BIOLOGICAL WEAPONS

MOTIVATION

I was motivated to write on this subject for the following reasons:

1. As an Instructor of non-science majors taking Micro 101/102 I feel that it is important to inform students (as citizens) of both the beneficial and harmful uses of biological knowledge.
2. As a microbiologist I am mindful of the following facts:

    A. That the US, Russia, and many other nations, have engaged, at one time or another, in biological weapons research and that some have stockpiled stores of biological weapons materials. The current fate of these stores is not clear[20, 21].
    B. Most living organisms engage in biological warfare against their enemies or competitors (e.g. antibiotics); the toxins of diphtheria and botulism being two examples of such warfare against humans. One might even say biological warfare is "in our genes".
    C. As a Molecular Biologist I am also aware of the potential of this science for creating even more effective and horrific biological weapons.

3. The recent war with Iraq and the current threat of further US military involvement with Iraq has reportedly raised the prospect of the use of biological weapons both on the battlefield and in terrorists attacks on civilian populations anywhere in the world.
4. Several recent movies (e.g. Outbreak), books (e.g. The Cobra Event, The Coming Plague, The Hot Zone, Rainbow Six) and news reports (Time Magazine 11/24/97; 12/1/1997) have attracted public attention to the possibility biological weapons being used.
5. As I am always on the lookout for ways of involving nonscience majors in the

world of biology, I felt the relevancy of this issue offered a golden opportunity to stimulate student interest. Students have the chance to earn extra credit by reading recommended books relating to biology and microbiology (for a list see the "Syllabus page" at: http://www.wsu.edu/~hurlbert/pages/101hmpg.html). Currently the most popular books have been "The Hot Zone" & "The Cobra Event", and, without exception, the students who have read either of these books have waxed enthusiastic about. The most common response is one that warms the cockles of every teacher's heart: "***I never realized that! Wow, that really makes you think***!".

Countries thought likely to be making biological weapons include Iran, Iraq, Libya, Syria, North Korea, Taiwan, Israel, Egypt, Vietnam, Laos, Cuba, Bulgaria, India, South Korea, South Africa, China and Russia. (Russian leaders insist that they have terminated their biological program, but U.S. officials doubt that claim.)[20]

PREFACE

No tool or piece of knowledge has an innate moral context. Just as a knife, in the hand of a skilled surgeon, may save lives (good) that same knife, in the hands of a murderer, can take life (evil), so can knowledge be used to achieve contrary ends.

- A brief story illustrates this point. The scientist who discovered vitamin C was passionately antiwar. He was certain that his discovery could never be used to further war. However, years later when touring a German submarine he noticed some laboratory containers in the submarine and inquired as to their purpose. He was devastated when told that they were used to produce vitamin C which, because it prevented scurvy, allowed the submarines to remain on station much longer thereby "***improving their lethal efficacy significantly***".

Since biological knowledge ***just is***, it remains the responsibility of humans and their societies to determine how information is used. Further, since the perception of good and evil lies in the eye of each individual, moral issues are forever in **flux**; i.e., consider our past and present views on slavery, women voting and the internment of the Japanese Americans during W.W. II.

Anyone who writes about biological weapons must consider how the information they publish might be used. As an educator, I am strongly bias towards information dispersal. There may truly be circumstances where "***ignorance is bliss***", but, in my experience, they are rare. Further, the information presented here is freely accessible on the Internet, in libraries and in the press for anyone willing to exert a modest effort.

A BRIEF HISTORY OF HUMANS AND BIOLOGICAL WARFARE

It is certain that ancient man used biological (germ) warfare long before recorded history. The use of biological toxins extracted from plants and animals on arrow heads or poison darts to kill game and human enemies certainly predates recorded history. This technology is still used by some South American Indians and Africans to slay game and to down a human enemy or two. It was standard operating procedure to dip arrows in fecal material or decaying meat before attacking an enemy as the role of infection in debilitating an opponent was well understood. Fecal matter usually harbors the gas gangrene bacterium, ***Clostridium perfringens***, and often the tetanus bacillus, ***Clostridium tetani***. The poisoning of an enemies' water supply by dumping dead bodies or fecal material into wells and other confined water sources is an ancient war strategy; still in use today. In these cases a variety of fecal pathogens could be counted on to take a large toll of an adversary using that water supply.

Within recorded history, cases of humans using biological warfare against their fellow humans are well documented. During the wars of the middle ages it was common to catapult the bodies of victims of smallpox or bubonic plague (In the 14th century an army besieging Kaffa, a seaport on the Black Sea in the Crimea in Russia, catapulted plague-infected cadavers over the city walls) into besieged towns since it was well known that these two diseases were highly contagious. There are numerous reports of Europeans knowingly trading the American Indians blankets on which men had died of smallpox or measles, two viral diseases that decimated these peoples. The Japanese in the Second World War have admitted to using germ warfare on the Chinese and to experimenting on POWs, but its effectiveness has been impossible to discern. Forms of "indirect biological warfare" have been employed throughout history. In the Middle Ages sieges depended upon starvation and disease to force the inhabitants to surrender. The Nazis forced the Jews in the concentration camps to live under conditions that they knew would lead to the outbreak and spread of virulent diseases among a cold, starving and

stressed population. Both sides in the first and second World Wars recognized that the indiscriminate bombing of large civilian populations would have the consequence of inducing disease outbreaks among the weakened and injured survivors. Embargoes that prevent food and medicine from reaching civilian populations can also could be considered to fit in this category. The Allies, at the end of W.W. II, were concerned that diseases within the civilian population of Europe could spread to their troops as they occupied the conquered regions, so one of the first actions taken in the liberated territories was to stop epidemics and establish sanitary conditions.

At the time the U.S. biological weapons program was terminated by President Nixon in 1969 two lethal biological agents, *Bacillus anthrax* and *Francisella tularensis* (tularemia), and three incapacitating biological agents, *Brucella suis* (brucellosis), *Coxiella burnetii* (Q fever) and Venezuelan equine encephalitis virus (VEE) had been standardized and weaponized. In addition they had also weaponized one lethal toxin, botox, and an incapacitating toxin, staphylococcal enterotoxin B. The U.S. had also stockpiled several other biological agents and toxins. (27)

DEFINITION OF A BIOLOGICAL WEAPON

Biological weapons are defined as:

- ***Microorganisms*** that infect and grow in the target host producing a clinical disease that kills or incapacitates the targeted host. Such microbes may be natural, wild-type strains or may be the result of genetically engineered organisms.
- ***Biologically Derived Bioactive Substances*** (***BDBS***) products of metabolism (usually, but not always, of microbial origin) that kill or incapacitate the targeted host. These include biological toxins, as well as substances that interfere with normal behavior, such as hormones, neuropeptides and cytokines.

- ***Artificially Designed Biological-Mimicking Substances***: With our knowledge of the mechanisms of biological processes it is now possible to design and manufacture substances that mimic the action of biologics. For example, we already make nerve gases and their close relatives, pesticides, that act by binding specifically to receptors of targeted organisms, so it takes little imagination to predict that, as we learn more about the specifics of biological processes, we will be able to create "designer" substances that can be specifically targeted to a particular cell-type in an enemy (e.g. people with blond hair and blue eyes).

