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CENTRAL INTELLIGENCE AGENCY
WASHINGTON, D.C. 20505

10 May 1978

MEMORANDUM FOR: The Director of Central Intelligence

FROM : John N. McMahon
Deputy Director for Operations

SUBJECT : MILITARY THOUGHT (USSR): Modern War and Certain Biological Problems

1. The enclosed Intelligence Information Special Report is part of a series now in preparation based on the SECRET USSR Ministry of Defense publication Collection of Articles of the Journal "Military Thought". At the beginning of the article the author discusses the dangerous effects of radioactive contamination on the human body from a nuclear burst and the importance of detecting this contamination. Then, quoting from Western sources, he shows how new developments in the field of microbiology in the "bourgeois countries" (particularly in the US) can and are being applied to biological warfare. He concludes by stating that the USSR has as a national task the development of the biological sciences in order to raise the defense capability of the country. This article appeared in Issue No. 4 (65) for 1962. [redacted]

2. Because the source of this report is extremely sensitive, this document should be handled on a strict need-to-know basis within recipient agencies. For ease of reference, reports from this publication have been assigned [redacted]

[redacted]

for John N. McMahon

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MILITARY THOUGHT (USSR): Modern War and Certain Biological Problems

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Summary:

The following report is a translation from Russian of an article which appeared in Issue No. 4 (65) for 1962 of the SECRET USSR Ministry of Defense publication Collection of Articles of the Journal "Military Thought". The author of this article is G. Frank, a corresponding member of the USSR Academy of Sciences. At the beginning of the article the author discusses the dangerous effects of radioactive contamination on the human body from a nuclear burst and the importance of detecting this contamination. Then quoting from Western sources, he shows how new developments in the field of microbiology in the "bourgeois countries" (particularly in the US) can and are being applied to biological warfare. He concludes by stating that the USSR has as a national task the development of the biological sciences in order to raise the defense capability of the country.

End of Summary

[redacted] Comment:

The author of this article was a specialist in biophysics. He died in 1976. After 1962 the SECRET version of Military Thought was published three times annually and was distributed down to the level of division commander. It reportedly ceased publication at the end of 1970. [redacted]

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SECRET

Modern War and Certain Biological Problems

by

Corresponding Member of the USSR Academy
of Sciences G. FRANK

Throughout history one of the most important factors in military success has been the destruction or incapacitation of the personnel and equipment of the enemy.

Along with the increase in the fire power of modern weapons there has also been an increase in the probability of the purely physical annihilation of people. The employment of aircraft and missiles, particularly under conditions of nuclear warfare, will lead to both enormous material damage and the mass destruction of people as a result of a direct hit and as a consequence of the suffering of numerous injuries when dwellings and industrial plants are destroyed. Consequently, the subject of mechanical injury has become one of the most decisive problems in the struggle to preserve human resources.

In this connection an exceptionally important role is played by the working out of the matters of administering first aid and of improving medical treatment procedures that will ensure the highest percentage of lives saved when there are serious injuries and the highest percentage of recovery of the injured in the shortest possible time.

In addition to the evacuation of the wounded and the organization of the medical treatment process, great importance will be attached to the development of new methods of treatment that are connected not only with the improvement of surgical techniques but also with a very complex set of measures that are based on the accomplishments of the various branches of modern biology.

Biology is becoming particularly important in connection with the appearance in the armies of the bourgeois countries of new types of weapons of mass destruction, the effects of which do

not produce mechanical injury, but have an entirely different character which can be generalized under the general designation "poisoning". These include not only combat toxic agents in the strict sense of the word, but also means producing radiation injury as well as everything that may be employed in "bacteriological warfare". In the action of radiation, there occurs poisoning of the body by substances that appear in the cells and tissues as a result of its effect, like the role played in infections by substances (so-called toxins) that are produced by bacteria or viruses as they multiply within the organism.

Within the framework of this article it is very difficult to characterize all of the particular features of the various types of biological weapons, either with respect to the mechanism of effect, or with respect to the resultant possibilities of tactical exploitation. Thus, we can treat this matter only in general outline and we can make no claim to expounding on it fully, particularly in regard to modern experimental biology.

The accomplishments of nuclear physics and nuclear engineering have made it possible to produce radioactive weapons of two types. These are the atomic and hydrogen bombs with which the main casualty-producing element is the crushing shock wave.

