Contract
University of Illinois, Urbana, IL	Trammel, HL	Development of a Toxin Knowledge System	Develop computerized system of abstracts and monographs that can provide user tailored reports.	1-Apr-87	1-Dec-89	$792,027	Detrickl	Linden, CD	DA312544	0601102A	Contract
University of California at San Diego	Taylor, P	Sequencing of Acetylchlorinesterase, Detection of Organophosphate Toxicity	Sequence acetylcholinesterase from torpedo Californica.	1-Aug-87	1-Jul-90	$744,436	Aberdeen/ Chem	Broomfield, C	DA313364	0601102A	Contract
University of Wyoming, Dept of Molecular Biology, Laramie, WY	Kaiser, II	Rattlesnake Neurotoxin	Study the structure, mechanism of action, immunology, and molecular biology of this toxin.	1-Mar-89	1-Jul-92	$730,119	Detrickl	Middlebrook, JL	DA317821	0602770A	Contract
University of Wyoming, Dept of Molecular Biology, Laramie, WY	. Kaiser, II	Structure Study of Snake Neurotoxins	Study Structure, Mechanism of Action, Immunology, and Molecular Biology	1-Mar-89	1-Jul-92	$730,119	Detrickl	Middlebrook, JL	DA317821	0601102A	Contract

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Hawaii University, Honolulu, HI	Scheuer, PJ	Marine Biotoxins	Produce and deliver research amounts of specific maine biotoxins	1-Sep-87	1-Dec-92	$706,404	Detrick1	Bunner, DL	DA313306	0602770A	Contract
Jefferson Medical College, Philadelphia, PA	Simpson, LL	Treatment of Botulism	Examine Interaction Between Toxin and Amino-Pyridines and Theophylline	1-Sep-85	1-Dec-89	$697,842	Detrickl	Middlebrook, JL	DA308044	0602770A	Contract
Health Research Inc., Buffalo, NY	Paoletti, E	Genetically Engineered Poxviruses and Live Recombinant Vaccines	Construct Live Recombinant Vaccines by Inserting Foreign Genes into Poxvirus	1-Jul-85	1-Dec-90	$692,582	Detrickl	Dalrymple, JM	DA307580	0602770A	Contract
Utah State University, Logan UT	Sidwell, RW	Determination of the in Vitro and In Vivo activity of compounds against Punta Toro Virus	Establish in vitro and in vivo screening program	1-Dec-85	1-Nov-90	$681,552	Detrickl	Pifat, D	DA309005	0603763A	Contract
Columbia University, New York, NY	Frame, JD	Lassa Fever Immune Plasma	Collect immune plasma from volunteers who are diagnosed with lassa fever	1-Jul-85	1-Feb-90	$680,519	Medical Material Development	Johnson-Winegar, A	DA307527	0603750A	Contract
Wright State University, Dayton, OH	Carmichael, WW	Cyanobacteria Blue-Green Algae Toxins	Isolate and Purify research Amounts of Algal Toxins, Microcystin and Anatoxins	1-Nov-86	1-Jan-90	$679,365	Detrickl	Bunner, DL	DA311711	0602770A	Contract
University of Alabama, Birmingham, AL	Woods, WT	Low Molecular Weight Toxins	Study microcystin slow death factors in dogs; determine how TTX, BTX and STX affect sodium channels	1-Sep-87	1-Jun-89	$677,802	Detrickl	Templeton, CB	DA318297	0601102A	Contract
Health Research Inc., Buffalo, NY	Bello, J	Interferon Inducers against Infectious Diseases	Prepare analogs of the standard antiviral interferon inducer poly ICLC	1-Mar-87	1-Mar-90	$672,411	Detrickl	Kende, M	DA312541	0602770A	Contract
Texas University, Galveston, TX	Baron, S	Combination Chemotherapy using immune modulators and antiviral drugs against Toga and Bunyaviruses	Develop combination chemotherapy drugs against alpha-, flavi-, and bunyaviruses	1-Mar-86	1-May-89	$668,613	Detrickl	Kende, M	DA309552	0603002A	Contract
University of California at Los Angeles	Pardridge, WM	Peptide Transport through the Blood-Brain Barrier	Study mechanisms of peptide transport in mammals across the blood-brain barrier	1-Jul-87	1-Jun-90	$664,053	Detrickl	Saviolakis, G	DA313214	0601102A	Contract

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Performing Organization	Principal Investigator	Title	Objective	Start Date	End Date	Cumulative Funding	Sponsoring Agency	Sponsor Name	Project Number	Program Element	Performance Method
University of Massachusetts at Amherst	Thorne, CB	Bacillus Anthracis Improved Vaccine Study	Apply New Genetics, Plasmids, and Toxin Gene Knowledge to Improve the Vaccine	1-Aug-85	1-Jan-91	$610,550	Detrickl	Leppla, SH	DA307949	0602770A	Contract
University of San Francisco, San Francisco, CA	Zavortink, T	Biosystematics of Ades Neomelaniconion (Mosquitoes)	Provide detailed information on the biosystematics of this mosquito	1-May-86	1-Oct-91	$601,348	Detrick1	Linthicum, KJ	DA310407	0602770A	Contract
Rhode Island University, Kingston, RI	Abushanab, E	Synthesis of Phosphates and Phosphonates of V, 2' seco-nucleosides and other antivirals	Antiviral evaluations	1-Jun-89	1-Nov-92	$595,851	Detrick1	Gabnelsen, BJ	DA318476	0603002A	Contract
University of Maryland, Baltimore, MD	Cole, GA	T Cell Responses to Arenavirus Infection	Study T cells induced in response to infections with old world arenaviruses	1-Aug-87	1-Nov-90	$592,214	Detrickl	Jahrling, PB	DA313465	0601102A	Contract
Wayne State University, Detroit, MI	Goldman, H	Blood-Brain Barrier Responses to Central Cholinergic Activity	Test hypothesis that changes that occur after exposure to organophosphorus compounds are blood-brain	1-Dec-87	1-Sep-90	$580,051	Aberdeen/ Chem	Sparenborg, SP	DA313998	0601102A	Contract
North Carolina State University, Raleigh, NC	Johnston, RE	Genetically Engineered Vaccine for VEE	Construct A Live Attenuated VEE Virus with Potential for Use as Vaccine	1-Sep-87	1-Mar-89	$574,668	Detrickl	Smith, JF	DA313286	0602770A	Contract
Southern Research Institute, Birmingham, AL	Tice, TR	Enhancement of Antiviral Agents Through Controlled Release Technology	Develop a Microencapsulation Vaccine Delivery System	1-Oct-85	1-Jul-89	$569,315	Detrickl	Kende, M	DA308752	0602770A	Contract
Kansas State University, Division of Biology, Manhattan, KS	Iandolo, JJ	Receptor Isolation for Staphylococcal Exotoxins	Identify and Isolate the receptor for several staphylococcal exotoxins	1-Sep-89	1-Oct-93	$569,015	Walter Reed	Gemski, P	DA320645	0601102A	Grant
Auburn University, Auburn, AL	Kemppainen, BW	Percutaneous Penetration of Low Molecular Weight Toxins	Determination of effects associated with dermal and mucosal exposure to toxins	1-Dec-86	1-Sep-90	$560,491	Detrickl	Pace, JG	DA311648	0602770A	Contract
NASA Ames Research Center, Moffitt Field, CA	Sebesta, P	RVF Virus Breeeding Sites in Kenya	Establish the relationship between remotely sensed spectral data and RVF breeding habitats (involving data from Kenya).	1-Dec-88	1-Jun-90	$557,835	Detrick1	Unthicum, K	DA317801	0602770A	