The difference between the second & third definitions and that of a classical chemical weapon is the manner of their production. A "biological chemical weapon" is produced by cultivating an organism and extracting from it or its spent medium the toxic material. A strict "***chemical weapon***" is one that is produced in a ***chemical plant*** and doesn't involve growing a living organism. An example of the former would be botulism toxin (botox) and of the latter, the nerve gas sarin. However, with improving technology these definitions will blur as we learn to chemically and genetically manipulate biological toxins so as to improve their efficacy and yield. For example, botox is unstable, but if it could be chemically modified or genetically manipulated, such as mutating its gene or fusing it to another molecule, so as to stabilize it, while maintaining its lethality, it would be a much more effective weapon.

ADVANTAGES AND DISADVANTAGES TO THE USE OF BIOWEAPONS (BW) IN WAR:

ADVANTAGES

1. A single microbial bioweapon can, because it reproduces in the host, theoretically produce the desired detrimental outcome in a target host. That is, a single smallpox virus or plague bacillus, if deposited in the right place in the host, can grow and produce a disease. In practice it usually takes more than a single organism to establish an infection.
2. Biological toxins are among the most toxic agents known. For example, the quantity of botox in the dot of an 'i' is, when delivered properly, enough to kill ~10 people.
3. Most bioweapons grade microbes are relatively easy and inexpensive to grow.

Their cultivation doesn't require large factories and can utilize common commercial equipment, such as that used in making cheese. While viral agents are more difficult to cultivate than bacterial agents, both can be cultivated by individuals with limited scientific training. Recent advances in the formulations of tissue culture media make the cultivation of viruses even easier. Just as certain illegal drugs are manufactured in mobile-van labs or marijuana plants are grown in buried semi-trailers, so it is possible to grow most bioweapons under similar, hidden and/or mobile, conditions. In fact those seeking bioweapons labs (e.g. the UN inspectors in Iraq) face the same problems as drug agents in the US searching for drug operations.

4. Large quantities of biological weapons can, in most cases, be produced in a short period (a few days to a few weeks) at small facilities scattered over a large area.
    - Kathleen C. Bailey, a former assistant director of the U.S. Arms Control and Disarmament Agency, has visited several biotechnology and pharmaceutical firms. She is "absolutely convinced" that a major biological arsenal could be built with $10,000 worth of equipment in a room 15 feet by 15. After all, one can cultivate trillions of bacteria at relatively little risk to one's self with gear no more sophisticated than a beer fermenter and a protein-based culture, a gas mask and a plastic over garment

DISADVANTAGES

1. **Difficulty of protecting the workers at all stages of production, transportation, loading of delivery systems and final delivery**: Untrained and inexperienced personnel, ignorant of routine precautions necessary to prevent contamination with the agents, are accident prone. Immunization of these personnel will not be effective in all cases.
2. **Difficulty in maintaining quality control and sufficient containment during growth and harvesting of agents**: Primitive conditions increase chances for the accidental release of the bioweapons into the surrounding environment (as happened in Russia with anthrax). Consider how much radiation has escaped from Hanford atomic weapons production plant during its history. Both examples represented **state-of-the-art** production facilities.
3. **Effective delivery problems**: Most biological materials, including spores, are destroyed by exposure to UV light and drying. Agents released in the air may disperse in unexpected ways due to the vulgarities of wind patterns. Dispersal patterns may be ineffectual. Rain may wash the agents out of the air before

they reach their target.

4. **Poor storage survival**: Many biological weapons must be stored under special conditions to maintain efficacy. Further, they are often difficult to maintain in a weapons-delivery state (e.g. loaded and ready to be fired in a rocket). This means that the warheads must be taken from storage and attached to the rocket engine, during which time they are exposed to attack.
5. **Difficult to control once released**: One's own troops may be infected under the chaos of a war. In theory it may be possible to protect your own population against a BW you plan to use by vaccination or the prophylactic administration of antibiotics, but the chance that your enemy will discover what you're doing is high.

CHARACTERISTICS OF THE PERFECT BIOLOGICAL WEAPON

The perfect biological organism or biologically derived bioactive substance (BDBS) for use as a weapon should have the following characteristics:

1. Highly infectious; requiring only a few organisms to cause the desired effect (e.g. smallpox) or highly effective; requiring a small quantity of material to cause the desired effect (e.g. botox).
2. Efficiently dispersible, usually in the air; contagious or effective on contact.
3. Readily grown and produced in large quantities.
4. Stable in storage; preferably in a ready-to-deliver state.
5. Resistant enough to environmental conditions so as to remain infectious or operational long enough to affect the majority of the target, but not so persistent as to affect the occupying army.
6. Resistant to treatment; e.g. antibiotics, antibodies, pharmaceutical drugs etc.

TARGETS OF BIOLOGICAL WEAPONS

Biological weapons may target living organisms or an environment seen as affecting the outcome of a struggle for control. These include humans, both soldiers and noncombatants, commercial crops and animals, the water supply, the soil, the air, or any combination of these. The object being, in each case, to weaken, terrify or punish the enemy to a degree which induces them to comply with the attacker's demands.

THE APPEAL OF BIOLOGICAL WEAPONS

"A biological weapon can be more effective, pound for pound, than the hydrogen bomb."[23]

Biological (and chemical) weapons are apply called the "***Poor Man's Weapons of Mass Destruction***". The modern weapons of war like the atom bomb, supersonic airplanes, atomic submarines and aircraft carriers all are horrendously expensive, technologically complex and require a large and sophisticated industrial capacity as well as a host of highly skilled scientists and engineers to produce and maintain. In contrast biological (and chemical) weapons production is relatively cheap, uses readily available commercial equipment and materials and can be managed by modestly trained scientists and technicians. A production facility for producing anthrax in weapon quantities could probably be set up in a small house, apartment or RV for <$100,000 and could be run by perhaps less than a dozen technicians with only the equivalent of a BS degree, operating under the direction of a single Ph.D. The basic knowledge for the growth of the majority of biological-weapons-grade microbes is freely available and the equipment and chemicals are obtainable from dozens of suppliers around the world.

As the genomes of more pathogens are sequenced and more is learned about the mechanisms of pathogenicity (e.g. pathogenic islands), this information can be combined with simple molecular biology techniques (e.g. cloning, chimera formation transgenic organisms) like those taught in some high school biology labs, to produce enhanced pathogens or BDBS materials. For example, the insertion of pathogenic genes into a number of common non-pathogenic bacteria has been shown to confer them with the ability to behave as a pathogen. So far there have been no reports of these chimeras escaping from the lab and producing any diseases, but it would be unwise to ignore this potential.

BIOLOGICAL WEAPONS LIST: PROVEN AND POTENTIAL ONES

Biological weapon are characterized by the following: Their target system; The nature of the biological weapon; and Whether it is a natural product or one that has been produced by genetic engineering. The following categorization is unofficial and of my own invention as I am unaware of any consensus in this

matter. Defining the target systems and the nature of a particular BW is not difficult, but deciding if it is a "natural biological product" or one constructed by genetic engineering is becoming more difficult as our knowledge and skills improve in these technologies. For the purposes of this discussion I define a "**Natural BW**" as one obtained from wild type strains or from selected mutants **randomly induced spontaneously or by classical mutagenic procedures (**e.g. exposure to UV or X-ray irradiation, chemical mutagenesis etc.). Therefore a "genetically engineered BW" is defined as one constructed by the **nonrandom** modification of a gene.