However, in addition, each nuclear burst is a most powerful source of radiation that directly affects the living organism of humans, animals and plants. At the moment of explosion in the atmosphere, thermal and ultraviolet radiation are emitted, as well as a flow of gamma rays, X rays, and neutrons.

Thus, here the radioactive danger is, so to speak, secondary. Nevertheless, antinuclear protection has to be established in view of the possibility of the simultaneous appearance of penetrating radiation. These questions are treated in a rather extensive special literature.

A nuclear burst leads also to a second type of side effect -- the formation (as a result of the fission of the nuclear fuel) of a considerable amount of radioactive substances which not only are carried to the upper layers of the atmosphere on the ascending thermal flows, but also settle in the areas immediately adjacent to the site of the burst.

We should take into account another peculiar effect, namely the formation of radioactive substances in the soil, in various objects, and even in the body, all of which are exposed to the effect of the neutrons emitted at the moment of the explosion.

The second type of radioactive weapon is the radioactive substances atomized or scattered in considerable amounts in a particular region.

Poisoning by radioactive substances as a result of the burst of a nuclear warhead, as well as a result of the scattering of radioactive substances, represents an enormous danger both to the civilian population and to the troops.

The emission at the moment of the burst is accompanied only by the destructive effect of the enormously powerful shock wave. Radiation injury may or may not be of significant importance against the determinate background of mechanical effects. But combined, or so-called "mixed", effects, when the traumatic injuries caused by the burst are accompanied by some degree of irradiation, nevertheless should be borne in mind.

Terrain contamination by radioactive substances represents a great danger not only from the standpoint of the penetration of these substances into the body. Immediately after a burst, or if a large amount of radioactive substances is employed, there will be a direct radiation effect from the soil and surrounding objects on the people in the area. Here a significant role might be played not only by the penetrating radiation, gamma rays and X rays, but also by the flow of beta particles produced by the so-called beta-radioactive substances. These flows are readily retarded by even relatively thin protective devices, but they represent a colossal danger to the eyes and exposed surface of the facial skin, hands, etc.

The penetration of radioactive substances into the body is the most serious case of radiation injury, since the radioactive substances concentrated in the organs and in the tissues serve as a source of radiation of constant and long-term effect in spite of any therapeutic measures that may be taken.

Several problems arise in the consideration of the question of the danger of radioactivity. First of all, we should discuss

"radioactive reconnaissance", the measurement of contamination, and diagnosis. It is extremely important to appraise the actual situation, primarily the degree of "pollution" of the surrounding terrain and air by radioactive substances.

At the moment the radiation exerts an effect on the body through external irradiation or penetration of the substances into it, there is no subjective perception of it whatsoever, even with high, indeed even lethal, doses. The person does not know that he is in a contaminated area, that he is being exposed to radiation, or that his life is threatened by it. Because of this special feature of the action of radiation, radioactive or dosimetric reconnaissance has admittedly become extremely urgent. We must organize everywhere a dosimetric service, a warning service, and, in addition to special, more complex and technically improved methods of determining the level of local radioactive contamination, we must popularize more useable methods and distribute the most uncomplicated devices that will make it possible to objectively evaluate an unexpected occurrence of radiation at any point from either the original burst or the scattering or atomization of radioactive substances.

No less important in this matter is the extensive indoctrination of the medical units in express methods of determining the contamination of the body by radioactive substances. Measurements of radioactivity in the blood and urine are possible, and we should make use of such measurements, since the major part of radioactive substances contain only highly-absorbed beta radiation. For this reason the direct contact of the surface of the body with a counter can by no means always give a correct picture of body contamination.

Also of extraordinary importance will be to increase the sensitivity of measuring devices. Current foreign literature describes a "tank" method, now in use, of determining the radioactivity of the body. The person being tested is put into a special type of tank with double walls, between which there is a fluorescent substance. This substance fluoresces under the effect of the radiation emitted from the body. The flashes of fluorescence from each elementary particle or of each absorbed quantum of gamma rays are measured by hundreds of counters with

photoelectric multipliers installed around the periphery of the tank.

This type of appliance greatly increases the sensitivity of the measuring device, which is able to measure distinctly the amplification or attenuation of even the natural radioactivity of the human body which comes from the traces of radium and also of one of the isotopes of potassium that the body contains. Even if the amplification of the background of natural radioactivity is extremely slight, all measures must be taken to determine the cause of additional body contamination.

