The reason for my appearance at these hearings is my deep and carefully pondered concern about the continued involvement of this and other nations in the development of biological warfare. This is a process which puts the very future of human life on earth in serious peril. It is all the more tragic because the great powers which should be hastening to institute the necessary disciplines of international control have very little to gain and much to loose in relation to the present balance of nuclear deterrence. Chemical warfare presents many similar issues but I cannot speak to them with the same immediacy of personal expert knowledge.

The ratification of the Geneva Protocol would represent only the first small step towards the negotiation of international controls. However, so long as we have isolated ourselves as the only major power to refuse to enter into its commitment, this stands as an immediate distraction to further negotiation and leaves on the record a very low reading, indeed, about our earnestness as a nation in seeking a world order for the management of this problem.

The possible theme of my own scientific career has been research in the genetics of bacteria. With Dr. E. L. Tatum, then at Yale, I had the thrill of discovering genetic recombination in bacteria. Later at the University of Wisconsin with my then graduate student Norton Zinder (like E. L. Tatum now a professor at Rockefeller University) I was similarly privileged to attend the

birth of scientific understanding of genetic transduction - the use of viruses to convey information from cell to cell. I have also deeply interested in the mechanism bacterial mutation, for example to resistance against the action of antibiotic drugs my work in that field having closely complemented that of Drs. S. E. Luria and Max Delbrueck.

I know that all of us including a great many other basic scientist who have worked in the genetics of bacteria and viruses believe that these discoveries have already been and will in the future continue to be of ever growing importance in facilitating many advances in the prevention and healing of serious human diseases. We live, in the present era, in an incompletely justified optimism about having "conquered infectious bacterial disease" as the fruit of the development of the antibiotics. However, viruses are in general still beyond the reach of antibiotic therapy and even bacteria believed to be under firm control with antibiotics are continuing their own evolution and renew their assaults upon human health with renewed vigor. In the long run only our continued vigilance and deepening insights into the patterns of bacterial evolution can justified any hope that we will continue to maintain our lead in this live and death race.

However, whatever pride I might wish to take in the eventual human benefits that may arise from my own research is turned into dismay by the knowledge that this kind of scientific insight is also applicable for the engineering of biological warfare agents. In this respect we are in exatly the same position as the nuclear physicists who foresaw the development of atomic weapons.

There is, however, a crucial difference. The technology of nuclear weapons has required the commitment of industrial resources on such a scale that they could be contained within the monopoly of the great powers long enough for the development of a de facto balance of deterrence and for the eventual establishment of the doctrine of non-proliferation now precariously being built. Nuclear power has thus, ironically, become a stabilizing factor tending to reinforce the status quo in parallel with established levels of economic and industrial development. This constraint does not exist with respect to biological weapons.

The United Nations Study Report on chemical and biological weaponry has summarized a few of the infectious agents that have served as points of departure for the development of biological weapons. I will also asked to be relieved of the task of reciting the very real chamber of horrors of the kinds of diseases that some of these agents provoke. I will also leave to your own conscience the estimation of the morality of ever using these kinds of weapons. Most Americans would, I believe, be repelled by the thought, but perhaps no less by exposure to the human realities of any other form of warfare. There is, however, a grave moral issue in the pursuit of any policy that risks the lives of innocent bystanders. However, none of these concerns conflict in any way with

My main fears about BW have to do with the side-effects of its proliferation 1) as a concept of warfare by smaller nations and insurgent groups and 2) by the inadvertent spread of disease.

If it were somehow possible for the great powers to continue their BW development work in absolute secrecy I would be much less alarmed. The chance of BW ever being used in a major strategic attack is essentially negligible in the face of the nuclear deterrent. The suggestion that we need BW or CW weapons for specific retaliatory purposes in order to deter their use aims at a rediculous kind of precision. Will our deterrent missles have to follow the same trajectories as those that might potentially attack us? Will they have to be launched at the same time of day? Will they have to have the same mix explosive energy and radio-active fallout? If we are attacked with anthrax strain B27 must we reply with anthrax B27?

On the other hand, if I were a Machiavellian adviser to a would be Hitler I might indeed advocate a considerable investment in biological weaponry as a desperate approach to the cheap aquisition of great power at very great risk. And, of course, the first thing I would do would be to plant my intelligence agents in the BW establishments of the existing powers in order to get the necessary scientific information at the lowest possible cost.

However, if I were patient I would not bother to do even that. No security system, no counter intelligence system in the world is predicated on accomplishing more than a delay of at most 10 years or so in the leakage of vital information. In practice the interval has often been much shorter. We do not have, I presume do not contemplate a security reservation like war time Los Alamos for the containment of BW research. If a high level activity is to be maintained there will be frequent turnover of personnel and it will be simply impossible to maintain any tighter security barrier here than has prevailed in any other area.

Besides the channels for defusion of information just eluded to they are also bound to be Pueblo incidents and finally cycles of calculated leaks in the preparation of budget justification. The American people might be the last to know but we can hardly be confident that there will be much more than a ten year delay between important discoveries in BW research laboratories and their availability to hostile and irresponsible forces outside.

