BIOLOGICAL WARFARE

AND AMERICAN STRATEGIC RISK

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ABSTRACT

The United States faces in biological warfare the very real prospect that virtually any actor–a state, terrorist group or individual–with the necessary will, ingenuity and resources could threaten or attack her cities for strategic effect or her military for operational or tactical purposes. Adversaries seeking asymmetric advantage against overwhelming American conventional military dominance may choose biological weapons. Ironically this superiority actually increases the threat of biological attack and the Department of Defense (DoD) assumes such attacks are likely conditions of future warfare.

After the Cold War and absent a monolithic threat, the Department of Defense adopted a threat assessment based on "weapons of mass destruction" (WMD) called *Proliferation: Threat and Response*. Further, President Clinton identified generic WMD as the greatest potential threat to global security. This deluge of rhetoric associated with the diplomatic term of art "weapons of mass destruction" and the doctrinal amalgamation of nuclear, chemical, and biological weapons obscures and confuses understanding of modern biological warfare. Unfortunately, most military and national security leaders do not consider biological weapons as independently decisive; instead, they view them as they regard airpower, as simply tools to be used on the battlefield. As this thesis shows, however, biological warfare is fundamentally distinct from chemical and nuclear warfare and must be treated as such to fully understand its nature and prepare its defense.

This thesis disengages biological weapons from WMD and focuses on biological warfare's unique characteristics and constraints. Biological weapons in the hands of state or non-state actors pose intricate and multi-level national security conundrums. The ubiquitous and duel-use biotechnological revolution is fundamentally altering mankind's relationship with life on Earth and portends a future in which any actor may be able to create and disseminate mass

casualty biological weapons. Using analogies from other strategic forms–airpower and nuclear warfare–this thesis delves into the complex enigmas of biological warfare counterproliferation, deterrence and defense, offering novel approaches to America's most dangerous security threat.

Chapter 1

Man, disease and Biological Warfare

Plagues are as certain as death and taxes.

–Dr. Richard Krause
US National Institutes of Health

The United States faces in biological warfare the very real prospect that virtually any actor with the necessary will, ingenuity and resources could threaten or attack her cities for strategic effect or her military for operational or tactical purposes. Despite the fact that the possession or use of biological weapons is banned by international convention and American domestic terrorism statutes, no insurmountable barriers prevent individuals, groups or states from harnessing the ubiquitous biotechnological revolution to exploit an army of pathogenic diseases and create mass casualty weapons.

The United States unilaterally abrogated its offensive biological warfare program in 1969 for pragmatic reasons and not, as Brad Roberts points out, because it considered biological warfare useless.[1] The Nixon administration regarded biological warfare and its weapons redundant to the mass destruction capability of American nuclear weapons. More importantly, this decision gave the United States moral advantage in successfully negotiating the Biological Weapons and Toxics Convention (BWTC), which ultimately restrained but did not eliminate proliferation of these weapons as evidenced by recent revelations of the Soviet, South African and Iraqi programs.[2] Adversaries seeking asymmetric advantage against overwhelming American conventional force dominance may choose biological weapons.[3] Ironically this superiority

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[1] The rationale behind the unilateral declaration is discussed in Lt Col George W. Christopher, et al., "Biological Warfare: A Historical Perspective," *Journal of the American Medical Association* 278, no. 5 (6 August 1997): 415. This article is also found as Chapter 3 of Joshua Lederberg's book *Biological Weapons: Limiting the Threat* (Cambridge: The MIT Press, 1999). Brad Roberts discussed the declaration in his opening remarks to the Carnegie International Non-Proliferation Conference. See Brad Roberts, address to Carnegie International Non-Proliferation Conference, Washington, D.C., 16 March 2000, n.p.; on-line, Internet, 12 May 2000, available from http://www.ceip.org/programs/npp/roberts2000.htm.

[2] "Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on their Destruction," 26 March 1975, TIAS 8062, *US Treaties and Other International Agreements* 26, pt 2 (Washington: Government Printing Office, 1976), 583-665.

[3] "Joint Doctrine Encyclopedia," 16 July 1997, *Joint Electronic Library*, CD ROM, Government Printing Office, February 2000, 59. "Asymmetrical operations are particularly effective when applied against enemy forces not postured for immediate tactical battle but instead operate in more vulnerable aspects–operational deployment and/or

actually increases the threat of biological attack and the Department of Defense (DoD) assumes such attacks are likely conditions of future warfare.[4]

Biological warfare has ancient historical roots and is not limited to the technologically advanced programs of the 20th century.[5] Inherently offensive, it harnesses and engages living organisms to attack other men or their agricultural infrastructures. Few other forms of war have so many individual weapons whose effects span the various levels of war.[6] Some of its weapons have theoretical casualty figures stretching more than eight orders of magnitude.[7] It has been employed across the spectrum of conflict.[8] Its core technologies are inherently dual-use with the ubiquitous medical, pharmaceutical, agricultural and related biotechnology industries and sciences. Biological warfare defense isn't symmetrical. A combatant doesn't employ biological agents to directly counter an enemy's use but instead defends with passive and active barriers, many of which are medical in nature. Successful defense in the past was largely predicated on medical and public health prevention, preemption and post-attack response.

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movement, extended logistical activity (including rest and refitting), or mobilization and training (including industrial production)." Asymmetric attack in its most basic form means pitting one's strengths against the weaknesses of the enemy. Asymmetric strategies are inherent to the theories of Sun Tzu and BH Liddell Hart. Sun Tzu recommended that armies not seek the enemy's force (hsing) but instead seek and attack the weaknesses. Refer to Sun Tzu, *The Art of War*, ed. Ralph D. Sawyer (Boulder: Westview Press, Inc., 1994), 183. Liddell Hart was advocating asymmetric warfare when he postulated his theory of indirect approach. He described it thus: "It should be the aim of grand strategy to discover and pierce the Achilles' heel of the opposing government's power to make war. And strategy, in turn, should seek to penetrate a joint in the harness of the opposing forces. To apply one's strength where the opponent is strong weakens oneself disproportionately to the effect obtained. To strike with strong affect, one must strike at weakness. It is thus more potent, as well as more economical, to disarm the enemy then to attempt his destruction by hard fighting." B. H. Liddell Hart, *Strategy* (London: Penguin Books, 1967), 212.

[4] Honorable William S. Cohen, *Report of the Quadrennial Defense Review* (Washington D.C.: Government Printing Office, May 1997), 13.

[5] The Japanese, Soviet and American programs are analyzed in Chapter 4. Other "technological" programs included the British, Canadian, German and more recently Iraqi.

[6] "Joint Doctrine Encyclopedia," 458-60. The levels of war are defined as strategic, operational and tactical. The strategic level encompasses national level objectives, interaction, vulnerabilities and effects. The operational level is usually bounded by the theater of war. It links the tactical level, in which units are employed in combat, to the strategic level. I argue in this thesis that biological weapons have been used or were planned for use throughout history at all three levels. These levels are relative to the actor. What are tactical actions to the United States may be both tactical and strategic actions for a transnational group or smaller state.

[7] Highly infectious and virulent pathogens such as smallpox or a reconstituted 1918 influenza virus could in theory after a single attack (with as little as a few viral particles) kill one individual, or tens of millions. Modern international and intercontinental travel might accelerate any epidemic or pandemic that couldn't be medically or otherwise controlled.

[8] I use the phrase "spectrum of conflict" to describe warfare in the broadest sense as violence used for political purposes by states or non-state actors. Biological warfare has been used in the past and could be used in the future in total or general wars, in smaller wars, in unconventional wars, by transnational terrorists, in civil wars, etc. I say this because the American experience with offensive biological warfare assumed it would only be used in a general war with the Warsaw Pact in Europe and this legacy dominates the military's concept of how it might be used against the United States today.

Despite its potential impact, biological warfare was rarely more than a sideshow in modern conflicts. Many believe it is "dirty business," a perversion of science that nations will naturally abstain from using. In a comment that reflects some contemporary opinions, President Roosevelt's wartime science advisor Vannevar Bush remarked in 1949:

> Without a shadow of a doubt there is something in man's makeup that causes him to hesitate when at the point of bringing war to his enemy by poisoning him or his cattle and crops or spreading disease. Even Hitler drew back from this. Whether it is because of some old taboo ingrained into the fiber of the race.… The human race shrinks and draws back when the subject is broached. It always has, and it probably always will.[9]

Yet the Japanese may have killed tens of thousands in Manchuria in the Second World War and the Soviets employed over 20,000 people in history's largest biological warfare program in the 1980s. The quasi-religious group Aum Shinrikyo experimented with and employed–albeit unsuccessfully–anthrax and botulinum toxin in the mid-1990s. Moral and ethical restraints in war are ephemeral and subject to changing social norms. International conventions and domestic laws may proscribe biological weapons but do not and cannot define its inherent characteristics. Questions of just war or justice in war may be central to American policy debates and conduct of war but are of questionable utility when contemplating the nature of biological warfare.

After the Cold War and absent a monolithic threat, the Department of Defense replaced its Cold War era threat assessment, *Soviet Military Power,* with one based on "weapons of mass destruction" (WMD) called *Proliferation: Threat and Response*.[10] In it Secretary of Defense Cohen warns the American people that WMD writ large has the potential to kill tens of thousands in single acts of malevolence. President Clinton identified generic WMD as the greatest potential threat to global security.[11] This deluge of rhetoric associated with the diplomatic term of art "weapons of mass destruction" hinders critical analysis of the nature of the individual types of warfare. The doctrinal amalgamation of nuclear, chemical, and biological weapons obscures and confuses understanding of modern biological warfare. American views of

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[9] Vannevar Bush, *Modern Arms and Free Men* (New York: Simon and Schuster, 1949), 142,146.
[10] Honorable William S. Cohen, *Proliferation: Threat and Response* (Washington D.C.: Government Printing Office, 1997) and Department of Defense, *Soviet Military Power* (Washington D.C.: Government Printing Office, published periodically in the 1980s). The military defines WMD as "In arms control usage, weapons that are capable of a high order of destruction and/or used in such a manner to destroy large numbers of people." See "Joint Doctrine Encyclopedia," 733.
[11] President William J. Clinton, *A National Security Strategy for a New Century* (The White House: December 1999), 6.

war and the legacy of its offensive biological, chemical and nuclear programs structure the dialogue in national security policy circles. "Weapons of mass destruction" evolved from an ill-defined 1940s diplomatic term of art to an all-inclusive domestic and diplomatic aphorism.[12] American national security policy, anti-terrorism programs, and assumptions about future warfare are predicated on a term of art and organizing principles whose constituent parts bear only superficial resemblance. Biological warfare is fundamentally distinct from chemical and nuclear warfare and must be treated as such to fully understand its nature and prepare its defense. This thesis will disengage biological weapons from WMD and focus on biological warfare's unique characteristics and constraints to shed light on critical national security issues. Biological warfare is the least understood, most complex and potentially one of the most dangerous forms of warfare the United States is likely to face in the 21st century. Outdated paradigms must be shed to fully appreciate the character of biological warfare.

As pointed out by Danzig and Berkowsky, unilateral American restraint in the late 1960s bred unfamiliarity with offensive biological warfare and neglect of the threat. They argue that this unfamiliarity, a perception that it has never been used and therefore never will be used, and a belief in the efficacy of nuclear deterrence dropped biological warfare low on the national agenda.[13] This is born out in *Proliferation: Threat and Response*. Despite recognition that the biotechnological revolution might produce novel weapons, the report's biological warfare organizing concepts merely dust off 30-year old archetypes reflecting the discarded biological weapon experience and doctrine.[14]

If strategy is based on doctrine, which in turn is based on accumulated experience and theory, the urgent need for a sound theoretical baseline for biological warfare becomes apparent. By assessing and categorizing biological warfare in both historical and contemporary contexts this thesis attempts to explain its place in the phenomena of war, connecting biological warfare to the

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[12] The earliest reference found comes from the United Nations' Commission for Conventional Armaments in a 12 August 1948 resolution "[The commission] advises the security council…that weapons of mass destruction should be defined to include atomic explosive weapons, radioactive material weapons, lethal chemical and biological weapons. …" See Committee on Chemical, Biological, and Radiological Warfare, *Report of the Secretary of Defense's Ad Hoc Committee on Chemical, Biological and Radiological Warfare*, 30 June 1950, 7 (Top Secret, declassified on 30 November 1987).

[13] Richard Danzig and Pamela B. Berkowsky, "Why Should We be Concerned about Biological Warfare?," in *Biological Weapons: Limiting the Threat*, ed. Joshua Lederberg, (Cambridge: The MIT Press, 1999), 10-12.

[14] Cohen, *Proliferation: Threat and Response*, 81-84. The dogmatic requirement for large scale manufacture, storage and transportation linked to consistent effects and efficient dissemination is a hallmark of the American program but history has many examples of lower technology biological warfare.

nature of man's most destructive instincts and impulses. Americans, both in general and more specifically their military, have fading collective memories of the ravages of epidemic disease and its decisive impact on economies and campaigns. Ultimately, the thesis presents a launchpoint for future strategists as they wrestle with real and anticipated threats to American national security. To that end I propose a biological warfare conceptual framework based on the competing forces of its definitive characteristics and its physical constraints. Figure 1 presents this dynamic function. Biological warfare is defined by the fundamental characteristics of its agents–non-linear effects, (non) contagious, (non) lethal–and its constraints–environmental, asymmetric defense, low precision/accuracy, positive target action required, time, and low certainty/predictability. Its effects span of the levels of war and the spectrum of conflict.

Figure 1. Biological Warfare Conceptual Framework

Ultimately those charged with the security and defense of the nation must go beyond theory and design strategies to deal with biological warfare. Historical debates about the nature and utility of airpower have many similarities with those of biological warfare. Both forms of warfare have utility at all levels of war and across the spectrum of conflict. Airpower theories generally focused on concepts of strategic attack; biological warfare today is most dangerous as a weapon of strategic attack. Both forms of warfare deal with revolutionary technologies, though biological warfare can exist in the absence of the ongoing biotechnological revolution. Asymmetries dominate discussions of each. American airpower was applied as the dominant indirect tool against enemy industries, societies, leadership and armies throughout the 20th century. Contemporary American threat assessments define biological warfare in terms of its

asymmetric edge against her conventional strengths. Airpower theorists continue to debate whether its weapons, its effects, its revolutionary technologies, or its operating environment should define it. Biological warfare's theoretical "utility" against civilian targets and its inherent nondiscrimination evoke the debates surrounding strategic bombing before and after the Second World War and civil defense in the early Cold War. In the final chapter I compare and contrast biological warfare with air warfare, and to a lesser extent nuclear warfare, to provide a basis for understanding the intricate and multi-faceted conundrum of biological warfare counterproliferation, deterrence and defense.

Evidentiary base

This thesis relies on several disciplines and is based on a variety of primary and secondary sources. As an explanatory theory of biological war, it draws upon history and political science. Current national strategies, threat documents and doctrine form the foundation of the argument. These include the *National Security Strategy*, *National Military Strategy*, *Quadrennial Defense Review*, various joint and service publications, *Preventing Emerging Infectious Diseases*, and national intelligence estimates, among others.[15] The thesis necessarily incorporates medical, epidemiological and microbiological science and terminology. Open source epidemiological and medical intelligence references, primarily from the US Centers for Disease Control and Prevention (CDC) and the US Army Medical Research Institute for Infectious Diseases (USAMRIID), and a variety of subject history texts provide background information on man's relationship with contagious disease. Historical texts and published military casualty data form the analytical basis of the interrelationship of disease and military campaigns.

Orders of battle, doctrines, and operational strategies of biological warfare programs come from a variety of sources. Cold War era US Army 3-series field manuals (operations) as well as

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[15] *The Biological and Chemical Warfare Threat*, Revised Edition (Washington: Government Printing Office, 1999); Clinton, *A National Security Strategy for a New Century* (The White House, February, 1999); Defense Special Weapons Agency, *Weapons of Mass Destruction Terms Handbook* (Alexandria, Va.: Defense Special Weapons Agency, 1997); Joint Publication 3-11, "Joint Doctrine for Nuclear, Chemical, and Biological (NBC) Defense," 10 July 1995; *Joint Electronic Library*, CD ROM, Government Printing Office, February 2000; Jeffrey P. Kaplan, *Preventing Emerging Infectious Disease: A Strategy for the 21st Century* (Atlanta: Centers for Disease Control, October 1998); Joint Chiefs of Staff, *National Military Strategy of the United States of America* (Washington, D.C.: Government Printing Office, 1997); National Defense Panel, *Transforming Defense* (Arlington Va.: National Defense Panel, December 1997), Honorable William S. Cohen, *Proliferation: Threat and Response* (Washington D.C.: Government Printing Office, 1997); W. Seth Carus, *Bioterrorism and Biocrimes: The Illicit Use of Biological Agents in the 20th Century*, working paper (Washington, D.C.: Center for Counterproliferation Research, National

briefings and writings of senior American officers document the American program. Dr. Ken Alibek, ex-deputy head of the Soviet offensive program (Biopreparat) provides the information on the Soviet program through his writings, briefings and interviews. Secondary sources, mainly subject texts, detail the Japanese program as well as the other historical anecdotes. Information on non-state use of biological warfare comes from a variety of open source texts and reports. I based my assessment of the so-called "biotechnology revolution" on personal interviews with subject experts and analysis of open source literature.

Methodology and Analytical Criteria

The thesis is organized into five chapters. In Chapter 2, I analyze the interrelationship of man, war and infectious disease. The chapter focuses on man's two enemies, himself and the pantheon of microscopic bacteria, viruses, protozoa and other organisms that collectively cause infectious disease. The fundamental natures of biological warfare and infectious disease are intimately related. Understanding the age-old conflict between man and microbe sets the foundation for analysis of biological weapons and warfare. In Chapter 3 I introduce biological weapons lexicon, taxonomy, the Biological Warfare and Toxins Convention and analyze the so-called "biotechnological revolution" to assess the impact of its dual-use sciences and technologies on these weapons.

Chapter 4 is an analysis of past biological warfare programs, non-state use of biological weapons, and current doctrine and academic thought on the subject. In it I evaluate the various examples and doctrines in order to elucidate biological warfare's multi-layered and intricate character. In Chapter 5, I compare and contrast biological warfare to its nuclear and chemical cousins to demonstrate conclusively its unique characteristics and the inherent problems with the legacy organizing concepts of "weapons of mass destruction." Finally I analyze biological warfare counterproliferation, deterrence and defense using analogs from air warfare, and to a lesser extent nuclear warfare, theory and practice.

Limitations and Caveats

This thesis is based solely on open and unclassified sources. It is not, nor is it intended to be, an exhaustive report on the known or suspect biological warfare threats or tactics/techniques for their employment. This is an attempt to elucidate the theoretical foundations of biological

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Defense University, March 1999); Department of Defense, *Chemical and Biological Defense Program* (Fort

warfare; it is not an advocacy for biological warfare. To fully understand this complex and chaotic form of war, strategists must detach themselves from the limiting WMD and morality constructs and ground their analysis on solid understanding of its nature. All errors in fact and interpretation are mine and mine alone.

Belvoir, Va.: Defense Technical Information Center, March 2000).

Chapter 2

The Four Horsemen of the Apocalypse

> *Typhus and its brothers and sisters–plague, cholera, typhoid, and dysentery–has decided more campaigns than Caesar, Hannibal, Napoleon, and all the Generals in history. The epidemics get the blame for defeat, the Generals the credit for victory. It ought to be the other way around.*
>
> –Hans Zinsser
> *Rats, Lice and History*

> *We are in eternal competition. We have beaten out virtually every other species to the point where we may now talk about protecting our former predators. But we're not alone at the top of the food chain.*
>
> –Joshua Lederberg
> *Biological Weapons: Limiting the Threat*

In order to understand biological warfare one must grasp its fundamental principles of action–infectious disease caused by pathogenic organisms. The essence of biological warfare is man's harnessing of pathogenic microbes, his most aggressive, resilient and deadly natural enemies. One often hears of technical revolutions and their impact on history–the agricultural, industrial and informational for instance. History's most significant revolution, modern medicine and its associated sciences, towers over all others because it tilted the balance to man over microbe for the first time. However, the cliché that no new offensive weapon can long exist without an effective counter is certainly true with infectious disease.

Man's recent victories–antibiotics, vaccines, and sanitation programs–may be ephemeral at best, and at worst may be engendering human complacency while bacteria and viruses evolve and adapt, circumventing man's best defenses. Soldiers, sailors, marines and airmen, just as their civilian counterparts, succumbed in great numbers to plagues and disease throughout history. The Four Horsemen of the Apocalypse, pestilence and its allies war, famine and death, remain decisive in the affairs of man.

This chapter is split into two sections. The first explores man's relationship with the microbial world. It describes the microscopic pantheon of life from which springs infectious diseases. It goes on to review how in the past two centuries man, for the first time in history, successfully

defended himself against this onslaught. It juxtaposes modern medicine, sanitary engineering and public health with the disease counteroffensive based on rapid adaptation and evolution to changing environments. The second section reviews the nature and impact of disease in war. Throughout human history disease killed and maimed far more men in battle than did force of arms.

Infectious Disease and Man

Any critical analysis of biological warfare must begin with the man's fundamental relationship with other life on Earth. For all intents and purposes man has overcome all his macrobiotic foes such as wolves, bears, and lions. These large competitors have been beaten back to what remains of the wilderness, and except for the occasional unlucky soul who ventures into the domain of the polar bear or great white shark, man today is not prey of any other large species. In the 21st century man faces only two enemies, himself and the various pathogens that cause infectious disease.[16]

Humans are unique in nature, as the only species that conducts reasoned and systematic deadly violence upon members of its own species to resolve competition for resources. We call this war. Life at macro (population) and micro (individual) levels is a competition for resources such as land, food, mates, money, trade routes, ideology, and religion among others. While deadly violence exists in nature, it is generally between species, specifically carnivores and prey–who kill to eat–or individuals such as males sparring over mating hierarchy. Man, who ironically is the only creature on Earth who is known to reason, is also the only that resorts to deadly internecine violence to settle group on group competition.

Man and microbe have been locked in conflict since humans first walked on Earth. Throughout history far more have died of disease than from war. In fact it wasn't until the Second World War that fewer men died of disease than battle wounds in war. The Black Death in medieval Europe and the global flu pandemic of 1918-19 only highlight man's frailty in the face of virulent bacteria, viruses, protozoa and other plagues. Over 300 million died of smallpox worldwide in the 20th century, more than died in all of its appalling wars combined.[17] These casualty statistics are certainly "massive" and might lead one to equate the effects with those of

[16] Consider it the sense of dynamic attack and defense in conflict. Man obviously faces other perils such as natural disasters but he is not in conflict with these forces.

[17] Michael B. Oldstone, *Viruses, Plagues and History* (New York: Oxford University Press, 1998), 27.

nuclear warfare. Yet infectious disease and its use in war–biological war–is so fundamentally different that comparisons are largely semantic. In no other form of war does man harness and use his most deadly natural enemies to conduct violence against fellow man.

Man first saw his enemy when the Dutchman Anton van Leeuwenhoek in 1674 peered through the original microscope and described "wee animalcules."[18] Louis Pasteur determined the relationship between those wee animalcules and disease in 1864. It was Pasteur and men like him in the late 19th and early 20th centuries that demonstrated that "microbes" and not "ill winds" or "miasmas" cause disease.

Each pathogen has its own unique order of battle and strategy, to borrow appropriate terminology from the military lexicon. Smallpox virus and brucellosis bacteria have no more in common than a B-2 Spirit bomber and an infantry battalion. Infectious disease terminology is critical to understanding the orders of battle and fundamental nature of biological warfare. It is the lexicon of physicians, epidemiologists and microbiologists and is generally unfamiliar to military strategists and others involved in national security policy.[19]

The microbial world is a pantheon of highly diverse and adaptable life. It contains millions of species from the distinct phylogenic kingdoms of bacteria, viruses, protozoa and fungi. They bear little morphologic or functional resemblance to the macrobiotic world and often little to each other. They range in size from less than 0.01 micrometers (μm, microns) to hundreds of μm–5 orders of magnitude–yet cannot be seen with the unaided eye. Many reproduce in minutes, not days or years; theoretically one bacterium could produce *140 trillion* identical offspring in 24 hours.[20] Most can live only in restricted environments, yet many can and do survive through environmental extremes.

Of the millions of species few interact with man and his domesticated plants and animals, and even fewer still are pathogenic (disease causing) and thus potential biological weapons. As will be seen in the next chapter, non-pathogenic organisms may in the future be engineered to cause disease. During the process of infection a pathogenic microbe establishes itself and replicates within the host human, animal, or plant. Most bacteria, protozoa, and fungi reproduce using their

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[18] William H. McNeill, *Plagues and Peoples* (New York: Anchor Books Doubleday, 1976 (preface 1998)), 36.

[19] For further information refer to any number of texts on microbiology and pathology. Basic terminology can be found in Marjory Spraycar, ed., *Physician's Desk Reference* (Baltimore: Williams and Wilkins, 1995) (see most current edition) and the *International Dictionary of Medicine and Biology* (John Wiley and Sons, Inc., 1986).

own processes while viruses generally hijack and apply the host cell's replication mechanisms. The host's immune system may fight and win against the invaders, it may lose resulting in death, or it reaches a stable state with a persistent and perhaps unnoticed low-grade infection.

Bacteria are single-celled organisms and are generally considered to be among the smallest and most primitive forms of life. They exhibit all the basic functions of life, i.e. they consume energy (food) in metabolism and they replicate. *Rickettsia* is a class of extremely small bacteria that only reproduce in a host cell, much like viruses. As prokaryotes, bacterial genetic material–deoxyribonucleic acid (DNA) and ribonucleic acid (RNA)–is not assembled into a nucleus as is found in higher forms of life.[21] Ubiquitous in the environment and man, many bacteria are symbiotic and beneficial, such as those found in the intestinal tract that aid digestion and uptake of nutrients. However, many are also the source of many infectious diseases, including cholera, plague, anthrax, tuberculosis, Q fever, and the common strep throat. Antibiotics and vaccines can help control bacterial infections and epidemics (contagious disease rapidly expanding in a given population).

The ancient Greek word *ios*, for poison, is the root of *virus*. Viruses are nothing more than specks of genetic material wrapped in a protein coat.[22] They are orders of magnitude smaller than bacteria and can only be viewed through electron microscopy. They exist at the margins of what we know as life in the sense that they have no independent metabolic or reproductive functions. By infecting host cells (any, from bacteria to man) viruses commandeer their host's metabolic machinery, forcing it to replicate the virus. Vaccines can be effective viral prophylactics while promising new therapies can inhibit the ability of some viruses to infect host cells. Common antibiotics have no effect. Examples of viruses are influenza, smallpox, yellow fever, measles, hepatitis, HIV/AIDS, Ebola, Marburg and the common cold.

Like bacteria, protozoa are unicellular organisms. Considered to be the smallest animals, they too have all the basic functions of life. They have much more sophisticated genetic and

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[20] Given ideal environments many bacteria can reproduce every 30 minutes resulting in 47 doublings in 24 hours. 2 raised to the 47^{th} power is 1.41×10^{14}.

[21] Genetic material consists of deoxyribonucleic acid (DNA) and ribonucleic acid (RNA). DNA is a double-stranded organic molecule in which genes, the basic hereditary units, are coded through unique sequences of four bases. Ribonucleic acid is a single stranded variant of DNA. As prokaryotes, bacterial DNA floats freely within the cytoplasm or "body" of the cell. In higher lifeforms, called eukaryotes, the DNA is organized in a nucleus. See any basic microbiological text for more information.

metabolic structures than bacteria, and generally are more difficult to defend against with antibiotics and vaccines. Common examples of protozoan disease are amoebic dysentery and malaria. Fungi are both uni- and multi-cellular. They include common yeast, mushrooms, and devastating agricultural diseases. They are not responsible for many human epidemics and generally aren't useful as human weapons. However, many are parasitic on plants and fungi could be decisive in attacks on agriculture. Examples include wheat rust and corn blight.