Since practically all of the radiation emitted in all directions from the human body is trapped by the casing containing the fluorescent material, it is very important that with such a sensitive system it is possible not only to measure the penetrating radiation of the gamma rays but also to obtain signals as to the beta-active substances that are found in the human body, but which are practically never expelled from it. This signalling is possible as a result of secondary, so-called braking radiation, i.e., the X rays that are excited by electrons (beta particles) at the moment they are absorbed in the tissues of the body.

Since this transformation of the weakly-penetrating beta particles, absorbed by the tissues, into X rays, that are emitted into the external environment, occurs with great losses (i.e., low yield or low efficiency), the detection of beta contamination in the body requires highly sensitive devices of the type discussed above.

A second special feature of the effect of ionizing radiation in comparison with other harmful agents is, as a rule, the more or less long-term concealed or latent period of damage. This damage develops gradually and, if it is not of a catastrophic nature, days of so-called "imaginary well-being" may go by, when the victim has no suspicion yet of the damage inflicted on him.

An extremely important role is played by the development of diagnosis, i.e., the detection of latent damage. Among the existing methods, the blood count is particularly important, since in this period of unsuspected damage the blood picture can signal increasing changes.

There arises the enormous problem of the mass examination of great numbers of people.

Both the use of the dosimetric service and the diagnosis of the first signs of radiation damage are required in connection with the third special feature of the biological effect of radiation -- the buildup of a number of successive effects, even though each of them separately would be subthreshold, i.e., would not itself cause any direct damage.

The effect of ionizing radiation on the human body is characterized by successive cumulative changes in the body. This can occur from the prolonged effect of low-intensity radiation or repeated exposure to small "fractional" doses, each of which, separately, as we mentioned above, does not represent a danger. For this reason it is necessary to determine precisely the tolerable exposure time for a human being, even for working in a weak radiation field.

The situation of the radiation field, the contamination of the terrain, the presence of radioactive substances in low clouds, and the contamination of the body, all of which are determined on the basis of the data of radiation surveys and radiation reconnaissance, as well as the dynamics of the shift in the body, for example, in the blood pictures, create the prerequisites for medical treatment procedures.

We cannot discuss here the data, already well known and widely described in the literature, on the very essence of the biological effect of radiation and on the fundamentals of the pathology of radiation sickness.

We shall point out only the fact that there are still significant blank spaces in regard to this problem. In particular, although the course of the illness has been studied from the blood picture to the terminal clinical symptoms, the latent internal mechanisms that lead to the manifestation of these illnesses have by no means been satisfactorily established. This involves the area of the so-called "primary" or incipient mechanisms of the radiation effect. It is assumed that the most significant immediate consequence of the absorption of an ionizing particle is the appearance of so-called free radicals in water, which, as we all know, makes up some 80 percent of the

tissue of the human body. We must also not rule out the "direct" effect, the proteolysis, i.e., the depolymerization of the protein complexes (for example the nucleoproteins) and of the protein molecules. The free radicals in water and the separating abnormal chemical products are toxic. From this there originates a whole chain of events which are not sufficiently clear to us, not to mention the fact that a whole list of initially forming substances and their relative importance are unknown at the present time. At the same time, these still hidden mechanisms are of great, and not just theoretical, interest.*

At the present time the world literature is carrying on a wide-ranging debate on the matter of so-called antidotes which greatly reduce the sensitivity of the body to radiation, provided these substances are administered just before exposure.

One of the most urgent problems in combating radiation damage is the discovery of the most effective antidotes which will be maximally long-lasting without causing side effects. On the one hand, finding such substances should help toward a deeper understanding of the entire material basis of the phenomena of life, particularly of the rules of metabolism and of a great number of chemical processes occurring in an organized way in the cells and tissues. As mentioned above, this is associated with a peculiar and specific arrangement -- the molecular structure of the living substrata. On the other hand, the discovery of the

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* At the end of 1960, a highly representative group of the most important specialists from many countries of the world held an international symposium on the incipient and primary changes in cells under the effect of radiation; the complete texts of the reports and discussions are in print and will be published in Russian as proceedings of the symposium by the Publishing House of the Academy of Sciences of the USSR in 1962 (for a brief treatment, see Nature, 14 January 1961, p. 110).

still unknown primary elements of the radiation effect, which destroy this arrangement, will be of decisive importance.*

A no less important problem facing the military medical specialists and wide circles of the population is the possible use of toxic agents by the armies of the capitalist countries. According to data available in foreign literature, scientific research is being conducted in a number of bourgeois countries for the purpose of improving the chemical compounds and the methods of employing them. Without doubt, one particular danger is the poisoning of agricultural crops over large territories, which can lead to a reduction in, or even the destruction of, crops.