Appendix C
Non-military contracts awarded **1989-90:**
ranked by cumulative $ amounts

Performing Organization	Principal Investigator	Title	Objective	Start Date	End Date	Cumulative Funding	Sponsoring Agency	Sponsor Name	Project Number	Program Element	Performance Method
Natural Environment Research Council, Swindon, United Kingdom	Bishop, DHL	Phlebotomus Fever Group Viruses	Identification of phlebovirus infection, characterize candidate strain of RFV virus vaccine	1-Feb-87	1-Jan-91	$548,051	Detrickl	Smith, JF	DA312090	0602770A	Contract
Colorado State University; Dept. of Biochemistry, Fort Collins, CO	Tu, AT	Hydrophiidae Postsynaptic Neurotoxins	Study Structure-Function Relationship of L. Hardwickii Neurotoxin	1-Mar-89	1-Jul-92	$546,199	Detrick1	Middlebrook, JL	DA317822	0602770A	Grant
Colorado State University, Dept. of Biochemistry, Fort Collins, CO	Tu, AT	Peptide Analogues of L. Hardwickii Neurotoxin	Study Structure-Function Relationship of L. Hardwickii Neurotoxin	1-Mar-89	1-Jul-92	$545,199	Detrickl	Middlebrook, JL	DA317822	0601102A	Grant
Scotgen, LTD, Aberdeen Scotland, UK	Harris, WJ	Reshaped Human Monoclonal antibodies for Therapy and Passive Immunization	Prepare reshaped human monoclonal antibodies from domains of murine monoclones	1-Jul-89	1-Dec-91	$534,903	Detrickl	Hewetson, JF	DA318658	0601102A	Contract
University of California at San Diego	Taylor, P	Sequence of Acetylcholinesterase and Detection of Organophosphate Toxicity	Sequencing of acetylchlorinesterase	1-Aug-87	1-Jul-90	$534,774	Aberdeen/ Chem	Broomfield, C	DA313364	0602770A	Contract
Pharm-Eco Laboratories, Simi Valley, CA	Schubert, E	Chemical Preparation Laboratory Vaccine Procurement	Obtain quantities of organic compounds for pre-clinical studies	1-Jan-85	1-Jun-90	$531,000	Detrickl	Gabrielson, B	DA306346	0603763A	Contract
SRI International, Menlo Park, CA	Jennings-White, C	Develop Synthetic Routes for Blue-Green Algal Hepotoxin, Microcystin	Synthesis of Research Quantities of Microcystin, Toxin	1-Apr-88	1-Jun-91	$530,410	Detrick1	Wannema-cher, RW	DA314425	0603002A	Contract
Southwest Foundation for Research and Education, San Antonio, TX	Chanh, T	Anti-Receptor Antibodies to Induce Systemic Immunity of Organophosphorous Compounds	Produce monoclonal antibodies with high affinity for soman	1-Aug-87	1-Jul-90	$517,010	Aberdeen/ Chem	Sadoff, JC	DA313267	0601102A	Contract
University of Wisconsin at Madison	Chu, FS	Detection of Fungal and Dinoflagelatte Toxins	To Produce 95-99% Pure Trichothecenes and their Metabolite	1-May-86	1-Oct-89	$509,681	Detrickl	Wannema-cher, RW	DA310354	0602770A	Contract
Harvard University, Cambridge, MA	Rheinhold, VN	Q Fever Vaccine	Study Structure Function Relationship of the Lipopolysaccharide Components	1-Sep-88	1-Feb-92	$505,442	Detrickl	Williams, JC	DA315340	0603807A	Contract

Appendix C
Non-military contracts awarded 1989-90:
ranked by cumulative $ amounts

Performing Organization	Principal Investigator	Title	Objective	Start Date	End Date	Cumulative Funding	Sponsoring Agency	Sponsor Name	Project Number	Program Element	Performance Method
University of Wyoming. Laramie, WY	Kaiser, II	Structural Studies and Gene Cloning of Crotoxin	Determine Complete Structure of Crotoxin and Related Snake Neurotoxins	1-Mar-86	1-Nov-89	$500,895	Detrick1	Middlebrook, JL	DA309564	0601102A	Contract
Children's Hospital, Boston, MA	Patterson, JL	Action of Ribavirin on Bunyavirus infected Cells	Determine the molecular mechanism of action for the antiviral drug Ribavinn	1-Aug-87	1-Jul-90	$489,021	Detrick1	Ussery, MA	DA313384	0602770A	Contract
Ohio University, Athens, OH	Romoser, WS	Rift Valley Fever Virus in Mosquitoes	Define routes of RVF virus infection and dissemination in mosquitoes and ticks	1-May-89	1-Oct-91	$481,763	Detnckl	Linthicum, K	DA318172	0602770A	Contract
Maryland University, Baltimore, MD	Rogers, TB	Mechanism of Action of the Presynaptic Neurotoxin: Tetanus Toxin	Study mechanism of the tetanus neurotoxin	1-Apr-86	1-Mar-89	$479,366	Detrick1	Middlebrook, J	DA309811	0602770A	Contract
Pharmatic, Alachuca, FL	Brewster, ME	Anti-RNA Viral Agents	Chemically synthesize derivatives of compounds with known brain specific antiviral activity	1-Nov-87	1-Feb-91	$476,470	Detrick1	Gabnelsen, B	DA313892	0601102A	Contract
Bionetics Research Inc., Rockville, MD	Sveda, MM	Molecular Biol Approaches to Disease Prevention and Diagnosis	Characterization and Identification of pathogens	1-Dec-87	1-Mar-93	$475,453	Detrickl	Smith, J	DA314045	0603002A	Contract
SRI International, Menlo Park, CA	Toll, L	Tetrodotoxin and Batrachotoxin Antagonists	Synthesis and Testing of Tetrodotoxin and Batrachotoxin Antagonists	1-Feb-86	1-Sep-89	$474,509	Detnckl	Gabnelsen, B	DA309871	0602770A	Contract
Baylor College of Medicine, Houston, TX	Atassi, 2H	Alpha-Neurotoxins: Molecular Recognition	Study structure-function relationship of alph-nuerotoxin binding to ACH; antigenic structure	1-Mar-89	1-Aug-92	$470,001	Detnckl	Stiles, B	DA318143	0601102A	Contract
Miami University, Miami, FL	Baden, DG	P. Brevis Polyether Neurotoxins	Prepare polyclonal antibodies to Brevetoxin, develop binding assays for these marine neurotoxins	1-Dec-86	1-Nov-89	$465,837	Detrickl	Wannema-cher, RW	DA311718	0601102A	Contract
Univ of South Florida, Tampa, FL	Schneller, SW	Synthesis and antiviral evaluation of pyrazofurin analogues	Antiviral evaluations	1-Jun-89	1-Nov-92	$457,303	Detnckl	Gabnelsen, BJ	DA318542	0603002A	Contract

Appendix C
Non-military contracts awarded 1989-90:
ranked by cumulative $ amounts