BIOLOGICAL WEAPONS CATEGORIES:

I. TARGETED HOSTS:

A. Humans
B. Commercial Animals
C. Commercial Plants
D. Environmental Systems

II. BIOLOGICAL WEAPONS CATEGORIES; KNOWN AND POTENTIAL BIOLOGICAL WEAPONS:

DESIGNATIONS:

- HOST: NO LETTER BEFORE AGENT = HUMAN HOST; A= ANIMAL HOST; P = PLANT HOST
- AGENT: B = BACTERIAL; R = RICKETTSIAE; V = Viral
- W = POTENTIAL BW

A. BACTERIAL

- NATURAL HUMAN BACTERIAL PATHOGENS:
  - R1. *Coxiella burnetii*
  - R2. *Bartonella Quintana* (*Rochalimea quintana*, *Rickettsia quintana*)
  - R3. *Rickettsia prowasecki*
  - R4. *Rickettsia rickettsii*
  - B1. *Bacillus anthracis*
  - B2. *Brucella abortus*
  - B3. *Brucella melitensis*
  - B4. *Brucella suis*
  - B5. *Chlamydia psittaci*
  - B6. *Clostridium botulinum*
  - B7. *Francisella tularensis*
  - B8. *Burkholderia mallei* (*Pseudomonas mallei*)

- B9. *Burkholderia pseudomallei* (*Pseudomonas pseudomallei*)
- B10. *Salmonella typhi*
- B11. *Shigella dysenteriae*
- B12. *Vibrio cholerae*
- B13. *Yersinia pestis*
- WB1. *Clostridium perfringens**
- WB2. *Clostridium tetani**
- WB3. *Enterohaemorrhagic Escherichia coli, serotype 0157 and other verotoxin producing serotypes*
- WB4. *Legionella pneumophila*
- WB5. *Yersinia pseudotuberculosis*

NATURAL COMMERCIAL ANIMAL BACTERIAL PATHOGENS:

- AB3. *Mycoplasma mycoides*
- *AB1. Bacillus anthracis*

NATURAL COMMERCIAL PLANT BACTERIAL PATHOGENS:

- PB1. *Xanthomonas albilineans*
- PB2. *Xanthomonas campestris* pv. *Citri*
- PWB1. *Xanthomonas campestris* pv. *oryzae*
- PWB2. *Xylella fastidiosa*

B. VIRUSES

NATURAL HUMAN VIRAL PATHOGENS:

- V1. Chikungunya virus
- V2. Congo-Crimean haemorrhagic fever virus
- V3. Dengue fever virus
- V4. Eastern equine encephalitis virus
- V5. Ebola virus
- V6. Hantaan virus
- V7. Junin virus
- V8. Lassa fever virus
- V9. Lymphocytic choriomeningitis virus
- V10. Machupo virus
- V11. Marburg virus
- V12. Monkey pox virus
- V13. Rift Valley fever virus
- V14. Tick-borne encephalitis virus (Russian Spring-Summer encephalitis virus)
- V15. Variola virus
- V16. Venezuelan equine encephalitis virus
- V17. Western equine encephalitis virus
- V18. White pox
- V19. Yellow fever virus
- V20. Japanese encephalitis virus

- WV1. Kyasanur Forest virus
- WV2. Louping ill virus
- WV3. Murray Valley encephalitis virus
- WV4. Omsk haemorrhagic fever virus
- WV5. Oropouche virus
- WV6. Powassan virus
- WV7. Rocio virus
- WV8. St. Louis encephalitis virus

All of these viruses can produce natural epidemics, but in many cases man is a secondary host and transmission from person to person from such viruses is, at the moment, usually poor (with some important exceptions like the Variola virus). However, a chance mutation or a genetically engineered mutation could change this picture.

"But the idea that the last smallpox virus sits in a few small freezers is absolutely not true. At least 10 countries have quietly kept it." Richard Preston, author of the *Hot Zone* and *The Cobra Event*, in *Genetic Engineering News* March 1, 1998, pg. 6

The Variola virus, the agent of smallpox, is considered to be naturally extinct. Supposedly only two well-guarded stocks of the smallpox virus remain in the world, in a Russian and an American lab. However, there are reports that Russia stockpiled Variola virus as a BW and the fate of these supplies is uncertain in many people's minds. Further, other nations (e.g. China) were suspected of producing stocks of this virus and the status of these programs is not public knowledge. Since routine smallpox vaccination is no longer carried out, the bulk of the world's population is susceptible to this highly communicable pathogen.

NATURAL COMMERCIAL ANIMAL VIRAL PATHOGENS:

- AV1. African swine fever virus
- AV2. Avian influenza virus2
- AV3. Bluetongue virus
- AV4. Foot and mouth disease virus
- AV5. Goat pox virus
- AV6. Herpes virus (Aujeszky's disease)
- AV7. Hog cholera virus (synonym: Swine fever virus)
- AV8. Lyssa virus
- AV9. Newcastle disease virus
- AV10. Peste des petits ruminants virus
- AV11. Porcine enterovirus type 9 (synonym: swine vesicular disease virus)
- AV12. Rinderpest virus

- AV13. Sheep pox virus
- AV14. Teschen disease virus
- AV15. Vesicular stomatitis virus

NATURAL COMMERCIAL PLANT VIRILE PATHOGENS:

- PWV1 Banana bunchy top virus

C. EUKARYOTIC BW PATHOGENS

NATURAL PLANT FUNGAL PATHOGENS:

- PF1. *Colletotrichum coffeanum* var. *virulans* (*Colletotrichum Kanawae*)
- PF2. *Cochliobolus miyabeanus* (*Helminthosporium oryzae*)
- PF3. *Microcyclus ulei* (syn. *Dothidella ulei*)
- PF4. *Puccinia graminis* (syn. *Puccinia graminis* f. sp. *tritici*)
- PF5. *Puccinia striiformis* (syn. *Puccinia glumarum*)
- PF6. *Pyricularia grisea*/*Pyricularia oryzae*
- PWF1. *Deuterophoma tracheiphila* (syn. *Phoma tracheiphila*)
- PWF2. *Monilia rorei* (syn. *Moniliophthora rorei*)

III. NATURAL BIOLOGICALLY DERIVED BIOACTIVE SUBSTANCES (BDBS):

A. TOXINS

- T1. Botulinum toxins
- T2. Clostridium perfringens toxins
- T3. Conotoxin
- T4. Ricin
- T5. Saxitoxin
- T6. Shiga toxin
- T7. Staphylococcus aureus toxins
- T8. Tetrodotoxin
- T9. Verotoxin
- T10. Microcystin (Cyanginosin)
- T11. Aflatoxins biologically
- WT1. Abrin
- WT2. Cholera toxin
- WT3. Tetanus toxin

- WT4. Trichothecene mycotoxins
- WT5. Modeccin
- WT6. Volkensin
- WT7. Viscum Album Lectin 1 (Viscumin)

***These organisms are ubiquitous, but, as they have been acquired in the past as part of biological weapons programs, they are worthy of special caution.**

Genetically-modified BWs

"...I have not confirmed this (that brain pox exists), but a company called M.P.O. Vektor, from Koltsovo, Siberia, has made a recombinant of smallpox and Venezuelan equine encephalitis (VEE) virus...My source claims it causes a smallpox-like illness, but with brain symptoms". Richard Preston in *Genetic Engineering News* March 1, 1998, pg. 6:

The Associated Press reported (2/14/98) that the Bacteriology Division of the U.S. Army Medical Research Institute of Infectious Diseases (USAMRIID) reported that Russia had developed an new form of anthrax that may be able to elude the vaccine that American troops receive. A spokesman stated "*This is coming in as anthrax, but it's got other bullets in it--different bullets*". This may become the first genetically modified microorganisms (or *BDBS*) to be officially listed as a biological weapon. However, this is no surprise as it is a virtual certainty that most of the BW-grade microbes have been mutated and strains selected, using conventional procedures, for characteristics that enhance their effectiveness. It is also likely that other genetically engineered strains have (or are in the process of being) been produced, but because such information is highly classified it is unlikely that the public will be made aware of their existence prior to actual use. As it is possible to place multiple virulence/toxic capacities within a single organism or to fuse two toxic proteins together so that both would be functional as a *BDBS* BW (e.g. botox and ricin) these types of BWs can be expected to appear on the scene sooner rather than later. It is now reasonable to assume that the gene for any *BDBS* can be cloned and expressed in BW quantities in some species. Consider, for example, that the genes that code for the venom of various spiders, jellyfish, the blue-octopus, and the toxins of *Pfiesteria piscicida* can all be cloned and thus represent potential BWs.