"Virulence" is the disease evoking strength of the pathogen, expressed as the number of cases of overt infection to the total number exposed in a population. Disease severity is expressed as morbidity (illness rate) and mortality (death rate). The human immune system is an extremely effective defense against most diseases and thus most infections result in varying levels of illness. These range from no observable effect to annoying colds and in extreme cases serious systemic infections. When the immune system is overwhelmed the pathogens can kill. Some influenza (the 1918 virus), Ebola, smallpox, anthrax, cholera and plague are all deadly, particularly without modern medical support and intervention.

Many diseases are contagious (also known as communicable) meaning the organism and thus disease is transmitted from host to host by contact or through fomites such as insects, aerosols, body fluids or soiled food and water.[23] Given modern transportation technologies and population mobility, a virulent and contagious disease can rapidly spread throughout a community and potentially the world. Depending on environmental conditions contagious diseases can generate extreme second and third order effects as the disease expands exponentially into a target population. This characteristic accounts for the wide variance (seven plus orders of magnitude) in potential casualty figures inherent in some contagious diseases.[24] Diseases such as smallpox, plague, HIV/AIDS and the 1918 influenza are contagious and responsible for devastating

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[22] In general viruses act by the protein coat attaching to a host cell and then injecting the genetic material into the host. Different species of virus use DNA or RNA. They hijack the host cell metabolic processes forcing the cell to replicate the virus.

[23] Aerosols are suspended particles such as bacterial spores, water droplets, or expectorate (cough or spittle) droplets. Aerosols with an aerodynamic diameter of 1-5 μm are most dangerous in man as they alone are able to reach and deposit in the lower lung's alveoli. This fact accounts for modern biological warfare focus on airborne delivery of biological agents. The lungs provide a much greater surface area for infection than do the skin or alimentary tract and barrier defense of the ambient air is more problematic than for food or water.

[24] As mentioned in Chapter 1. A reoccurrence of the 1918 influenza could create a single casualty, or in theory up to 227,000 dead, 735,000 hospitalized and 43.5 million sick if just 35 percent of the US population were infected. See National Intelligence Estimate 99-17D, *The Global Infectious Disease Threat and Its Implications for the United States* (Washington D.C.: National Intelligence Council, January 2000), 55.

pandemics. Everyone who's acquired a cold or flu is familiar with less debilitating examples of the rapid and exponential spread of contagious disease. It's a question of when, not if, the next pandemic will occur.

Non-contagious disease emanates from a natural reservoir to infect a population. Its pathogens are not passed from host to host and therefore infection is limited to the initially affected population. Examples include yellow fever, malaria, anthrax, and Rickettsial diseases. The range of effects of infectious disease is graphically demonstrated in figure 2. These effects are best visualized as a matrix in which lethal and contagious pathogens present the most dangerous, complex and highest magnitude effects in terms of potential deaths, impact on society, and cost in resources to defend against. Dashed lines reflect the fact that many pathogens are both lethal and non-lethal depending upon many factors including host immune response, medical support, etc. and may exhibit contagious characteristics in certain environments.

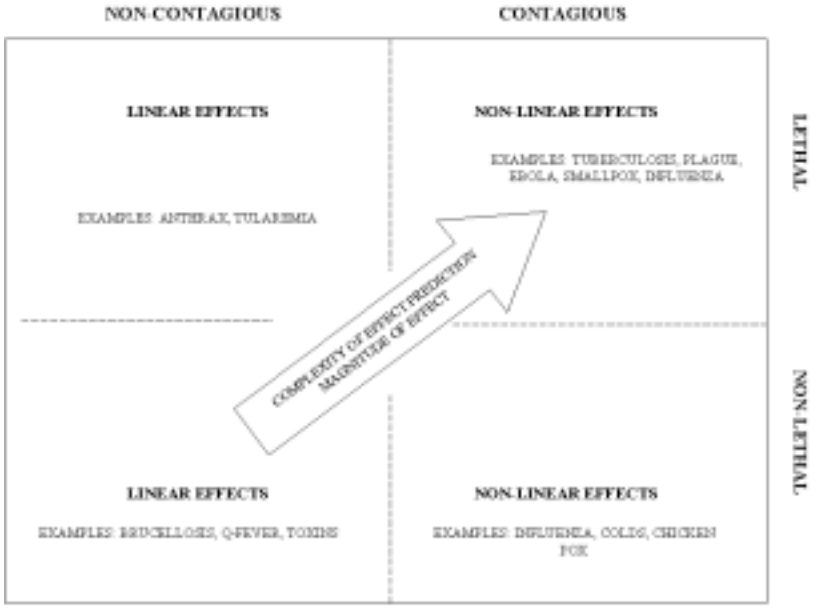

Figure 2. Infectious Disease Characteristics

As pre-World War II generations pass on, modern America will have but a distant collective memory of crippling illnesses and death by tuberculosis, smallpox, malaria, measles, yellow fever, meningitis, diphtheria, polio and whooping cough. It seems axiomatic that man's worst enemy is infectious disease, yet the advent of modern medicine, antibiotics, vaccines and public health in the 20th century produced such a sense of triumph over the age old enemies that man has largely forgotten the lessons of history–at least in the Western world. Secretary of State

George Marshall spoke of this optimism in 1948, only three years after the most destructive human war in history, when he predicted the imminent conquest of all infectious diseases.[25]

An arsenal of antibiotics beat back tuberculosis, staphylococcus infections, and sexually transmitted diseases and his predictions appeared valid at first. Potent pesticides such as DDT gained the upper hand on insects, initiating campaigns to wipe out malaria and other mosquito-borne diseases. Widespread immunization brought polio and smallpox to heel. Basic sanitation and chlorinated water ended cholera and dysentery in the developed world. That all was not well first came to light when doctors began seeing patients who were ill with bacteria resistant to antibiotics. What they were witnessing was the fast and furious pace of microbiological evolution, sped up in response to a human-modified environment.

Scientists soon discovered a tragic truth, that use of antibiotics that failed to kill 100 percent left surviving bacterial colonies with natural resistance if not immunity to the antibiotic weapons. Worse yet, they discovered that bacterial DNA are not rigid but rather are dynamic codes in which bits of genetic material (DNA or RNA) called transposons and plasmids can be exchanged between individual organisms.[26] Especially disconcerting was the bacterial ability to transpose drug resistance cross-species. Even malaria eradication suffered from evolution, as the few *Anopheles* mosquitoes (malaria vectors) who survived pesticide application repopulated the tropics with resistant spawn. By the 1980s it was apparent, at least to microbiologists and physicians, that man had in fact failed to beat his age-old enemies. The eminent historian William H. McNeill expressed the situation best:

> Development of resistant strains of malaria, [tuberculosis], and other familiar infections was a second, and in many ways more important, sign that twentieth-century victories over the parasitic microorganisms that feed upon our bodies was only an unusually dramatic and drastic disturbance of the age-old balance between human hosts and disease organisms. As the century comes to its close, it seems sure that infections are coming back, regaining some of their old importance for human life; and medical men have begun to recognize how their increasingly powerful interventions had the unexpected effect of accelerating the biological evolution of disease germs, making them impervious to one after another form of chemical attack [antibiotics, etc.].[27]

McNeill was prescient. The situation is deteriorating and is of significant concern to the security of the United States. The National Intelligence Council issued a national intelligence estimate

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[25] Laurie Garrett, *The Coming Plague* (New York: Penguin Books, 1994), 30-31.
[26] Garrett, Chapter 13, "The Revenge of the Germs."
[27] McNeill, 10.

(NIE) on the global threat of infectious disease.[28] It is striking how rapidly the situation is deteriorating and how global infectious disease issues are interrelated to potential future biological warfare.

Infectious disease accounted for a quarter to a third of deaths worldwide in 1998 and increasing international travel and trade, inappropriate use of antibiotics and pathogen mutation accelerated disease expansion.[29] In the United States annual infectious disease related deaths have nearly doubled to 170,000 from a historic low in the early 1980s.[30] As shown in figure 2, disease rates fell precipitously as understanding of the causation of infectious disease coupled

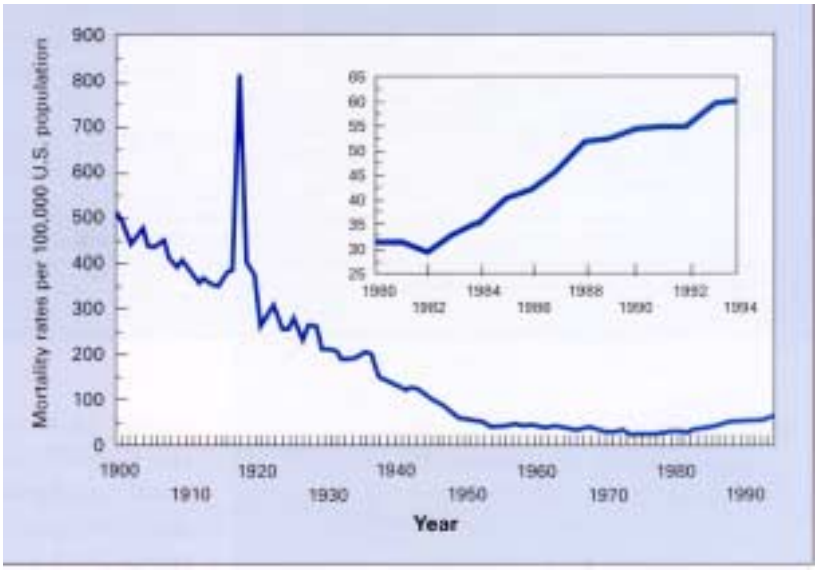

Figure 3. Infectious Disease Mortality Trends in United States, 1900-1994

(From Jeffrey P. Koplan, *Preventing Emerging Infectious Disease: A Strategy for the 21st Century* (Atlanta: Centers for Disease Control, October 1998), 1. This document is the functional equivalent to the Defense Department's *National Military Strategy*.)

with improved medical care, antibiotics, vaccination programs and public health programs dramatically reduced disease-caused mortality in the past century. That few Americans today have firsthand experience with death by infectious disease is a blessing few peoples have known throughout history. The corollary is of course that a sense that the fight is over could engender complacency and future vulnerability, and the trend in the past 20 years is certainly alarming.

[28] National Intelligence Estimate 99-17D.
[29] National Intelligence Estimate 99-17D, 5.
[30] Ibid., 54.

In the United States the most likely new infectious disease threat will be a previously unknown pathogen and it is only a question of when the next virulent and deadly flu pandemic will strike.[31] Influenza remains essentially uncontrolled due to viral mutations. An epidemic of the magnitude of the 1918 event is not only possible but would be more catastrophic in terms of death than World War II. Estimates range up to 227,000 dead, 735,000 hospitalized and 43.5 million sick if just 35 percent of the population were infected.[32] The US Centers for Disease Control and Prevention (CDC) estimates ten of millions of foodborne illnesses occur annually in the US, with 9,000 deaths. Per the CDC the total direct and indirect costs of infectious disease are about $120 billion in 1995 dollars.[33] As previously discussed virulent new pathogens and antibiotic resistance accounts for the marked rise in infectious disease rates.

Infectious disease microbes constantly evolve and antibiotic resistant strains of bacteria are becoming more and more common. In any habitable environment, such as an infected person, there may be bacteria with genetic mutations that confer resistance to a particular antibiotic. Resistance is perpetuated when these bacteria are not killed and thus thrive in the absence of their "normal" cousins. At this time a few strains of tuberculosis and pneumonia are almost impossible to combat with existing antibiotics. Multi-drug resistant *Staphlylococcus*, *Shigella* and *Streptococcus* (penicillin only) bacteria can be found and isolated around the world.[34]

There is strong evidence that in nature bacteria share DNA through plasmids.[35] This process could, in theory, disseminate antibiotic resistance throughout a community of bacteria. Evidence exists that antibiotics may actually encourage a plasmid sharing response among bacteria.[36] Manipulation or control of this process could greatly impact biological warfare, as will be shown in the next chapter.

Compounding the issue is the nature of infection control. Defense against infectious disease is extremely personal and invasive. At the micro-level defense requires physical or behavioral modification of individual humans (or animals and plants). "Passive" measures such as vaccination require injection of foreign material into one's own body. Avoidance requires

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[31] Ibid., 6.
[32] Ibid., 55.
[33] Ibid., 54.
[34] Ibid., 23.
[35] *Antimicrobial Resistance: Data to Assess Public Health Threat from Resistant Bacteria are Limited* (Washington D.C.: General Accounting Office, 28 April 1998), 35.
[36] Ibid., 6.

changes in life style and functions, including recognition and control of disease vectors. Food and water must be made safe and air cleansed of harmful aerosols. Active defense may also require invasive procedures, injection or consumption of antibiotics and other pharmaceuticals in order to halt or defeat the foreign invader.

Infectious Disease and Military Campaigns

Soldiers, sailors and airmen are not immune to disease. The magnitude of the microbial world's dominance prior to World War II is staggering. Mercer claims that prior to World War II battles and wars were decided not by force of arms alone but more by the army which suffered the least at the hands of disease.[37] Today's A-team of biological warfare agents–smallpox, plague, and anthrax–plus dysentery, typhus and others determined the course of wars and history. Zinsser, in *Rats, Lice and History*, details the costs of epidemics in antiquity, from plague and dysentery's decimation of Xerxes' Persians in Greece through the Crusades (scurvy, plague, smallpox, anthrax) to dysentery's contribution to the Prussian's ignoble defeat at Napoleon's hand in 1792.[38] Cartwright describes perhaps the most famous but least understood campaign lost to disease, Napoleon's tragedy in Russia in 1812. Of the 600,000 French and allied troops who departed east in the spring of 1812, fewer than 100,000 marched into Moscow in September, the vast majority lost to typhus, dysentery, and other diseases.[39] The last great pandemic, the 1918 influenza, may have been decisive in World War I. German Field Marshall Ludendorff reportedly blamed this highly contagious and virulent flu for halting the German advance in the summer of 1918.[40] American losses were staggering with over 43,000 US servicemen dead of the disease and another 69,000 ill.[41]

Table 1 summarizes the impact of disease in military campaigns in the 19th and 20th centuries. Its data represent the effects of modern sanitary engineering, public health and medical practices on the battlefield. The ratio of deaths by disease to deaths by battle injury fell by more than three orders of magnitude in the past two centuries. The first dramatic reduction

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[37] Lt Col Nelson Mercer, "Disease in Military Campaigns," *The Military Surgeon* 78, no. 2 (February 1936): 130-134.
[38] Hans Zinsser, *Rats, Lice and History* (Boston: Little, Brown and Co., 1935), 150-665.
[39] Frederick F. Cartwright, *Disease and History* (New York: Thomas Y. Crowell and Co., 1972), 90. His Chapter 4, "General Napoleon and General Typhus," is a fascinating account of how *Rickettsia prowazeki* (the causative agent of typhus), rats, mice and lice (the vectors to man) were decisive in 18th and 19th century warfare.
[40] Michael B. Oldstone, *Viruses, Plagues and History* (New York: Oxford University Press, 1998), 173.
[41] Cartwright, 173.

Table 1.
Deaths from Disease in Military Campaigns

WAR	COUNTRY	Died of Disease (A)	Killed or Died of Wounds (B)	A/B
Russia Campaign, 1812	France and Allies	420,000	60,000	7.0
Mexican War, 1846-47	US	10,986	1,549	7.1
Crimean War, 1854-56	Britain and France	67,000	25,000	2.7
Civil War, 1861-65	North	233,789	114,757	2.0
	South	165,000[a]	85,000	1.9[a]
Spanish-American War, 1898-99	US	4,795	379	12.7
Boer War, 1899-1902	Britain	16,171	5,773	2.8
World War I, 1917-18	US	55,868	51,259	1.1
World War II, 1941-45	US	14,243	237,049	0.06
Korea, 1950-53	US	2,410	21,310	0.11
Vietnam, 1964-73	US	930	28,862	0.03
Gulf War, 1990-91	US	1	147	<0.01

[a] Reported as deaths from combined disease and injury

Sources: Data are from secondary sources. Mercer provided the non-American data, and the data for the Spanish-American War and the Mexican-American War. He also has data on the Civil War, and World War I, though I chose to use the more current references. Mercer doesn't differentiate Navy and Army. Most of the American data come from Michael E. Carey, "Learning from Traditional Mortality and Morbidity Data used in the Evaluation of Combat Medical Care," *Military Medicine* 152, no. 1 (January 1987), 7. Carey's data is for the US Army only. See also Col James J. James, Lt Col Alyce J. Frelin, and Col Robert J. Jeffrey, "Disease and Nonbattle Injury rates and Military Medicine," *Medical Bulletin of the US Army, Europe* 39, no. 8 (August 1982), 17-27. Data for the Gulf War came from James V. Writer, Robert F. DeFraites and John F. Brundage, "Comparative Mortality Among US Military Personnel in the Persian Gulf Region and Worldwide During Operations Desert Shield and Desert Storm," *Journal of the American Medical Association* 275, no. 2 (10 January 1996), 119. Vietnam War disease casualties are from "Vietnam War Casualties Cause: Hostile and Non-hostile," *American War Library*, n.p., on-line, internet, 27 February 2000, available from http://members.aol.com/warlirary/vwcl.htm. While the various authors disagree somewhat about the absolute casualty figures, the ratios of disease deaths to battle deaths are consistent.

was in the mid-19th century as armies attempted to control infection through basic sanitary practices. The loss ratio in the Crimean campaign was less than half of earlier wars. The Spanish American War fiasco reversed the trend. Malaria, yellow fever, and dysentery in Cuba and the Philippines and typhoid fever (in camps in the US) decimated the immunologically naïve Americans.[42] Despite the 1918 influenza epidemic, the ratio in World War I was 50 percent of the previous best. The advent of antibiotics, infection control in hospitals, modern pesticides, and other medical and sanitary practices virtually eliminated death by naturally occurring disease (in Western militaries) by the end of the 20th century. Death is not the only casualty statistic in

[42] Stanhope Bayne-Jones, *The Evolution of Preventive Medicine in the United States Army, 1607-1939* (Washington D.C.: Office of the Surgeon General, Department of the Army, 1968), 124.

war, however, as a soldier or airmen laid up in a hospital bed is not only ineffective but creates additional logistical burdens.

Field Marshall Rommel, despite his acclaimed brilliance as a tactical commander, suffered extreme casualties in North Africa due to disease. His army literally rotted away around him from dysentery, hepatitis, malaria and other preventable diseases. While few of his soldiers died of disease, he lost three to illness for every one to battle injury.[43] The American Army lost 286 billion days to disease in World War II.[44] Malaria caused over 100,000 hospital admissions and 90 deaths in the US Navy in World War II and 4,542 cases in Korea.[45] Over 7,000 soldiers of the 1st Cavalry Division were stricken by dysentery in the Ashau Valley in 1968.[46] Though only one death by disease was reported in Desert Storm, diarrhea was common among deployed personnel. Six hundred and forty-eight Air Force personnel reported to the emergency room with acute gastroenteritis within 72 hours of January 20, 1991.[47] Diarrhea almost grounded airborne command and control operations in September 1990.[48]

Summary

A pantheon of bacteria, viruses, protozoa and fungi inhabits the microbial world and persists, as man's only natural enemy. Understanding the fundamental characteristics and modes of action is essential to defining a general theory of biological warfare. Morphologically and functionally bacteria, viruses, protozoa and fungi often bare little or no resemblance to each other and almost none to other weapons of war. Millions of species exist, yet relatively few interact negatively with man and his domesticated plants and animals as pathogens. As few as 10 organisms could infect a man (plant or animal as well), and in the case of highly contagious and virulent smallpox or influenza could reproduce and infect large populations creating epidemics or even pandemics.

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[43] Col Ronald F. Bellamy and Col Craig H. Llewellyn, "Preventable Casualties: Rommel's Flaw, Slim's Edge," *Army* (May 1990): 53.
[44] Col B. Dixon Holland and Col Arthur P. Long, "Cost of Non-battle Injuries and Diseases as Compared to Battle Casualties," *Military Medicine* (July 1955): 46.
[45] C. Beadle and S. Hoffman, "History of Malaria in the United States Naval Forces at War: World War I through the Vietnam Conflict," *Clinical Infectious Diseases*, no. 16, (1993): 320-29.
[46] B. G. Withers et al., "Preventing Disease and Non-Battle Injury in Deployed units," *Military Medicine*, no. 159, (1994): 39-43.
[47] J. Demaio et al., "A Major Outbreak of Foodborne Gastroenteritis among Air Force Personnel during Operation Desert Storm," *Military Medicine* no. 158, (1993): 161-64.
[48] Maj Donald C. Hickman, "A Chemical and Biological Warfare Threat: USAF Water Systems are at Risk," Counterproliferation Papers: Future Warfare Series no. 3 (Maxwell AFB, Ala.: Air University Press, September 1999), 1.

A matrix based on the dimensions of communicability and lethality best describes the inherent characteristics of infectious disease on populations. In the past 150 years the most significant revolution in human affairs put pestilence on the defensive. For the first time in his history man had weapons with which to attack and defeat his ancient foes. Deaths by disease fell precipitously in the general population and in military campaigns. However, mutating viruses and fast evolving bacteria are perhaps outpacing modern science and medical practices. These same pathogens were decisive in past conflicts and may well prove to be highly effective weapons of future war.

Chapter 3

Biological Weapons and the Biotechnological Revolution

> *It has also been asserted that new, horrible diseases will be unleashed if [biological warfare] occurs; this claim is obviously nonsensical, because man can only work with existing germs, not create new forms of life.*
>
> - Army Technical Manual TM 3-216
> *Military Biology and Biological Warfare Agents*
> October 1952

> *Scientists report on a project in which they aim to create a kind of life form by building each bit of genetic code for a type of simple bacterium called mycoplasma. At the end of the effort, the scientists can prove not only that the bits of genetic information they stack together can be artificially "animated" into acting just like any other bacterium, but also that the most important parts of bacteria and viruses can be synthesized at will in a laboratory. Who needs to find a tiny sample of smallpox, when you can synthesize it from scratch?*
>
> - Glenn McGee, *MSNBC News*
> 15 December 1999

Chapter 2 demonstrated the impact of infectious disease on the historical affairs of man, both in peace and in war. The tide turned against pestilence in the 19th and 20th centuries, largely due to revolutions in medicine, though that apocalyptic horseman appeared to regroup in the latter half of the century. This chapter explores the revolutionary nature of biotechnology and its potential impact on future biological warfare. It introduces the lexicon and taxonomy of biological weapons and links them to the biotechnological revolution.

Two debates dominate the national security political dialogue: 1) how will the United States fight its future wars and 2) against what threats? These are not necessarily mutually inclusive. The fighting the future war debate centers on how to transform the post Cold War military to face and succeed against uncertain 21st century challenges. Much of the debate focuses on military technical revolutions (MTR) and their offspring, the so-called revolution in military affairs (RMA). The RMA, at least for the United States' military, is information superiority, the heart

of the joint operational concept of "full-spectrum dominance."[49] This RMA, if realized, will presumably enable the US significant and decisive advantages in any operational environment.

On the other hand, the most complicated and potentially dangerous threat to vital American interests and international security is biological weapons and biological warfare, not information superiority. There is an ongoing biotechnical revolution that portends profound change in man's relationship with himself and other lifeforms. The mantra of full-spectrum dominance through information superiority endangers focused evaluation within the national security establishment of the other technical revolution of the 21st century, biotechnology, and concomitant advances–largely theoretical at this time–in biological warfare. Sun Tzu admonished the wise commander to know his enemy as he knows himself.[50] The nation cannot afford to ignore or misunderstand a revolution that offers radical, asymmetric technologies to its adversaries.

This chapter introduces the lexicon and taxonomy of biological weapons and links them to the biotechnological revolution. The basic facts of biological weapons are well publicized. Extremely high casualty rates are possible with almost insignificant weapon mass. As few as 10 bacteria or viruses, weighing less than a millionth of a gram, are lethal doses in many cases. A kilogram properly delivered could infect, sicken and potentially kill hundreds of thousands if not millions. Their low mass makes concealment, transportation and in some cases dissemination relatively easy. Attribution is difficult to prove. Conversely, they are highly vulnerable to and dependent upon the environment in which they are deployed. Operation effects are often dependent on chaotic (and thus difficult to predict) natural systems such as weather.

The biotechnological revolution has two dimensions and is the product of an evolving understanding of and ability to manipulate the basic functions of life. Zalinskas describes three phases to this evolution: the "pre-Pasteur," "applied microbiology," and the "molecular biology."[51] In the "pre-Pasteur" era man didn't understand the underlying biological processes behind fermentation and "microbiology" was purely empirical. Pasteur's elucidation of microbes and their role laid the applied microbiology foundation. In this second era, man modified plants, animals and microbes using the natural evolutionary processes of gross

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[49] See "Joint Vision 2010," *Joint Electronic Library*, CD ROM, Government Printing Office, February 2000, 1 and Honorable William S. Cohen, "Report of the Quadrennial Defense Review," *Joint Force Quarterly*, Summer 1997, 9.

[50] Sun Tzu, *The Art of War*, ed. Ralph D. Sawyer (Boulder: Westview Press, Inc., 1994), 179.

mutation, selection and breeding. Large-scale biological warfare applied these same techniques (as will be shown in the next chapter). The current era, molecular biology, started with the advent of recombinant DNA technology in the 1970s.

The first biotechnological revolution dimension involves gross manipulation and production of microbial life and products in a set of sciences called industrial microbiology. These techniques are mostly products of Zalinskas' second era. Among the major powers biological weapons research, development and production was–and continues to be in theory–very much a product of industrial microbiology. It is ubiquitous and its science and practical techniques are taught in universities and practiced by companies throughout the world. It isn't "rocket science," and literally thousands of papers, journals, textbooks, and Internet websites freely disperse the methodologies of industrial-scale isolation, fermentation and concentration of microbes.

The second dimension entails genetic material manipulation. The biotechnological revolution is fundamentally altering man's knowledge of, relationship with, and manipulation and exploitation of life forms (including his own). Cohen and Boyer's transfer of genetic material between bacteria in 1973 opened a Pandora's box.[52] Their technique and its progeny (recombinant DNA) literally enable genetically distinct life forms with "designer" metabolic processes that offer radical new drugs, agricultural products, energy sources, as well as precise, highly virulent, antibiotic resistant and vaccine-proof biological weapons. This is as revolutionary as was the harnessing of mechanical power in the 19th and 20th centuries, the taming the atom in the 1940s, and creating the semi-conductor in the 1960s.

Biological Weapons Lexicon

Biological warfare is the use of human, animal or plant pathogens or derived toxins in the conduct of war. As defined in Chapter 2, pathogens are living organisms that cause infectious disease through invading hosts–humans, plants and animals–resulting in no effect, illness or death. Toxins are biologically-derived chemicals and usually, but not always, the natural products of bacterial, fungal or plant metabolism. By convention they are included as weapons

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[51] Raymond A. Zalinskas, *Biological Warfare: Modern Offense and Defense* (Boulder: Lynne Rienner Publishers, 2000), 2-3.