Performing Organization	Principal Investigator	Title	Objective	Start Date	End Date	Cumulative Funding	Sponsoring Agency	Sponsor Name	Project Number	Program Element	Performance Method
Pathology Associates, Inc, Ijamsville, MD	Hall, WC	Research Pathology and Special Techniques	Visualization of viruses and viral antigens in research samples	1-May-87	1-May-91	$446,807	Detrickl	White, JD	DA313054	0603002A	Contract
Iowa State University, Iowa City, IA	Nair, V	Unique Purine Nucleosides with Broad-spectrum RNA antiviral potential	Evaluation of antiviral compounds	1-Jun-89	1-Nov-92	$443,835	Detrick1	Gabrielsen, BJ	DA318475	0603002A	Contract
Southern Research Institute, Birmingham, AL	Shannon, WM	Delivery Systems for Antiviral Drugs	Develop derivative of known drugs capable of crossing blood-brain barrier	1-Sep-85	1-Feb-90	$434,483	Detrick1	Gabrielsen, BJ	DA308751	0601102A	Contract
University of North Carolina, Chapel Hill, NC	Johnston, RE	Genetically Engineered Vaccine for VEE	Construct a live attenuated VEE virus with potential for use as a vaccine	1-Jun-89	1-Apr-91	$429,643	Detrickl	Smith, JF	DA318408	0602770A	Contract
Yale University, New Haven, CT	Tignor, GH	Drug Development against viral Diseases (Biological Testing)	In Vivo Screening for the identification of antiviral compounds	1-Feb-86	1-Jan-91	$429,409	Detrickl	Pifat, D	DA309364	0603763A	Contract
State University of New York Research Foundation	Schmidt, J	Mass-Screening of Curarimemetic Neurotoxin Antagonists	Develop Standardized Binding Assays to Screen for Agents that Interact with Toxic Binding Site	1-Feb-86	1-Jan-90	$405,520	Detrickl	Gabrielsen, B	DA309368	0602770A	Contract
Medical College of Georgia, Augusta, GA	Goldstein, B	Soman· Interactions with Benzodiazepines	Characterize electrophysical effects of soman alone and with diazepam	1-Nov-85	1-Feb-89	$399,334	Aberdeen/ Chem	Chang, T	DA309000	0602770A	Contract
Harvard University, Cambridge, MA	Spielman, A	Infectivity of Pathogens in Vector Ticks	To identify physiologic factors that regulate the infectivity of tick-borne pathogens	1-May-87	1-Oct-90	$396.456	Detnckl	Turell, M	DA313057	0602770A	Contract
Hebrew University, Jerusalem, Israel	Soreq, H	Biogenesis of Human Cholinesterases in Humans'Directed by Cloned CNA Cholinesterases Sequences	Study Human Cholinesterase Genes	1-Sep-87	1-Dec-90	$388,522	Aberdeen/ Chem	Wolff, R	DA313450	0601102A	Contract
Ohio University, Athens, OH	Romoser, WS	Rift Valley Fever in Mosquitoes	Study dissemination of RVF virus in mosquitoes, use DNA probes to localize antigens	1-May-86	1-May-89	$388,018	Detnckl	Linthicum, K	DA310371	0602770A	Contract

Appendix C
Non-military contracts awarded 1989-90:
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Performing Organization	Principal Investigator	Title	Objective	Start Date	End Date	Cumulative Funding	Sponsoring Agency	Sponsor Name	Project Number	Program Element	Performance Method
University of Maryland, Baltimore, MD	Warnick, J	Acetylchlonnesterase Inhibitors in the Spinal Cord	Characterize mechanisms for electrophysical effects of organophosphorous compounds	1-Feb-86	1-Sep-89	$369,961	Aberdeen/ Chem	Traub, R	DA309256	0602770A	Contract
Yale University, New Haven CT	Shope, RE	Antigens and Antibodies for diagnosis of arbovirus diseases	Develop Rabbit Antisera and suckling mouse brain antigens to a number of arboviruses	1-Apr-87	1-Mar-90	$368,823	Detrick1	Leduc, J	DA312312	0602770A	Contract
University of Minnesota, Duluth, MN	Mirocha, CJ	Analysis of Saxitoxin from Urine	Develop Method to Analyze Saxitoxin in Urine	1-Jul-89	1-Dec-91	$365,212	Detrick1	Wannama-Cher, RW	DA318543	0603002A	Contract
University of Wisconsin Food Research Inst , Madison, WI	Chu, FS	Marine Toxins	Isolating Marine Toxins	1-Nov-89	1-Mar-93	$365,049	Detnckl	Wannama-cher, RW	DA320648	0601102A	Contract
Imperial College of Science and Technology, London, United Kingdom	Dolly, JO	Botulinum Neurotoxin Treatment Development	Create monoclonal antibodies to polypeptide fragments identified as crucial to its toxic action	1-Jan-88	1-Apr-91	$362,287	Detnckl	Middlebrook, JL	DA314414	0602770A	Contract
New England Medical Center, Boston, MA	Klempner, MS	Mechanism of action of tetanus toxin	Examine the Effects of Tetanus Toxin on Calcium Transport pump	1-Sep-85	1-Aug-89	$354,822	Detrick1	Middlebrook, JL	DA308054	0601102A	Contract
Hahneman Medical College and Hospital, Philadelphia, PA	Fletcher, JE	Membrane Perturbing Agents Snake Venom Cardiotoxins and Phospholipase A	Determine the Effects of Cardiotoxin on Skeletal Muscles, Free Fatty Acids	1-Jun-87	1-Jun-90	$353,011	Detrick1	Smith, L	DA313356	0601102A	Contract
University of Alabama, Birmingham, AL	Brown, GB	NA Channel Neurotoxins	Develop and Standardize an in vitro assay for screening possible therapeutic agents	1 Jan-86	1-Jun-89	$344,719	Detrick1	Gabrielsen, B	DA309246	0603002A	Contract
Georgetown University, Washington DC	Jenson, AB	Antigen and Genome detection of Arena, Bunya, and Filovirus Infections	Identify and quantitate viral genetic protein materials to elucidate morbidity and mortality	1-Sep-88	1-Feb-92	$340,840	Detrick1	Zack, PM	DA315324	0603002A	Contract
Spelman College, Atlanta, GA	Muldrow, LL	Genetic Engineering of Clostridium Difficle Toxin A Vaccine	Produce a toxin vaccine based on protective epitopes	1-Jun-87	1-Nov-91	$340,512	Medical Material Development	Brandt, WE	DA314471	0602770A	Contract