THE ETHNIC BOMB

In the fall of 1998 there was a report that the White SA government had ordered a

program to develop a genetic engineered biologicial weapon that would specifically kill blacks. Recently a rumor surfaced (in the English press) that Israel was working on a Biological Weapon that would specifically harm Arabs carrying certain genes. Two questions come to mind:

- **IS THIS SORT OF WEAPON POSSIBLE?**
- **SHOULD PEOPLE EVEN BE THINKING OF SUCH THINGS?**

"Biological weapons are green weapons, they're biodegradable."[23]

The answer to the first question is theoretically YES. It is possible to conceive of genetically engineering a virus or toxin-synthesizing gene in a bacterium which is "activated or induced or regulated" by the product of a gene or by binding to a specific receptor that determines an "ethnic" characteristic; e.g. pigment formation for skin or eye color or some other characteristic that is a single-gene characteristic (e.g. ear lob attachment, hitchhiker's thumb etc.). Another general approach that would theoretically work is being actively pursued as a means of treating cancer; i.e., find a unique antigen on a cancer cell; make an antibody against it; attach a cell toxin to the antibody and inject (see Genetic Engineering News 1/1/99, pg 7). It would likely be a very tricky business to be certain that the activation was as specific as desired (that it wouldn't come back and bite the distributor on the fanny), which would probably mean human testing; which takes us right back to the darkest events of WWII discussed above.

The answer to the second question is that unfortunately people have already thought of it. Frank Herbert (the author of Dune) even wrote a SF novel based on this possibility. Such a weapon might be viewed in the same perspective as the "Neutron Bomb" which was discussed with great enthusiasm in some quarters (and maybe even built) in the days of the Cold War. This bomb was touted as having the dubious *benefit* of neatly killing all life forms in a given area without destroying the infrastructure (e.g. buildings, roads etc.). So the users of this horror could have come in after a few weeks, cleaned up the unsightly skeletons (or to be efficient, turned them into phosphate fertilizer) and moved into to a virtually undamaged area. Presumably an ethnic biological weapon would achieve roughly the same ends. Consider this however, once such a Pandora's Box is opened it could be applied to all sorts of things like cleasing the earth of left-handers, brown eyed people, the Irish etc. After all in ~2003-4 the entire human genome sequence will be on the Internet for any nut case to play with, so watch out folks it could be a very bumpy ride.

Pfiesteria piscicida: The Cell from Hell
USAMRIID is reported to have shown an interest in the toxins produced by this microbe. ***Pfiesteria*** toxins cause a variety of symptoms including disorientation, memory loss, loss of ability to concentrate, loss of motor coordination and impairment of a variety of other mental functions. These toxins have been demonstrated to be effective both airborne and on contact. "From ***And the Waters Turn to Blood: The Ultimate Biological Threat***" by Rodney Barker, 1997"

Below are given the designations to be used to label genetically modified microorganisms, as they become available.

G1. Genetically modified microorganisms or genetic elements that contain nucleic acid sequences associated with pathogenicity and are derived from organisms in the core list.

G2. Genetically modified microorganisms or genetic elements that contain nucleic acid sequences coding for any of the toxins in the core list, or their subunits.

WG1. Genetically modified microorganisms or genetic elements that contain nucleic acid sequences associated with pathogenicity and are derived from organisms in the warning list.

WG2. Genetically modified microorganisms or genetic elements that contain nucleic acid sequences coding for any of the toxins in the warning list, or their subunits.

AG1. Genetically modified microorganisms or genetic elements that contain nucleic acid sequences associated with pathogenicity and are derived from organisms in the list.

PG1. Genetically modified microorganisms or genetic elements that contain nucleic acid sequences associated with pathogenicity derived from the plant pathogens identified on the export control list.

PWG1 Genetically modified microorganisms or genetic elements that contain nucleic acid sequences associated with pathogenicity derived from the plant pathogens identified on the awareness raising list.

OTHER BW CATEGORIES

There are no parasitic microbes (e.g. protozoan) listed above as BWs, but that doesn't mean they couldn't be employed for such a purpose. For example, a variety of protozoa species are candidates for BWs. These include the parasites Cryptosporidium, *Entamoeba histolytica*, and *Giardia lamblia*, all of which are common water borne pathogens capable of producing large natural epidemics. All have resting forms that render then resistant to environmental stress and to common water purification treatments. All that is required is to find a way of mass cultivating them in the laboratory. These parasites would also qualify as "Environmental Systems" BW as they could pollute a region's water and food supply.

THE TOP BIOLOGICAL WEAPONS[20]

With an abundance of potential biological weapons to chose from, what are the top choices and why? This is a difficult question to answer because of the extreme secrecy surrounding biological warfare. Based on what is known, combined with some reasonable assumptions, the following are prime suspects in this rogue's gallery of biological horrors:

- **SMALLPOX**: #Recently a number of stories have surfaced suggesting that many countries retain viable stocks of the smallpox virus and that some may even have large stores of this virus ready for delivery as a biological weapon. The smallpox virus is a prime candidate for a BW because of the following characteristics:

  1. It is a DNA virus whose genetic code has been sequenced.
  2. It is easily (for a virus) cultivated and large quantities of the virus could be produced in a relatively short period of time. There is good evidence that Russia produced tons of smallpox during the cold war and there is some evidence that they still have it stored away.
  3. It is a prime candidate for genetic engineering. It is easy to engineer it so that the current vaccines are no longer effective and to add virulence factors to the smallpox genome (e.g. botox gene) that would make it virtually 100% fatal.
  4. It is highly infectious, being spread by close human contact. It can be contracted by inhaling the virus.
  5. It is extremely hardy; surviving on fomites for days or weeks.
  6. Most of the world's population is susceptible to this virus as routine

vaccination was stopped when the WHO declared its eradication in 1979.

7. The mortality rate is strain dependant, however the mortality rate of the variola major strain is ~50%. It is likely that any BW-strain would have an even higher mortality rate.
8. There is no known treatment to abate the course of the disease other than routine medical care.

Although there is an effective vaccine against the wild type strain of this virus, the stocks of this vaccine are very low (7 to 10 million doses for a population of >260 million) and may have spoiled. Also, since it takes several days to 2 weeks after vaccination to develop full immunity, vaccination following a widely dispersed application of the virus would be unlikely to have any significant effect on the near-term spread of the disease. Even those of us who received the vaccine as children may have lost our immunization, particularly against genetically engineered highly virulent strains.

One indication of a potential use of this BW would be the sudden vaccination against smallpox of the military of a perpetrator. However, as smallpox immunization is likely to be routine for the military in many countries (including possibly the US military), and it could be hidden as a part of normal immunizations, making it difficult to detect. Further, recent advances in vaccination, such as the ability to immunize people by feeding them transgenic plants (e.g. bananas) that produce one or more antigens, make it possible to immunize the majority of a population without them even knowing it.