[52] S.N. Cohen et al., "Construction of Biologically Functional Bacterial Plasmids in Vitro," *Proceedings of the National Academy of Sciences USA* 70, (1973): 3240-3244. They isolated and transposed a gene from one bacterial plasmid to another resulting in a biologically active and genetically engineered bacteria. In the laboratory they

of biological warfare because they are products of natural metabolism versus human control chemical processes. Otherwise toxins have little in common with pathogens. They are not alive, do not infect and replicate, and are not transmissible. Those pathogens and toxins that are harnessed and used violently against other humans are collectively known as biological agents. Biological weapons are the combination of delivery, dispersion or dissemination system and the biological agents. The term's biological weapon and biological agent are often used interchangeably.

In general, biological warfare and its agents have properties not possessed by other weapons. It is the only form of war in which other lifeforms are used as weapons. This induces the fog and friction inherent in the chaotic nature of life. If contagious they can in theory spread exponentially through a population generating second and third order effects out of proportion to the original attack. Once released, these weapons are subject to the ambient environment and will act according to their natural inclinations. Unlike other weapons, they are solely anti-personnel (or animal/plant) weapons with little to no impact on physical structures. The pathogens are living organisms that by their very nature infect and reproduce in the target's body. Pathogen effect is delayed because the infectious microbe must establish itself and reproduce many-fold prior to onset of symptoms. The delay ranges from hours to years depending on pathogen. In theory their intended effect may be obtained with minute quantities of active agent (as few as 10 organisms for smallpox and Q-fever).[53]

The biological agent toxins are close analogs to chemical weapons. Where the pathogens require incubation time before manifestation of effect, the toxins act quickly and many are lethal upon successful attack. They act via degradation or destruction of vital metabolic functions or organ systems. Toxins are isolated and concentrated from the parent organism and deployed as independent "chemical" agent. They are generally more toxic than traditional chemical agents pound for pound.[54]

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circumvented the natural and seemingly random processes of mutation, natural selection and evolution to "create" a new life form.

[53] Col David R. Franz, et al., "Clinical Recognition and Management of Patients Exposed to Biological Warfare Agents," *Journal of the American Medical Association* 278, no. 5 (6 August 1997): 400.

[54] For example, the lethal dose to kill 50 percent of an exposed population is 0.14 micrograms of botulism toxin and 20 milligrams of VX nerve agent, 5 orders of magnitude. See Office of the Deputy Assistant Secretary of Defense for Counterproliferation and Chemical and Biological Defense Programs DASD (CP/CBD), *Biotechnology and Genetic Engineering: Implications for the Development of New Warfare Agents*, 4, on-line, Internet, 23 November 1999, available from http://www.acq.osd.mil/cp/biotech96/biotech96.pdf.

Taxonomy

The purpose of this thesis is to explore the nature of biological warfare in general, not the nature of specific weapons that have either been used or developed for use in the past. However, the literature assumes familiarity with the taxonomy of these weapons and therefore accepted categorization is included to aid the reader. The Australia Group is an informal organization of 31 nations who are on record as committed to export control of chemical and biological warfare dual-use technologies.[55] This group publishes the most comprehensive lists of known or suspected biological agents. *The Biological and Chemical Warfare Threat* reproduces the lists and they are included in Appendix 1, *List of Biological Agents*.[56] The appendix lists the organisms and toxins that the Group defines as having potential against man, plants and animals in biological warfare.

Close inspection of these lists reveals the direct lineage from natural infectious disease. The lists include bacterial, viral, and fungal pathogens and toxins of man, plant and animal representing the three modes of attack; inhalation, oral (food and water) and cutaneous. Contagious, non-contagious, lethal and disabling pathogens are all well represented. Plague, typhus, dysentery, smallpox, yellow fever, Dengue, Ebola, anthrax, cholera, typhoid fever and botulism are a but a few on these lists. For more detailed information of the etiology, ecology and utility of these biological agents see the various service manuals and medical textbooks.[57] Of particular utility are Franz et al. and Sidell, Takafuji and Franz.[58]

The Biotechnological Revolution

Man has modified and used life forms for thousands of years. Modern civilization is dependent on domesticated plants and animals. By selective breeding man culled undesirable traits and

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[55] US Arms Control and Disarmament Agency, "Fact Sheet: Australia Group Export Controls" (Washington D.C.: US Arms Control and Disarmament Agency, Office of Public Information, 25 October 1993).

[56] *The Biological and Chemical Warfare Threat*, Revised Edition (Washington: Government Printing Office, 1999), 13-15. See also Department of Defense, *Militarily Critical Technologies List*, Part III (Defense Technical Information Center: February 1998). For more specific information on many of these agents refer to Army Field Manual 8-9, *Handbook on the Medical Aspects of NBC Defensive Operations*, February, 1996, Annex C.

[57] Army Field Manual 8-9, *Handbook on the Medical Aspects of NBC Defensive Operations*, February 1996 and Air Force Manual 32-4017, *Civil Engineer Readiness Technician's Manual for Nuclear, Biological and Chemical Defense*, 1 June 1998. Field Manual 8-9 provides the most complete information.

[58] Col David R. Franz et al., "Clinical Recognition and Management of Patients Exposed to Biological Warfare Agents," *Journal of the American Medical Association* 278, no. 5 (6 August 1997): 399-425 and Frederick R. Sidell,

enhanced preferred characteristics. Mankind's newfound ability to elucidate and manipulate the fundamental processes of life differentiates the past with the now and future. In the "pre-Pasteur" and "applied microbiology" eras man, by trial and error, grossly modified other species and perfected mass production techniques. In today's molecular biology era man can decode the blueprint of any organism and is rapidly acquiring the techniques to adjust molecular physiology at the cellular level. Today's "biotech" industries combine the mass production techniques of the applied microbiology era–industrial microbiology–with the revolutionary methodologies of DNA manipulation in the molecular biology era.

Industrial Microbiology

Those seeking controlled production and large-scale exploitation of biological agents would in theory employ some form of the industrial microbiology process.[59] The biological weapons production programs of the United States and Soviet Union/Russia were industrial microbiological processes that could only be differentiated from non-military use by the organisms produced (Chapter 4 includes detailed discussion of these programs). These weapons production requirements are a military version of legitimate civilian industrial microbiology.

The Hungarian Karl Ereky coined the term "biotechnology" in 1917 to describe his concept of an integrated process for large-scale swine production.[60] Ereky defined biotechnology as "all lines of work by which products are produced from raw materials with the aid of living things."[61] The modern form has evolved to include molecular biology, agriculture, microbiology, biochemistry, pharmacology, genetics, cell biology, and chemical engineering. Thackray differentiates biochemical biotechnology and molecular biotechnology.[62] The beer brewing process is the archetype of the former. Genetic engineering and genomics represent the latter. Biochemical

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Ernest T. Takafuji, and David R. Franz, *Medical Aspects of Chemical and Biological Warfare* (Washington D.C.: Borden Institute, 1997).

[59] Controlled meaning active cultivation, production and isolation of the agent organism and/or metabolic toxin. Contrast to uncontrolled contamination of water supplies with corpses or feces. A biological warfare program does not require large scale controlled processes.

[60] Bernard R. Glick and Jack J. Pasterna, *Molecular Biology: Principles and Applications of Recombinant DNA* (Washington D.C.: ASM Press, 1998), 5.

[61] Ibid.

[62] Arnold Thackray, *Private Science: Biotechnology and the Rise of the Molecular Sciences* (Philadelphia: University of Pennsylvania Press, 1998), ix.

biotechnology is best represented by the term industrial microbiology in which microbe culture isolates are cultivated and optimized prior to large-scale production.[63]

Figure 4. Notional Industrial Microbiological Process

Figure 4 is a schematic of a notional industrial microbiological process.[64] Raw material includes the microorganisms and their essential nutrients required for growth. Upstream processing is the preparation of the raw materials for growth. Fermentation and transformation are the growth of the microbe and, in some cases, transformation or production of desirable metabolic by-products (antibiotics, enzymes, proteins, hormones, alcohol, etc.). Downstream processes isolate and purify the desired product. Barley, hops and water combine with yeast to produce beer and its active component alcohol. It requires little more than a home brewing kit with the appropriate agars to grow vast quantities of many bacteria, including anthrax in theory. The ability to do so safely and to process the resulting fermentation products into usable agents or weapons is not so easy.

Modern pharmaceutical, agriculture, cosmetics and pesticide industries employ industrial microbiological systems. Medical facilities and university laboratories often have and use small-scale analogs to the large industrial systems. Texts such as *Manual of Industrial Microbiology and Biotechnology* provide an educated and experienced microbiologist with the protocols for culture isolation (microbe, plant, mammalian, bird, etc.), raw material selection, fermentation (at any scale), downstream process control, bio-safety, and pilot plant design.[65] A literature search reveals literally hundreds of subject texts, journals and Internet-based information.

In theory the technologies and science required to isolate pathogenic and/or toxin-producing organisms, cultivate and isolate them, test their efficacy, mass produce and weaponize them are practically undifferentiated from civilian, commercial industrial microbiology. In actual practice testing requires human subjects or human analogs (great apes usually). As will be seen in

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[63] Arnold L. Demain and Julian E. Davies, eds., *Manual of Industrial Microbiology and Biotechnology* (Washington D.C.: ASM Press, 1999), 1.
[64] Ibid., adapted from their Figure 1.1.
[65] Ibid.

Chapter 4 the Japanese did in fact use prisoners and unsuspecting civilians to test their weapons. *The Biological and Chemical Warfare Threat* identifies what, at least in the experience and conventional wisdom of the Australia Group, are the dual-use technologies.[66] They are: fermenters, centrifugal separators, cross-flow filtration equipment, freeze dryers, aerosol generators, microencapsulation, biohazard containment equipment, complex growth media, and detection or assay systems. The report identifies manufacturers and suppliers of these dual-use technologies, documenting the wide availability of the necessary components to a biological agent production capability.

DNA Manipulation

The oft-quoted Tofflers express revolution as changes in the structure of society. Institutions, families, and cultural roles evolve, at times radically, through technological breakthroughs and resulting social upheaval.[67] They identify three fundamental revolutions or "waves" which in their construct have defined human history. The first wave was evolution from Neolithic hunting-gathering to agrarian societies. The industrial revolution was the second. The ongoing third wave represents a transfer to "intangibles," economies and cultures based on information. Man's 19th and 20th century victories over disease and the resultant social/cultural change are as profoundly revolutionary as the Toffler's three waves. The biotechnical revolution is a branch of this earlier event, and may lead to the 21st century being known as the "Biotechnical Century." Genetic engineering and genomics portend a brave new world. By laying bare blueprints of all life, science-legitimate and otherwise-man will create new forms of life and modify existing ones in countless ways. Enhanced infectivity and virulence, novel toxins and regulatory peptides, antibiotic resistance, and genetic weaponry are a distinct future possibility. The future isn't all dark as the same technologies may produce novel antibiotics and broad-spectrum immune enhancers, rapid and precise detection, new anti-virals, and metabolic-based defenses. The revolution isn't fantasy or science fiction, it is happening today. Data presented in this section are primary evidence of one of the most critical revolutions in human and military affairs.

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[66] *The Biological and Chemical Warfare Threat*, Revised Edition, Appendix E, "Availability Review of Key Dual-Use Bioprocessing Equipment" (Washington D.C.: Government Printing Office, 1999), 17-23.

[67] Alvin Toffler and Heidi Toffler, "Foreword: The New Intangibles," in *In Athena's Camp: Preparing for Conflict in the Information Age*, John Arquilla and David Ronfeldt eds., (Washington D.C.: RAND, 1997), 1-11.

Victor Utgoff paints pictures of fascinating new biotechnologies that, depending on their use, portend a future of rapid and radical change in man's relationship with other forms of life.[68] Skeptics should question if this is evolutionary or revolutionary. One common measure of information technology's revolutionary character is the geometric acceleration of processing speed known as Moore's Law. This empirically derived law states that computer processing speeds double every 18 months. The same is happening in the core information processing technology of genetics research known as "biochips." These devices, formally known as "DNA arrays," enable the rapid decoding of genetic material (as in the Human Genome Project). Their processing power is exponentially growing at least at the rate of Moore's law, and may eventually personalize genetic coding in the way that Intel brought the computer into the home in the early 1980's.[69] The Militarily Critical Technology List reports technological doubling rates of six months for basic genetic engineering, the Human Genome Project, bioregulators, and other biotechnical applications.[70] There is indeed a revolution in biotechnology in the sense of the revolution in computer and information processing power.

Utgoff also identified three trends in the biotechnology revolution.[71] First, as noted above, biotechnology offers tools to unravel the complex genetic codes and functions of organic molecules upon which all life depends, the science of genomics. This is a dual-edged sword with respect to national security. The Human Genome Project–due to be complete by 2001–is an excellent example. It will make available the precise programming language (to use an information technology metaphor) of humans by sequencing all the human genes and mapping their locations on the various chromosomes. This new information technology is revolutionary. On the one hand it is a powerful weapon for understanding how diseases affect the body in order to develop new countermeasures, on the other it could aid in developing more precisely targeted and therefore effective weapons.

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[68] Victor A. Utgoff, "The Biotechnology Revolution and Its Potential Military Implications," in *Biological Weapons*, ed. Brad Roberts (Washington, D.C.: The Center for Strategic and International Studies, 1993), 28-29. Mr. Utgoff was the deputy director of the Strategy, Forces, and Resources Division of the Institute for Defense Analyses at the time.

[69] David Stripp, "Gene Chip Breakthrough," *Fortune* 135, no. 6 (31 March 1997): 58-59. Meaning that a person's genetic code could be quickly and cheaply determined. Instead of now common identifying characteristics such as hair and eye color a person could be defined and identified by the exact sequence of his DNA. This portends unlimited possibilities and excesses.

[70] Department of Defense, *Militarily Critical Technologies List*, II-3-4.

[71] Utgoff, 28-29.

Genomics uses recombinant DNA technologies to mass-produce and sequence an organism's DNA. The object is to identify the structural code of the DNA and the location of the various genes within the sequence. An organism's genome is its blueprint, its internal operating system, the fundamental expression of the variation between organisms and species, and the code for nearly all of its molecular processes and products. New sequencing technologies coupled with the evolving field of bioinformatics are exponentially increasing the speed and accuracy of genomics. Entire "genomic encyclopedias" for various bacteria, viruses, fungi and higher animals, including man, will soon be available. Numerous viruses, bacteria and higher order forms have already been genotyped.[72]

Utgoff's second trend is biotechnology's new tools for precisely targeting and manipulating organic molecules, specifically DNA. These tools are commonly referred to as genetic engineering. In the past by trial and error man found and isolated the strains that coaxed the most alcohol out of yeast, penicillin from penicillin mold, or botulism toxin from the *Clostridium botulinum*. New technologies already enable tailored molecular manipulation of the various genes encoded in a simple organism's DNA (bacteria, virus, and yeast) to produce, at least in theory, any organic molecule. In terms of biological warfare, this may mean novel toxins, pathogens, antibiotics and vaccines.

Genetic engineering or recombinant DNA technology is the transfer of genetic information (DNA or RNA) from one organism to another. Cohen and Boyer first accomplished it in 1973 with the common bacterium *Escherchia coli (E. coli).* The primary objective of gene transfer and subsequent cloning is the expression of the gene in the host (new) organism. Successful insertion doesn't guarantee expression, and expression can often interfere with other host cellular metabolic processes. Yet today thousands of genetically engineered viruses, bacteria, fungi, plants and animals express drugs, disease resistance, higher yields and a multitude of other products. Most commercial applications use the *E. coli* bacterium though strategies employed for *E. coli* are in principle applicable to most potential hosts.[73] Pharmaceutical companies have for some time used engineered *E. coli* to "pharm" commercial quantities of human insulin,

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[72] See The Institute for Genomic Research, "TIGR Databases," on-line, Internet, 17 March 2000, available from http://www.tigr.org/tdb/index.html and the Department of Energy, "DOE-Funded Microbial Genomes: Completed and Ongoing Projects," on-line, Internet, 17 March 2000 available from http://www.er.doe.gov/production/ober/EPR/mig_cont.html.

growth hormone and other proteins. In theory these techniques could produce mass quantities of toxins, antigens, or whatever designer proteins a bioweaponeer might choose to construct.[74] Kadlec and Zelicoff point out genetic engineering's dominant role in modern Western agriculture.[75] Much of America's commercial food crop has been genetically modified to enhance yields or provide resistance to various diseases. Genetic engineering is indeed ubiquitous in modern society.

With respect to biological warfare, in theory microbiologists can engineer genes for antibiotic resistance, increased human virulence, or specific or multiple toxins into any number of microbes or higher forms of life. By isolating and cloning virulence factors weapon designers could transform common, innocuous bacteria into pathogenic agents.[76] Not only might a bioweaponeer engineer multiple drug resistance from, for example, resistant staphylococcus or tuberculosis, he might modify these weapon's antigenic markers in the process circumventing prophylactic vaccination programs.[77] A bioweaponeer might create new "species" with multiple pathogenicities, like plague with myelin toxin or endemic, non-pathogenic bacteria with regulatory peptides.[78] The Soviets successfully transferred the myelin toxin, which degrades the central nervous system, into the plague bacteria *Yersinia psuedotuberculosis*.[79] They also managed to engineer tetracycline resistant anthrax and extensively studied regulatory peptides.

Utgoff's final trend operationalizes the first two. Production technology is rapidly advancing, enabling more efficient and compact means for manufacturing and distributing biological material. This is the industrial microbiology discussed in the previous section. At least in theory a garage could house the equipment necessary to ferment and weaponize sufficient anthrax bacteria to kill millions of people. Genetic decoding, molecular manipulation and efficient mass

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[73] Glick and Pasterna, 109. This and Demain's book are two of the many references available to those seeking more in-depth understanding of genetic engineering.

[74] A bioweaponeer is one who designs and constructs biological weapons.

[75] Robert P. Kadlec and Alan P. Zelicoff, "Implications of the Biotechnology Revolution for Weapons Development and Arms Control," in *Biological Warfare: Modern Offense and Defense*, ed. Raymond A. Zalinskas, (Boulder: Lynne Rienner Publishers, 2000), 14.

[76] Ibid., 19.

[77] Ibid., 20. Influenza viruses and *Streptococcus pneumoniae* naturally modify the protein markers upon which a body's immune system depends for identification and response to infection.

[78] These peptides are long chains of amino acids which control/influence a wide variety of basic functions. Some control hormones, other effect the central nervous system. As a weapon the genes for these could be inserted into microbes and expressed within the body with specific system targets. They wouldn't have to be expressed from pathogenic microbes.

production have and will enable designer vaccines, antidotes, and other therapies. Conversely, these same trends could in theory combine to enable designer biological weapons for those that have the will, knowledge and resources to apply the technologies.

The potential impact of the combination of genomics and genetic engineering is difficult to overstate. By combining intimate and exact understanding of an organism's basic structural code with the ability to selectively cut and paste information to and from it, science has the ability to selectively create and control life. Scientists recently examined the minimum gene complement necessary for laboratory growth of a simple bacterium.[80] Of 480 genes in its genome, between 265 and 350 genes must be present and expressed in *Mycoplasma genitalium* (a benign bacteria found in the human genital track and lungs) for it to function "normally." Frankenstein can't yet be built, but this is an important building block towards designer bacteria. The authors suggest a set of experiments to be carried out as a first step towards a man-made, minimum-gene living cell.

By genotyping pathogenic organisms the bioweaponeer will in theory be able to catalog the genes for specific effects and tailor organisms to express those same effects in new operating environments. Barnaby reports that Japanese scientists have engineered turkey viruses to be less virulent.[81] There is little stopping manipulation, either constructive or destructive, of human influenza if avian viruses can be engineered. The Armed Forces Institute of Pathology pieced together part (5 percent) of the 1918 influenza virus genome using biopsies from their medical specimen library.[82] Scientists are searching for the virus in frozen corpses in Spitzburg and Norway. If successful they may have complete and possibly live viruses. If these same scientists genotype and publish the viral genome, little could stop a bioweaponeer from attempting to re-engineer a modern influenza strain into its distant, deadly cousin. Kadlec and Zelicoff report that a multinational collaborative effort has sequenced the smallpox genome.[83] With the genomic data it is now possible in theory to engineer a related virus such as *Vaccinia*

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[79] Ken Alibek, *Biohazard* (New York: Random House, 1999), 164. The Soviet program is discussed in detail in Chapter 4.

[80] Clyde A. Hutchinson III et al., "Global Tranposon Mutagenesis and a Minimal Mycoplasma Genome," *Science*, no. 286 (10 December 1999): 2165.

[81] Wendy Barnaby, *The Plague Makers: The Secret World of Biological Warfare* (London: The Bath Press Ltd., 1999), 131.

[82] Elizabeth Farnsworth, "Revisiting the 1918 Flu," *ONLINE Newshour*, 24 March 1997, n.p.; on-line, Internet, 25 January 2000, available from http://www.pbs.org/newshour/bb/health/march97/1918_3-24.html.

[83] Kadlec and Zelikoff, 13.

(cowpox) into *Variola* (smallpox), thus reintroducing the smallpox virus. Block reports the JASON Group's hypothesis of six new synthetic or unconventional pathogens resulting from the revolution.[84] These are binary weapons, designer genes and life forms, human gene manipulation, stealth viruses and host-swapping viruses. Genetic engineering coupled to precise structural coding of genomics portends a complex and extremely unpredictable future.

The biotechnological revolution is not a one-sided advantage to offensive biological warfare. Clearly, the industries are firmly grounded in civilian medicine and agriculture, not in offensive warfare. Genomics and genetic engineering already enable better, faster and safer vaccines, antibiotics and other pharmaceuticals. Near-real time detection, long an Achilles' heel of biological warfare defense, is now possible using genetic sensors and immuno-response technologies. The Department of Defense's medical biological defense research program literally is dependent upon the biotechnological revolution for its investigational new vaccines, therapeutics and diagnostics. The same is true of the various novel detection and surveillance systems in development for military contamination avoidance.[85]

There is little consensus about the revolution's current or potential impact on biological warfare. For example, Novick and Shulman argue that while improvements may be made on existing agents or delivery systems, genetic engineering cannot alter the fundamental unpredictability and uncertainty that makes the biological weapons "virtually useless" in open warfare.[86] The Department of Defense's "Militarily Critical Technology List" report, on the other hand, concludes that biotechnology "has changed the qualitative and quantitative impact that biological warfare, or threat of such warfare, can have on military forces and communities."[87] Whether or not the fundamental constraints of biological warfare can be overcome, ubiquitous nature of the revolution greatly increases the ability and capacity of nations or groups to develop biological weapons.

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[84] Steven M. Block, "Living Nightmares: Biological Threats enabled by Molecular Biology," in The New Terror: Facing the Threat of Biological and Chemical Weapons," eds. Sidney D. Drell, Abraham D. Sofaer and George D. Wilson (Stanford: Hoover Institution Press, 1999), 51. Block is a microbiologist and served as a member of the JASON group.

[85] Department of Defense, *Chemical and Biological Defense Program* (Fort Belvoir, Va.: Defense Technical Information Center, March 2000), Appendices A and D.

[86] Richard Novick and Seth Shulman, "New Forms of Warfare?," in *Preventing a Biological Arms Rac*e, ed. Susan Wright (Cambridge: MIT Press, 1990), 117.

[87] Department of Defense, *Militarily Critical Technologies List*, Parts II and III, II-3-2.

Summary

The weapons of biological warfare have historically come from the very microbes responsible for man's timeless conflict with infectious disease. The international community defines biological weapons as clear and present dangers to mankind and outlawed their use as a means of state policy. The viruses, bacteria, fungi and toxins listed in Appendix 1 represent the Australia Group's collective opinion on which agents have utility in warfare. Sophisticated adversaries, even individuals, with the knowledge and resources could relatively easily convert the same industrial microbiological systems that mass-produce life-saving human insulin and pharmaceuticals into biological agent production units. The ubiquitous biotechnology industries and civilian institutions it supports–medicine, agriculture, public health, etc.–coupled with the unregulated availability of underlying technical and scientific information in essence proliferates the ability to create biological weapons. Virtually all the equipment, material and techniques are dual-use with legitimate civilian medical, pharmacological, and agricultural practices.

There is a revolution in biotechnology, and it is readily available to any state or non-state actor who wishes to pursue a biological warfare program. This revolution may well transform society more than any previous scientific endeavor. It is and will continue to profoundly change how man interacts with all life on Earth. The possible impacts on biological warfare discussed in this chapter seem to be more a matter of scale than modification of the fundamental characteristics and constraints of biological warfare. Novel and synthetic weapons with designer toxicities, precise genetic targeting, enhanced environmental stability, increased virulence and defenses are theoretically possible, as are improved detection, immune-response enhancement, and novel antibiotics and vaccines. Effects harnessed from living organisms that span multiple orders of magnitude across the spectrum of conflict and at any level of war will remain the form's basic characteristics. What might change is the magnitude of these effects and the weapons response to biological warfare's inherent constraints.

The revolution raises the national security ante. It vastly complicates defense planning and assumptions. Modern medicine and science for the most part understands the "natural" form of the Australia Group pathogens, even if they can't protect or respond adequately to them all. The ability at the most fundamental levels of life to engineer any number of characteristics into any

number of microbes (or higher orders of life) should cause concern in all and prompt action by those tasked to defend the country.

Chapter 4

Applied Biological Warfare

> *The general belief that [biological warfare] is a peculiarly "dirty" and horrible type of warfare is not borne out by facts, but is another example of fear of the unknown, as in the case of chemical warfare. Biological warfare is simply an adaptation or perversion of naturally occurring biological attacks. The suffering caused by most diseases cannot compare with that of men terribly wounded and mutilated by shell fragments or machine-gun fire; and the chances of complete recovery of casualties from infective agents is much greater than that of casualties from so-called "conventional" warfare.*
>
> -Army Technical Manual TM 3-216
> *Military Biology and Biological Warfare Agents*
> October 1952

Some have argued that biological warfare is today highly unlikely because in all of the major wars of the 20th century only once did a combatant conduct offensive biological warfare (Japan, as a component of a deliberate program) and that despite massive Soviet, American and later rogue state arsenals, biological weapons have remained sheathed.[88] This is a myopic and incomplete assessment of history. As shown in Chapter 2 man and microbe have long crossed paths in war, with pathogens often proving to be decisive in this most human of affairs. The historical record is replete with examples of military use of biological agents to gain advantage in war and conflict. These range from resource denial (contaminating water) to mass application of contagious and virulent plague bacteria. Americans need to address biological warfare outside their cultural approach to warfare. It is a form that is available to state actors as well as to transnational groups and individuals that may be intent on violent political or criminal acts against the United States or her allies. The latter events are called "bioterrorism" in American lexicon, but despite the legal fictions are in fact within the universe of biological warfare. By exploring this rich narrative it is possible to establish organizing principles for a general theory of biological warfare.

This chapter first presents the 1972 Biological Warfare and Toxins Convention (BWTC) and its ancestor the 1925 Geneva Convention. These international agreements proscribe research,

development, possession, weaponization, and use of biological weapons. However, as will be shown in the remainder of the chapter, they are not perfect prohibitions against biological warfare. The next section explores biological warfare's rich history in the pre-Pasteur era. The paucity of solid epidemiological data from this age restricts definitive conclusions, but sufficient evidence exists to suggest combatants often employed the form and at times with decisive effect. The chapter next focuses on eras of applied microbiology and molecular biology. The 1930s saw the birth of industrialized military biological warfare in the Japanese program and campaigns waged in Manchuria. Japanese biological warfare was seminal to the post World War II Soviet and American programs. The chapter the traces the Soviet record from the Bolshevik Revolution through the early 1990s based on a book and briefings by Dr. Ken Alibek, ex-deputy chief of the Soviet biological warfare research and development program.