Appendix C
Non-military contracts awarded 1989-90:
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Performing Organization	Principal Investigator	Title	Objective	Start Date	End Date	Cumulative Funding	Sponsoring Agency	Sponsor Name	Project Number	Program Element	Performance Method
Natural Environment Research Council, Swindon, UK	Nuttall, PA	Diagnosis and Prevention of Infection by DUG Nairovirus	Determine Molecular Mechanisms of Nairovirus infections in vectors and hosts	1-Sep-87	1-Sep-90	$331,881	Detrick1	Peters, CJ	DA313454	0601102A	Contract
Hebrew University, Jerusalem, Israel	Green, BS	Protein Toxin Destruction with Hydrolyzing Catalytic Monoclonals	Create antibodies that can recognize and detoxify toxin peptides by catalyzing their hydrolysis	1-Dec-89	1-Jan-93	$319,894	Walter Reed	Lowell, GH	DA320742	0602787A	Grant
Weizmann Institute of Science, Department of Chemical Immunology, Rehovot, Israel	Arnon, R	Development of carriers and adjuvants for use with peptides to induce mucosal and systemic immunity	Enhance immunogenicity of ricin, NTP2 and SEB peptides to elicit secretory and systemic antibodies	1-Dec-89	1-Apr-93	$317,320	Detrickl	Hewetson, JF	DA330873	0601102A	Grant
SRI International, Menlo Park, CA	Judd, AK	Immunization Against Ricin Using Synthetic Peptides	Develop synthetic peptide analogs of the highly toxic protein ricin	1-Mar-87	1-Jul-89	$307,070	Detrickl	Siegel, L	DA312318	0602770A	Contract
Maryland University, Baltimore, MD	Bergey, CK	Mechanisms of Action of Clostridal Neurotoxins	Define Method of Action of Botulinum and Tetanus Toxins	1-Jan-86	1-Dec-86	$291,235	Detrickl	Middlebrook, JL	DA309151	0602770A	Contract
Scripps Clinic, La Jolla, CA	Tsoukas, CD	Effects of Immunomodulatory drugs on T-Lymphocyte activation and function	Determine the effects of immunomodulatory Drugs on T Lymphocyte activation and function	1-May-86	1-Sep-89	$289,748	Detrickl	Kende, M	DA310386	0602770A	Contract
Alabama University	Leblanc, PA	Arena- Alpha- and Adenoviridae	Screen for immunoenhancing drugs with antiviral capability against these toxins	1-Jan-86	1-May-89	$269,166	Detrickl	Kende, M	DA309247	0603002A	Contract
National Marine Services NOAA, Seattle, WA	Eklund, MW	Plasmids and Bacteriophages in Toxigenicity of C. Botulinum	Determine the presence of plasmids in toxin, study the genetic structure of converting bacteriophage.	1-Sep-84	1-Sep-90	$261,700	Detrick1	Smith, LA	DA305617	0601102A	
University of Maryland, Baltimore, MD	Cole, GA	Alphavirus Epitopes	Identify and characterize neutralizing epitopes, genomic sequences; create synthetic peptide vaccine	1-Sep-85	1-Aug-87	$252,230	Detrickl	Peters, CJ	DA308071	0601102A	Contract
Plum Island Animal Disease USDA/ARS, Greenport, NY	Breeze, RG	Animal Vaccine Trails: VEE and RVF	Test VEE and RVF virus vaccines in large animals.	1-Nov-88	1-Oct-89	$250,500	Detrickl	Dalrymple, JM	DA317940	0603002A	

Appendix C
Non-military contracts awarded 1989-90:
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Performing Organization	Principal Investigator	Title	Objective	Start Date	End Date	Cumulative Funding	Sponsoring Agency	Sponsor Name	Project Number	Program Element	Performance Method
University of Minnesota, Minneapolis	Condie, RM	Immunotherapy of Hemorrhagic Fever Infections	Fractionate and purify immunoglobin from lassa immune plasma	1-Jul-85	1-Dec-88	$232,870	Medical Material Development	Johnson-Winegar, A	DA307518	0603750A	Contract
Virginia Commonwealth University, Richmond, VA	Martin, BR	Organophosphates in Guinea Pigs and Mice	Investigate Tissue Disposition of Soman and its metabolites	1-Jun-88	1-Oct-90	$229,660	Aberdeen/ Chem	Lenz, DE	DA314735	0601102A	Contract
Kansas State University, Manhattan, KS	landola, JJ	The enterotoxin D&E Genes from S. Aureus	Clone structural genes, to find similarities between the toxins	1-Nov-85	1-Jun-89	$225,277	Detnck1	Crumrine. MH	DA309001	0601102A	Contract
Anzona State University, Tempe, AZ	Pettit, GR	Drugs against Lethal Human RNA-Viruses	Collect, Isolate and Characterize potentially useful antiviral substances	2-Jan-89	1-Jul-91	$210,332	Detrickl	Gabnelson, BJ	DA317987	0602770A	Contract
Pasteur Institute, Bangui, Central African Republic	Georges, AJ	Epidemiology of Filoviruses in Central Africa	Conduct seroepidemiological surveys for filoviruses	1-Oct-86	1-Sep-88	$196,000	Detrick1	Johnson, E	DA311672	0602770A	Grant
George Washington University Washington DC	Conn, ML	Screening immunomodulators in Humans	Use of virus specific Human T Lymphocyte clones to screen immunomodulators for in vivo activity	1-Mar-86	1-Apr-89	$188,659	Detrickl	Kende, M	DA309562	0601102A	Contract
University of Florida, Gainesville, FL	Dankert, JR	Botulinum Toxins	Determine the Receptor Binding and Membrane Transport Interactions of Botulinum	1-Apr-86	1-Mar-90	$188,267	Detrickl	Middlebrook, JL	DA310518	0602770A	Contract
University of Virginia, Charlottesville, VA	Hunt, DF	Neurotoxin and Epitope Structural Studies	Analyze the ammo acid sequences of vanous Botulinum toxin peptides	1-Sep-87	1-Dec-90	$164,137	Detrickl	Schmidt, JJ	DA313304	0601102A	Contract
La Plata University, La Plata, Argentina	Romanowski, V	Molecular Characterization of Attenuated Junin Virus Variants	Clone and sequence attenuated Junm vaccine	1-May-89	1-Oct-92	$155,900	Detrickl	Fifat, D	DA318199	0603002A	Grant
National Bacteriological Laboratory, Stockholm, Sweden	Milestone, B	Nephoropathia Epidemic in Sweden	Study voles and puumala virus outbreak to determine correlation between the two.	1-Nov-88	1-Apr-92	$150,000	Detnck1	Leduc, JW	DA315683	0602770A	Grant

Appendix C
Non-military contracts awarded 1989-90:
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Performing Organization	Principal Investigator	Title	Objective	Start Date	End Date	Cumulative Funding	Sponsoring Agency	Sponsor Name	Project Number	Program Element	Performance Method
Food and Drug Administration, Rockville, MD	Page, SW	Seafood Toxins	Confirm Structures of up to 12 additional PSP reference standards, and hold a conference.	1-Jul-87	1-Jul-88	$150,000	Detrick1	Bunner, DL	DA313381	0602770A	
Louisville University, Louisville, KY	Doyle, RJ	Vaccine for Anthrax	Purify and Characterize Surface Structures of Bacillus Anthracis as potential vaccines	1-Jun-87	1-Sep-89	$146,142	Detrickl	Ezzell, JW	DA312798	0602770A	Contract
U.S. Dept. of Health and Human Services, Atlanta, GA	Chu, MC	Analysis of Dengue Virus Enhancing Epitopes	Identify enhancing epitopes to Den-1 and Den-2 strain, complete genomic sequence of sensitizing genes.	1-Sep-89	1-Sep-91	$112,372	Medical Materiel Development	Brandt, WE	DA320711	0601102A	
Birmingham University, Birmingham, UK	Walker, RT	Sysnthesis of Nucleoside analogues with antiviral potential against RNA virus targets	Develop new antiviral compounds	1-Sep-86	1-Aug-89	$104,080	Detrick1	Gabrielsen, BM	DA311008	0602770A	Contract
NASA Goddard Space Center Lab for Terrestrial Physics, Greenbelt, MD	Tucker, CJ	Remotely-Sensed Satellite Imagery to Ecologically-Linked Disease Outbreaks in Africa and S. America	Analyze data to determine possible correlation between disease outbreaks and changes in ecology.	1-Jul-88	1-Jun-91	$102,000	Detrickl	Linthicum, K	DA314904	0602770A	
Tennessee University, Dept. of Medical Biology	Chen, JP	Pichinde Virus Pathogen in Guinea Pigs	Measure pichinde virus peptides in infected guinea pigs	1-Dec-88	1-Nov-89	$79,891	Detrick1	Lewis, RM	DA315691	0602770A	Grant
National Academy of Sciences, Washington, DC	Spindel, W	Develop a Guide for Safe Handling and Disposal of Haz. Biological. Materials	Comprehensive guide for the handling of hazardous. biological materials	1-May-86	1-Nov-88	$75,000	Detrickl	Spertzel, RO	DA311682	0603753A	Grant
Ohio University Dept of Zoological and Biomedical. Sciences, Athens, OH	Romoser, WS	Mosquito Immunity following ingestion of blood from immune host	Evaluate effects of vertebrate anti-mosquito antibodies on 3 mosquito species	1-Nov-89	1-Mar-91	$48,969	Detrickl	Linthicum, KJ	DA320647	0603002A	Grant