"If you took a gram of smallpox, which is highly contagious and lethal, and for which there's no vaccine available globally now, and released it in the air and created about a hundred cases, the chances are excellent that the virus would go global in six weeks as people moved from city to city……the death toll could easily hit the hundreds of millions…..in scale, that's like a nuclear war."[23]

ANTHRAX: Another old favorite BW, ***B. anthracis,*** is an aerobic spore forming, gram positive bacterium that is highly infections and lethal to man and many of his domestic animals. It is naturally contracted through wounds, commonly by farm workers, but it can also be inhaled. In the former case, it produces a large cutaneous wound which, if the bacteria reaches the blood stream, results in a fulminating septicemia that is

"Doctors who've treated anthrax patients have found that they'll be asking a patient how he feels, and the patient dies in mid-sentence."[23]

usually fatal if untreated. Inhaled spores germinate in the lungs and produce a pulmonary anthrax which is rapidly fatal in 80% of the cases. The spores remain viable in the soil for many years and their presence there renders contaminated land virtually unusable for non-immune farm animals (and man) for years. Strains with increased virulence and resistance to antibiotics have been produced. For a lecture on anthrax visit this site, this site or this site and to learn about a vaccination program visit this defense site.

Gruinard Island, off the coast of Scotland, remained infected with anthrax spores for 40 years after biological warfare tests were carried out there in the 1940s. Only recently has it been declared save.

Treatment consists of immunization for prevention and antibiotic treatment for an infection or as prophylactic treatment of soldiers likely to come into contact with the organism. Antibiotic treatment must be started quickly and continued for 60 days. Human immunization requires a two to three week lead time before exposure to anthrax. Troops in the recent war with Iraq were immunized against anthrax and all US soldiers are now (1999) routinely immunized against anthrax. However, in the case of pulmonary anthrax, treatment is of little use because of the virulence of the infection. The anthrax bacteria are easy to grow and can produce a lot of weapons-grade spores in a short time. The spores store well, probably in the delivery systems (e.g. rocket warheads) in the field.

The Iraqis reportedly produced >2,000 gallons of anthrax and prepared 50 bombs and 4 missile warheads with this material. There is considerable doubt that they told us the entire truth?

A REMNANT OF THE COLD WAR

June 2, 1999: VOZROZHDENIYE ISLAND, Uzbekistan (NYT Syndicate) - In the spring of 1988, germ scientists 850 miles east of Moscow were ordered to undertake their most critical mission. Working in great haste and total secrecy, the scientists in the city of Sverdlovsk transferred hundreds of tons of anthrax bacteria--enough to destroy the world many times over--into giant stainless-steel canisters, poured bleach into them to decontaminate the deadly pink powder, packed the canisters onto a train two dozen cars long and sent the illicit cargo almost a thousand miles across Russia and Kazakhstan to this remote island in the heart of the inland Aral Sea, American and Central Asian officials say. Here Russian soldiers dug huge pits and poured the sludge into the ground, burying the germs and, Moscow hoped, a grave political threat.

While Mikhail Gorbachev was warming ties with the West, intelligence evidence was mounting in Washington that the Soviet Union, contrary to its treaty pledges, was producing tons of deadly germs for weapons that the world had banned. The stockpile had to be destroyed in case the United States and Britain demanded an inspection, Russian scientists close to the program said. Vozrozhdeniye Island was a natural choice. Until the military left here for good in 1992, Renaissance Island, as it translates from the Russian, had been the Soviet Union's major open-air testing site. Today, Renaissance Island, which the former Soviet republics of Uzbekistan and Kazakhstan now share, is the world's largest anthrax burial ground. For the United States, it is an intelligence gold mine. At the invitation of Uzbekistan and Kazakhstan, American military scientists and intelligence experts have secretly been traveling here for the past four years. Their tests show that, although the anthrax was soaked in bleach at least twice, once inside the 66-gallon containers and again after it was buried under three-to-five feet of sand, some of the spores are still alive--and potentially deadly. Tests have shown that the anthrax vaccine now being given to 2.4 million Americans in uniform is effective against the anthrax. While this has reassured the Clinton administration, the discovery of live spores has alarmed Kazakhstan and especially worries Uzbekistan, which has been exploring for oil on the two-thirds of the island it controls.

Because the Aral Sea is shrinking--the result of wrongheaded Soviet irrigation policies--this now-deserted, isolated island has grown from 77 square miles to 770 and will soon be connected to the mainland. Uzbek and Kazakh experts fear that the buried anthrax spores could escape their sandy tomb, stirred up by carriers like rodents, lizards and birds, and be brought to Uzbek and Kazakh territory. The disease is spread by direct contact; it is treatable with antibiotics if detected immediately.

SOURCE: http://www.intelihealth.com/

BOTULINUM TOXIN (botox): Often touted as the most toxic substance in the world or at least in the biological world, botox is an obvious front runner. ***C. botulinum*** can be isolated from its natural habitat, the soil and it has been obtained from culture supply houses. It is an obligate anaerobe, which makes it a bit difficult to grow, but this presents no serious obstacle to a competent microbiologist. It grows rapidly on common bacterial media and the conditions

for achieving optimum toxin production are well researched. Purification of the botox protein is not difficult. One suspects that by using new affinity column chromatography, gram quantities could be isolated in a day or less, or even on a continuous-flow basis.

botox is relatively stable and can be stored in crystalline form, but the weapon-ready forms are classified. It can be absorbed through the mucous membranes so aerosol dispersal, addition to a municipal water or food supplies are likely ways of introducing botox into a population. It is tasteless and odorless and, depending on the dosage, and may take from 2 to 14 days before the symptoms appear. The symptoms include double vision, difficulty in swallowing and speaking, muscle weakness, vomiting and eventually respiratory failure. The protein is a neurotoxin and once the symptoms appear the damage is irreversible (after ~48 hours). There are several botox immunologically unique strains. The only treatment involves passive antibody shots against all the botox strains; the assumption being that a mixture of botox strains would be applied. Immunization of a large population is not considered feasible.

The advantages of botox is that since its symptoms are delayed, the damage is done (walking dead) before victims realize what has occurred. The amount of antiserum required to treat 100,000s of exposed people is not available, plus the fact that many people would be beyond saving even if given the antitoxin.

The known disadvantages are that botox is unstable in the air if exposed to sunlight and dry conditions and is destroyed by brief boiling, thus effective exposure is limited by a small window of lighting and humidity conditions. Even though botox is highly toxic it would still take a large quantity to reach a lethal concentration in a large city's water supply. Further, contaminating a food supply would be difficult, although individual food processing plants are a likely target for terrorists. The centralization of huge food-processing plants that provide food for outlets around the country offers terrorists a tempting opportunity to commit mass murder.

A realistic view **of the botox situation is that many of the problems of**

dispersal were likely solved by the >3,000 US scientists that reportedly worked on biological warfare during W.W. II & the cold war. It is also reasonable to assume that the botox can be fused by common molecular biology technology with other proteins that stabilize it for dispersal without decreasing its lethality or it can be mixed with other protective agents (e.g. trehalose, viral-glass) or that it can be encapsulated in protective material (timed release) that dissolves once it is in the digestive system. It should also be possible to clone the botox gene into common bacteria that inhabit the human gut (e.g. *E. coli*), which would establish themselves there long enough to produce a quantity of botox sufficient to disable the victim before their immune system responded; a natural condition seen in young babies who ingest the spores in foods like honey. For a chilling description of how this might be done visit the Cal Poly site.