A rich record of the American program exists in the form of rescinded 1950s and 1960s vintage doctrine and in briefings by top leadership at the Air War College in the 1940s and 1950s. These sources trace American views of biological warfare through the late 1960s and President Nixon's decision to abrogate unilaterally the form of warfare. The chapter concludes the American experience by reviewing and interpreting post Cold War threat assessments, subject texts and various military doctrine and reports. A section on bioterrorism explores biological warfare in the context of non-sate actors. This is followed by a detailed assessment of biological warfare as strategic warfare with the intent of setting the stage for Chapter 5's policy analysis and recommendations.

Biological Weapons and Toxins Convention

The Biological Weapons and Toxins Convention (BWTC) opened for signature on 10 April 1972 and has been ratified by one hundred and forty nations. Signatories foreswear the development, production, stockpiling or acquisition of biological agents or toxins in any quantity that have no justification for prophylactic, protective or other peaceful purposes.[89] Possession of

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[88] Dr. Matthew S. Meselson as reported by Thomas J. Castillo, "Biological Warfare Fears Misplaced, Harvard Professor Says," 22 February 2000, n.p.; on-line, Internet, 6 March 2000, available from http://news.excite.com/news/uw/000223/health-33.

[89] See "Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on their Destruction," 26 March 1975, TIAS 8062, *US Treaties and Other International Agreements* 26, pt 2 (Washington: Government Printing Office, 1976), 583-665. For a concise history of the BWTC and events leading to its international adoption see Robert P. Kadlec, Allan P. Zelikoff and Ann M. Vrtis, "Biological Weapons Control: Prospects and Implications for The Future," in *Biological Weapons: Limiting*

a minute amount in a covert dissemination device is a clear violation, though a vaccine plant could maintain vast quantities. At the time the BWTC was unique among weapons control treaties as it prohibited an entire class of weapons (the Chemical Weapons Convention has since joined its ranks). It traces its heritage to the Geneva Protocols of 1925 that banned the use, but not possession, of "bacteriological weapons."[90] Kadlec et al. observed that "[d]espite its all-encompassing and enduring prohibitions, the BWTC has no implementation or verification provisions."[91] The convention tasks the United Nations Security Council (UNSC) as the arbiter of alleged violations instead of establishing an independent and veto-proof mechanism. Marie Chevier rightly notes that unfortunately, when compared to other WMD, "biological weapons arms control has been treated as a neglected stepchild, usually disparaged and shunted aside. Nations have questioned the efficacy of that regime yet have been loath to remedy its shortcomings."[92]

Four review conferences have met since the BWTC went into force. The most far-reaching accomplishment to date was the third conference's action in 1991 to create a "verification expert"–VEREX for short–group and task it to recommend on and off site verification and confidence building measures. They reported a consensus document in which they offered that potential verification measures could improve confidence, but that the signatories could not rely on any one measure to differentiate violations and that any implementation must protect intellectual property rights. Importantly, they did not conclude that their proposals could or would ensure compliance.

> It is significant to note that the VEREX process did not state that "effective verification" was possible, only that certain measures in combination could help increase transparency and enhance confidence that members of the [BWTC] were fulfilling their obligations. In short, no combination of measures could be found with sufficient certainty or reliability

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the Threat ed. Joshua Lederberg (Cambridge: The MIT Press, 1999), 95-111. The BWTC entered into force in 1975.

[90] "Protocol for the Prohibition of the Use in War of Asphyxiating, Poisoning or Other Gases, and of Bacteriological Methods of Warfare," 26 March 1975, TIAS 8062, *US Treaties and Other International Agreements* 26, pt 2 (Washington: Government Printing Office, 1976), 571-82.

[91] Robert A. Kadlec, Allan P. Zelicoff, and Ann M. Vrtis, "Biological Weapons Control: Prospects and Implications for the Future," in *Biological Weapons: Limiting the Threat*, ed. Joshua Lederburg (Cambridge: The MIT Press, 1999), 100.

[92] Marie I. Chevier, "Strengthening the International Arms Control Regime," in *Biological Warfare: Modern Offense and Defense*, ed. Raymond A. Zalinskas, (Boulder: Lynne Rienner Publishers, 2000), 149.

> to convince VEREX participants that it was possible to uncover violations with a high degree of confidence, while at the same time avoiding false accusations.[93]

The experience of the United Nations Special Commission (UNSCOM) in Iraq sends strong warnings of the hard task facing those seeking to strengthen the BWTC. Despite the most intrusive routine and challenge inspections in history and mandatory declarations, no incriminating evidence was found of the Iraqi program until the defection and subsequent testimony of Saddam Hussein's son-in-law Hussein Kamel Hassan. The UNSCOM chairman could not report that Iraq had forsaken and fully destroyed its capabilities in 1996 and the American intelligence community estimates that Iraq could reconstitute its program in a matter of weeks once sanctions are lifted.[94] The Iraqi case serves to hammer home the most troublesome aspect of biological warfare and greatest hurdle facing the BWTC, that "[I]t is essentially impossible to separate the dual-use nature of biological processes and equipment used in legitimate and prohibited activities."[95]

Biological Warfare in the Pre-Pasteur and Early Applied Microbiology Eras

The deliberate use of pathogens and biologically derived toxins in warfare has been common throughout history, evolving from efforts to contaminate water supplies and use of animal-derived toxins to modern mass-production of virulent bacteria and viruses. However, as Christopher et al. point out, the history of biological warfare is difficult to assess because of a variety of compounding factors.[96] Natural epidemics and endemic diseases often played decisive roles in general and military history (refer to Chapter 2). The nature of pathogenic organisms makes it extremely difficult to differentiate natural outbreaks from deliberate employment. The general poverty of medical, epidemiological and microbiological data prior to the 20th century confounds assessment. Prior to the interwar period few countries studied biological warfare as an art and science in and of itself, let alone the effects of natural infectious disease upon campaigns.[97]

In the so-called pre-Pasteur era combatants employed biological weapons across the spectrum of modes of action without understanding the means of action (bacteria, viruses, etc.). Militaries in

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[93] Kadlec, Kelikoff and Vrtis, 103.
[94] Ibid., 106.
[95] Ibid., 100.
[96] Lt Col George W. Christopher, et al., "Biological Warfare: A Historical Perspective," *Journal of the American Medical Association* 278, no. 5 (6 August 1997): 412.
[97] See Zinsser's comments in Chapter 2

antiquity conducted water, food, insect vector and inhalation attacks. Water's import manifested itself early and often, as wells, reservoirs and other water supplies were common targets.[98] Without means of identification and treatment, targeted populations faced illness and death or dehydration by denial once they recognized the contamination and the threat. In the American Civil War, Confederate soldiers shot and left farm animals to rot in ponds during General Sherman's march through the Southeast, compromising the Union water supply.[99] The Germans are known to have contaminated a Bohemian reservoir with raw sewage in 1945.[100] The practice continues in modern times, as Yugoslav federal forces or those allied with them appear to have poisoned wells throughout Kosovo in October/November 1998. The perpetrators dumped animal carcasses and hazardous materials (chemicals such as paints, oil, and gasoline) in 70 percent of area wells, deliberately sickening the populace and denying use of the wells.[101]

Plague offers a textbook example of the difficulties of determining the relative impact of natural and deliberate disease in medieval warfare. The Tatars catapulted casualties who died of plague into the city of Kaffa (now Feodossia, Ukraine) in the 14th century.[102] Plague soon broke out among the defending and retreating forces, and was probably spread to Western Europe via plague-infested men and rats aboard ships (initiating the second great plague pandemic of the Middle Ages). Similar incidents occurred throughout Europe, most notably at Carolstein in 1422 and by the Russians against the Swedes in 1710 at Revel. However, the complex ecology of plague indicates attribution to the overt Tatar acts is an oversimplification. Endemic rodents and their fleas may have imported the plague instead of the cadavers.

Several observations about the nature of biological warfare can be drawn from this example. The Tatars sought tactical advantage in their investure of Kaffa. Not only was that objective accomplished (via a deliberate act or a convenient natural infection), they acquired strategic effects throughout Europe though did not capitalize on them. The Tatars isolated a contagious and virulent pathogen which was devastating their own force (they didn't know the means of

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[98] Stockholm International Peace Research Institute (SPIRI), *The Rise of CB Weapons: The Problem of Chemical and Biological Warfare* (New York: Humanities Press, 1971), 1.
[99] Frederick R. Sidell, Ernest T. Takafuji, and David R. Franz, *Medical Aspects of Chemical and Biological Warfare* (Washington D.C.: Borden Institute, 1997), 416.
[100] SPIRI, 1.
[101] Jeffrey R. Smith, "Poisoned Wells Plague Towns all over Kosovo", *The Washington Post,* n.p.; on-line, Internet, 9 December 1998, available from http://ebird.dtic.mil/Dec1998/e1998 1209poisoned.
[102] See Lt Col George W. Christopher, et al., 412, and Frederick R. Sidell, Ernest T. Takafuji, and David R. Franz, 416.

action (*Yersina pestis*) or mode (fleas,) but may have acquired the intended effect with the cadavers). The fact that Kaffa's epidemic could have resulted from natural or manmade causes highlights the potential ease of deniability of biological warfare.

Smallpox, one of history's greatest scourges and one of a few true success stories in man's battle with infectious disease, played important roles in past North American military campaigns. As with plague it is difficult to separate natural disease effects from deliberate use in the absence of detailed epidemiological data. European explorers, conquistadors and colonists brought the virus *Variola major* (smallpox's causative agent) to the Americas. Casualty estimates vary, but there is no doubt about the impact. Smallpox decimated the immunologically naïve Native Americans, exterminating whole tribes and killing as much as half of the pre-Columbian population. There is no evidence that these pandemics were deliberate. However, the British attempted deliberate infection during the French and Indian Wars in the 1750-60s.[103] In 1763 they distributed blankets and handkerchiefs that may have been contaminated with smallpox to Indians at Fort Pitt. An epidemic in the Ohio Valley Indian population soon followed this act. It is impossible to conclusively attribute the epidemic to the British act.

A more illuminating example comes from the American Revolution. Until General Washington ordered inoculation for all recruits who hadn't experienced the disease, smallpox ravaged the Continental Army and influenced several campaigns. General Washington received compelling, though circumstantial, evidence that the British intended to spread smallpox among the Continental Army at Boston in December 1775.

> By recent information from Boston, General Howe is going to send out a number of the inhabitants in order, as it is thought, to make room for his expected reinforcements; there is one part of the information that I can hardly credit; a Sailor says that a number of them coming out have been inoculated with the design of spreading the Smallpox throughout the Country and Camp. [4 December 1775]
>
> The information I received that the enemy intended spreading smallpox among us I could not suppose them capable of. I now must give some credit to it as it [smallpox] made its appearance on several of those who last came out of Boston. Every necessary precaution has been taken to prevent its being communicated to the Army, and the General Court will take care that it does not spread throughout the country. [10 December 1775] [104]

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[103] Ibid.

[104] James E. Gibson, *Dr. Bodo Otto and the Medical Background of the American Revolution* (Baltimore: George Banta Publishing Company, 1937), 89.

By March 1776 General Washington believed that the British had deliberately caused or encouraged a smallpox epidemic in Boston, which found its way into the Continental Army. The General published orders on 13 and 14 March 1776 that read:

> As the Enemy with a malicious assiduity has spread the infection of Smallpox throughout all parts of the Town, nothing but the utmost caution on our part can prevent that fatal disease from spreading through the Army and Camp to the infinite detriment of both. Therefore, no Officer or Soldier may go into Boston when the Enemy evacuates the Town.
>
> The general was informed yesterday evening by a person just out of Boston that our Enemies in that place have laid several schemes for communicating the infection of the Smallpox to the Continental Army when they get out of town. This shows the propriety of yesterday's Order.[105]

Washington's force managed to limit the damage by isolation of the infected and vaccination of those who had not been previously exposed. Of 18,000 men besieging Boston, 2,500 were sick in mid-March. The situation was even worse in Quebec where Benedict Arnold's army suffered miserably, not at the hands of the British, but to the invisible virus. Attrition to disease approached half of his force, resulting in the ignoble retreat to Ticonderoga.[106] Official action on widespread inoculation didn't come until the spring on 1777 because of policy differences within the colonies. Some routinely practiced inoculation while others outlawed it. Washington argued the case to Patrick Henry (then Governor of Virginia, a colony opposed to inoculation) in April 1777.

> You will pardon my observation on the Smallpox because I know *it is more destructive to an Army in the natural way than the swords* and because I shudder whenever I reflect upon the difficulties of keeping it out and that in the vicissitudes of war the scene may be transferred to some Southern State.[107]

These smallpox examples illustrate the broad range of effects obtainable with a communicable and highly virulent pathogen. The British probably sought what we would call today tactical effects against the Continental Army, and strategic effects against the Indian populations of the Ohio Valley. While epidemiological data paucity means a cause and effect relationship cannot be conclusively drawn, the Indians and the early American Army both suffered horrendous losses to smallpox. British released civilians to expose the Continental Army. Close association with these infected persons–even one individual could spread the highly contagious disease–and

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[105] Ibid., 90.
[106] Ibid., 98-99.
[107] Ibid., 85, emphasis in original.

concomitant inhalation of viral particles likely caused the epidemic in Washington's men. It isn't clear that infected blankets could spread smallpox, but an infected and contagious British soldier could easily have had contact with the Indians and spread the disease. Without knowing the causative agent (smallpox virus) the British nonetheless successfully employed biological warfare.

Armies didn't limit biological warfare to anti-personnel attacks in the past. Substantial evidence exists that the Germans attempted anti-animal operations during World War I. They attempted covert operations in neutral Allied trading countries to infect Romanian sheep (in export to Russia), mules in Mesopotamia (exported to France) and Argentinean livestock (beef exports to Europe).[108] The Germans aimed these attacks at the Allied food supply and military transportation/ logistics systems.

A food crop epidemic initiated as biological warfare might well look like a natural outbreak. Many crop diseases are fungal, and could be spread from plant to plant in the form of spores. If applied against a country's staple food crop this form of biological warfare could in theory have devastating impact on civilian populations. The French and Germans both investigated insect and fungal anti-crop agents in the 1920-30s.[109] In Germany, a large-scale program to breed the Colorado Beetle for use against against Allied potato crops may have been ready for employment in June 1944.[110]

Though clouded in sketchy historical record, biological warfare was not unknown and was often decisive in antiquity. Armies in combat deliberately obtained, controlled and employed all forms of infectious diseases ((non) contagious and (non) lethal), via water, food, insects, cadavers, and infected persons. Effects ranged from the friction caused by the sick to mass panic and decisive impact caused by rapidly spreading smallpox and plague. Limited conflicts and total wars experienced biological warfare. History has examples of the tactical, operational and strategic effects incident to this form of warfare. Perpetrators targeted men, plants and animals. All this occurred in environments where attacker and defender poorly understood the underlying nature of the biological weapons, had no effective antibiotics, lived, ate, and drank in unsanitary conditions (by today's standards), and medical practice was based as much on superstition as

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[108] Christopher et al., 413. The agents were *Bacillus anthracis* and *Burkholderia (Pseudomonas) mallei*.
[109] Paul Rogers, Simon Whitby and Malcolm Dando, "Biological Warfare Against Crops," *Scientific American* (June 1999): 70-75.
[110] Ibid.

science. As the plague and smallpox examples proved, the attacking side often faced the ravages of the weapon as well because it was−and continues to be today−difficult to limit and control a contagious disease.

Japan

The Japanese program is not well understood although the American and Soviet programs both reaped the benefits of the Japanese experiments and experience. Most books on the subject focus on the inhumanity of their program, not on Japanese doctrinal concepts and operational experience. The current assessment is admittedly superficial as it is based solely on secondary sources whose authors' agendas were to expose the inhumanity of the Japanese experiments and American "cover-ups."[111]

Post-World War II statements by senior Japanese officers, whose motivations did not necessarily include full disclosure of the truth, obscure the rationale behind the Japanese program. General Yoshijiro, the final Army Chief of Staff before surrender in 1945, claimed the Japanese pursued a program because they couldn't be sure the Soviets, Americans and British were not doing so.[112] Interestingly, similar rationales present themselves in the American and British cases vis à vis the Germans and later Soviets. The Japanese program incubated and matured in a total war context. Japan was at war in China through much of the 1930s, and with the United States and its allies until Japan's defeat in September 1945.

The Japanese program was the brainchild of an energetic and ultra-nationalist military doctor, Lt Gen Ishii Shiro. Ishii was the scion of a rich and powerful land-owning family, who channeled his intellect and ambition into convincing the Japanese high command of the utility of biological warfare. He apparently succeeded on the premise that it must have distinct advantages otherwise the League of Nations would not have outlawed it.[113] While assigned to the Kwantung Army in Manchuria Ishii developed and demonstrated his claims. Limited information on his activities is available. When Japan surrendered he destroyed many of his records, killed his test subjects and

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[111] Two books offer detailed historical accounts of the Japanese biological warfare program. Sheldon H. Harris, *Factories of Death*(New York: Routledge, 1994) and Peter Williams and David Wallace, *Unit 731: Japan's Secret Biological Warfare in WWII* (New York: The Free Press, 1989). Both focus on the nature of the Japanese human experiments. Neither delves in detail into official Japanese theory or doctrine for employment of Unit 731's weapons and offer but few anecdotes about their operational use. William and Wallace's Chapter 6, "Waging Germ Warfare," offers the best review of Japanese operational use and concepts.

[112] Harris,, 23.

[113] Ibid., 19.

bargained with the American occupiers by offering what he had learned from his experiments in exchange for immunity from prosecution as a war criminal.[114]

Ishii had ideal cover for his experiments under auspices of the "Anti-epidemic Water Supply and Purification Bureau." The Japanese biological warfare program matured separately from its conventional and chemical cousins. At a facility known as Ping Fan his organization, Unit 731, tested the efficacy of a litany of pathogens on Chinese civilians and later prisoners of war (POWs). The list of pathogens included: anthrax, yellow fever, plague, typhoid, paratyphoid A and B, typhus, smallpox, tularemia, gas gangrene, tetanus, cholera, dysentery, glanders, and scarlet fever among others. The Japanese experimented with the full dimension of anti-personnel weapons. The list includes both bacteria and viruses. Recognizing the varied nature of infectious disease, the Japanese experimented with oral, inhalation, cutaneous and insect/rodent vectors. Using applied microbiology, Unit 731 proved that natural infectious disease could be isolated, cultured, concentrated, and disseminated in forms that caused illness and death.

Japanese biological warfare doctrine may be distilled from Ishii's experiments and operational use of his weapons. Ishii made plans for tactical and operational use against the Chinese and Russians. These plans included the employment of artillery shells, porcelain gravity bombs and water supply contamination. His superiors restrained his desire to employ his weapons against the Soviets until summer 1939. Concern about biological reprisals apparently deterred operational commanders.[115] In June and July 1939 Ishii's troops reportedly contaminated the Halha River, the water supply of invading Soviets. The attacks' objectives were tactical/operational effects through denying the river's use and infecting those who drank the water. Artillery containing plague, dysentery and cholera were fired at the Soviets as well, though their effect is not known.[116] The Japanese conducted large scale biological warfare again during the Chekiang Campaign in 1942.[117] Chinese losses were so great that they were "inestimable," but the weapons backfired because of the poor preparation of the invading

[114] Both authors extensively report these facts.
[115] Harris, 75.
[116] Ibid., 75-79.
[117] Wiliiam and Wallace, 69.

Japanese force.[118] Upwards of 10,000 Japanese became ill with plague, cholera and dysentery and at least 1,700 perished.[119]

Ishii appears to have intended strategic effects against Chinese civilian populations by contaminating water and food supplies with plaque, cholera and other agents and dropping porcelain bombs containing plague-infected fleas. Unit 731 forces sprayed infected wheat and millet from modified bombers throughout Manchuria. Japanese attacks on civilians are known to have left thousands sick and dead from typhus, plague and cholera.[120]

It is difficult to judge Japanese theoretical constructs and strategic intent. Based on the methods of employment the Japanese considered biological warfare an adjunct to the total war they were waging against the Chinese and periodically against the Soviets. The Japanese certainly demonstrated that infectious disease could be harnessed and used in war. Effects spanned the spectrum from tactical and operational (on the Halha River and the Chekiang Campaign) to strategic (economic and/or psychological against the Chinese). They sought and achieved both illness and death with contagious and non-contagious bacteria, viruses and fungi. Poor coordination with field commanders resulted in significant Japanese casualties from their biological weapons. The Japanese didn't employ biological warfare against the Americans for unknown reasons. The Japanese attacked populations (Chinese army and civilians and the Soviet army) who had little to no access to vaccines or modern medicine. Ishii employed vectors (fleas, food and water) that are relatively easy to control when and if the threat is recognized though the evidence suggests that recognition was frequently late in coming. However, despite Ishii's efforts, the Japanese program does not seem to have produced decisive effect. Thousands, perhaps tens of thousands, of civilians and POWs died, but Unit 731's weapons do not appear to have significantly altered the course of the war in Manchuria.

Soviet Union and Russia

Dr. Ken Alibek was the first deputy chief of Biopreparat from 1988-1992. He defected to the United States in 1992. His book, *Biohazard*, and later briefings provide this assessment of Soviet and Russian biological warfare principles.[121] Biopreparat was the Soviet's biological

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[118] Ibid.
[119] Ibid., 70.
[120] Harris, 78-79, 111. Focus of Chapter Six of his book.
[121] Ken Alibek, *Biohazard* (New York: Random House, 1999); Ken Alibek "Biological Weapons," lecture, United States Air Force Counterproliferation Center Conference, Maxwell AFB, Ala., 1 November 1999 (hereafter referred

weapons research and development organization. Its facilities also stood as reserve wartime production plants. During his debriefing Dr. Alibek noted with disdain the lack of interest in Soviet strategy, indicating in his mind a profound American misunderstanding of biological weapons and warfare.[122]

The Soviet program traced its origins to the Red Army's experiences in the Bolshevik Revolution. Alibek claims as many as 10 million people died between 1917-21, most from disease and famine. These deaths had tremendous effect on military commanders.

> The casualties inflicted by a brutal epidemic of typhus [the same disease that destroyed Napoleon's army in 1812] from 1918 to 1921 made a deep impression on the commanders of the Red Army. Even if they knew nothing of the history of biological warfare, they could recognize that disease had served as a more potent weapon than bullets or artillery shells.[123]

A secret decree in 1928 ordered the transformation of typhus into a battlefield weapon. At the time there was no known way of combating the ailment (antibiotics had yet to be invented and no vaccine was available). Alibek claims that Gulag prisoners may have been unwilling human subjects in experiments with typhus and other organisms.[124]

Alibek intimates that Soviet biological weapons were used at least once, at the battle of Stalingrad in 1942.[125] Desperate to not lose the vital industrial heartland, the Soviets apparently deployed tularemia against the advancing Germans. Alibek doesn't account for the German deaths, but the weapon appears to have turned on its handlers. At least 100,000 Soviets perished of tularemia that summer, well above the normal rate of 10,000 from endemic disease.[126] This lesson deeply affected Soviet doctrine as from this time forward biological weapons were to be used only against "deep" targets and not at the point of contact of the armies. After the Great Patriotic War the Soviets captured members of the Japanese Unit 731 and benefited from their experiments and experience. Alibek asserts that in 1946 Stalin ordered an accelerated program

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to as Alibek, CPC Conference); and Ken Alibek, address to the Air War College Chemical and Biological Warfare Issues for the USAF course, Washington D.C., 10 February 2000 (hereafter referred to as Alibek, address in Washington D.C.). Biopreparat was the Soviet biological warfare research and development apparatus under the 15th Military District.

[122] Alibek, *Biohazard*, 258.

[123] Ibid., 32.

[124] Ibid., 35.

[125] Ibid., 30.

[126] Ibid., 31.

to match and if possible surpass the Japanese program.[127] As in the Japanese case a separate and distinct military organization (from the chemical and conventional weapons apparatus) directed biological weapons. Alibek claims that the Soviet Union was the only country with "good biological warfare doctrine."[128]

One cannot separate the Soviet view of biological warfare from its context. Prior to the Great Patriotic War, Soviet doctrine viewed biological warfare as having utility at the tactical level (because of typhus' effects on the Revolutionary Red Army). After the experience with tularemia in 1942, the Soviet General Staff reordered doctrine to focus on the Soviet concept of operational and strategic levels of war apparently to avoid infecting their own troops.[129] They had difficulty gauging their weapon's effectiveness, it backfired on them, and it had marginal impact on the campaign. Concurrently, the Soviets developed deep strike weapons such as aircraft, rockets and mechanized vehicles with which to prosecute their new doctrine. After 1945 Soviet doctrine assumed biological warfare would only be used in a total war, most likely with NATO and the United States.[130] In a total war the gloves were to come off and all available weapons could–or would–be used as appropriate. The mature Soviet program had no plans for tactical use of their biological weapons although this doesn't mean the theoretical potential for tactical effects had been dismissed altogether.[131]

The Soviets organized their biological warfare program around three types of action (antipersonnel, anti-livestock and anti-crop) and three modes of action (inhalation, oral, and cutaneous).[132] They investigated and weaponized bacterial, viral, and fungal organisms as well as biological toxins and bio-regulators (neuro-peptide depressors).[133] They investigated and

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[127] Ibid., 37.
[128] Alibek, address in Washington D.C.
[129] What we now call the operational level of war. Prior to the mid-1970s the United States doctrine spoke only of strategic and tactical levels of war. The Soviet General Mikhail Tukhachevskii is generally credited as the father of this doctrinal concept. See A.A. Sevchin, "Strategy and Operational Art" and G. Isserson, "The Evolution of Operational Art," in Harold S. Orenstein, trans., *The Evolution of Soviet Operational Art, 1927-1991: The• Documentary Basis*, vol. I, *Operational Art, 1927-1964*, 5-32 and 48-77.
[130] Alibek, address in Washington D.C. This is consistent with his briefing at Maxwell AFB in which he described the Soviet view of biological weapons as weapons to be used for strategic effects.
[131] Ibid. Alibek reminded his audience that the tactical level was at the point of contact of the armies, and Soviet doctrine called for attack in enemy rear areas. The Soviets recognized it could be used tactically, but the risk of boomerang effect limited their doctrine.
[132] Alibek, *Biohazard*, 37.
[133] Biopreparat was responsible for the human bacterial, viral and bio-regulator agents (natural and synthesized proteins that affect body metabolic and other functions). A Ministry of Agriculture organization called

demonstrated genetic engineering applications to biological warfare, having developed a genetically engineered plague-myelin toxin weapon and were working on modifying the smallpox virus.[134] Within these broad groupings they differentiated between those weapons that killed or merely incapacitated, were contagious or not, were disseminated by aerosol or via other means, and were of strategic or operational effect. Soviet bombers or ballistic missiles using bomblets or sprayers were to deliver weaponized anthrax to deep operational or strategic targets, including the continental United States in a general war. By the end of the Cold War the Soviets viewed biological warfare solely in terms of total war with NATO and the United States.

Early Soviet experience with infectious disease and later tactical use of biological weapons had a profound impact on their doctrine. They were leery of repeating the tactical disaster at Stalingrad and therefore focused on the operational and strategic levels of war. Unlike other forms of war, the biological warfare had weapons that didn't necessarily kill but often "only" incapacitated. This process could create cascading second and third order logistical and psychological effects. Their anti-personnel weapons focused on aerosols as the most efficient and effective means of attack. However, their security apparatus apparently planned for and may have conducted covert use of toxins in food/water or cutaneous pathways. The Soviets recognized and planned for the varied effects of contagious and non-contagious weapons.