Legend for Agency Names: See page. 55.

Source. DOD Research and Technology Work Unit Summaries.

BW DATABASE KEY CODES

Detrick1--MDRC [Medical Defense Research and Development Command] Medical Research Institute of Infectious Diseases, Fort Detrick, Frederick, MD 21701

Detrick2--MDRDC Medical Research Institute of Infectious Diseases, Aiborne Diseases Division, Fort Detrick, MD 21701

Detrick3--MDRDC Medical Research Institute of Infectious Diseases, Pathophysiology Division, Fort Detrick, MD 21701

Detrick4--MDRDC Medical Research Institute of Infectious Diseases, Disease Assessment Division, Fort Detrick, MD 21701

Detrick5--MDRDC Biomedical Research and Development Laboratory (USABRDL), Fort Detrick, Frederick, MD 21701

Detrick6--MDRDC Medical Research and Development Command

Walter Reed-Walter Reed Army Institute of Research

Aberdeen/Chem--Walter Reed Army Institute of Research

Medical Materiel **Development**--MDRDC US Army Medical Materiel Development Agency, Fort Detrick

MDRDC Aeromedical Research Laboratory, Fort Rucker, Alabama

MDRDC Institute of Dental Research (USAIDR) Washington, DC

Appendix D

1985-91 Publication Record of 12 Top BDRP Researchers

Journal	No. of articles (1985-1991)*	Overall Impact Rank*
American Journal of Tropical Medicine and Hygiene	13	594
Toxicon	8	864
Journal of Infectious Diseases	7	110
Journal of the American Mosquito Control Association	6	2,047
Journal of Medical Entomology	6	1,477
Antiviral Research	5	363
Journal of General Virology	5	242
Review of Infectious Diseases	5	158
Advances in Experimental Medicine and Biology	4	not ranked
Antimicrobial Agents and Chemotherapy	4	210
Microbial Pathogenesis	4	not ranked
Infection and Immunology	4	213
Virology	4	181
Toxicology and Applied Pharmacology	3	528
American Journal of Epidemiology	2	273
Biochemical Pharmacology	2	441
Current Topics in Microbiology and Immunology	2	994
Journal of Clinical Pathology	2	434
Journal of Virology	2	85
Lancet	2	19
Acta Virologica	1	2,961
Advances in Virus Research	1	72
Annals of the New York Academy of Science	1	1,639
Archives of Virology	1	788
Chinese Medical Journal	1	3,862
Epdemiology and Infection	1	1,155

Appendix D, Cont'd

Journal	No. of articles (1985-1991)*	Overall Impact Rank*
Fundamental and Applied Toxicology	1	1,168
Immunology	1	332
Immunopharmacology	1	1,069
Intervirology	1	1,165
Journal of Biological Chemistry	1	62
Journal of Clinical Microbiology	1	365
Journal of Experimental Medicine	1	27
Journal of Immunology	1	56
Journal of Medical Primatology	1	2,410
Journal of Pharmacology and Experimental Therpeutics	1	199
Journal of Toxicology and Environmental Health	1	1,262
Journal of Wildlife Disease	1	2,444
Laboratory Animal Science	1	2,532
Methods in Enzymology	1	556
Orvosi Hetilap (Budapest)	1	not ranked
Proceedings of the National Academy of Sciences, USA	1	not ranked
Protein Chemistry	1	not ranked
Research in Virology	1	n.a.
Science	1	not ranked

Source: Raw data from Medline, impact analysis from Insitute for Scientific Information. *The impact ranking number is based upon citation impact factors determined by articles published in 4,291 journals tracked during the year 1989. A rank of "1" would mark the most frequently referenced journal.

SELECTED BIBLIOGRAPHY

Bernstein, Barton, "The Birth of the U.S. Biological-Warfare Program," *Scientific American,* Vol. 256, No. 6, 1987, p. 116-121.

. . . ."Origins of the U.S. Biological Warfare Program," in Susan Wright, ed., *Preventing a Biological Weapons Arms Race,* Cambridge, MA: The MIT Press, 1990.

Cole, Leonard, *Clouds of Secrecy: The Army's Germ Warfare Tests Over Populated Areas,* Totowa, New Jersey: Rowman and Littlefield, 1988.

Dasey, Charles, "Medical Benefits of the Biological Defense Research Program," *Politics and the Life Sciences,* Vol. 9, No. 1, August 1990.

Dashiell, Thomas, "The Need for a Defensive Biological Research Program," *Politics and the Life Sciences,* Vol. 9, No. 1, August 1990.

Federation of American Scientists Working Group on Biological and Toxin Weapons Verification, "Implementation of the Proposals for a Verification Protocol to the Biological Weapons Convention," Washington DC: Federation of American Scientists, February, 1991.

Feith, Douglas, Testimony by Deputy Assistant Secretary of Defense for Negotiations Policy Douglas J. Feith before the Subcommittee on Oversight and Evaluation of the House Permanent Select Committee on Intelligence, August 8, 1986. Reprinted in *Defense Issues,* Vol. 1, No. 60, American Forces Information Service.

Geissler, Erhard, ed., *Biological and Toxin Weapons Today,* London: SIPRI/Oxford University Press, 1986.

Genewatch, Special Issue, Vol. 2, No. 2, "The Military and the New Biology," May-August 1985.

Gordon, Michael, "Britain, Like U.S., is to Give Germ-War Shots in the Gulf," *The New York Times,* December 29, 1990.

King, Jonathan, Testimony before U.S. Senate, Governmental Affairs Committee and its Permanent Subcommittee on Investigations, "'Germ Wars' -- Biological Weapons Proliferation and the New Genetics," May 17, 1989.

——"The Threat of Biological Weapons," *Technology Review,* May-June 1982, p. 10-11.

Krimsky, Sheldon, *Genetic Alchemy,* Cambridge: MIT Press, 1982.

Lehman, Ronald, II, Head of United States Delegation, "Statement Before the Biological and Toxin Weapons Convention Third Review Conference," September 10, 1991.