The Iraqis own up to producing ~5,000 gallons of *C. botulinum*, but the yield of botox was not reported. Other nations like Iran, Syria, North Korea and Libya are suspected of being in the biological weapons production business. Further, it is unclear what has happened to the massive Soviet Union's biological weapons' production facilities and their BW-arsenal since the breakup of the Soviet Union.

- **AFLATOXIN**: This is a class of biological carcinogens, product by certain molds, that induce liver cancer. Man and many other animals are susceptible to this material. The molds that produces this material grows well on grain, peanuts and other rich nutrients. Aflatoxins are readily extracted with ethanol and easily concentrated. They are stable on storage, but their stability after dispersal has not been reported. The onset of the cancer is uncertain and clearly dose dependent. As there are no known human tests on the toxicity of this material, it is impossible to assign a minimal lethal dose.

  Since there is a delay between exposure and the development of the clinical disease, as well as difficulty in differentiating cancer origins between accidental and intentional exposure, even recognizing that a target population had been "attacked" would be laborious; this

would be a case of a "stealth BW attack". The Iraqis reportedly produced ~600 gallons of concentrated aflatoxin which was loaded in bombs and missiles.

- ***Clostridium perfringens***: The Iraqis produced 90 gallons of this microbe. ***C. perfringens*** is an anaerobic gram positive spore former that grows well in the absence of oxygen and produces spores resistant to adverse conditions. It enters the body through wounds, particularly the jagged, deep, and dirty type produced in war, where it cause gas gangrene. Gas gangrene is an especially nasty disease that eats away the body while producing a stench that would gag a maggot. It is one disease that physicians can diagnose a block away from the patient. Since ***C. perfringens*** is a natural inhabitant of the human intestine as well as most other animals it is not hard to obtain. It also is one of the most common agents of food poisonings, frequently spoiling foods like turkey and other fowl as well as any rich food it contaminates.

Little has been reported about its delivery, its survival once dispersed etc., but a working assumption is that it would behave similar to anthrax in those respects. Since *C. perfringens* produces a host of toxic proteins, it is likely that super "hot" strains have been isolated for use as BW, and perhaps the toxin genes have been cloned for use as *BDBS*.

Treatment involves antibiotics and exposure of the patient to pure oxygen which inhibits the growth of the bacillus. However, as this latter treatment involves individual pressure chamber, it is not a reasonable treatment for an infected population.

RICIN: Ricin is a protein toxin (view with the helper application Chime) extracted from the castor bean plant. Ricin kills by destroying an important component of the protein synthesizing machinery of cells, the ribosome. It works as a slow poison, eventually causing a total body collapse as necessary proteins are not replaced. The structure and mechanism of action of ricin is well understood, thus making it an excellent candidate for genetic manipulation. That is, because of this knowledge, it should be possible to genetically modify ricin so as to make it a more effective BW. Ricin is already being investigated for its "magic bullet" properties as an agent that might selectively destroy cancer cells. This same technology could easily be applied to improving its BW-capacity. For example, if ricin is chemically bound to antibodies that only bind to a certain type of cancer cell, the attached ricin should only kill the targeted cancer cells and no other cells. The same principle could be used to specifically target an enemy; in theory one could be specific enough to use this procedure to target a ***single individual*** for assassination.

The delivery issues of ricin are probably similar to those for botox and are clouded in the same cloak of secrecy. It is reasonable to assume that relatively effective dispersal methods are available for delivering this toxin to a population and further, that since the components of ricin are being genetically manipulated for a variety reasons, that one of these uses might involve Black Biology.

In theory it is possible to immunize against the ricin protein, but I know of no source of an appropriate vaccine, although it should not be difficult to produce one; the problem is preparing it in quantity ahead of time (like the flu vaccine every year) and inoculating the target population far enough in advance. I know of no effective treatment once the ricin has produced clinical symptoms (similar to the botulism toxin story).

***Fusarium oxysporum*: The potential use of genetic engineering in the production of biological weapons is illustrated by the on-going studies on the possible of the use**

of the mold *Fusarium oxysporum* as a candidate for drug plant eradication. (28) This fungus, which has devastated commercial crops (e.g. bananas & muskmelon), is being investigated for its potential to destroy coca and cannabis plants, from which cocaine and marijuana are derived. Preliminary studies indicate that host specificity is narrow and species "jumping" is rare; i.e., targets can be carefully selected without posing danger to other commercial crops. However, its use in the U.S. could devastate the economies of several regions of the U.S.

Obviously, the same technology could be applied by terrorists to assail the commercial crops of perceived enemy states. Natural outbreaks of plant epidemics have repeatedly demonstrated, that the potato, corn, wheat and soybean mono-culturing techniques used to cultivate these crops offer optimal conditions for the spread of plant pathogens. Not only could rogue nations do this, it is possible (as depicted in James Bond movie, *On Her Majesty's Secret Service*) that a criminal organization, such as a drug cartel, with its vast cash and organizational resources, could engage in such activities as retaliation for its economic loses. It is even possible that terrorists/criminals might hold a nation(s) up for ransom with the threat of using such a weapon.

Assuming that the research is successful and target-specific *F. oxysporum* strains are developed, they would then be employed, to destroy coca and cannabis crops. The mold pathogen's spores could be disseminated by conventional aerial crop-spraying techniques, by ground personnel or by small, self-propelled robots dropped into an area and guided by satellite to the targets (see below; Delivery of BW). Since it is known that environmental conditions, such as temperature, humidity, cloud cover etc. effect the efficacy of fungal diseases, release could be coordinated with satellite weather data. Bands of robots, equipped with analytical tools, could roam the countryside seeking out targeted crops on which they release their biological agent; i.e., chemical sensors that pick up the emanations from

target plants would follow the gradient of the identifying substances to its source—much as insects do.

Once the fungal genes involved in target specificity are known (through gene mapping and sequencing) and their manipulation becomes routine, new fungi strains could be developed rapidly to counter resistant cultivars constructed by the drug cartels. It is possible that a biological-arms race could occur with victims developing resistant plant cultivars and drug-agencies countering with new-strains of the pathogen capable of attacking the new plant varieties—ad infinitum.

DELIVERY OF BW

Currently, because of the recent confrontations with Iraq with their suspected missile capability, the world is concerned about rockets being used to deliver BWs. However, considering the crude nature of the SCUD missiles, they are probably more useful in a publicity capacity than as a credible military threat. The SCUD missiles have a range of between 400 and 500 miles. They lack a sophisticated guidance system, so their chances of hitting a target are limited. Further, the warhead must explode at the proper height to create an aerosol capable of dispersing effective quantities of BW agent over a wide area, but it appears they lack this capacity as they apparently only explode on contact. The explosion would likely destroy much of the BW. Any BW material that survives the explosion would be dependant on low level air currents to disperse it. If the wind was not blowing, most of the MW material would settle near the site of impact, severely limiting its efficacy. Finally, it is clearly understood that if the Israelis are the target of such a SCUD attack, Iraq would suffer nuclear retaliation almost certainly designed to forever eliminate an Iraqi threat.