As a matter of prudent self-protection BW research laboratories have pioneered in the development of methods for containing dangerous infectious organisms. I have great respect for the technical capabilities of the senior civilian management of these laboratories and believe that they should be credited with the outmost diligence in protecting both their personnel and the surrounding community. They have also published most if not all their work in the engineering of such protective facilities and this experience is unquestionably of great value in public health work. For example, the British laboratories,at Fordham, were acclaimed for the safe handling of the very dangerous Marburg virus upon its first outbreak in Europe two years ago.

Nevertheless, in spite of these precautions disease organisms have escaped from time to time and inevitably will do so in the future. Such escapes constitute a breach not only of security but also of public health, the latter being briefly complicated by keeping civilian physicians in ignorance of the dangerous diseases capable of spreading into large scale epidemics that they might encounter. The intentional development of virulent strains resistant to conventional antibiotics

obviously worsens the problem and we simply have no way of assuring ourselves that a BW development activity will not eventually seed a catastrophic world wide epidemic.

It is entirely plausible that modern developments in molecular genetics could permit the development of agents against which no reasonable defense can be mounted. Such agents are hardly likely to be used in consequence of any rational military decision but would obviously play into the hands of aggressive insurgence.

Finally, the actual publication, albeit as a contribution to humanity, of the technology of containment of infectious agents has the insidious side-effect of opening one more door to the potential insurgent who will himself use this information for BW purposes also.

The problem of containing infectious agents stored in very large quantities or tested in the open air is a much more difficult technological challenge but is encumbert with even more official secrecy than the laboratory work. I suspect that it is not dealt with nearly as confidently and we may count ourselves furtunate that the Skull Valley incident helped to uncover how such matters are handled.

If BW research is to be continued one might recommend that it be relegated to the moon but only after this has seized to become a center of traffic for other purposes.

BW agents for use against man can be expected to be far more capricious than any other form of weapon. For any strategic purpose they are essentially untestable since large populations would have to be held to an uncertain risk for this purpose. With nuclear weapons we can at least be confident of the laws of scaling and of the certainty of destruction of targets as a function of simple physical measures like

the energy released. Nothing comparable to this can possibly apply to BW agents. For this reason again the United States and similarly placed powers would have absolutely nothing to lose in disavowing their conceivable use in war.

We then have nothing to gain by our own participation in BW development except where this coincides with programs of public health research or defense against natural microbial enemies of a kind that should be vastly multiplied in any case. Our public health officials have, I believe, refused to give prudent thought to the prospects of major pandemics of human disease be they of spontaneous or human-intelligent origin. Perhaps this is simply a consequence of their sense of futility by instituting the necessary measures of global health needed to protect the species. If we add to existing concerns the possibilities of spread of dangerous diseases from large foci of infection established as a consequence of BW attack, the prospects become even gloomier. Our own participation in this kind of development would be akin to our arranging to make hydrogen bombs available at the 5-and-10.

Our self-interest both as Americans and human beings urgently calls for the institution of improved measures of general public health and of international controls on the development and use of BW agents. Research related to BW probably should continue but it is of the first importance that this be fear-reducing rather than fear-generating, for the latter can only lead to mutual escalation of anti-human developments. It is difficult at this stage to outline the texture of new agreements in detail. They probably should include 1) public legal commitments

against secret BW research, towards which our ratification of the Geneva Protocol would be an important step; 2) the establishment of central, international laboratories to monitor the occurrence of threatening organisms and to help develop generally available means of protection against them; 3) a legal system to protect the freedom of information and communication of data on disease organisms to such central authorities; 4) a general acceleration on behalf of the interests of nationals of individual states, of research and health services to minimize the incidence of infectious disease, particularly in underdeveloped countries.* No situation could be better designed for the evolution of serious new viruses than the existence of crowded, underfed human populations in which foci could development spread with a minimum of medical control.

* 5) treaty commitments and alleges to the nuclear non-proliferation treaty 6) an extension of these calling for sanctions by the civilized world against any party that undertook the deploiment of or risked the release of BW agents on the grounds that this would indeed be an offense gainst mankind.

Some of the expectations that I have outlined are speculations which I feverently hope will prove to be untrue. Unfortunately, they have a measure of historical precedence. As many of you may ~~have~~ already know the Black Death - the epidemic of the Bubonic Plague in Europe between 1346 and 1350 - was the immediate consequence of a primitive form of bacteriological warfare. Venicean colonists in the Crimea brought the plague back to Italy with them when they retreated from the fortress of Theodosia after having been assaulted with the corpses from the attacking Tartar hordes who had been infested with the disease. This epidemic subsided only after killing approximately 1/3 of the population in Europe. We do not know what it did to the population,

of Asia and India where it may have had an even greater impact. We have very little reason to believe that similar incidents cannot recur unless we learn to apply our common energies against the common enemy of all mankind.

✱ Side note: add large scale manufacturers as well as storage to the previous discussion, and also that the main effect of security is not to deny information to an enemy but to protect an establishment from both destructive and constructive criticism at home. In this case the constructive criticism would be very important if we would have any hope of maintaining the integrity of containment of micro-organisms.