United States

The American biological warfare program was a product of World War II and the subsequent threat of total war with the Soviet Union. It existed in the shadow of nuclear warfare, never gaining much emphasis beyond a possible force multiplier to be applied against operational level targets in a total war in Europe. The legacy of this experience and supporting doctrine continues to dominate American military views of today. Primary sources provided this assessment of the American view, the most important being the Army 3-series and joint field manuals that recorded American biological warfare doctrine.[135] Senior military and academic views of the

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Biokombinant researched and developed bacterial, viral and fungal anti-livestock and anti-crop agents. The KGB apparently was responsible for biological toxins.

[134] Alibek, *Biohazard*, 166-67 and 260-63.

[135] Air Force Manual 355-6 (Army Technical Manual TM 3-216), *Military Biology and Biological Warfare Agents*, October 1952 (Restricted, unclassified on 9 October 1985); Army Field Manual 3-5, *Chemical, Biological and• Radiological (CBR) Operations*, September 1961 (rescinded); Army Field Manual 3-5, *Tactics and Techniques of• Chemical, Biological and Radiological Warfare*, 1 September 1954, Change 1, 12 February 1957 (rescinded); Army Field Manual 3-5,*Tactics and Techniques of Chemical, Biological and Radiological (CBR) Warfare*, 5 November 1958 (rescinded); Army Field Manual 3-10, *Chemical and Biological Weapons Employment*, 20 February 1962

utility and applications of biological warfare come from Air War College lectures in the late 1940s and early 1950s.[136] Post Cold War documentation includes threat assessments, doctrine and published academic material.

Although the United States unilaterally abrogated biological warfare in 1969, it had a robust program through much of the 1950s and 60s. Despite strong support within the Army Chemical Corps in the late 1940s, biological warfare never overcame the stigma of "dirty business" and its employment doctrine lagged behind chemical doctrine by the 1960s.[137] Unlike the Soviet and Japanese cases, a separate institutional structure did not advocate and manage the American biological warfare programs. The Army Chemical Corps was the executive agent for both the chemical and biological offensive programs as well as nuclear, biological and chemical defense. Despite early recognition of biological warfare's unique aspects, its definition as a "toxic weapon" and amalgamation into the operation concepts of first "chemical, biological, and radiological (CBR) warfare" and later "chemical and biological warfare" restricted its doctrinal growth as a separate form of warfare. Like the Soviets experience, the American program benefited from captured Japanese Unit 731 personnel and data.

Major General Alden Waitt, Chief of the Army Chemical Corps, set the theoretical baseline in the late 1940s. He differentiated biological (and chemical) warfare from nuclear warfare in terms of "anti-personnel" (or "toxic") versus "destructive" warfare.[138] The underlying presumption was that future war would be total war with the Soviet Union. He asserted that biological weapons had never been used as strategic weapons in war and admitted their utility

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(rescinded); Army Field Manual 8-9, *Handbook on the Medical Aspects of NBC Defensive Operations*, February 1996; Army Field Manual 101-40, *Armed Forces Doctrine for Chemical and Biological Weapons Employment and• Defense*, 19 April 1964 (rescinded).

[136] Air War College Evaluation Staff, "Biological Warfare," lecture, Air War College, Maxwell AFB, Ala., 1 March 1951, top secret (declassified on 20 March 1975), Air Force Historical Research Agency (AFHRA) call no. K239-716251-185; Col James E. Totten, "Biological and Chemical Warfare," lecture, Air War College, Maxwell AFB, Ala., 8 November 1951, top secret (declassified on 2 November 1979), AFHRA call no. K239-716251-196; Maj Gen Alden H. Waitt, Chief US Army Chemical Corps, "Strategic Implications of Biological and Chemical Warfare," address, Air War College, Maxwell AFB, Ala., 10 January 1949, AFHRA Doc. call no. K239.716249-98; Waitt "Trends in Chemical Warfare," address, Air War College, Maxwell AFB, Ala., 2 April 1948, AFHRA Doc. call no. K239.716248-54, declassified EO 11652, 25 October 1988.

[137] "… [biological warfare] is of course 'dirty business,' but … I think we must be prepared." Secretary of War Henry Stimson upon recommending investigation into biological warfare in 1942 to President Roosevelt. Quoted in Harris, 154.

[138] Waitt, "Strategic Implications of Biological and Chemical Warfare," 1. He includes nuclear (as an absolute) and conventional high explosive/incendiary weapons in the destructive class.

was theoretical.[139] However, he was confident that they would be decisive. "We can now … produce in quantity agents which attack man, animals or plants, and which are more toxic, pound for pound, than any weapon we know. And we have means for their dissemination."[140] Linked to airpower as the means of delivery, Waitt foresaw toxic weapons as the most efficient means of breaking the enemy's will and ability to fight while limiting post conflict costs by theorizing that less destruction of enemy infrastructure would require less capital for reconstruction.[141]

> The theory of anti-personnel versus destructive weapons has not been proven in actual war, but having seen the results of one method and knowing the capabilities of the other, I believe strongly that the toxic weapon will go much further to break an enemy's will than the destructive weapon will effect it.[142]

Waitt's view of biological warfare harkens back to early airpower theory. The Chemical Corps Chief unabashedly foresaw biological warfare as a means of achieving great strategic physical and psychological effects.

> …[T]he psychological factor is even more important in this field [biological warfare], with fear, horror, and panic almost certain to follow even an actually minor attack. Biological agents will generally be used in the same way that chemical agents will be used. That is, they will find its greatest value against centers of population and industry.[143]

His advocacy isn't surprising when one considers the primacy of Strategic Air Command and its manned bombers in American defense strategy in 1949. Waitt obliquely admits some tactical application of biological warfare as well. "…[It] is also one which aside from the normal open method of attack [strategic bombing], lends itself particularly well to sabotage through surreptitious use in small amounts against selected individuals or groups."[144] To Waitt, the ultimate criterion for biological warfare was a question of effectiveness. In a total war the "[W]eapon which will end a war most quickly, and most cheaply, and with the least postwar hangover, will best serve the public of the nation which is victorious."[145]

As the American program matured in the 1950s, an increasingly "battlefield" orientation (tactical and operational doctrine) subsumed Maj Gen Waitt's strategic baseline, ultimately resulting in

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[139] Fresh out of World War II, Mag Gen Waitt was either unaware of the events with plague and smallpox in the previous centuries, or was locked in a contemporary definition of strategic/total war.
[140] Ibid., 9.
[141] In context, the United States was rebuilding Europe and Japan at the time.
[142] Waitt, 4.
[143] Ibid., 9.
[144] Ibid.

doctrinal definition not as a form of warfare but as a set of weapons which may complement others in certain circumstances. This evolution is found in the various iterations of Army Field Manuals 3-5, 3-10 and 101-40 and supporting technical manuals. These documents define the principles around which the United States organized itself for biological warfare. Biological agents were considered weapons of Chemical, Biological and Radiological (CBR) warfare (a form of combined toxic warfare). They were hard to detect, lent themselves to covert use, depended upon infectious organisms to which the target might be immune, and had second and third order effects such as long-range political and economic relations with friendly and enemy nations. All biological agents could cause great numbers of casualties and any resulting epidemics within the enemy population presumably were "bonuses."[146]

Early on the Chemical Corps categorized biological warfare into anti-personnel, anti-animal and anti-crop.[147] Early doctrine recognized the potential for strategic, operational and tactical effects.[148] For strategic effects, antipersonnel weapons could be employed against "rear area populations" to decrease support to military operations. Anti-animal weapons could be used to reduce the enemy food supply and draft animals necessary for the war effort. Anti-crop weapons could reduce the food supply and to redirect military resources to fight spread of crop diseases. Commanders could obtain operational and tactical effects by employing anti-personnel weapons against troops in the field and rear areas and with anti-animal weapons to incapacitate draft animals.[149]

Despite these ideas on employment, chemical weapons doctrinally overshadowed biological weapons when it came to actual tactics. Biological weapons were just another arrow in the CBR quiver, though an arrow that in 1954 and 1957 had no written tactics or techniques in the basic army field manuals. Well-developed doctrine employing chemical weapon tactics in offensive and defensive maneuvers existed. Biological weapon tactics were non-existent, consisting of generic statements such as: "When biological and radiological munitions are authorized for use,

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[145] Ibid., 18.
[146] Army Field Manual 3-5, *Tactics and Techniques of Chemical, Biological and Radiological Warfare*, 1 September 1954, Change 1, 12 February 1957 (rescinded), 65.
[147] Ibid., 66.
[148] Ibid.
[149] Ibid., 68-70.

their employment will normally be coordinated at army of theater level to insure that allied forces and friendly nations are not jeopardized."[150]

The 1958 version of Field Manual 3-5 modified the basic doctrine to identify the fundamental flexibility of biological weapons–multiple weapons with varied effects, from high lethality and communicability to incapacitation and not contagious–and to account for the fact that the effects are time delayed.[151] It also introduced the concepts of on-target attack and off-target attack. On-target referred to release over the desired target and off-target referred to upwind release.[152] Employment concepts focused on military rear areas and other deep targets because of the time delay of effects. The doctrine didn't incorporate strategic use against civilian infrastructure.

The 1961 version of Field Manual 3-5 virtually eliminated biological warfare as a doctrinally separate form of warfare. While it recognized nuclear *warfare*, it bounded biological warfare conceptually in the framework of *biological operations*. These were activities in a tactical setting that meant the employment of biological weapons against enemy personnel.[153] This doctrinal concept of biological operations carried over to other Army doctrine. Field Manual 3-10 dropped the radiological component (it was then "chemical and biological") and discussed "biological weapons in military operations."[154] This field manual brought back considerations for strategic use in the concept of operations.[155] However, joint doctrine published in 1964 completed the doctrinal amalgamation of chemical and biological into "CB weapons."[156] Field Manual 101-40 subsumed their individual attributes into combined characteristics and operational application concepts. The manual defined CB weapons as fire support (artillery) extensions, though in some cases they could supplant high explosives or nuclear firepower.

The mature US program didn't focus solely on anti-personnel weapons. Robust research and development resulted in anti-crop weapons focused on the basic cereal crops of the Soviet Union

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[150] Ibid., 74-107. These pages contain the "Tactics of CBR Warfare." Biological weapons were though to have little utility in offensive operations except to neutralize isolated and contained enemy troop concentrations or enemy reserves. In defensive operations they "may be used to reduce the personnel strength of enemy concentrations."

[151] Army Field Manual 3-5,*Tactics and Techniques of Chemical, Biological and Radiological (CBR) Warfare*, 5 November 1958 (rescinded), 112-13.

[152] Ibid., 114.

[153] Army Field Manual 3-5, *Chemical, Biological and Radiological (CBR) Operations*, September 1961 (rescinded), 4.

[154] Army Field Manual 3-10, *Chemical and Biological Weapons Employment*, 20 February 1962 (rescinded), 51.

[155] Ibid., 55.

[156] Army Field Manual 101-40 (Air Force Manual 355-2), *Armed Forces Doctrine for Chemical and Biological Weapons Employment and Defense*, 19 April 1964 (rescinded), 5-6.

and China. America produced and weaponized the etiologic agents for wheat stem rust and rice blast disease in quantity.[157] Anti-crop warfare focused on long terms effects by reducing a nation's ability to produce basic foodstuffs, thus degrading civilian industrial output and morale and potentially impacting sustainment of fielded forces.

When President Nixon unilaterally dismantled the American offensive biological warfare program in late 1969 and early 1970, the United States had weaponized or stockpiled lethal agents (anthrax, botulism toxin, and tularemia,) incapacitating agents (brucellosis, Q fever, staphylococcal enterotoxin B and Venezuelan equine encephalitis virus,) and anti-crop agents (rice blast, rye stem blast and wheat stem blast).[158] None of the human pathogens are contagious to any significant degree. The Americans were concerned about the potential "boomerang" effect, particularly in the situation where armies eventually come into conflict with each other and the various non-combatant populations in the theater of operations (as was the expected case in a European war). (The Soviets situation was different in that they intended to attack American cities with ballistic missiles and therefore could be relatively secure from the contagious weapons as the land war would be fought on Europe.) In addition the Central Intelligence Agency (CIA) had various toxin weapons designed for "covert" use. As discussed in Chapter 1, pragmatic geopolitical and military decisions motivated the decision to renounce all methods of biological warfare.[159] The US felt it could deter and if necessary defend without biological weapons and therefore by renouncing their use and supporting an international treaty outlawing their use, the US hoped to take biological weapons out of an enemy's quiver. By outlawing biological weapons the US hoped to make nations' quest for strategic effects weapons (nuclear in this case) prohibitively expensive.[160]

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[157] Rogers, Whitby and Dando, 73. *Puccinia graminis tritici* and *Piricularia oryzae*.
[158] Christopher, 414.
[159] Two national security decision memoranda document the event. National Security Decisions 35 and 44. Henry A. Kissinger, "National Security Decision Memorandum 35," Subject: United States Policy on Chemical Warfare Program and Bacteriological/Biological Research Program, 25 November 1969, (top Secret, declassified with deletions on 19 September 1977) and Henry A. Kissinger, "National Security Decision Memorandum 44," Subject: United States Policy on Toxins, 20 February 1970, (secret, unclassified on 18 September 1975). Refer again to the following sources for the rationale behind the decisions: Lt Col George W. Christopher, et al., "Biological Warfare: A Historical Perspective," *Journal of the American Medical Association* 278, no. 5 (August 6, 1997): 415, and Chapter 3 of Joshua Lederberg's book *Biological Weapons: Limiting the Threat* (Cambridge: The MIT Press, 1999).
[160] Christopher et al., 415.

Alibek's revelations and post Desert Storm disclosures of the Iraqi program woke the United States up to the impotency of the BWTC.[161] The Defense Department responded to the emergence of the WMD threat from the Soviet-American nuclear shadow with the Counterproliferation Initiative (CPI), which is now eight years old. The CPI seeks to deter or dissuade enemy use or threatened use of nuclear, biological or chemical weapons by preparing the American military and its allies to fight conventionally and prevail in an NBC environment.[162] Through this preparedness the CPI seeks to ensure that proliferant states will not succeed with NBC as an asymmetrical counter to overwhelming American conventional military capabilities.

Secretary of Defense Cohen notes in *Proliferation: Threat and Response* that NBC weapons may be used for asymmetric advantage against American or coalition vulnerabilities such as seaports, airbases, or as tools of terrorism against the American people.[163] As Wallerstein notes "In order to truly understand *why* a proliferant may be seeking to acquire [biological weapons] and *how* they might intend to use them, it is necessary to step outside U.S./Western modes of thinking and cultural constructs. The challenge of developing reliable "red side" thinking is among the most difficult-and important-aspects of the CPI."[164] The CPI focuses on the threat to military forces and American ability to project force globally, yet defines biological warfare against the American homeland not as strategic attack, but as terrorism. The sad fact is that biological weapons offer states and non-state actors strategic effects.

While the nation worries about potential attacks, the Department of Defense's assessments remain largely grounded in organizing principles from its discarded offensive program. Official defensive doctrine (*Joint Publication 3-11*, "Joint Doctrine for Nuclear, Biological, and Chemical (NBC) Defense") continues to define biological warfare not as a separate form but within the pantheon of WMD.[165] It does, however, recognize the fundamental characteristics

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[161] For information on the Iraqi program see Raymond A. Zalinskas, "Iraq's Biological Warfare Program: The Past as Future?" and Stephen Black, "Investigating Iraq's Biological Weapons Program," in *Biological Weapons: Limiting the Threat*, ed. Joshua Lederburg (Cambridge: The MIT Press, 1999), 137-58 and 159-64 respectively.

[162] Mitchell B. Wallerstein, "The Origins and Evolution of the Defense Counterproliferation Initiative," in *Countering the Proliferation and Use of Weapons of Mass Destruction*, eds. Peter L. Hays, Vincent J. Jodoin and Alan R. Van Tassel (New York: McGraw-Hill, 1998), 21.

[163] Honorable William S. Cohen, *Proliferation: Threat and Response* (Washington D.C.: US Government Printing Office, 1997), *iii*.

[164] Wallerstein, 31.

[165] Joint Publication 3-11, "Joint Doctrine for Nuclear, Biological, and Chemical (NBC) Defense," 10 July 1995, *Joint Electronic Library*, CD ROM, US Government Printing Office, June 1998, vii, I-2, and II-4-5.

(contagious, lethal and their antonyms) defining them as the fundamental threats posed by these types of weapons.[166] Joint doctrine focuses on defending the military, not the nation, from biological attack. It focuses on military operational vulnerabilities, such as rear area command centers, troop assembly areas, ports of debarkation, airfields, industrial areas, forward combat areas, as likely targets of biological attack.[167]

Proliferation: Threat and Response reiterates Cold War doctrine: "Certain characteristics are *required* for an organism to be an effective biological agent." [168] Officially, an agent must consistently produce a given effect, be manufacturable on a large scale, be stable (in production, storage and transportation), be capable of efficient dissemination, and be stable after dissemination.[169] The American construct presumes an airborne aerosol attack, which is not surprising given the experiences of the American offensive program and presumptions about how, when and where a biological weapon would be used.[170]

Despite Defense Department apathy to questions of strategic defense, Americans remain concerned about homeland attacks. This concern about vulnerability to so-called terrorist attacks using biological weapons (bioterrorism) spawned domestic laws and regulations in the late 1980s and 1990s.[171] Implicit in these laws is a recognition that American cities could be targets and are at risk. Immutable psychological barriers to domestic attacks no longer exist, if they ever did. Attacks using salmonella bacteria in The Dalles, Oregon and dysentery in a Houston hospital broke any such boundary.[172] In Japan, the Aum Shinri Kyo employed biological agents (anthrax), albeit unsuccessfully.[173] Timothy McVeigh in Oklahoma and the World Trade Center bombing shattered American illusions of homeland security. These relatively minor domestic events foreshadow what could happen, though not necessarily what will happen, in the future.

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[166] Ibid., vii. Refer to Figure 2. Infectious Disease Characteristics, page 14.
[167] Ibid., II-5.
[168] Cohen, 82. Emphasis added.
[169] Ibid.
[170] Joint Publication 3-11, II-5.
[171] James R. Furguson, "Biological Weapons and U.S. Law," in *Biological Weapons: Limiting the Threat*, ed. Joshua Lederburg (Cambridge: The MIT Press, 1999), 81-92.
[172] The events are documented in Thomas J. Torok et al., "A Large Community Outbreak of Salmonellosis Caused by Intentional Contamination of Restaurant Salad Bars," in *Biological Weapons: Limiting the Threat*, ed. Joshua Lederburg (Cambridge: The MIT Press, 1999), 167-84 and Shellie A. Kolavic et al., "An Outbreak of *Shigella dysenteriae* Type 2 Among Laboratory Workers Due to Intentional Food Contamination," in *Biological Weapons: Limiting the Threat*, ed. Joshua Lederburg (Cambridge: The MIT Press, 1999), 185-92.
[173] David E. Kaplan and Andrew Marshall, *The Cult from the End of the World* (New York: Crown Books, 1996).

The US CDC's Kaufmann, Meltzer and Schmid estimated the economic impacts of non-contagious and lethal biological weapons attacks. Their findings ranged from $480 million per 100,000 exposed to brucellosis to $26 billion per 100,000 exposed to anthrax.[174] The impacts of contagious weapons such as plague, smallpox, or revitalized 1918 influenza are potentially orders of magnitude greater. Kadlec reinvigorated the debate about economic warfare, pointing out that a nation's agriculture, regardless of its developmental phase, remains vital to to the nation's security and prosperity.[175] Modern industrialized agriculture, prevalent in the Western World, is largely a product of selective breeding and biotechnology. Trends are leading to higher yields on less land by fewer species and strains of basic cereal and other food crops.[176] Kadlec postulates significant strategic effects from anti-plant or anti-animal attacks ranging from attacks on non-staple crops causing economic disruption to attacks on basic cereal crops causing extreme fluctuations in availability.[177] Others share his views. Highly contagious foot and mouth disease could devastate the US cattle industry, costing $27 billion in lost exports.[178] While it is unlikely that the American agricultural system could be so disrupted that her population faced starvation, these scenarios point out strategic vulnerabilities obtainable through biological warfare. Other nations may well have greater vulnerabilities.

Over the past fifty years American doctrine vacillated between tactical, operational and strategic concepts of application, ultimately concluding that biological warfare wasn't separate and distinct but just another arrow in the combined arms quiver. The American biological weapons program did not enjoy a separate institutional existence as did its Japanese and Soviet peers. Able to rely on conventional, chemical and nuclear arsenals for defense and deterrence, the United States abrogated any offensive biological weapons program in an attempt to increase the real and political costs of adversary weapon of mass destruction programs (thereby limiting the

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[174] Arnold F. Kaufmann, Martin I. Meltzer, and George P. Schmid, "The Economic Impact of a Bioterrorist Attack: Are Prevention and Postattack Intervention Programs Justifiable?," *Emerging Infectious Diseases*, 3, no. 2 (April-June 1997): 83-94.

[175] Lt Col Robert P. Kadlec, "Biological Weapons for Waging Economic War," in *Battlefield of the Future: 21st Century Warfare Issues*, eds. Barry R. Schneider and Lawrence E. Grinter, Air War College Studies in National Security no. 3 (Maxwell AFB, Ala.: Air University Press, 1998), 251.

[176] Paul Rogers, Simon Whitby and Malcolm Dando, "Biological Warfare Against Crops," *Scientific American* (June 1999): 74.

[177] Kadlec, 260-63.

[178] "Experts Warn of 'Agroterrorism' Threat," 2 December 1999, n.p.; on-line, Internet, 9 December 1999, available from http://www.apbnews.com/newscenter/breakingnews/1999/12/02/agroterror1202_01.html.

universe to expensive nuclear weapons).[179] Revelations about Soviet and Iraqi biological weapons programs coupled with increased concern about domestic vulnerability sparked renewed focus on biological warfare in the post-Cold War era. American military doctrine remains locked in the legacy of its offensive program, identifying targets largely at the operational level and assuming future perpetrators would seek weapons and effects similar to the Cold War American construct. Others, however, point out the potentially significant strategic effects obtainable through biological warfare waged against the United States. American perspectives of the level of effects differ between official defense doctrine and concerns of the civilians.

Bioterrorism or Non-State Biological Warfare

The assessment of past biological warfare practice up to this point has focused on state programs. However, the threat today from non-state actors is probably much greater than that posed by states−even rogue states−for a variety of reasons. First, the BWTC, though flawed and not perfectly effective, does in fact proscribe state use. Second, the biotechnological revolution enables those with minimum resources to pursue biological weapons and engage in biological warfare. Individuals and groups have engaged in biological attacks, even though they have yet to achieve massive effects. Third, biological attack offers, in theory if not yet proven in practice, massive effects that may serve the purposes of individuals or groups. To the extent that bioterrorism is conducted for political purposes the national security community is best served by addressing it as biological warfare, particularly strategic biological warfare.

The model adopted by the American offensive biological warfare program (non-contagious, lethal or non-lethal, aerosols) is not necessarily a valid construct for bioterrorism though most analysts continue to focus on it through that lens. Terrorists (or states for that matter) may not need mass aerosol clouds if they have highly virulent and contagious pathogens to threaten or use covertly. Unlike the Soviet and American militaries, these actors do not intend to invade and occupy enemy territory and therefore are not at risk to the boomerang effects of contagious disease. Terrorists do not have the concomitant risk to their own forces and peoples and therefore have fewer restraints on the use of such pathogens as plague, lethal influenza,

[179] Brad Roberts points out that the United States acted unilaterally *not* because biologcial weapons were useless but because they were redundant to the American nuclear and conventional forces. See Brad Roberts, address to

reconstituted smallpox, etc. Also, civilian food and water supplies do not enjoy the robust protection afforded those of the fielded military.

Seth Carus, in *Bioterrorism and Biocrimes*, and the various authors of *Terrorism with Chemical and Biological Weapons: Calibrating Risks and Response* provide comprehensive assessments and analyses of this non-state application of biological warfare.[180] Karl Lowe concludes that "[Bioterrorism] certainly is possible and the prospect is indeed worrisome, but there is a wide gap between the possible and the probable."[181] Carus defines bioterrorism as "the threat or use of biological agents by individuals or groups motivated by political, religious, ecological, or other ideological perspectives.[182] He found that publicly available information could only substantiate biological agent use in 19 of 44 terrorist cases and acknowledged the paucity of data about the group's intents and actual capabilities hamstrings analysis. Carus concludes that in the 20th century terrorists used biological agents but rarely and with relatively little effect.[183] Lowe claims there are three common misconceptions about bioterrorism that shape American public perception. They are first that nearly anyone can in fact create mass casualty biological weapons in their bathroom, second that anyone who can "grow" an agent can modify it into an effective aerosol, and third that aerosol weapons are contagious.[184]

What is interesting about Lowe's analysis is the presumption that the American military model would apply to bioterrorism (Carus approaches bioterrorism in a similar manner). Civilian populations are at risk through their food and water, though maybe not for truly massive effects (once the attack is discovered people can stop eating or drinking the infected medium). Food and water attacks do not require aerosols, and contrary to Lowe's assertion, chlorine at levels

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Carnegie International Non-Proliferation Conference, Washington, D.C., 16 March 2000, n.p.; on-line, Internet, 12 May 2000, available from http://www.ceip.org/programs/npp/roberts2000.htm.

[180] W. Seth Carus, *Bioterrorism and Biocrimes: The Illicit Use of Biological Agents in the 20th Century*, working paper (Washington, D.C.: Center for Counterproliferation Research, National Defense University, March 1999). Carus has a chapter on the subject in *Biological Warfare: Modern Offense and Defense*, ed. Raymond A. Zalinskas, (Boulder: Lynne Rienner Publishers, 2000). Brad Roberts, *Terrorism with Chemical and Biological Weapons: Calibrating Risks and Response*, Alexandria, Va.: The Chemical and Biological Control Institute, 1997. See, in particular, Karl Lowe's analysis in the chapter titled "Analyzing Technical Constraints on Bio-terrorism: Are They Still Important?" (pages 53-64).

[181] Lowe, 63-64.

[182] Carus., 3.

[183] Ibid., 7.

[184] Lowe., 53-56.

common to American water systems does not kill all pathogens.[185] More importantly, civilian populations are at high risk to virulent and contagious pathogens. Everyone is familiar with the annual course of influenza and colds as they quickly migrate through populations. The Soviets attempted to aerosolize smallpox so that they could deliver it on ballistic missiles. A terrorist need not attack with missiles when he could attack with a sprayer (nebulizer) in a congested area such as Times Square or any major airport terminal. The relatively few who are initially infected will rapidly spread the disease throughout the community, nation and globally, in the case of an airport attack.

Fortunately, there is no publicly available evidence of non-state actors attempting to use aerosolized contagious pathogens. Carus reviews the cases of the Rajneeshees and the Aum Shinri Kyo. The Rajneeshees sickened 751 with salmonella in The Dalles, Oregon in 1984. (Their purpose, infecting salad bars, was to keep voters away from the polls on Election Day, not to kill or permanently disable). In the 1990s the Aum Shinrikyo obtained and may have attempted to develop anthrax, botulinum toxin, Q fever, and Ebola (the only pathogen investigated by either group that is contagious by contact or aerosol) but apparently failed to deliver any of these weapons with significant effect.