BWs lend themselves to the far greater danger as terrorist's weapons attack on a large population area such as New York, Washington or London etc. For example. a light plane equipped

with crop spraying equipment (see the movies Goldfinger & North by Northwest) could spray BWs downwind from the target of an evening without attracting much notice, particularly since the plume of the aerosol probably couldn't even be seen (i.e., just a student pilot practicing turns). Alternatively, a motor vehicle as small as a car could cruise the streets of a city while emitting a fine spray of BW-aerosol through a fake tailpipe or other small vent; after all car or truck trailing a plume "smoke or steam" is a common sight isn't it. The only equipment needed would be a hand-pumped sprayer like those used to spray insecticide on one's garden. The Japanese terrorists used small exploding devices to disperse sarin in the subway. Although, their devices proved to be inefficient, their choice of a subway was malignantly inspired; a subway, particularly crowded with people at rush hour, insures the maximum exposure in the smallest area. Further, the subway's air exchange system would likely carry the BW agent rapidly out into the general environment, usually a crowded city. An individual carrying a large suitcase or backpack could disperse BW material while walking the streets. Even more fearsome is the possible use of better remote-control devices than those used in Japan. In this case the suspension of BW material could be placed in a container attached to an aerosol-producing pump (such as used to spray insecticide on trees) that could be turned on by remote control or with a timer. Such a unit could even be set to release material periodically over several days depending on the direction of the wind; something the *Mission Impossible* crew might do if they went bad.

Recent novel drying technologies being used to preserve vaccines in a temperature resistant form can likely be used to preserve biological weapons and to make their delivery more efficacious. This rechology involves drying the reagents in high concentrations of the sugar trehalose, or its analogs (sugar glass). Vaccines prepared in this way can be stored at 60ºC for up to 12 weeks without loss of activity. Genetic Engineering News Feb. 15, 1998, pg. 6

Robotic delivery offers another likely possibility. As illustrated by the Mars Rover satellite-controlled robotic delivery is possible with today's technology. Such robots would be small

enough to be camouflaged as pieces of wood or rocks and could be programmed to bury themselves under ground until activated. They could even be solar-powered so they could function independently for long periods.

A version of a robotic delivery method was described in the James Bond movie (as depicted in James Bond movie, *On Her Majesty's Secret Service*) that involved brainwashed young women. These nubile young ladies had been brainwashed to return to their countries of origin with the biological-crop-destroying-agent and, on command, to go to an assigned location and release it unless the Evil Scientist was paid a humongous amount of boodle. The use of mechanical robots would not only abolish the sexism of the movie, but would be more efficient; particularly if extended concealment underground was required.

A case of Salmonella terrorism in Oregon: A microbiologist applied Salmonella she grew in her house to food in a local restaurant in Dalles OR, sickening 750 people.

If these scenarios frighten you, you are normal; if they don't cause you to suffer a "pucker attack" on critical sphincter muscles of your body, there is probably something wrong with you and you should seek help. However, there are things that you can do to lessen the chances of the above happening or if the worse should happen, of limiting the damage. Some of these are listed in the concluding section.

The following site is a 10/13/98 FAQ section form a Frontline report and contains much of the information I've collected plus some additional material; read it and be very, very concerned folks.

CONCLUSION AND DISCUSSION

It would be extremely naive to assume that the horror and indiscriminate nature of BWs will prevent their use. Indeed it is this

very horror and dread of these weapons that appeal to certain mind-sets. The panic and societal disruption that a BW attack would engender in a population satisfies the aim of those who wish to punish their enemies in the most painful way possible. BWs are more implements of that most powerful of destructive urges, revenge, than of conquest. BW also have the added perverse "advantage" of destroying an enemy while leaving his infrastructure intact as booty for the winner. That is, an atomic bomb leaves only radioactive rubble, whereas a successful BW leaves only a few million rotting bodies and an intact, functioning city. This scenario has been chillingly depicted in several science fiction movies; it is frightening to realize that Sci-Fi is often predictive.

However, it is worth considering what can be done about the possibility of BW use? First, of course, is to gain a clear understanding of the nature of the problem. A chilling analysis of the economic effects of a biological attack and the efficacy of various counter measures can be read at this site. Ignorance leads only to misunderstandings, panic, chaos and fatal mistakes; ignorance always makes a bad situation catastrophic. While a careful analysis of the situation probably can't prevent BWs from being used, it can lead to actions that minimize that possibility and lessen the death and destruction if it occurs. The following are a partial list of measures that might be taken to diminish the problem:

"The Presedential Commission on Bioethics spends lots of time on the ethics of cloning; bioweapons are not even a topic of concern. Yet, genetically engineered bioweapons are the single greatest problem in bioethics today." Richard Preston in *Genetic Engineering News* March 1, 1998

1. **Develop full international cooperation in dealing with this problem; probably through the UN. See "*Botulism Surveillance and Emergency Response: A Public Health Strategy for a Global Challenge*" in the JAMA - August 6, 1997**
2. **Educate likely target populations as to what precautions and protective actions to take in case of an BW attack. Simply extend the "disaster plans" already in effect to include BW. The Israelis, who have already done this, can provide valuable experience as to what does and doesn't work.**

3. **Coordinate the monitoring of the potential producers and users of BW as closely as possible; this is implied in #1, but requires both money, close cooperation and highly trained personnel.**
4. **Continue to improve on BW monitoring techniques and apparatus; making them smaller, faster, more sensitive and more accurate so as to detect BWs rapidly so as to take action to minimize loses and disruption. New detection systems using biochips will soon make it possible to deploy small, automated monitoring stations at appropriate locations as early warning detectors of a BW attack. Air quality in cities throughout the world is routinely monitored using similar automated equipment. Police cars, buses and other vehicles that travel daily throughout an area could be equipped with detection units to routinely monitor an area.**

"Most practicing doctors have never seen smallpox or anthrax. Anthrax is hard to diagnose, but easy to manufacture and disperse. The military and the FBI have a biotectection device that can identify anthrax in 20 seconds."Richard Preston in *Genetic Engineering News* March 1, 1998

5. **Stockpile BW-fighting supplies, particularly medical ones, throughout the world so that they could be transported quickly to areas of BW use. It might be reasonable to have these supplies stored in transport aircraft ready to take of in a few minutes. After all this was the situation during the cold war when military planes were kept at the ends of the runways with their engines running and pilots in their cockpits ready to go.**

Task Force Scorpio is a "biological swat team" based in Switzerland. Scorpio had its own jet transportation, and when in standby mode could leave within 24 hours of a call, traveling under the protection of neutral Swiss diplomatic passports. Task Force Scorpio was put at the disposal of the Secretary-General of the United Nations, and was immunized, trained and ready to go when the ground war began on 28 February 1991.