McDermott, Jeanne, *The Killing Wind,* New York: Arbor House, 1987.

Meselson, Matthew, Testimony before U.S. Senate, Governmental Affairs Committee and its Permanent Subcommittee on Investigations, "'Germ Wars'--Biological Weapons Proliferation and the New Genetics," May 17, 1989.

Nass, Meryl, "The Labyrinth of Biological Defense," *The PSR Quarterly,* Vol. 1, No. 1, March 1991.

The *New York Times,* "Panel of Scientists Fears a Biological Arms Race," January 18, 1989.

Novick, Richard and Seth Shulman, "New Forms of Biological Weapons?" in Susan Wright, ed., *Preventing a Biological Arms Race,* Cambridge MA: MIT Press, 1990.

Piller, Charles and Keith Yamamoto, *Gene Wars: Military Control Over the New Genetic Technologies,* New York: Beech Tree Books, William Morrow, 1988.

Root-Bernstein, Robert, "Infectious Terrorism," *The Atlantic,* May 1991, p. 44-50.

Rosenberg, Barbara, "Updating the Biological Weapons Ban," *Bulletin of the Atomic Scientists,* Jan.-Feb. 1987, p. 40-3.

——"Biological Weapons," Encyclopedia of the Twentieth Century, Vol. 8, revised draft, September 1986.

Rutman, Robert and Harry Disch, "Commentary on Articles by Dasey and Dashiell on the Biological Defense Research Program," *Politics and the Life Sciences,* Vol. 9, No. 1, August 1990.

——"Microbiologist Butt of Protests," *Nature,* Vol. 339, No. 4, May 1989.

——"Poisons from the Pentagon," *Progressive,* November 1987.

——"Funding for Biological Weapons Research Grows Amidst Controversy," *Bioscience,* Vol. 37, No. 6, June 1987.

ter Haar, Barend, *The Future of Biological Weapons,* New York: Praeger, 1991.

U.S. Army, Biological Defense Research Program Draft Programmatic Environmental Impact Statement, Ft. Detrick, MD: USAMROC, May 1988.

U.S. Army Medical Research Institute of Infectious Diseases, USAMRIID, Program Description Booklet, United States Army Medical Research Institute of Infectious Diseases, Fort Detrick, MD.

U.S. Department of Defense, "Biological Defense Research Program Obligations Report," in *Annual Report on Chemical Warfare and Biological Research Programs,* 1977-1989.

——Department of Defense Biological Defense Program, Report to the House Committee on Appropriations, May 1986.

U.S. General Accounting Office Report, Operation Desert Storm: DOD Met Need for Chemical Suits and Masks, but Longer Term Actions Needed, GAO/NSIAD-92-116, April 1992.

——Biological Warfare: Role of Salk Institute in Army's Research Program, GAO/NSIAD-92-33, December 1991.

——Chemical Warfare: Soldiers Inadequately Equipped and Trained to Conduct Chemical Operations, GAO/NSIAD-91-197, May 1991.

——Biological Warfare: Better Controls in DOD's Research Could Prevent Unneeded Expenditures, GAO/NSIAD-91-68, December 1990.

U.S. Senate, Governmental Affairs Committee and its Permanent Subcommittee on Investigations, "'Germ Wars'--Biological Weapons Proliferation and the New Genetics," May 17, 1989.

——Appropriations Committee, Hearings on Appropriations for FY 1993, Washington DC: Government Printing Office, 1992.

——Armed Services Committee, Hearings on Appropriations, June 18, 1991, Washington DC: Government Printing Office, 1992, p. 776.

Whiteside, Thomas, "Annals of the Cold War: The Yellow Rain Complex, I and II," *The New Yorker*, February 11, 1991, p. 38-67; and February 18, 1991, p. 44-68.

Wright, Susan, ed., *Preventing a Biological Arms Race*, Cambridge MA: The MIT Press, 1990.

Yamamoto, Keith, "Retargetting Research on Biological Weapons," *Technology Review*, Aug.-Sept., 1989, p. 23-4.

——Testimony before U.S. Senate, Governmental Affairs Committee and its Permanent Subcommittee on Investigations, "'Germ Wars'--Biological Weapons Proliferation and the New Genetics," May 17, 1989.

NOTES

1. "Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction." U.S. officials signed the agreement on April 10, 1972. It entered into force on March 26, 1975.

2. Department of Defense, "Annual Reports on the Chemical Warfare and Biological Research Program Obligations," 1974-1986, and Interview with Charles Dasey, USAMRIID, Nov. 18, 1992.

3. For a discussion of the Sverdlovsk allegations, see: Matthew S. Meselson, "The Biological Weapons Convention and the Sverdlovsk Anthrax Outbreak of 1979," FAS Public Interest Report in *Journal of the Federation of American Scientists*, Vol. 41, No. 7, September 1988; and David Dickson, "Soviets Discuss Sverdlovsk," Science, Vol. 234, No. 10, October 1986, p. 144.

4. Michael Gordon, "Britain, Like U.S., is to Give Germ-War Shots in the Gulf," the *New York Times*, December 29, 1990.

5. United States Department of State, "Action Memorandum 9016243," July 19, 1990, "Foreign Policy Controls for Proliferation-Related Exports to Iraq"; and an attachment, "Iraqi Export Cases: Why They Make The Case For Expanding License Requirements And Review." The memorandum was released to the press by Rep. Sam Gejdenson, Chair of the Subcommittee on International Economic Policy and Trade of the House Committee on Foreign Affairs, on Sept. 23, 1992.

6. See Michael Gordon, op cit., fn. 4.

7. General Accounting Office Report, "Chemical Warfare: Soldiers Inadequately Equipped and Trained to Conduct Chemical Operations," GAO/NSIAD-91-197, May 1991.

8. Testimony of Dr. Billy Richardson, U.S. Senate Armed Services Committee, "Hearings on Appropriations," June 18, 1991, Washington DC: Government Printing Office, 1992, p. 776.

9. Testimony of Dr. Billy Richardson, U.S. Senate Appropriations Committee, "Hearings on Appropriations" for FY 1993, Washington DC: Government Printing Office, 1992, p. 848.

10. Testimony of Dr. Billy Richardson, Op Cit., fn. 8.

11. Numerous experts have made this case. See, for example: Testimony of Dr. Jonathan King, Hearing before the Senate Governmental Affairs Committee and its Permanent Subcommittee on Investigations, "'Germ Wars,' Biological Weapons Proliferation and the New Genetics," May 17, 1989.

12. Michael Gordon, "Negotiators Agree on Accord to Ban Chemical Weapons," the *New York Times*, Sept. 2, 1992; and William Drozdiak, "Historic Pact Bans Chemical Weapons," the *Washington Post*, Jan. 14, 1993.

13. Henry L. Stimson to President, April 29, 1942, quoted in Barton Bernstein, "Origins of the U.S. Biological

Warfare Program," Susan Wright, ed., *Preventing a Biological Weapons Arms Race,* Cambridge, MA: MIT Press, 1990, p. 10.

14. Several scholars have identified these three phases. See, for example: Susan Wright, "Evolution of Biological Warfare Policy: 1945-1990," in Susan Wright, ed., *Preventing a Biological Weapons Arms Race,* Cambridge, MA: The MIT Press, 1990.