Carus notes that the trends in bioterrorism are disturbing despite the relatively ineffectual use to date of biological warfare by terrorists. Over fifty-percent of the events occurred in the 1990s suggesting heightened interest in biological warfare amongst non-state actors.[186] Neither Carus nor Lowe evaluates the potential impact of the biotechnological revolution upon future bioterrorism, though Carus notes that while access to agent seed stock is relatively easy, weaponizing in a form that could produce massive effects is problematic for the non-state actor.[187]

According to Carus non-state actors are motivated to employ biological warfare for a variety of reasons. These include mass murder, murder, incapacitation, political statement, extortion and

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[185] See W. Dickinson Burrows and Sara E. Renner, "Biological Warfare Agents as Threats to Potable Water," *Environmental Health Perspectives* 107, no 12 (December 1999): 975-84 and Maj Donald C. Hickman, "A Chemical and Biological Warfare Threat: USAF Water Systems are at Risk," Counterproliferation Papers: Future Warfare Series no. 3 (Maxwell AFB, Ala.: Air University Press, September 1999). Burrows and Renner clearly demonstrate that many pathogens may be effective in chlorinated water supplies, including sporulated anthrax. The present author identified common critical nodes and vulnerabilities in water supplies. Most European water supplies do not maintain chlorine residual in their finished water, and many do not chlorinate the raw water.

[186] Carus., 10.

[187] Ibid., 15. He is focusing on mass aerosol clouds.

anti-agriculture.[188] Using military lexicon these reasons can be translated to effects at all levels of war. The threat of mass "murder" by terrorists or a rogue state could, if credible, have strategic effects upon American national policy. The effective employment of a mass casualty weapon certainly would. Selective use against individuals, particularly leadership, could have strategic implications as well. Lower order effects, such as those sought in the incapacitation attack of the Rajneeshees, cannot be ignored, but they are unlikely to force dramatic policy change.

Strategic Biological Warfare

Strategic attack seeks to directly influence the national ability or will to wage war. American civilian vulnerability most acutely differentiates the policy questions surrounding biological warfare from most other forms of warfare. America cannot discount the prospect that the biotechnological revolution will enable individuals, groups and states the ability to create not only lethal and non-contagious weapons such as aerosolized anthrax, but virulent, lethal and highly contagious pathogens such as a reconstituted smallpox or an influenza similar to the 1918 virus. In fact, the nature of many biological agents makes them ideal for those seeking to directly effect the American national ability or will to follow through with its national objectives.[189] This is strategic attack, whether by a nation, individual or group.[190] No other form of warfare enjoys weapons that can be manufactured or acquired by individuals or states and that affect not only on the battlefield but can attack directly at the strategic or national level.[191] Biological warfare opens a Pandora's box of complex issues that do not lend themselves to solely military-oriented debate or solutions. In Richard Danzig's words:

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[188] Ibid., 9.

[189] As virulent contagions they could in theory be disseminated covertly in vital transportation nodes (airports for instance) and the epidemic would spread non-linearly throughout the population. America and the world for that matter simply don't have the infrastructure to detect and mitigate such an attack, and its effects, in terms of casualties, could rival theorized nuclear warfare.

[190] If war is the application of violence for a political purpose, then non-state groups or individuals can certainly wage war. The legal fictions of the international conventions and laws, the Laws of War and Geneva Conventions, as well as domestic anti-terrorism legislation, do not and can not transform the fundamental nature of biological warfare. That the collective world body chooses to define war in terms of States and other conflict in terms of criminal or terroristic acts does not change the fact that an individual, group or nation could threaten or in fact attack American or allied cities for strategic effect.

[191] Classic naval warfare offers strategic effects through blockade and seas control, but these effects are not immediate or direct. Ground forces usually achieve strategic effects by first defeating or neutralizing the enemy ground forces and then occupying the enemy country. These effects are not immediate. Modern information warfare can be immediate and direct, on a modern, information dependent infrastructure, but not yet on a nation's people in the sense of casualties.

> [B]iological warfare can be richly ambiguous. It blurs distinctions. Definitively determining whether an outbreak is an attack or naturally occurring disease can be a tough challenge. Even if an incident is known to be an attack, it would be extremely difficult to demonstrate who initiated it. Distinctions between state and non-state actors are critical, but often insidious. Moreover, distinctions between home and abroad are no longer operable–the traditional notion of "Fortress America" immune from foreign attack rapidly deteriorates.[192]

Strategic effect is not neat and tidy like its lower order cousins. It involves not only the military but all national instruments of power and more importantly the multitude of systems, structures and psychologies that collectively form the two adversaries, their support base and any third parties. It is often extremely difficult to measure effectiveness in strategic campaigns or attacks.[193] Navies in blockades, air forces in strategic bombing campaigns and posited nuclear warfare often claimed effect but rarely could explain definitively what effect and how, where, why, when and against whom it was to be obtained. The versatility of biological warfare, just as with air warfare, forces questions of strategic effect as well as tactical and operational effectiveness.

Strategic attack in biological warfare is not new. The Soviets prepared for it by arming SS-18 ballistic missiles with anthrax. The British used smallpox in America and the Japanese used a variety of agents against civilians in Manchuria. The Tatars attacked Kaffa with plague in the Middle Ages. What is new is immune naivete in Western populations, rapid global transportation and general lack of experience with fast spreading and lethal disease. America had zero battle casualties (killed in action or from wounds) over Serbia in 1999, 147 in Kuwait and Iraq in 1991, and just under 29,000 in Vietnam. She faces casualty rates that are orders of magnitude greater in many biological attack scenarios on her military forces and her essentially unprotected and unprepared civilian population. Economic impacts would be enormous. If an adversary in the future can credibly threaten biological attack on an American or allied city, the

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[192] Richard J. Danzig, "Two Incidents and the NEW Containment," in *The New Terror: Facing the Threat of Biological and Chemical Weapons*, eds. Sidney D. Drell, Abraham D. Sofaer and George D. Wilson (Stanford: Hoover Institution Press, 1999), 342-43.

[193] David MacIsaac points out how difficult it was for the members of the US Strategic Bombing Survey to measure the "effectiveness" of the strategic bombing campaigns in World War II. Multitudes of decisions by both adversaries and the fact that bombing could be evaluated in isolation from other applied forces made measurement of effectiveness a enormous problem and quite literally impractical. Therefore, these lessons seem to apply to any attempt to definitively attribute cause and effect in the multidimensional, chaotic, non-linear strategic level. See David MacIsaac, *Strategic Bombing in World War Two* (New York: Garland, 1976), 153-67.

prospect of casualties, particularly civilian, on these scales will force the national command authority into uncharted decision situations in contingencies absent truly vital interests.[194]

Various scenarios highlight the potential strategic effects of biological warfare. Biological warfare could in theory, and did in past practice, directly target civilians in attacks reminiscent of the various bombing campaigns of World War II. The adversary might intend the following effects: annihilation, as in the cases of the Ohio Valley Indians or Chinese in Manchuria; decreased agricultural production and concomitant decreased industrial output and foodstuffs to the military; decreased industrial output by disabling or killing civilian workers of key industries or infrastructure; or psychological to affect the will or morale of a people or nation. Similar effects were presaged in the strategic bombing theories of the 1920s and 30s and found application in the Second World War. These similarities will be discussed in more detail in the Chapter 5.

The Office of Technology Assessment reported that 100 kilograms of anthrax delivered as an aerosol cloud over Washington, D.C. could kill up to three million people.[195] Effective prosecution of such an attack could cause more casualties than America experienced in all her 20th century wars combined. This scenario is credible only for adversaries who can create and disseminate environmentally stable and respirable aerosols, no easy feat according to many authors.[196] However, it is possible and the fact that 3 million dead is almost ten times the total number of Americans killed in action in all her wars should be cause enough for alarm.

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[194] Defined in the US National Security Strategy as "those of broad, overriding importance to the survival, safety and vitality of out nation." See President William J. Clinton, *A National Security Strategy for a New Century*, The White House, December 1999, 1.

[195] As reported by Richard K. Betts, "The New Threat of Mass Destruction," *Foreign Affairs* 77, no. 1 (January/February 1998): 26. This common scenario is popular in the media and the Department of Defense as the "typical" biological attack. Danzig offers a different twist in a hypothesized deterrent threat scenario. See Danzig, 341-42.

[196] This statement is open to debate. Bill Patrick, former head of the American offensive biological warfare production program, claims that for the time being only state actors can produce aerosolized weapons and effective delivery systems (William Patrick III, "The U.S. Offensive BW R & D Program from 1945 to 1969: Lessons for Today," lecture, United States Air Force Counterproliferation Center Conference, Maxwell AFB, Ala., 1 November 1999.) Steven Block and Ken Alibek believe that non-state actors could develop mass casualty biological weapons (see Steven M. Block, "Living Nightmares: Biological Threats Enabled by Molecular Biology," in *The New Terror: Facing the Threat of Biological and Chemical Weapons*, eds. Sidney D. Drell, Abraham D. Sofaer and George D. Wilson (Stanford: Hoover Institution Press, 1999) and Ken Alibek "Biological Weapons," lecture, United States Air Force Counterproliferation Center Conference, Maxwell AFB, Ala., 1 November 1999.) I've attempted in the conceptual model to expose the entirety of biological warfare. It is not just anthrax and botulism toxin delivered as aerosols over troop concentrations. These were the preferred weapons in an American doctrine of operational level employment. Actors (state or non-state) who have less concern about non-linear effects of contagious diseases such

Other scenarios are more troubling from the strategic perspective, particularly genetically-modified influenza or reconstituted smallpox.[197] In theory these contagious and potentially lethal viruses do not require aerosol clouds for massive effect. Smallpox or influenza could be spread covertly with a backpack portable sprayer (nebulizer) in congested transportation nodes such as air terminals or subways.[198] Clandestine attacks at transportation hubs could spread this virulent virus throughout the United States (or the world) in a matter of hours. Coughing and sneezing spreads these viruses through normal, everyday human contact. Less than 15 percent of Americans have immunity to smallpox and there are no more than 15 million doses of existing vaccines. There are only 100 beds in the Washington D.C. metro area with adequate isolation to protect unvaccinated medical workers, a situation common throughout the United States. An influenza virus such as the 1918 Influenza would have similar effects, but without the protection of any vaccinated immunity.[199]

Most analysts assume water is not a vulnerable vector because of chlorination, filtration and dilution. This view is not borne out by recent research. Burrows and Renner present compelling evidence that biological attack could be successful through water systems, if one could covertly target finished water supplies.[200] If the United States is vulnerable, one can assume friends and allies are as well because few other nations mandate chlorination of water. Agricultural attack with biological weapons could have devastating economic impact upon the United States, and could cripple the food production capabilities of less robust nations.

Summary

As shown in Table 2, belligerents practiced or prepared for biological warfare throughout history, harnessing and using natural infectious diseases against man, beast and crop. Men found utility across the spectrum of conflict for both contagious and non-contagious diseases and those that were lethal or "only" non-lethal. Close inspection of past wars reveals tactical, operational

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as smallpox, flu or plague do not need to produce environmentally robust aerosols to generate mass casualties. Additionally, there is evidence that water systems can be effectively targeted, even in the United States.

[197] See page 32 in Chapter 3.

[198] D.A. Henderson, "Bioterrorism as a Public Health Threat," *Emerging Infectious Disease* 4, no. 3, July-September 1998, 1-5; on-line, Internet, 8 April 2000, available from http://www.cdc.gov/ncidod/eid/vol4no3/hendrsn.htm.

[199] Danzig, 337-40. Danzig describes the ambiguity involved with influenza, as it is extremely difficult if not impossible to differentiate man-made from natural epidemics.

[200] See W. Dickinson Burrows and Sara E. Renner, "Biological Warfare Agents as Threats to Potable Water," *Environmental Health Perspectives* 107, no 12 (December 1999): 975-84 and Maj Donald C. Hickman, "A

and strategic effects obtained or postulated through biological warfare. Despite its wide use and theoretical utility, biological warfare is, however, not a panacea as there are many constraints to

Table 2.
Comparison of Historical Biological Warfare

	LEVEL OF EFFECT (actual or doctrinal) [a]	WEAPON CATEGORY [b]	TARGETS [c]	MODES OF ACTION [d]
PRE-20th CENTURY	Tactical? Operational Strategic	L-C, NL-C, L-NC, NL-NC	Military Civilians	Inhalation, Fomite Ingestion Agriculture?
JAPAN	Tactical? Operational Strategic	L-C, NL-C, L-NC, NL-NC	Military Civilians	Inhalation, Fomite Ingestion Agriculture?
USSR / RUSSIA	Tactical (covert) Operational Strategic	L-C, L-NC, NL-NC	Military Civilians	Inhalation Agriculture?
TERRORISM	Tactical Operational Strategic	L-C, NL-C, L-NC, NL-NC	Civilians Military	Inhalation ,Fomite Ingestion Agriculture?
US OFFENSIVE (<1969)	Tactical (covert) Operational Strategic (agriculture only)	L-NC, NL-NC	Military Civilians (agriculture)	Inhalation Agriculture
US DEFENSIVE (>1969)	Operational Strategic	L-C, NL-C, L-NC, NL-NC	Military Civilians	Inhalation (mil/civs Ingestion (civs) Agriculture (civs))

[a] This is a subjective assessment of the actual or planned employment of biological warfare. The Soviet and Americans both developed toxin weapons for covert use. The Americans only developed anti-crop weapons for strategic use. The American military defensive doctrine remains largely fixated on the operational effects while the civilians are concerned about potential strategic attacks against the United States.

[b] Human pathogens that are: L-C (Lethal and Contagious), L-NC (Lethal and Non-contagious), NL-C (Non-lethal and Contagious), or NL-NC (Non-lethal and Non-contagious). All forms were found in antiquity and the Japanese program. The Soviets investigated and may have weaponized smallpox and plague (L-C). The Americans only weaponized NC agents. Contemporary defensive doctrine remains largely fixated on those agents while the civilian community is concerned about contagious pathogens as well.

[c] Both the military and civilians were targets of biological warfare throughout history which highlights its use and utility at all levels of war. Civilians are the primary targets of terrorists while the conventional military programs tended to focus on militaries as the primary targets.

[d] Inhalation, fomites, ingestion, and agriculture were modes or action found throughout history and in the Japanese program (and are postulated for bioterrorist use). The Soviet and American offensive programs focused on inhalation of aerosol clouds and agricultural attacks.

Chemical and Biological Warfare Threat: USAF Water Systems are at Risk," Counterproliferation Papers: Future Warfare Series no. 3 (Maxwell AFB, Ala.: Air University Press, September 1999).

its use. All of its weapons are subject to the physical forces in their operational environment. As was pointed out in Chapters 2 and 3, as living organisms most biological weapons face a multitude of obstacles. The medium may or may not be hostile to their survival and each mode of attack has particular constraints. It is nontrivial to successfully effect ground targets with large aerosol clouds. Passive defensive can effectively counter many of the weapons (sanitizing water, vaccines, donning protective garments, etc.). Modern medicine has antibiotics and other active defenses to counter many of the various diseases.

Militaries succeeded in the Middle Ages with little understanding of the causative agents. That this could be done against the United States today is doubtful, but perhaps not so in other parts of the world. Once released to the environment the weapons are uncontrollable because they are subject to the environment and operate per their natural functions. For many militaries this poses operational problems, and in the case of the Soviets and Americans bounded their weapons development programs. Biological weapons can and have turned on their masters (the Soviet tularemia case for example). Rapid and revolutionary technical change in man's understanding and manipulation of microbiological processes, the so-called "biotechnological revolution" enabled the evolution from the "pre-Pasteur" and "applied microbiology" eras of biological warfare into the current period. This revolution literally enables individuals or groups as well as states the means to not just carry out tactical or operational level attacks on the forward-deployed American military, but more importantly to threaten or carry out strategic attack against the American homeland.

Chapter 5

Biological Warfare And American Strategic Risk

Chivalry in combat … is the prerogative of the victor. It may follow, but never proceed, an ambush.
–Air Vice Marshal Tony Mason
Airpower: A Centennial Appraisal

Biological warfare is the most dangerous security threat facing the United States and global community. No other forms of warfare offers states, transnational terrorist groups or individuals so many weapons that can affect at all levels of war for such little cost. Unfortunately, as Kadlec and Larsen point out, most military and national security leaders do not consider biological weapons as independently decisive; instead, they view them as they regard airpower, as simply tools to be used on the battlefield.[201] Despite American recognition during the early Cold War that biological weapons could be used for strategic effect against civilian targets and clear historical evidence based on the nature on biological warfare, current military defensive doctrine focuses on attacks against operational military targets and leaves strategic defense to the civilians.[202] If biological warfare by individuals, groups or nations is or could be strategic warfare, as I've concluded it to be, then the United States must re-evaluate its understanding of biological warfare and approach its defense as it did other strategic threats in the past.

In this final chapter I compare and contrast biological warfare with nuclear and chemical warfare to demonstrate that biological warfare bears little resemblance save a diplomatic and political term of art to those other forms of warfare. To better grasp the complex problems of biological warfare America must shed the bifurcated paradigm of military use on the battlefield and terrorist use at home, and regard biological warfare as multi-level warfare with extremely dangerous strategic level effects. Towards that end, I suggest analysis through comparison with other forms of war that have direct and immediate strategic effect. Nuclear and air warfare both offer immediate and direct strategic effect, and air warfare, like biological warfare, offers

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[201] Robert P. Kadlec and Randall J. Larsen, "Passive Defense," in *Countering the Proliferation and Use of Weapons of Mass Destruction*. eds. Peter L. Hays, Vincent J. Jodoin and Alan R. Van Tassel (New York: McGraw-Hill, 1998), 234-35.
[202] Joint Publication 3-11, "Joint Doctrine for Nuclear, Biological, and Chemical (NBC) Defense," 10 July 1995, *Joint Electronic Library*, CD ROM, US Government Printing Office, February 2000, vii, I-2, and II-4-5.

military tactical and operational effects as well. The final sections of this thesis explore the relevancy of counterproliferation, deterrence and defense theories and practice of these other forms to contemporary biological warfare.

There is insufficient intellectual analysis about biological attack as strategic warfare against the United States. Just as airmen have found it difficult to explain precisely how strategic attack through its various non-linear mechanisms influences the will or ability of the adversary, American understanding of biological warfare is captive to misunderstanding of its characteristics and constraints. The nature of strategic attack in particular seems to demand this ambiguity. Theories and experience of nuclear and air warfare therefore present compelling analogs for studying biological warfare. Nuclear theories because they provide the greatest body of thought on deterrence of strategic level attack and war. Airpower theories because of the fundamental questions and few definitive answers posed by a form that can have near simultaneous affects at all levels of war. Also, airpower is America's preferred asymmetric military tool, an appropriate counterpoint for biological warfare as our enemy's asymmetric trump card.[203] Airpower, like biological warfare, "suffers" from a certain lack of definitiveness, as heated arguments continue to rage among scholars and military men about the actual impacts of airpower throughout the 20th century. The nuclear and aerospace warfare lenses will highlight important analogies, departure points and policy questions for addressing the key national security issues of proliferation, deterrence and defense of biological warfare.

Biological ≠ Nuclear ≠ Chemical

Clearly, biological warfare presents significant security challenges to the United States. The central postulate of this thesis is that American doctrinal amalgamation of biological weapons into the diplomatic and now domestic legal term of art "weapon of mass destruction" obscures analysis and understanding of this complex and dangerous form of warfare. Using the following series of notional graphs I demonstrate that biological warfare and its weapons are indeed quite

[203] "Joint Doctrine Encyclopedia," 16 July 1997, *Joint Electronic Library*, CD ROM, US Government Printing Office, February 2000, 59. Asymmetric attack in its most basic form means pitting your strengths against the weaknesses of your enemy. "Asymmetrical operations are particularly effective when applied against enemy forces not postured for immediate tactical battle but instead operate in more vulnerable aspects–operational deployment and/or movement, extended logistical activity (including rest and refitting), or mobilization and training (including industrial production)."

dissimilar from the nuclear and chemical warfare and weapons and that the amalgamated term of art does a disservice to those tasked with defending the nation.

First and foremost, the dimensions of lethality and communicability offer theoretical casualty figures, dead or otherwise, ranging eight orders of magnitude with single weapons. A nuclear weapon might effect several million, and while in theory could kill just one person, in tactical use would likely not effect more than a few thousand. Chemical weapons do not self-replicate, are less toxic than biological toxin, and therefore for all practical purposes cannot effect more than a few thousand in the extreme with one weapon. These facts are depicted in figure 5. Biological weapons lack the extreme physical destruction of nuclear weapons but may in limited circumstances restrict access or use of exposed terrain, water, buildings, or other structures (environmentally stable pathogens such as anthrax in soil or water for example).

Biological warfare has in the past and could well in the future offer effects than span the levels of war. Nuclear warfare is most often associated with strategic effects, though in theory its weapons could be used for operational and perhaps tactical effects. Any nuclear attack against the United States or its forces would dictate strategic level decisions upon the National Command Authorities as it would up the ante and scope of war. Chemical weapons offer tactical and operational effects, and in theory may have strategic effect if used against certain centers of gravity (leadership and public opinion/support for example). Figure 6 portrays this dynamic.

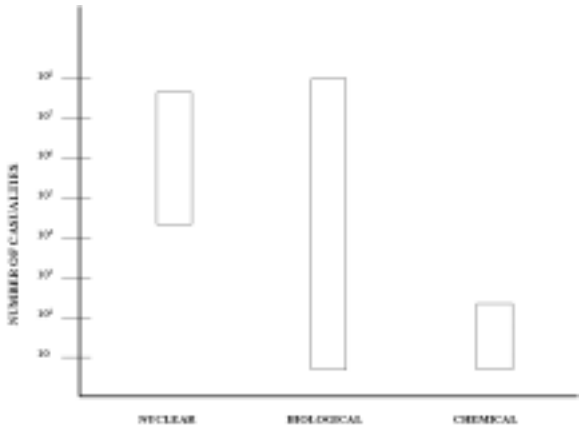

Figure 5. Casualty Comparison

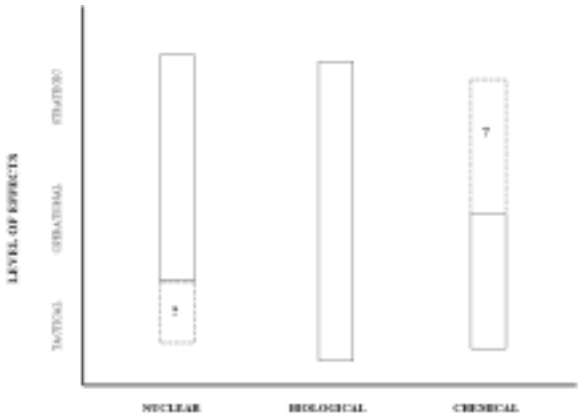

Figure 6. Level of Effects

It is important to view application in the spectrum of conflict through a potential adversary's eyes when comparing and contrasting the three forms of warfare. What may be a limited conflict to the United States may well be total war to the adversary. "Terrorists" may wage "total war" and not be as restricted in their choices of weapons effects by possible consequences of their

actions. In that context, nuclear warfare remains unlikely outside of total war, even by terrorists. The costs, both material and political, of developing and using these weapons would seem to limit their use to the more absolute axis of the spectrum. Both biological and chemical weapons have been used in and in theory could still be used throughout the spectrum of conflict. Figure 7 depicts this assessment.

Figure 8 demonstrates the importance of time for differentiation of the three forms of warfare. The primary effects of nuclear weapons are immediate and devastating, and for the most part confined to the area of detonation. Chemical weapon effects take seconds to days (for those that are persistent) to manifest themselves and remain located at the point of attack. There is little that is ambiguous about a nuclear or chemical attack. They manifest through explosions and near immediate effects. Biological weapons, on the other hand, may exhibit themselves in minutes (or seconds) in the case of toxins or days, if not months, to fully manifest themselves in the case of contagious disease. Without real time detection and/or overt declaration a biological attack will infect and affect until recognized and mitigated by competent authorities. Historically this limited its tactical or battlefield effectiveness. Soviet and American doctrine thus focused on deep targets so that effects could be realized prior to military engagement.

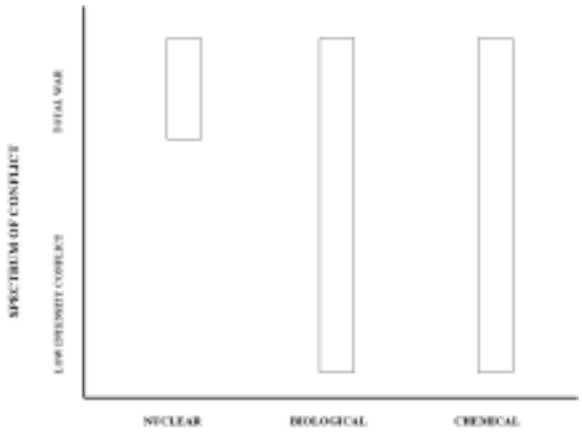

Figure 7. Utility in the Spectrum of Conflict

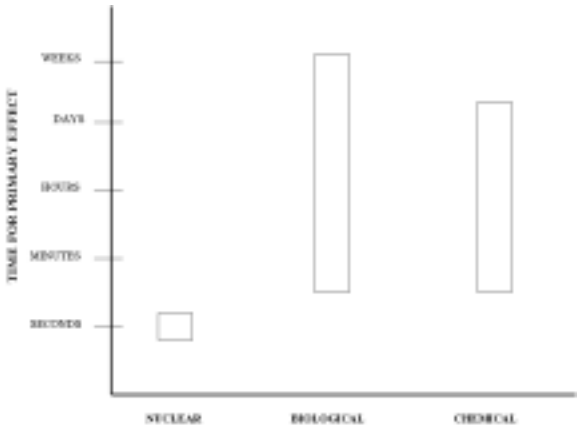

Figure 8. Time Dimension

Biological warfare could be fought today with practices of the pre-Pasteur era. For example, contaminating food or water with feces does not require knowledge of etiologic agents or modern applied microbiology. However, more sophisticated biological warfare is firmly grounded, in theory and in past practice, in applied microbiology and molecular biology. The sciences underlying these practices are dual-use and underpin the basic civilian institutions of medicine and agriculture. As Steven Block points out, biological weapons do not require rare

materials, rare finances, rare knowledge or rare infrastructure.[204] Their underlying sciences and technologies are not secret and literally thousands of texts, journals, papers and Internet websites openly distribute the basic and specific knowledge required for mass production and manipulation of microbial life. Biological warfare can be waged with almost zero cost (by contamination of reservoirs and wells with fecal material). For less than $10,000, anyone with gear no more sophisticated than a home brewing kit, protein cultures and personal protection can cultivate trillions of bacteria with relatively little personal risk.[205] Covert deployment against civilians doesn't require missiles or artillery and can be successful with cheap, off-the-shelf systems. Chemical, and particularly nuclear, weapons development and delivery is much more expensive and difficult. The costs for a high probability of kill over a square kilometer are $2,000 for conventional munitions, $800 for a nuclear device, $600 for nerve gas or just $1 for a

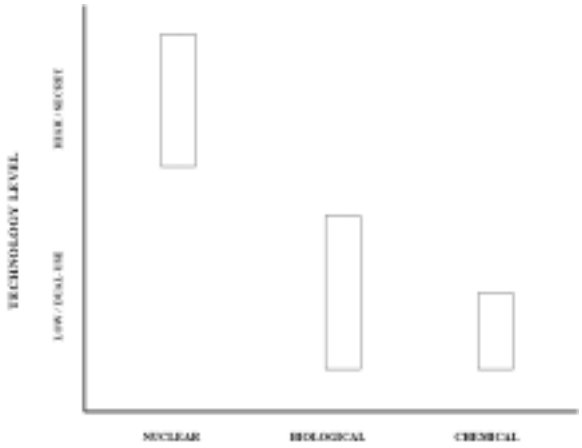

Figure 9. Technological Transparency

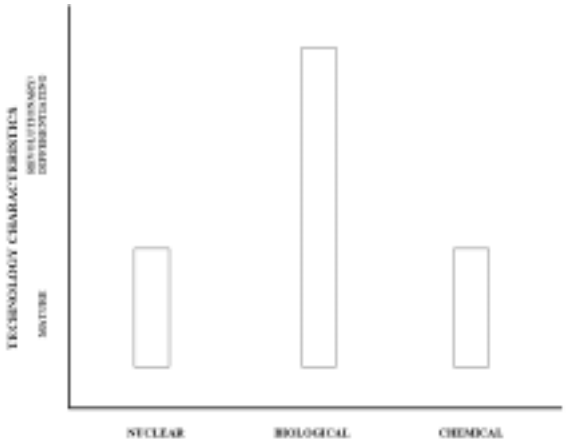

Figure 10. Technological Maturity

lethal pathogen like anthrax.[206] Figure 9 demonstrates that biological warfare is similar to chemical warfare but not to nuclear warfare in the level of technology required. Fissile material isn't readily available and weapon design and assembly are not dual use with civilian nuclear power plant operation.