POSITIVE PROGRESS (as of spring 1999)

ACTION	EFFECT	STATUS	REFERENCE
Surveillance for odd outbreaks	Early detection of BW attack	Proposed 22% increase inFunds	19
Establish regional BW labs	Early management of BW attack	Part of above	19
25 New metropolitan emergency centers	Effective management & coordination of BW attack	Funds being sought	19
Research on vaccines	Prevent infection	Boosted by $30 million	19
Work on new sensors & study airflow in cities	Early detection and prediction of patterns of dispersion	Research by Dept. of Energy & Defense Advanced Research Projects Agency (DARPA)	19
Development of blocking spread of BW in cities	Minimize infection	Research at Sandia labs	19
Development of agents to neutralize many BW	Minimize/stop infection	Research at Sandia labs & DARPA	19
Search for broad-spectrum material to neutalize BW	Minimize/stop infection	Research at DARPA	19
Development of DNA vaccines against BW	Prevent infections	Research at Maxygen Labs	19
Understanding motivation of BW users	Prevent use of BW	Research at Monterey Institute of International Studies	19
Moral suasion	Prevent use of BW	Research at Rutgers University	19
Improve organization of Federal agencies	More efficient response to BW attack	Presidential directive; Roles of FBI, FEMA, OEP, HHS, DOD defined	20

Involvement of professional scientific societies	Improvement of BW education	Committees at work	20
WHO involvement	Better world coordination in dealing with BW	At work revising prgm for dealing with BW	20
National guard units	Trained to deal with BW	10 NG units: Rapid Assessment and Initial Detection Teams	20
Marine Corp BW Units	Deals rapidly with BW incidents	MC Chemical and Biological Incident Response Force ready	20
DOD Research on BW equipment	Protection: masks and suits; Detection of BW	Rapid detection of BW; efficient clean up	20
US armed service personnel vaccinated against anthrax	Protection	In effect NOW	20
Degree of technical knowledge required	Few people have the expertise to isolate & grow BW	Number of possible users of BW are growing slowly	20
Money to HHS	More knowledge on all aspects of the BW problem	$133 million for dealing with BW threats; $51 million for vaccines & antibiotics	19, 20
Anthrax hoaxes	Publicizes BW issue	Keep response teams on alert & trained	21

MAJOR GAPS IN BW PROTECTION	REFERENCES

Little involvement of FIRST RESPONDERS to BW incident training: ER physicians, nurses, family physicians, epidemiologists, Public Health personnel	20
Massive misunderstanding of the **difference** between chemical and biological weapons and how each should be dealt with.	20
Limited vaccine supplies: only 7 million doses of smallpox vaccine for >250 million susceptible Americans	19
No mechanism to verify compliance with BW-treaty; the US refuses to agree to inspection	20
Evidence of stocks of BW in several countries	19, 20
Vast majority of world's population is susceptible to smallpox	19, 20
The Japanese cult that attempted to disperse both botulism and anthrax is still active with lots of money	19, 20
Libya, Iran, Syria, Iraq, and North Korea are actively recruiting Russia BW scientists to work for them	20
The number of countries that possess the sophistication and capacity to produce BW is growing	20
No mechanisms for screening for BW at borders are available	20
Only a small quantity of a BW agent is required to infect a large area and population	20
Hospital facilities for dealing with BW very limited; 100 cases would overwhelm most communities	20
Tooling up smallpox vaccine production would take 36 months	19, 20
Facilities for growing BW are readily available from the Western world	20

Biological Scientists not involved in educating society about BW issues	20

REFERENCES

1. http://www.brad.ac.uk/acad/sbtwc/; Index to resources on BW

2. http://www.fas.org/bwc/index.html; The Federation of American Scientist's Biological and Toxin Weapons Verification Program.

3. Cole LA. The specter of biological weapons. Sci Am 1996;275:60-5.

- http://www.sciam.com/1296issue/1296cole.html#1;

4. http://www.usia.gob/journals/itgic/0297/ijge/ijge0297.htm; Links to sites about terrorism.

5. http://www.sipri.se/cbw/sipri-bradford.html; BW site.

6. http://www.emergency.com/anthrax.htm; Information on anthrax.

7. http://www.emergency.com/hzmtpage.htm; Hazardous materials site, including biological weapons..

8. http://198.202.146.1/factshee/wmd/bw/auslist.htm; Much of the information above was extracted from this site.

9. Outbreak; Great site for emerging disease, current and complete, but must register to obtain best information; has recently added material on biological weapons.

10. http://www.ama-assn.org/sci-pubs/journals/archive/jama/vol_278/no_5/toc.htm#top August 6, 1997 - Vol 278, No 5. JAMA - The Journal of the American Medical Association; several articles on biological warfare.

- Clinical Recognition and Management of Patients Exposed to Biological Warfare Agents; JAMA. 1997;278:399-411
- Biological Warfare: A Historical Perspective; JAMA. 1997;278:412-417
- Biological Terrorism: Preparing to Meet the Threat; JAMA. 1997;278:428-430

11. http://www.calpoly.edu/~drjones/chemwarf.html; This is well thought out site written by students at Cal Poly that shows what a great job students can do when they accept a challenge.

12. http://www.fas.org/bwc/index.html; Biological Weapons index fo sites on the Internet.

13. http://www.cm.utexas.edu/groups/robertus/rcn_ppt/index.htm; Ricin site.

14. http://www.fas.org/bwc/papers/scorpro.htm; Information about Task Force Scopio.

15. http://golgi.harvard.edu/meselson/cbwbib.html; Bibliography of chemical and biological warfare; not for reading before you go to bed. Information on potential monitoring equipment:

- 16. http://www.affymetrix.com/; Visit this site to learn about current commercial biochips; includes pictures. Visit the AFFYMETRIX LAUNCHES GENECHIP® p53 ASSAY site to learn about their latest product.
- 17. http://www.igen.com/htdocs/origtech.htm; Electrochemiluminescent Detection. Description of several assays in PDF Adobe format.

18. Biological weapons pose challenge for microbiology community. Ronald A. Atlas ASM News 64:383 (1998). An excellent overview of the situation and the role microbiologists can play in dealing with this horror.

19. Facing an Ill Wind, Scientific American April 1999, pg. 19.

20. The Looming Threat of Bioterrorism: Science 283:1279 (1999).

21. The New Bomb Threat: Newsweek Magazine 3/22/1999, pg 36.

22. http://www.mindspring.com/~nbcnco/; A very fancy and scary site. Will need a Pentium computer and a fair amount of memory to view some of the items at this site. I can not verify the accuracy of everything on this site so "reader caution" is advised.

23. "A conversation with Richard Preston" in Laboratory Medicine, vol. 30, pg 517 Aug. 1999.

24. "Bioterrorism Prevention" in Genetic Engineering News June 1, 1999, pg. 6.

25. The New Yorker, March 9, 1998. "The Bioweaponeers", by Richard Preston. The Washington Post, New York Times and "Prime Time Live"/ABC News, February 26, 1998.

26. http://www.newscientist.com/nsplus/insight/bioterrorism/allfall.html; Review of bioterrorism

27 The Biology of Doom: The history of America's secret germ warfare project. by Ed. Regis. Henry Holt and Co. 1999.

28. ASM News 65: 734 (1999)

Several recent books, fiction and nonfiction, that offer interesting, instructive information and imaginative insights into BW and related issues:

- ***The Hot Zone*** by Richard Preston; a griping account of an actual near biological disaster.
- ***The Cobra Event*** by Richard Preston; an imaginative and scientifically accurate fictional presentation of a terrorist's construction and use of a BW.
- ***Virus Hunter*** by C. J. Peters and M. Olshaker; Chapter 10 is especially relevant to this discussion.

- ***Level 4: Virus Hunters of the CDC***. By J. B. McCormick and S. Fisher-Hoch, 1996; a biography of CDC personnel that search for viruses around the world.
- ***Rainbow Six*** by T. Clancy, 1998. Fiction but based on detailed factual knowledge for which Clancy is well known.
- Clouds of Secrecy: The Army's Germ Warfare Tests over Populated Areas. Leonard A. Cole. Rowman and Littlefield, 1990.
- Biological Weapons: Weapons of the Future? Edited by Brad Roberts. Center for Strategic and International Studies, 1993.
- Biological Warfare in the 21st Century. Malcolm Dando. Macmillan, 1994.
- The Eleventh Plague: The Politics of Biological and Chemical Warfare. Leonard A. Cole. W. H. Freeman and Company, 1996.
- Biological weapons information from the Federation of American Scientists

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