15. Barton Bernstein, op cit., fn. 13.

16. Barton Bernstein, "The Birth of the U.S. Biological-Warfare Program," *Scientific American,* Vol. 256, No. 6, 1987, p. 116-121.

17. National Academy of Science Committee Report (WBC Committee), February 17, 1942.

18. Bush and Conant to Stimson, October 27, 1944, cited by Barton Bernstein, op cit., fn. 13.

19. For a detailed account of the Japanese program, see Jeanne McDermott, *The Killing Winds,* NY: Arbor House, 1987, Chapter 8. When the U.S. military occupied Japan at the end of the war, the details of Japan's experiments fell intact into U.S. hands. Those records were retained in secret for decades. In return for their cooperation, leaders of the Japanese biological warfare program were spared prosecution for war crimes.

20. See, for example, John Glenn, Opening Statement, "Proliferation of Biological Warfare and the New Genetics," Hearing Before the Senate Governmental Affairs Committee and its Permanent Subcommittee on Investigations, "'Germ Wars', Biological Weapons Proliferation and the New Genetics," May 17, 1989. See also, *Journal of the American Medical Association,* April 4, 1966, p. 179.

21. One of many authors on the subject who notes this fact is Barend ter Haar, *The Future of Biological Weapons,* NY: Praeger, 1991.

22. George Merck, "Biological Warfare," Report to the Secretary of War by Mr. George Merck, Special Consultant for Biological Warfare, January 3, 1946, reprinted in the U.S. Senate, Committee on Human Resources, "Hearings: Biological Testing Involving Human Subjects by the Department of Defense," p. 23-234, Annex A, p. 71.

23. Quoted in Stockholm International Peace Research Institute, The Prevention of CBW, Stockholm: Almqvist and Wiksell, 1971, p. 278.

24. See Testimony of Dr. Jonathan King, op cit., fn. 11.

25. Han Swyter, "Political Considerations and Analysis of Military Requirements of Chemical and Biological Weapons," Proceedings of the National Academy of Sciences 65, 1970, p. 266.

26. Testimony of Dr. Matthew Meselson, Hearing Before the Senate Governmental Affairs Committee and its Permanent Subcommittee on Investigations, "'Germ Wars,' Biological Weapons Proliferation and the New

Genetics," May 17, 1989.

27. ibid.

28. Henry Kissinger, National Security Decision Memorandum 35, November 25, 1969. Text reprinted in Susan Wright, ed., op cit., fn. 13, Appendix H.

29. Testimony of Douglas Feith, Deputy Assistant Secretary of Defense for Negotiations Policy, Subcommittee on Oversight and Evaluation of the House Permanent Select Committee on Intelligence, August 8, 1986, reprinted in Defense Issues, Vol. 1, No. 60, September 8, 1986.

30. Derived from annual funding figures, see Appendix A.

31. For an account of the Dugway aerial testing facility, see: *Genewatch* Vol. 2, No. 2, May-August 1985; Seth Shulman, "Biological Research and Military Funding," *Technology Review,* April 1987, p. 13-14.

32. Testimony of Douglas Feith, op cit., fn. 29.

33. For further discussion, see Richard Novick and Seth Shulman, "New Forms of Biological Warfare?" in Susan Wright, ed., op cit., fn. 13, chapter 5.

34. Representative Wayne Owen sponsored HR # 806 in the 101st Congress (1989) the "Biological Defense Safety Act of 1989" which was bitterly opposed by the Department of Defense. The bill, which was defeated and has not been reintroduced, would have required the Secretary of Defense to publish an annual listing of all biological agents under investigation by the BDRP.

35. United States Army Medical Research Institute of Infectious Diseases, USAMRIID, Program Description Booklet, Fort Detrick, Frederick MD.

36. Testimony by Col. David Huxsoll, U.S. Senate Governmental Affairs Committee and its Permanent Subcommittee on Investigations, May 17, 1989.

37. ibid.

38. For more information, see fn. 34.

39. John Wagner, "Drafting Rules of Deception - How and When," *Washington Post,* August 6, 1992, p. A23. See also, Federation of American Scientists, *Secrecy and Government Bulletin,* March 1993.

40. From Annual Budget of the United States. For historical detail about these funding categories, see also, U.S. Army Medical Defense Program, "Biological Defense: Functional Area Assessment," USAMRIID, Fort Detrick, November 1984, p. C-10 - C-28.

41. U.S. Army Medical Research and Development Command, Broad Agency Announcement, Fort Detrick, MD,

September, 1989, p. 4.

42. U.S. General Accounting Office, Biological Warfare: "Better Controls in DOD's Research Could Prevent Unneeded Expenditures," GAO/NSIAD 91-68, December 1990.

43. Ibid. See also U.S. General Accounting Office, "Biological Warfare: Role of Salk Institute in Army's Research Program," GAO/NSIAD-92-33, December 1991.

44. Interviews with Dasey took place on Nov. 18 and 19, 1992.

45. Col. David Huxsoll Testimony, op cit., fn. 36, p. 3.

46. U.S. Office of the Secretary of Defense, "Report of the Secretary of Defense's Ad Hoc Committee on Biological Warfare," July 11, 1949, declassified June 25, 1986. Quoted in Susan Wright, "Prospects for Biological Disarmament," paper delivered at a conference of the Canadian Institute of Peace and Security, Ottawa, June 18-21, 1991, p. 9.

47. This information derives primarily from an unpublished background briefing paper prepared by Dr. Meryl Nass for the Committee on the Military Use of Biological Research of the Council for Responsible Genetics, 1992.

48. This illustrates the difficulty of effective medical defense; P. tularensis has been studied intensively by the military since the 1940s.

49. A.K. Galloway, Research and Technology Work Unit Summary, MDRDC Medical Research Institute Infectious Diseases, Medical Division, Fort Detrick, MD, Program Element: 0503807A, Project Number: 3M463807D309, October 20, 1988.

50. 1) P.B. Jahrling, Research and Technology Work Unit Summary [of the BDRP], MDRDC Medical Research Institute Infectious Diseases, Disease Assessment Division, Fort Detrick, MD, Program Element: 0302770A, Project Number: 3M162770A871, October 1988-January 1989.

2) J.M Dalrymple, Research and Technology Work Unit Summary [of the BDRP], MDRDC Medical Research Institute Infectious Diseases, Virology Division, Fort Detrick, MD, Program Element: 0601102A, Project Number: 3M161102BS12, October 20, 1988.

3) K.J. Linthicum, Research and Technology Work Unit Summary [of the BDRP], MDRDC Medical Research Institute Infectious Diseases, Disease Assessment Division, Fort Detrick, MD, Program Element: 0602770A, Project Number: 3M162770A871, October 20, 1988.

51. See fn. 50, #3.

52. K.J. Linthicum, et al, "Venezuelan Equine Encephalomyelitis Virus Infection in and Transmission by the Tick Amblyomma Cajennense (Arachnida: Ixodidae)," *Journal of Medical Entomology,* Vol. 28, No. 3, May 1991, p. 405-9.

53. T.M. Logan, K.J. Linthicum, et al, "Egg Hatching of Aedes Mosquitoes During Successive Floodings in a Rift Valley Fever Endemic Area in Kenja, *Journal of the American Mosquito Control Association,* Vol. 7, No. 1, March 1991, p. 109-112.