Chemical weapons are close kin to common industrial and agricultural chemicals, though weaponization is not inherent to these legitimate industries. Figure 10 points out that of the three forms only biological rides the wave of an emerging technical revolution. Chemical and nuclear engineering are both mature and undifferentiating.

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[204] Steven M. Block, "Living Nightmares: Biological Threats Enabled by Molecular Biology," in *The New Terror: Facing the Threat of Biological and Chemical Weapons,* eds. Sidney D. Drell, Abraham D. Sofaer and George D. Wilson (Stanford: Hoover Institution Press, 1999), 42. Block is a microbiologist and served as a member of the JASON group.

[205] Leonard A. Cole, "The Specter of Biological Weapons," *Scientific American* 275, no. 6 (December 1996): 61.

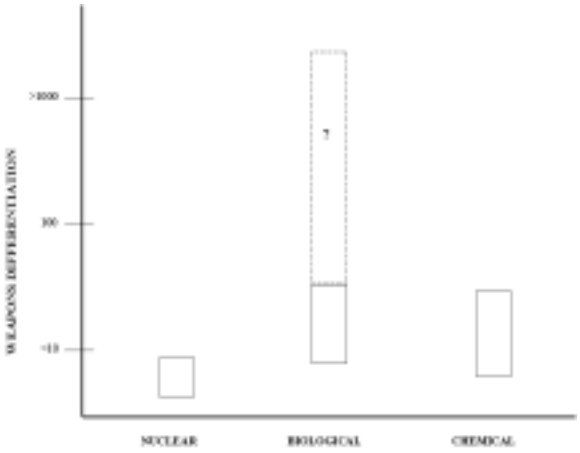

Figure 11. Variation in Weapons

Finally, the very nature of biological warfare, particularly with the explosive opportunities of the ongoing biotechnological revolution, offers multiple weapons all with specific and unique modes of action and characteristics. Appendix 1 lists around 80 naturally occurring pathogens and toxins that might be used in biological warfare. Genetic engineering portends great, if not unlimited, expansion of this list. On the other hand, nuclear weapons only come in three forms (two fission (implosion or gun) and fusion weapons) and fewer than 30 chemical weapons have so far been used or developed. Figure 11 depicts this variation.

Differences far outweigh similarities when biological warfare is compared to chemical and nuclear warfare. These differences aren't just variations of degree. They are in most respects basic to the characters of the three forms of war. "Mass destruction" is certainly relative, but only biological warfare offers belligerents–individuals, groups or states–casualty statistics ranging eight orders of magnitude across the spectrum of conflict and effects spanning all levels of war. Conversely, the effectiveness of biological weapons is difficult if not impossible to reliably predict. The risk to American military operations is clearly stated in national threat assessments. Biological warfare in many of its varied forms could significantly degrade our ability to fight and win. However, the clearest and most dangerous threat to American national security is strategic biological attack.

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[206] Barry R. Schneider, *Future War and Counterproliferation: U.S. Military Responses to NBC Proliferation Threats* (Westport, Conn.: Praeger, 1999), 93.

Counterproliferation

In this section I compare and contrast the proliferation issues of biological warfare to that of air and nuclear warfare. The specific foci are the legal status and the technological transparency of the various forms and how these factors constrain or enhance efforts to restrict proliferation of the weapons or their supporting technologies. Biological weapons are proscribed by international law yet can be produced through relatively cheap and transparent technologies by virtually any state or non-state actor. Air warfare is legal yet its offensive form is based on expensive and restricted high technology and is not available to non-state actors. International law restricts nuclear weapons possession to a few states and their proliferation is constrained by the availability of fissile material.

As described in Chapter 3, in banning the development, production, stockpiling or acquisition of biological agents or toxins in any quantity that has no justification for prophylactic, protective or other peaceful purposes the 1972 BWTC *de facto* prohibited an entire form of war as an instrument of *state* policy. Despite the fact that at least Iraq, Russia and South Africa are known to have had biological warfare programs through the early 1990s, no state today or since 1972 argues that biological weapons are legitimate and appropriate weapons in war. The BWTC and the various subsequent confidence-building measures support and internationalize the principle that deliberate development and use of biological material in war is repugnant to mankind. This regime in and to itself cannot perfectly protect mankind from a bioweaponeer, particularly in the context of the biotechnological revolution, and makes no provisions for control of non-state actors.

Air warfare, on the other hand, is not an illegal form of war and was employed or intended for employment for a variety of tactical, operational, and strategic effects in every major American conflict the 20th century. Airpower was the preferred American instrument of asymmetric military power in the 20th century.[207] It has become an operational and tactical imperative for American warfighting, playing prominently in every surface campaign since 1941. Its utility as an instrument of strategic effect, however, has dominated most theoretical and practical debates. Airpower was the only significant military force applied and won the campaign, if not war, for

[207] I include all forms of airpower in this general typology. American airpower is not limited to her Air Force, but includes her naval and marine air, Army aviation, and supporting civilian industries as well as the embryonic space-based capabilities of the United States.

Kosovo against Serbia in 1999. In perhaps its greatest triumph American airpower in 1991stripped the Iraqi army of its operational effectiveness and much of its tactical strength while simultaneously crippling the nation's controlling functions. American soldiers were free from airborne attack throughout much of World War II, in Korea after Inchon, in Vietnam and in Kuwait and in those same wars American airmen could attack much of the enemy surface with impunity though not always with decisive effect. Bombers laid waste to most of the Japanese cities and hamstrung the German war effort in 1943-45, leaving millions dead and displaced and undeniably shortening the war in terms of time and American casualties.

Vociferous debates raged throughout the 20th century about the nature of airpower and how best to employ it.[208] Guilio Douhet and others argued it could–and would–independently win wars by holding cities at risk or punishing them into submission. Colonel John Warden argues that airpower, employing modern precision-guided munitions, can directly target a nation's leadership and therefore cause capitulation without first defeating its military (strategic attack without directly attacking the enemy's civilians). Others, particularly Robert Pape, argue that airpower is most effective when used to degrade an enemy's surface forces to coerce capitulation by denying the enemy military its ability to seek and obtain national objectives.

The interwar years witnessed serious international debate centered on restricting or eliminating strategic bombers as instruments of war.[209] Politicians and publics feared aerial bombardment and took very seriously the theories and predictions of Douhet, Trenchard, Mitchell and like-minded airmen. Many felt that the next war would be a total war in which aerial armadas would lay waste to cities and civilians. Nations were unsure how their citizenry would react psychologically to the presumed devastating physical destruction. This led to proposals to restrict or eliminate bombers at the Geneva Disarmament talks of 1932-34. The talks faltered for several reasons. Unlike biological warfare, the Great Powers recognized the unique and compelling utility of airpower and none were willing to forego their ability to acquire and use it

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[208] I recommend Col Philip S. Meilinger, ed., *The Paths of Heaven: The Evolution of Airpower Theory* (Maxwell AFB, Ala.: Air University Press, 1997) to those unfamiliar with the various airpower theories. The text's bibliography directs interested parties to more in-depth reading. Also consider Robert A. Pape, *Bombing to Win* (Ithaca, N.Y.: Cornell University Press, 1996) and Mark Clodfelter, *The Limits of Air Power* (New York: Free Press, 1989) to round out the arguments.

[209] George Questor, *Deterrence Before Hiroshima* (New Brunswick: Transaction Books, 1986), 50-104 and Philip Meilinger, "Clipping the Bomber's Wings: the Geneva Disarmament Conference and the Royal Air Force, 1932-1934," *War in History* 6, no. 3 (July 1999): 303-330. These two sources provide concise histories of the debates

absent effective and verifiable means of insuring their adversaries were complying as well. This was unattainable because at the time the technology and industry of civilian transport aircraft was essentially dual-use with bombers and it proved impossible to develop verification regimes in such a rapidly evolving industry. No state argues today that air warfare is illegitimate though there are continuing debates about the morality and legitimacy of bombardment in which civilians are killed or otherwise injured by the "collateral" damage of legitimate military strikes.

The major belligerents entered World War II under no international restraint on bombers or bombing civilians. Strategic bombing became a cornerstone of the allied efforts against Germany and Japan, with civilians taking the brunt of the attacks. In Europe, the British targeted cities to break German morale and the Americans bombed "industrial vital centers," that for all practical purposes included civilians because of the imprecise targeting technology of the time. There is no doubt that the bombing negatively impacted German war production and morale. There is little consensus about the actual effect towards the nominal objectives of forcing a German surrender. There simply are too many variables associated with these strategic attacks to conclusively assign cause and effect relationships. American bombing of Japanese cities, particularly Hiroshima and Nagasaki with atomic bombs, may have precipitated the Japanese surrender. That these attacks significantly contributed to the war effort is undisputed, that they were solely or even primarily responsible for the American victory cannot be proven. This is the nature of strategic attack.

States recognize the utility of nuclear weapons (at least by those that have them) if not for war fighting then as the ultimate deterrent or insurance of national security. After the demise of President Truman's attempt to establish international control of nuclear energy and weapons (the Baruch Plan presented to the United Nations in 1946) international attention focused on controlling the proliferation of nuclear weapons and technology versus banning them as weapons of war. Unlike airpower, nuclear warfare required–and still does–advanced technology and access to rare primary resources, principally fissile material. The United States found itself unable to control proliferation among its wartime allies and the five victors all boasted nuclear weapons within 20 years of World War II. However, no other state claimed membership in the nuclear club until India and Pakistan in 1998. The superpowers managed horizontal proliferation

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surrounding international control of bombers and its ultimate failure in the face of a rapidly differentiating and critical dual-use industry.

by encouraging peaceful development of atomic energy and codifying a system of have and have nots. The International Atomic Energy Agency (IAEA) developed atomic energy programs in the Third World for the price of accepting inspections and safeguards. The multilateral nuclear Nonproliferation Treaty (NPT), which went into force in 1970, legitimized existing arsenals (but required concrete steps towards superpower arms control and eventual disarmament) and required non-nuclear states to foreswear the weapons. The IAEA safeguards and NPT proved inadequate in the Iraqi, Pakistani and Indian cases.

Nuclear technology is high technology requiring rare materials, rare knowledge, rare infrastructure and rare financial resources. Nuclear weapons counterproliferation was and continues to be aided by the fact that only states have the resources manufacture fissile material (Uranium 235 from ore or Plutonium 238 from reactors). Certainly this is not fail safe as individuals or groups could purchase fissile material or perhaps an assembled weapon on the black market if they were made available by a rogue state or through security failures in Russia. By and large however, nuclear weapons proliferation debates and policy have always been and should continue to be state-centered and concerned with control of critical resources and the knowledge to build a weapon.

Airpower in general is also solely available to states. States and states alone have the resources and infrastructure to research, develop, manufacture and operate most tools of offensive airpower (aircraft, missiles, bombs, etc). This was true in 1934 and is true in 2000. While it is conceivable that individuals or groups could purchase an advanced system on the black market, it is not probable that they could obtain and operate sufficient numbers to create effective mass without being identified by western intelligence sources.

Biological weapons present vastly different proliferation problems. The nature of the ubiquitous and civilian biotechnological revolution distributes the very technologies, techniques and information required manufacturing biological weapons. Mass production is relative as well. Kilograms of anthrax could kill millions, albeit to do so requires rare skill, knowledge and effective dissemination. But contagious, lethal and virulent pathogens (smallpox, influenza, et al.) in theory do not require kilograms and could be deployed for mass effect with simple devices like backpack sprayers in vital nodes such as airports. Biological weapons and biological warfare, unlike nuclear and air warfare, are available to individuals and groups, as well as to states.

In the anarchic global community few real disincentives to clandestine biological warfare research and development exist for a determined rogue nation, and fewer still for individuals or groups. The Iraqis successfully hid their program under a strict inspection regime, and the Soviets were found out only through a catastrophic failure in one of their safety procedures. As it stands now only the UNSC can investigate and impose sanctions on proliferant states, and sanctions have to date failed to force Iraq to acquiesce to international demands. Can the international community, or for that matter the United States unilaterally, significantly influence biotechnology development and *de facto* biological warfare availability? Prospects are not good against a determined actor. Airpower in the 1930s demonstrated the difficulties in controlling weapons proliferation when the weapons are based on a vital and diffuse civilian industry. Many nations felt bombers should be banned for moral and practical reasons (as long as the ban could be verified). First, it would protect civilians and second a ban would reduce the coercive effect of airpower in war. However, few were willing to forego commercial aviation and thus allowed proliferation. Despite near unanimous international ratification of the BWTC the nature of the biotechnological industry makes counterproliferation extremely difficult to practically enforce.

Any modern state or non-state biological warfare program will emanate from the ubiquitous and dual-use biotechnological industry. This industry is based on and supports the basic civilian institutions of medicine and agriculture, among others. It seems that attempts to control the spread of technologies essential for biological weapons are therefore bound to bear little fruit, for to do so the international community must counter or stop not only proliferation of vital, legitimate civilian technologies, but information, ideas, and intentions. The biotechnological revolution touches many aspects of daily life, its resource requirements are relatively few and its knowledge base essentially freely available via worldwide and transparent scientific media. Where states were and continue to be the only actors with the resources to acquire air forces, non-state actors can acquire and use biological weapons. Proliferation is probably as much a function of information dispersion as technology and raw material availability.

It is difficult to conceive how the international community can control the free flow of information in microbiology, pharmacy, agricultural, genetics, and medicine.. It can't, nor should it even try to do so. The greater good of better and plentiful food and medicine should and will outweigh fears of nefarious use. Attempts to control or safeguard peaceful application of biotechnology in the IAEA model seem to offer little more than speed bumps to determined

users. It didn't work with nuclear weapons (Iraq, Pakistan and India are prime examples) and is far less likely to do so with biological weapons given that the technologies and resources are available to states, groups and even individuals.

While the world community cannot expect perfect protection given the nature of the underlying technologies, it can strengthen the BWTC and institute other measures that will increase international confidence in the regime and further deter weapons production and use. First, the states parties to the BWTC should adopt the on and off site verification measures of the VEREX process. The verification proposals are neither exhaustive nor comprehensive, but implemented as a whole they should increase state program transparency and intrastate confidence.[210] This regime must include an independent and empowered inspection mechanism with which to investigate and report alleged programs or use. Such a mechanism is the most arduous task facing the international community. It must have provisions and capabilities for rapid undeclared and declared inspections–otherwise the probability of detecting violators will remain at near zero. Second, a worldwide epidemiological reporting network must be established. This will include measures for investigating suspicious or unusual outbreaks of disease. The biotechnological revolution provides tools that allow the reconstruction of the geographical and evolutionary history of most outbreaks.[211] Such an outbreak could be man-caused or the emergence of a natural disease, but in either case such a network could quickly establish its source, its character, and its rate of expansion to aid the in its containment and control. An international system could include the resources of the World Health Organization and those of the various states parties, for example the CDC.

Finally, the international community must forge effective hammers with which to nail not only state proliferators but individuals and groups as well. Any state or non-state party that is found to have developed, produced, stockpiled, acquired or used biological agents or toxins in any quantity that has no justification for prophylactic, protective or other peaceful purposes must face automatic punitive action. In the case of states this should be managed under a veto-proof

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[210] Robert A. Kadlec, Allan P. Zelicoff, and Ann M. Vrtis, "Biological Weapons Control: Prospects and Implications for the Future," in *Biological Weapons: Limiting the Threat*, ed. Joshua Lederburg (Cambridge: The MIT Press, 1999), 102-3.

[211] Mark. L. Wheelis, "Investigation of Suspicious Outbreaks of Disease," in *Biological Warfare: Modern Offense and Defense*, ed. Raymond A. Zalinskas, (Boulder: Lynne Rienner Publishers, 2000), 116. These technologies are polymerase chain reaction (PCR), restriction enzymes, gene cloning and sequencing and comparing with known, natural strains.

system, in other words outside of the UNSC. For non-state actors the BWTC signatories must agree to collectively create and enforce appropriate domestic criminal legislation or agree to an international protocol akin to a standing war crimes tribunal. The world community agrees biological weapons are repugnant in war between states, it must now affirm they are repugnant in conflicts by all actors at all levels. The American example is the Anti-terrorism Act of 1996 which criminalized the acts of developing or threatening to develop and use biological agents.[212] It also created a regulatory framework for controlling "hazardous" biological material to be administered by the CDC. A standing war crimes tribunal would require subjugation of national sovereignty to an international judiciary and police to be effective, a highly unlikely prospect in the short term. However, as Scharf points out, international criminalization could serve to strengthen or maintain sanctions and to isolate the offending leaders while not, theoretically, punishing the innocents in the nation.[213] Regardless of international action on the subject, the United States must retain its ability, if not international right, to act unilaterally as it did against the Sudanese chemical plant in 1998. The risk to international stability by expanding interpretation of Article 51 of the United Nations charter is perhaps outweighed by the danger posed by individual biological weapon proliferators and those who engage in biological warfare.[214]

Deterrence

Effective deterrence requires making an act (use of biological weapons in this case) look less attractive than the alternative in the mind of the adversary. Deterrence is particularly problematic in air and biological warfare, for how does one effectively deter the use of weapons that have effects−some ambiguous, some not−at all levels that can be used throughout the spectrum of conflict? By comparison nuclear deterrence is straightforward.

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[212] James R. Furgeson, "Biological Weapons and U.S. Law," in *Biological Weapons: Limiting the Threat*, ed. Joshua Lederburg (Cambridge: The MIT Press, 1999), 87.
[213] Michael P. Scharf, "Enforcement Through Sanctions, Force, and Criminalization," in *The New Terror: Facing the Threat of Biological and Chemical Weapons*, eds. Sidney D. Drell, Abraham D. Sofaer and George D. Wilson (Stanford: Hoover Institution Press, 1999), 478-79.
[214] Ibid., 454. Article 51 codifies the international right to self-defense from attack and may or may not have overridden the customary right of anticipatory self-defense.

As Karl Mueller points out, nuclear strategic thought reached and remained at an intellectual plateau within the first two decades after World War II.[215] The subject is intrinsically simple to grasp and is intimately linked to technological development of the weapons themselves and their delivery systems (bombers and missiles). The Hiroshima bomb was less than 20 kilotons, killed 60-70,000 people and ruined a city. By the late 1950s both the Americans and Soviets had warheads whose energies were over a thousand times greater. Employed on hypersonic missiles and in armadas of bombers, nuclear weapons not only threatened massive civilian casualties but swift national destruction. Nuclear warfare theory promptly became a question not of war winning but war avoidance through deterrence as it was apparent that nuclear war between the superpowers would have no winners in any classical sense.

Nuclear war is most likely a total war, at least for one of the belligerents, with weapons effects most likely at the strategic or operational levels. A nuclear attack is unambiguous and there is little doubt about the weapon's immediate effects. It is fairly easy for national leaders to weigh the costs of nuclear attack with the postulated benefits of war. No state has chosen the nuclear option since atomic bombs helped to bring about the Japanese surrender in 1945. Cold War nuclear deterrence appears to have worked because the threat of symmetric (nuclear) retaliation (by either party) was credible and the costs were too high, particularly for countervalue targets (cities).

In the convoluted world of nuclear deterrence theory, vulnerable weapons (counterforce targets) stabilized deterrence while efforts to defend civilians (countervalue targets) threatened deterrence because they reduced the adversary's second-strike assured destruction capability.[216] Rational states whose civilians were held hostage by assured destruction had to remain non-aggressive. Civil defense, ballistic missile defenses and air defenses could enhance defense, but destabilized the relationship and reduced deterrence in a mutual assured destruction (MAD) environment. Mobility and hardened silos protected a second strike capability and thus enhanced deterrence. MAD enthusiasts found strategic defenses to be destabilizing and dangerous while those who felt nuclear wars could be fought and won found them enticing.[217] Post Cold War

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[215] Dr. Karl Mueller, "Strategic Airpower and Nuclear Strategy: New Theory for a Not-Quite-So-New Apocalypse," ed. Col Philip S. Meilinger, *The Paths of Heaven: The Evolution of Airpower Theory* (Maxwell AFB, Ala.: Air University Press, 1997), 279.
[216] Mueller, 303.
[217] Mueller, 304.

American nuclear deterrence is still predicated on assured destructive nuclear retaliation against any nuclear aggressor.

Deterrence by threats of massive symmetric retaliation didn't work for long in air warfare. Depending on perspective, Hitler deterred French and British air attacks on Germany, or coerced their acquiescence, at Munich in 1938 by rattling his skeletal Luftwaffe saber. The Phony War of Sep 1939 through May 1940 saw the great bomber armadas deterred from attacking enemy cities by the prospect of symmetric retaliation. This symmetric deterrence of strategic level attack hasn't held since Hitler attacked London in the summer of 1940 (except in terms of nuclear warfare). No two air forces have simultaneously wielded conventional air weapons that could raise the other's cost too high. Allied strategic bombing in World War II didn't deter German V-1 and V-2 attacks. Iran and Iraq persisted in lobbing medium range conventional missiles at each other's cities in the 1980s. In total war air forces have flown in the face of extreme odds (Japanese and Germans in World War II). By gaining air superiority air forces seem to be able to deter, in limited wars, symmetric enemy air action (the Iraqis in 1991 and Serbians in 1999 flew few sorties in the face of overwhelming US advantage). The Serbians were able to deter NATO low level attack by contesting the airspace with air defense systems.

Deterring biological warfare is far more complex than deterring nuclear or air warfare. The United States must literally deter rogue states, transnational groups and disaffected individuals. This is not the case with nuclear and air warfare. More importantly, the United States is faced with the serious question about how to deter. Nuclear deterrence was symmetric. Air warfare deterrence, when it worked, was symmetric. America does not have a biological warfare capability, nor is it at all clear that this form of symmetric deterrence would work best, despite the apparent success in the other forms. The offensive doctrines discussed in Chapter 4 sought not the destruction of enemy biological warfare capabilities, but various asymmetric effects at all levels of war.

The military and national security communities have given the subject of deterring biological warfare as strategic warfare scant individual attention. Several authors offer important starting points in the context of WMD, but none have approached biological warfare as the unique deterrent conundrum that it is. Joseph and Reichart in 1996 and Bernstein and Dunn in 1998 laid important conceptual frameworks for deterring nuclear, biological and chemical (NBC) use writ

large.[218] Schneider in 1999 proposed "thirty key questions" for deterring NASTIs (NBC-Armed Sponsors of Terrorism and Intervention), focusing on the concept of "belligerent reprisal" and recognizing the limitations of nuclear reprisal as a deterrent of chemical and biological attack.[219] Joseph and Blechman argue the pros and cons of nuclear deterrence of chemical and biological warfare.[220] Joseph brings out the salient point that even at the height of the Cold War no one possessed an exact understanding of how deterrence worked. They recognize that the United States may not be able to make clear to its adversaries or itself what types of chemical or biological attacks would risk a nuclear response.

The real dilemma for the United States is biological warfare's potential as an asymmetric threat to American action in a less than truly vital national interest. By threatening an attack on an American or allied city an adversary may be able to deter American action or force an American President to risk civilian lives for limited national objectives. In Korea and Vietnam the risk of involving the Soviets or Chinese with concomitant escalation to nuclear confrontation constrained American options and enemy leaders rightly could question whether or not the United States is any more willing to risk civilian casualties today.

How should a President respond to such a threat? Uncertainty about what deterred Saddam Hussein from using his biological weapons during the Gulf War highlights the complexity of the issue. Are threats of "overwhelming and devastating" response to a non-lethal and non-contagious attack credible? Would an American President release the nuclear genie if American's didn't die, even if the adversary gained significant, even decisive, operational or tactical advantage? Even if Americans died en masse is the nuclear option against enemy civilians in a police state credible? What does "overwhelming and devastating" mean in an American war whose objectives are less than regime surrender? The multi-dimensional nature of biological warfare make deterrence, and attack response for that matter, extremely problematic.

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[218] Robert G. Joseph, and John F. Reichart, "Deterrence and Defense in a Nuclear, Biological and Chemical Environment," *Comparative Strategy* 15, no. 1 (January-March 1996): 59-80 and Paul I. Bernstein and Lewis A. Dunn, "Adapting Deterrence to the WMD Threat," in *Countering the Proliferation and Use of Weapons of Mass Destruction*, eds. Peter L. Hays, Vincent J. Jodoin and Alan R. Van Tassel (New York: McGraw-Hill, 1998), 147-70.

[219] Schneider, 62-78.

[220] Robert Joseph and Barry Blechman, "Deterring Chemical and Biological Weapons," in *Transforming Nuclear Deterrence*, eds. Hans Binnendijk and James Goodby (Washington D.C.: Institute of National Strategic Studies, National Defense University Press, 1999), 1-4, on-line, Internet, 20 April 2000, available from http://www.ndu.edu/ndu/inss/books/tnd/tnd2.html.

Fortunately, the complexity of response decisions appears to be the inverse of the complexity and danger of effect in biological warfare. Figure 15 depicts this "deterrence paradox." Threat or use of a contagious, virulent and lethal weapon, the upper right quadrant, is the most likely to create "massive" effects. The non-linear nature of the contagious disease is problematic, presenting obstacles to prediction and limitation of its impact. Yet, at least against a state actor, such effects raise the ante and make an overwhelming and devastating response, even with nuclear weapons, more credible. This may not be the case with non-state actors for several reasons. Successful deterrence requires someone who rationally has something to lose and therefore can make some sort of cost-benefit calculus regarding his future actions. We may not know whom we're dealing with and there may be no credible cost to deter their actions. Many contagious weapons are not likely to mimic naturally occurring diseases–a virulent and lethal influenza being the most obvious exception–and therefore their use likely will not be

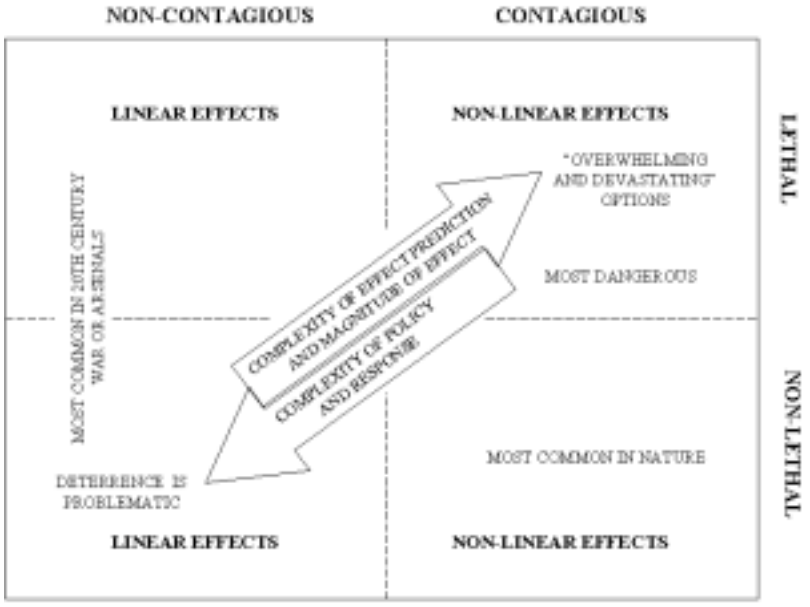

Figure 12. Deterrence Paradox

ambiguous. Their effects in terms of casualties potentially match or exceed those predicted in nuclear attacks. On the other hand, a non-contagious and/or non-lethal disease does not present such massive effects and begs fundamental questions about how to respond if few or none are actually killed, or if the attack is economic (against agriculture) instead of against humans. These weapons are more likely to mimic endemic disease and therefore create ambiguity about

their source. Their effects in terms of casualties will be less significant. Thus, in many potential biological attack scenarios, the effect may be so minor as to not warrant American escalation. Clearly a "one size fits all" deterrence policy, even deliberate ambiguity, simply cannot work because it will raise credibility questions in the mind of the potential adversary. Like air warfare, biological warfare effects manifest at many levels across the spectrum of conflict and therefore they cannot easily be deterred in all scenarios. The United States needs to approach deterrence through the lens of this paradox and ask and answer the following questions:

1. In what scenarios can a state or non-state actor credibly threaten significant civilian casualties to deter American action? Military casualties? Allied civilians?
2. Do all biological attacks require the same deterrent or response (lethal versus non-lethal, contagious versus non-contagious)?
3. If not, what criteria differentiate the deterrent posture and response?
4. What are the appropriate deterrent threats and responses? Is declaration of war and willingness to force regime surrender with conventional means the appropriate "overwhelming and devastating" response? Is the United States willing to do so in a limited war (considering the United States hasn't done so since World War II)? Does the doctrine of proportionality matter?
5. Is criminalization of biological warfare credible and enforceable?

Even if the world community adopts and enforces the VEREX verification measures, an independent inspection regime, enhanced epidemiology and some form of effective international criminalization it cannot expect perfect protection from biological warfare proliferators. The United States must face the prospect of vulnerability to coercion or actual attack by state or non-state actors and ask and answer the proceeding questions. The deterrence paradox seems to dictate varied strategies for the different types and levels of potential biological attacks. Given that actors–particularly non-state–may not be "deterrable" in some scenarios, America must protect her people as she's attempting to protect her military. A defense-in-depth based on multi-layered active and passive measures and existing infrastructure and institutions can and should compliment the international counterproliferation efforts and the national deterrence strategy.

Defense

The Battle of Britain in 1940 illustrated the complex nature of multi-level warfare and determining appropriate and effective defense against strategic attack. Prior to the war the Royal Air Force (RAF) focused on a doctrine and force structure based on daylight "precision" bombing of the enemy's industrial infrastructure and the more ephemeral enemy morale or will

to fight under the theory that such an attack might independently win the war. The RAF chose to meet the threat of strategic air attack on Great Britain not with an integrated air defense including fighters, air defense artillery (ADA) and warning, but by attacking German airfields first (to gain air superiority) and then German cities. This was akin to the theory that the best defense is a good offense. Fortunately for Britain the RAF didn't wholly disregard fighter aircraft and other defensive technologies such as radar. The Inskip report in 1938 forced Government to reorder the RAF's priorities and by 1940 RAF Fighter Command had enough Spitfires, Hurricanes, ADA, and warning (radar and a command and control system) to withstand the Luftwaffe's attack. Air raid shelters provided effective though not impervious final civil defense for the people of London and other communities. The point to be made is that while the military preferred an offensive doctrine and force structure what saved the day for Britain was effective active and passive defense.

Several analogies can be made to contemporary biological warfare. Bombers as offensive counterforce and supporting doctrine were the RAF's preferred solutions to the British security dilemma. During the Battle of Britain however it was the defense in depth that saved the day, not offensive attacks against German airfields or cities. Radar and spotters detected the incoming attacks. These are analogous to epidemiology and environmental detectors in biological warfare. Fighters and ADA attacked and destroyed incoming bombers. Antibiotics and other therapies perform the same functions in biological attacks. Civil defense air raid shelters protected civilians from the effects of the attacks. Vaccines and other prophylactics serve the same function against pathogens.

Biological warfare defense is in many respects practical and presents significant deterrent and warfighting value, though it is impossible to ensure complete protection.[221] Most texts on WMD present a chapter or two on NBC defense, but few focus on the complex and broad spectrum of issues posed by biological warfare.[222] Biological warfare defense can be viewed through

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[221] Kadlec and Larsen, 235-36.

[222] See Stanley L. Weiner, "Biological Warfare Defense," in *Biological Warfare: Modern Offense and Defense*, ed. Raymond A. Zalinskas, (Boulder: Lynne Rienner Publishers, 2000), 119-29. His work is one of the few to focus almost exclusively on biological warfare and he concludes that at present all militaries and civilians in the world are vulnerable to biological warfare attack and that the best defense are pro-active, preventive measures. See also Robert P. Kadlec and Randall J. Larsen, "Passive Defense," in *Countering the Proliferation and Use of Weapons of Mass Destruction*. eds. Peter L. Hays, Vincent J. Jodoin and Alan R. Van Tassel(New York: McGraw-Hill, 1998), 217-37; Col David R. Franz et al., "Clinical Recognition and Management of Patients Exposed to Biological Warfare Agents," *Journal of the American Medical Association* 278, no. 5 (6 August 1997): 399-425; Frederick R.

standard military lexicon of active and passive defense. Active defense entails counterforce measures to locate and destroy enemy biological weapons (agents and/or delivery systems) and weapons production infrastructure. This may occur preemptively or during weapons employment. Passive defenses include intelligence, detection and surveillance, barriers, vaccination, post-attack antibiotics and similar therapies, and supporting medical/logistical systems and infrastructure.[223] Given the difficult task of inhibiting proliferation of dual-use biotechnology and the paradoxes of deterring biological warfare, the United States must develop a defense in depth to first protect its citizens and military and second reduce or eliminate the coercive value of strategic biological warfare.

I suggest a strategy based on how an adversary might plan its defense against American airpower. American airpower can strike and effect near simultaneously on the battlefield, in the rear areas, and strategically against national level assets. An adversary will prepare to defend its military in different ways than its civilian infrastructure, though there may be important commonalities. Active counterforce missions may be the same at all levels, but many passive defenses are bound to be different. The comprehensive defense in depth strategy would address not only defense of fielded forces but also the strategic vulnerabilities of essential American allies and the American homeland. The military's biological defense program is the appropriate departure point for erecting a defense in depth.

The Department of Defense (DoD) is actively improving its own biological warfare passive defensive posture. Doctrinally it organizes the chemical and biological defense concept under the rubrics of contamination avoidance, protection, and decontamination.[224] Contamination avoidance includes reconnaissance, detection, identification, warning and reporting. The major technical challenges are biological agent collection and discrimination, sample processing, interference and gene-based probe development.[225] The DoD is developing and fielding a

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Sidell, Ernest T. Takafuji, and David R. Franz, *Medical Aspects of Chemical and Biological Warfare*, Washington D.C.: Borden Institute, 1997; Army Field Manual 8-9, *Handbook on the Medical Aspects of NBC Defensive Operations*, February 1996 (this is a joint manual) and Air Force Manual 32-4017, *Civil Engineer Readiness Technician's Manual for Nuclear, Biological and Chemical Defense*, 1 June 1998.

[223] In my opinion antibiotics are active defenses by their purpose and mode of action. They seek and kill the offending pathogen versus provide some sort of passive barrier. Most texts on counterproliferation and NBC defense list them as passive defenses however and I'll use their convention.

[224] Department of Defense, *Chemical and Biological Defense Program* (Fort Belvoir, Va.: Defense Technical Information Center, March 2000), 23.

[225] Ibid., 28.

variety of biological agent detection efforts.[226] Protection includes individual and collection protection as well as medical defenses. Individual protection (suits and masks) encompass tradeoffs between decreased physiological performance and cost, size/weight, comfort and interfaces with other equipment. Medical protection–prophylaxes, pretreatments and therapies–must meet a variety of product safety and informed consent provisions.[227] Its elements must protect, rapidly diagnose infections or intoxication, and treat casualties. Ongoing research and development fully mobilizes the tools and techniques of the biotechnological revolution.[228] The anthrax vaccine is fielded and other vaccines and antisera are in development (smallpox, botulinum toxin, tularemia, Venezuelan equine encephalitis, and Q-fever).[229] Decontamination seeks to eliminate, neutralize or incapacitate biological agents particularly from equipment. Patient decontamination is relatively simple with soap, water and disinfectants.

The DoD has cooperative research efforts with various governmental agencies. The Defense Advanced Research Projects Agency (DARPA) is focusing on real-time environmental sensing, novel medical countermeasures, and advanced medical diagnostics. Their research fully involves the tools and techniques of the biotechnological revolution. The DoD is a member of the interagency Technical Support Working Group's Chemical, Biological, Radiological, Nuclear and Countermeasures sub-group TSWG-CBRNC). With the Department of State, FBI and CIA the group works to maximize technological development and reduce redundancy.

Figure 13 presents the requirements of an effective defense in depth based the military's doctrinal rubrics (it doesn't include decontamination as patient decontamination is relatively simple). Active defensive concerns are similar at all levels. Counterforce against aircraft and missiles at the battlefield and rear areas (tactical and operational levels) is possible but not guaranteed with American air superiority and missile defense systems such as Patriot. Special forces (SOF) or covert operations pose complex problems at all levels, particularly with agents that do not require large, dispersed airborne clouds. Missiles and aircraft may be effective within allied nations if these nations do not have effective defensive capabilities. Within the United States civilian aircraft could be used to covertly attack cities and the Korean Taepo Dong 2 may be able to reach Hawaii and Alaska.

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[226] Ibid., 32. These include point source and standoff detection.
[227] Ibid., 52.
[228] Ibid., 63.

As Betts pointed out, most military planners concern themselves with preventing and mitigating asymmetric advantage on the battlefield, and civilian planners, leadership and the public concern themselves with catastrophic attack on American cities.[230] However, recent Congressionally mandated initiatives have increased the DoD involvement in homeland WMD defense. Army Chemical Corps personnel have trained over 20,000 "first responders" to anticipate and recognize the hazards of various WMD scenarios.[231] This program incorporates military NBC defense doctrine into the civilian incident command and hazardous materials

	AMERICAN HOMELAND	ALLIED HOMELAND	CIVILIANS IN THEATER	REAR AREAS	BATTLEFIELD
ENEMY TARGET	Civilians Critical infrastructure	Civilians Critical Nodes	Nationals US Citizens	Military Critical Nodes	Military
ENEMY INTENDED EFFECT	Deter Degrade Destroy	Deter Deny US use Degrade Destroy	Deter Deny resources Degrade Destroy	Degrade Destroy	Degrade Destroy
ACTIVE DEFENSE CONCERNS	Covert Aircraft Missiles?	Covert Aircraft Missiles?	Covert Aircraft Missiles	Covert Aircraft Missiles	Covert Aircraft Missiles
CONTAMINATION AVOIDANCE	Improving Epidemiology	?	?	Limited Detection, Epidemiology	Limited Detection, Epidemiology
PROTECTION: BARRIERS	?	?	?	Individual & Collective	Individual & Collective
PROTECTION: VACCINES AND ANTISERA	Insufficient	?	?	Anthrax, others in development	Anthrax, others in development
PROTECTION: ANTIBIOTICS/ THERAPIES	Severely Limited Stocks	?	?	Limited Stocks	Limited Stocks
MEDICAL SYSTEM	Severely limited	?	?	Limited	Limited
CONSEQUENCE MANAGEMENT	Medical or HAZMAT Model?	?	?	Recover and Operate	Recover and Operate

Figure 13. Biological Warfare Defense Roadmap

(HAZMAT) response protocols. In 1999 the DoD created a standing joint task force for domestic civil support (JTF-CS). Its mission is to plan and prepare for domestic WMD contingencies and to make available through regional National Guard teams unique military

[229] Ibid., 54.
[230] Betts, 30.

NBC consequence management expertise. These measures, while important first steps, do not adequately address the fundamental characteristics of biological warfare. By training first responders one presumes there will be an "event." In chemical, nuclear or conventional terrorism something will go "boom" or people will start dying. This is not necessarily the case in a biological attack and the incident command system and HAZMAT protocols may not be the best response posture for biological attack. The JTF-CS teams have appropriate equipment with which to sample suspect material, but offer little support to emergency rooms flooded with patients complaining of mysterious flu-like symptoms. Current DoD efforts do not fully address America's national strategic risk to biological warfare.

A Congressionally mandated commission recently evaluated America's WMD vulnerabilities but fell short with respect to biological warfare in its 14 July 1999 report to Congress.[232] The Commission recognized the disjointed and dispersed nature of WMD policy and responsibility within the Federal Government and called for a comprehensive policy–for WMD writ large–managed by a new Deputy Assistant to the President for Combating Proliferation.[233] It recognized and advocated the unique and important contributions and responsibilities of the Departments of Defense, Justice and State, yet barely mentioned the Public Health Service (USPHS, under the Department of Health and Human Services) as integral to active and passive defense of biological warfare.[234] This situation is unsatisfactory. If active biological warfare defense fails at any point of the defense in depth America must have a strong passive defense, one that is necessarily medical in nature.

Biological warfare is clearly different than chemical or nuclear warfare, and it requires different defensive paradigms, particularly for civil defense. The United States has an existing disease control framework. This is the federal, state and local public health and medical systems, the biotech and pharmaceutical industries, and university and private research. The medical

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[231] Linda D. Kozaryn, "DoD helps Hometown USA Confront Terrorism," *Armed Forces News Service*, 8 January 2000, 2; on-line, Internet, 3 May 2000, available from http://www.defenselink.mil/news/.

[232] Commission to Assess the Organization of the Federal Government to Combat the Proliferation of Weapons of Mass Destruction (hereafter referred to as "The Commission"), *Combating Proliferation of Weapons of Mass Destruction* (Washington, D.C.: Commission to Assess the Organization of the Federal Government to Combat the Proliferation of Weapons of Mass Destruction, 14 July 1999).

[233] The Commission, 25.

[234] Ibid., viii and 101. To their credit the enabling legislation prohibited The Commission from reviewing or assessing domestic response or preparedness. However, The Commission failed to recognize the unique characteristics of biological warfare that demand a medical defensive posture best obtained by an integrated command structure under the USPHS.

infrastructure will most likely first detect an "epidemic" through case presentations and epidemiological evidence. The same infrastructure will be called upon to mitigate any actual disease outbreak (natural or man-caused), and is the system that is responsible for vaccination and other preventive programs. To defend itself against biological warfare the United States must transform these systems into a coordinated national priority. Danzig agrees:

> A proactive effort to build national [consequence management] capabilities, through a robust public health program, is far more than a traditional one-way investment in civil defense. Resources put towards [biological warfare] civil defense are not sterile investments like 1950s-style bomb shelters. They are investments in public health, the benefits of which are manifold. Developing new vaccines and stockpiling them protects mankind from both natural and man-made threats. Educating the public on [biological warfare] threats improves awareness about, and thus aids in prevention of, naturally occurring disease.[235]

An improved and empowered system would comprehensively target many of the threats outlined in the National Security Strategy. Medical defense in depth is the best strategy to deter, deny, degrade and destroy biological warfare by state and transnational threats against the United States while concomitantly protecting her people from natural disease.[236] I propose that Congress designate the Public Health Service (USPHS) as the Federal executive agent for biological warfare defense and that it create a medical "joint task force" under the command of the USPHS to be called the "Joint Task Force-Biological Warfare Defense (JTF-BWD). Its mission would be to prepare for and conduct biological warfare civil defense within the United States.

The USPHS is the uniformed and commissioned service charged with monitoring and protecting the nation's health and is commanded by the US Surgeon General.[237] This Congressionally mandated standing task force under the command and operational control of the Surgeon General would incorporate appropriate USPHS resources and those of the armed forces. In a sense this

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[235] Danzig, 345.

[236] President William J. Clinton, *A National Security Strategy for a New Century* (The White House: February, 1999), 5-6. The report lists six security threats. State and transnational actors (both of which may use WMD), dangerous technologies (including biological weapons), failed states, foreign intelligence collection, and environmental and health threats.

[237] The Surgeon General is duel-hatted as the Assistant Secretary for Health (ASH) in the Department of Health and Human Services.

would "operationalize" civilian biological warfare defense. In crises command and control of military units, mostly medical but also logistical, would be transferred to the USPHS, much like military units are "chopped" to various joint force commanders today. It would create synergies and economies of scale and make available the knowledge and resources of the defense community while alleviating *posse comatatus* concerns.

This joint task force would create a better integrated defense in depth. The JTF would plan and execute the civilian analogs of contamination avoidance, protection and crisis management. In peacetime it would plan and execute national epidemiological surveillance through the state and local levels, monitor and manage therapeutic stocks (vaccines, antibiotics, etc.), monitor and manage the National Disaster Medical System (NDMS), and integrate with and capitalize on the DoD's medical protection programs. In crises it would implement the Federal Response Plan, Emergency Support Function #8, Health and Medical Services Annex in command of joint medical and other logistical support as required.[238] This annex provides "coordinated federal assistance to supplement State and local resources in response to public health and medical care needs following a major disaster or emergency, or during a developing medical situation."[239] Table 3 summarizes JTF-BWD's nominal mission responsibilities.

[238] Federal Emergency Management Agency, *Federal Response Plan*, 9230.1-PL, April 1999, ESF #8-1-22.
[239] Ibid., ESF#8-1.

Table 3.
Joint Task Force-Biological Warfare Defense (JTF-BWD) Missions

PLANNING	EXECUTION
CONTAMINATION AVOIDANCE	CONTAMINATION AVOIDANCE
- National Epidemiological Surveillance	- Assess trends, react accordingly
- Integrated Detectors and Diagnostics	- Report to Emergency Operations Center, activate
- Integrate DoD, other Agencies	Contingency Plans (ESF #8)
PROTECTION	PROTECTION
- Antibiotic/Vaccine/Therapeutic Stock Requirements	- Manage Nationwide Antibiotic/Vaccine/ Therapeutic
- Citizen Vaccination Status	Stocks
- NDMS Status	- Monitor Citizen Vaccination Status
- Future Technological Requirements (new vaccines, etc.)	- Mobilize NDMS
- Integrate DoD, other Agencies	- Coordinate with DoD and NIH on future
	technological requirements
CRISIS RESPONSE	- Integrate DoD, other Agencies
- Emergency Support Function #8	CRISIS RESPONSE
EXERCISES	- Implement Emergency Support Function #8
- Integrate with State and Local Systems	EXERCISES
	- Conduct

The JTF-BWD must be given the charter and resources to identify and pursue advanced biotechnologies to replace or enhance existing vaccination and antibiotic therapies. The JTF-BWD should integrate the resources of the CDC, Food and Drug Administration (FDA) and National Institutes of Health (NIH) as well as the appropriate components of the DoD's medical protection program and DARPA. The US Army Medical Research and Materiel Command, as the military's lead agent for biological warfare medical defense, would be the primary DoD component of this joint command. Other likely units include the medical services of the Air Force and Navy, the JTF-CS teams of the National Guard, and other logistic and service support functions as necessary (engineering, transportation, etc).

This will require a paradigmatic shift within the military. First, to be under the command of an outside agency (USPHS), and second for line personnel to be commanded by medical personnel (the Surgeon General). The Coast Guard might serve as a model for this integration, as it can be placed under the operational command of the Navy upon presidential order. This will also necessitate a mind set change in the USPHS, from a "peacetime" agency focused on natural disease to one dedicated as well to defense and mitigation of deliberate biological attack.

The Commission, in proposing a National Director for Combating Proliferation, also proposed a Combating Proliferation Council that would report to the National Security Council.[240] The Commission did not include the USPHS as a member of this council. This is short sighted given the nature of biological warfare and the USPHS' current mission. In the event that the JTF-BWD is created by Congress, the Surgeon General must be given a seat at this council.

Conclusion

In this thesis I've presented the case that biological warfare is unlike nuclear and chemical warfare and that the term of art "weapons of mass destruction" does disservice to those charged with the nation's defense. Biological warfare is not simply another arrow in the WMD quiver; it must be viewed as the intricate and multi-layered form described in my conceptual framework. Belligerents employed pathogens and toxins throughout the millennia. This ancient form of war now rides the wave of the most dynamic and epochal technological revolution man has yet created and faced, for we now have the ability to literally create life, including forms whose sole purpose is to kill or sicken mankind. America focused on biological warfare's operational utility in the context of a theoretical total war with the Soviet Union during her brief experience with offensive weapons. American military planners continue to assume America's enemies will employ their weapons for effects at those levels. Despite international prohibitions to its possession and use, states and other actors acquired and in a few cases attempted to use biological weapons in the final quarter of the 20th century. Unfortunately, biological warfare presents clear and immediate strategic level issues and effects.

Analyzing biological warfare through a multi-level warfare lens such as airpower may help military planners and the national security community better understand its characteristics and constraints. The ubiquitous nature of the biotechnological industries and sciences make nonproliferation to determined state or non-state users problematic. Certain measures–enhanced global epidemiological surveillance, inspection regimes, and criminalization–are practical and may reduce the threat in the long term. Deterrence is bound by the paradox that the complexity of effect prediction is proportional to the most dangerous attacks while the complexity of policy response is proportional to the most likely attacks. The nation must ask and answer serious questions about deterrence credibility in light of these paradoxes. Ultimately, to protect her vital

[240] The Commission, 16.

interests America must approach biological warfare as multi-level warfare and plan a defense in depth. Civil defense is not only possible but will enhance deterrence. Congress should designate the Public health Service as the executive agent for biological warfare defense and create a standing Joint Task Force-Biological Warfare Defense under the command and control of the US Surgeon General.

Appendix 1

LIST OF BIOLOGICAL AGENTS

Core List of Organisms having Potential BW Applications Against Man	
VIRUSES	**RICKETTSIAE**
V1. Chikungunya virus	R1. *Coxiella burnetii*
V2. Congo-Crimean haemorrhagic fever virus	R2. *Bartonella Quintana* (*Rochalimea quintana, Rickettsia quintana*)
V3. Dengue fever virus	R3. *Rickettsia prowasecki*
V4. Eastern equine encephalitis virus	R4. *Rickettsia rickettsii*
V5. Ebola virus	
V6. Hantaan virus	**BACTERIA**
V7. Junin virus	
V8. Lassa fever virus	B1. *Bacillus anthracis*
V9. Lymphocytic choriomeningitis virus	B2. *Brucella abortus*
V10. Machupo virus	B3. *Brucella melitensis*
V11. Marburg virus	B4. *Brucella suis*
V12. Monkey pox virus	B5. *Chlamydia psittaci*
V13. Rift Valley fever virus	B6. *Clostridium botulinum*
V14. Tick-borne encephalitis virus (Russian Spring-Summer encephalitis virus)	B7. *Francisella tularensis*
V15. Variola virus	B8. *Burkholderia mallei* (*Pseudomonas mallei*)
V16. Venezuelan equine encephalitis virus	B9. *Burkholderia pseudomallei* (*Pseudomonas pseudomallei*)
V17. Western equine encephalitis virus	B10. *Salmonella typhi*
V18. White pox	B11. *Shigella dysenteriae*
V19. Yellow fever virus	B12. *Vibrio cholerae*
V20. Japanese encephalitis virus	B13. *Yersinia pestis*

GENETICALLY MODIFIED MICROORGANISMS	
G1. Those microorganisms that contain nucleic acid sequences associated with pathogenicity and are derived from organisms on the core list.	
HUMAN TOXINS	
T1. Botulinum toxins	T7. Staphylococcus aureus toxins
T2. Clostridium perfringens toxins	T8. Tetrodotoxin biologically
T3. Conotoxin	T9. Verotoxin
T4. Ricin	T10. Microcystin (Cyanginosin)
T5. Saxitoxin	T11. Aflatoxins
T6. Shiga toxin	

Core List of Animal and Plant Pathogens with Potential BW Applications	
ANIMAL PATHOGENS VIRUSES	PB2. *Xanthomonas campestris* pv. *Citri*
AV1. African swine fever virus	**PLANT PATHOGENS FUNGI**
AV2. Avian influenza virus2	
AV3. Bluetongue virus	PF1. Colletotrichum coffeanum var. virulans (Colletotrichum Kanawae)
AV4. Foot and mouth disease virus	PF2. Cochliobolus miyabeanus (Helminthosporium oryzae)
AV5. Goat pox virus	PF3. Microcyclus ulei (syn. Dothidella ulei)
AV6. Herpes virus (Aujeszky's disease)	PF4. Puccinia graminis (syn. Puccinia graminis f. sp. tritici)
AV7. Hog cholera virus (synonym: Swine fever virus)	PF5. Puccinia striiformis (syn. Puccinia glumarum)
AV8. Lyssa virus	PF6. Pyricularia grisea/Pyricularia oryzae
AV9. Newcastle disease virus	
AV10. Peste des petits ruminants virus	PLANT PATHOGENS VIRUSES
AV11. Porcine enterovirus type 9 (synonym: swine vesicular disease virus)	
AV12. Rinderpest virus	BarleyYellow Dwarf Virus
AV13. Sheep pox virus	
AV14. Teschen disease virus AV15. Vesicular stomatitis virus	PLANT WARNING LIST
ANIMAL PATHOGENS BACTERIA	PWB1. *Xanthomonas campestris* pv. *oryzae*
AB1. *Bacillus anthracis*	PWB2. *Xylella fastidiosa*
AB3. *Mycoplasma mycoides*	PWV1 Banana bunchy top virus
	PWF1. Deuterophoma tracheiphila (syn.

	Phoma tracheiphila)
PLANT PATHOGENS BACTERIA	PWF2. Monilia rorei (syn. Moniliophthora rorei)
PB1. *Xanthomonas albilineans*	
GENETICALLY MODIFIED MICROORGANISMS	
AG1. Those genetically modified microorganisms that contain nucleic acid sequences associated with animal pathogenicity and are derived from organisms on the core list.	
PG1. Those genetically modified microorganisms that contain nucleic acid sequences associated with plant pathogenicity and are derived from organisms on the core list.	

WARNING LIST	
BACTERIA	WV5. Oropouche virus
	WV6. Powassan virus
WB1. *Clostridium perfringens**	WV7. Rocio virus
WB2. *Clostridium tetani**	WV8. St. Louis encephalitis virus
WB3. *Enterohaemorrhagic Escherichia coli, serotype 0157 and other verotoxin producing serotypes*	
WB4. *Legionella pneumophila*	TOXINS
WB5. *Yersinia pseudotuberculosis*	
	WT1. Abrin
VIRUSES	WT2. Cholera toxin
	WT3. Tetanus toxin
WV1. Kyasanur Forest virus	WT4. Trichothecene mycotoxins
WV2. Louping ill virus	WT5. Modeccin
WV3. Murray Valley encephalitis virus	WT6. Volkensin
WV4. Omsk haemorrhagic fever virus	WT7. Viscum Album Lectin 1 (Viscumin)
GENETICALLY MODIFIED MICROORGANISMS	
WG1. Those genetically modified microorganisms that contain nucleic acid sequences associated with any of the organisms in the warning list.	
WG2. Those genetically modified microorganisms that contain nucleic acid sequences associated with any of the toxins in the warning list.	

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