54. M.J. Turell, K.J. Linthicum, et al, "Transmission of Rift Valley Fever Virus by Adult Mosquitoes After Ingestion of the virus as larvae, *American Journal of Tropical Medicine and Hygiene,* Vol. 43, No. 6, December 1990, p. 677-80.

55. U.S. General Accounting Office, December 1990, op cit., fn. 42, p. 16.

56. Charles Piller and Keith Yamamoto, *Gene Wars: Military Control Over the New Genetic Technologies,* NY: Beech Tree Books/William Morrow, 1988, p. 132.

57. Curtis Thorne, Research and Technology Work Unit Summary [or the BDRP], University of Massachusetts, Amherst, MA, MDRDC Medical Research Institute Infectious Diseases, Fort Detrick, MD, Program Element: 0502770A, Project Number: 3M162770A871, Aug. 1985-January 1991. Further information about this research can be found in the published literature: B.D. Green, L. Battisti and C.B. Thorne, "Involvement of Tn4430 in transfer of Bacillus anthracis plasmids mediated by Bacillus thuringiensis plasmid pX012," *Journal of Bacteriology*, Vol. 171, 1989, p. 104-113.

58. Dr. Keith Yamamoto discussed this BDRP-sponsored research in testimony at a Hearing of the Senate Governmental Affairs Committee and its Permanent Subcommittee on Investigations, "'Germ Wars', Biological Weapons Proliferation and the New Genetics," May 17, 1989. See I.I. Kaiser, Research and Technology Work Unit Summary, University of Wisconsin, Department of Molecular Biology, Laramie, WY, MDRDC Medicial Research Institute Infectious Diseases, Fort Detrick, MD, Program Element: 0602770A, Project Number: 3M162770A871, March 1989-July 1992.

59. Information on these studies was derived from the following DOD Research and Technology Work Unit Summaries:

Speilman, A. Harvard University, Cambridge, MA. Program Element 0502770A, Project Number 3M162770A871, May 1987-Oct. 1990.

Romoser, W. S., Ohio University, Athens, Ohio. Program Element 0603002A, Project Number 3M2630020807, Nov. 1989-March 1991.

Eckles, K. H., Walter Reed Army Institute of Research, Washington, DC. Program Element 0603002A, Project Number 3M2830020807, Oct. 1988-(no end date).

Kaiser, I. I., University of Wyoming, Laramie, WY. Program Element 0501102A, Project Number 3M1611026S12, March 1986-Nov. 1989.

Kaiser, I. I., University of Wyoming, Laramie, WY. Program Element 0602770A, Project Number 3M162770A871, March 1989-July 1992.

See also: Schmidt, J. J., and Middlebrook, J. L., U.S. Army Research Institute of Infectious Disease, "Purification, sequencing, and characterization of pseudexin phspholipases A2 from Psuedechis porphyriacus (Australian red-bellied black snake)," Toxicon, 1989, 27(7), p. 805-18.

60. Testimony by Col. David Huxsoll, U.S. Senate Governmental Affairs Committee and its Permanent

Subcommittee on Investigations, op. cit., fn. 36.

61. For a more complete discussion of the BDRP's award procedure, see Charles Piller and Keith Yamamoto, op cit., fn. 55, p. 212-14.

62. Two excellent sources on the mycotoxin, yellow rain episode are Thomas Whiteside, "Annals of the Cold War: The Yellow Rain Complex, I and II," *The New Yorker,* February 11 and 18, 1991; and, p. 38-67 and Leonard Cole, "Sverdlovsk, Yellow Rain, and Novel Soviet Bioweapons: Allegations and Responses," in Susan Wright, ed., op cit., fn. 13, Chapter 9.

63. See R.W. Wannemacher, Research and Technology Work Unit Summary [for the BDRP], MDRDC Medical Research Institute Infectious Diseases, Pathophysiology Division, Fort Detrick, MD, Program Element: 0602770A, Project Number: 3M162770A871, October 1983-Jan. 1989; and J.F. Hewetson, Research and Technology Work Unit Summary [for the BDRP], MDRDC Medical Research Institute Infectious Diseases, Pathophysiology Division, Fort Detrick, MD, Program Element: 0603763A, Project Number: 3M263783D807, October 1984-Jan. 1989.

64. ibid.

65. See W.L. Thompson, R.W. Wannemacher, "In vivo effects of T-2 mycotoxin on synthesis of proteins and DNA in rat tissues," *Toxicological Applied Pharmacology*, September 15, 1990, Vol. 105, No. 3, p. 483-91; D.A. Creasia, R.W. Wannemacher, et al., "Acute inhalation toxicity of T-2 mycotoxin in the rat and guinea pig," Fundamentals of Applied Toxicology, Jan. 1990, Vol. 14, No. 1, p. 54-9; and B.L. Bunner, R.W. Wannemacher, et al., "Cutaneous absorption and decontamination of [3H]T-2 toxin in the rat model," *Journal of Toxicology and Environmental Health,* 1989, Vol. 26, No. 4, p. 413-23.

66. The estimate of papers produced annually by the in-house BDRP program derives from Thomas Dashiell, "The Need for a Defensive Biological Research Program," *Politics and the Life Sciences,* Vol. 9, No. 1, August 1990, p. 87.

67. As with other data about the extent of publication, we have relied on a comprehensive search of the MEDLINE database which tabulates and abstracts publications in the biomedical field from 1966 to the present.

68. Keith Yamamoto, Testimony at a Hearing of the Senate Governmental Affairs Committee and its Permanent Subcommittee on Investigations, "'Germ Wars,' Biological Weapons Proliferation and the New Genetics," May 17, 1989.

69. Institute for Scientific Analysis, Science Citation Index, Philadelphia, PA, 1989. For further explanation, see analysis in the "Research Caliber" section.

70. For more on Robertson and similar cases, see: Shulman, Seth. "Poisons From the Pentagon," *Progressive,* November 1987, p. 16-19.

71. See, for example, quotation of Ambassador Winfried Lang, President of Second Review Conference of the

Biological Weapons Convention, in Susan Wright, ed., *Preventing a Biological Arms Race*, (Cambridge, MA: MIT Press, 1990), p. 300. See also, Marie Isabel Chevrier, "Verifying the Unverifiable: Lessons from the Biological Weapons Convention," *Politics and the Life Sciences,* August 1990, Vol. 9, No. 1, p. 93-105.

72. Robert J. Rutman and Harry J. Disch, "Commentary on Articles by Dasey and Dashiell on the Biological Defense Research Program," *Politics and the Life Sciences*, Vol. 9, No. 1, August 1990, p. 119.

73. One example is H.R. 2371 in the 101st Congress (1989), "The Biological Weapons Oversight Act," an unsuccessful initiative sponsored by Wayne Owens (D-UT). This bill called upon the Defense Department to transfer all medical research on biological weapons to the National Institutes of Health.

74. See, for example: Geissler, Erhard, "Vaccines for Peace: An International Program of Development and Use of Vaccines Against Duel-Threat Agents," *Politics and the Life Sciences,* 11(2), 1992, p. 231-43.

75. See: U.S. General Accounting Office Report, Operation Desert Storm: DOD Met Need for Chemical Suits and Masks, but Longer Term Actions Needed, GAO/NSIAD-92-116, April 1992; and Richard Davis, Director, Army Issues, National Security and International Affairs Division, U.S. General Accounting Office, before Subcommittee on Readiness, Committee on Armed Services, U.S. House of Representatives, April 16, 1991.