The very first production of toxic agents was to a certain extent empirical and even of an accidental nature. The first toxic agents were, so to speak, by-products of various processes of chemical synthesis. One of these, for example, was yperite (mustard gas), which, incidentally, they say has not lost its practical importance even today, and its subsequent derivatives. At the present time new trends have developed in which, in connection with the development of biochemistry, there has emerged a possibility of producing in a more efficient way the chemical compounds that block or inhibit strictly determinate processes in the body.

As mentioned above, the metabolism that occurs continously within the body is supported by the action of a number of catalysts/enzymes, each of which is specific for a particular chemical reaction. The substances that inhibit particular processes and that block particular enzymes and interrupt their activity are called "anti-enzymes". The action of a particular "anti-enzyme" leads to the shutting off a certain component element from the complex flow of coordinated processes, and, if this component element is the decisive one, this leads to the cessation of the life process itself. Thus, the series of enzymes that provide the chemical basis for the transmission of nerve impulses at the point of contact of the branches of a nerve cell with the organ being controlled, for example a muscle fiber, are very important for the normal activity of the nervous system.

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* See G. ALEKSANDER and Z. BAK, "Chemical Protection Against Radiation", Collection of Essays "The Effect of Radiation and the Use of Isotopes", No. 3 (27), Publishing House of Foreign Literature, 1956.

This, so to speak, is a "commutation" function carried out at this point of contact in a microscopic "plug-and-socket connection", the so-called "synapse".

According to data presented at a meeting of the American Chemical Society,* there are various substances that block this transmission and thereby disrupt the controlling action of the nervous system. This leads to an immediate switching-off of not only the "commutation connection" and a disruption of the signalization, but also to the inhibition of the entire control system of the body, including the functioning of the heart, lungs, etc.

A representative of the chemical service of the US Army at this meeting reported that paralytic nerve gases will be the most destructive weapons that can possibly be used in modern chemical warfare. These gases do not have any characteristic odor or color; the victim inhales the gas and dies before anything can be done to save him.

Since these "anti-enzymes" have specific chemical properties, it is said they do not have to saturate the entire body. A given type of "anti-enzyme" has such a reaction capability that, once introduced into the body, it attaches itself only to the substance that it is to block, that is, it "addresses itself" directly to its appropriate enzyme. For this reason the amount of "anti-enzyme" substance required for the cessation of vital activity is quite negligible, and in certain cases infinitesimal.

Within the category of toxic agents which cause "general paralysis of function" there is an entire series of organophosphoric compounds, among which is a substance called "tabun" which has become widely known in modern foreign toxicological literature.

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* Science News Letter, 1960, 77, 16, 243.

Thus, we see that in addition to mechanical injury and the disruption or switching-off of the nervous system by the interruption of its blood supply, the cessation of vital activity can be carried out with an inifinitesimal amount of "anti-enzyme". This is one of the newest types of toxic agents.

The American literature mentions and even publicizes yet another category of toxic chemical substances which has come to be known as "hallucinogens". As the name implies, the effect of this type of substance on a human being occurs in the form of neuropsychic disorders. The bourgeois military theorists consider the use of such substances "advantageous" because the incapacitation of considerable numbers of personnel with the use of ordinary toxic agents leads to less disorganization of the enemy than the confusion, or even mutual destruction, caused by psychic disorders. Actually, with complex modern technology, extensive mechanization and the centralization of control of the enormous military-technical strength of armies, psychic disorders not only of leaders, but also of the executors, could lead to incalculable disasters.

Consequently, against such a "weapon", as against any other, we must search for a means of protection; against a poison there has to be an antidote. In order for us to devise protective or therapeutic measures in a rational manner, we must know precisely how the toxic agents behave in the body, i.e., the paths of their movement, concentration, and the chemical and biological mechanisms of their action. This applies both to agents of the "old type" such as blister gas, and particularly to the specific "anti-enzymes". The extensive employment of various "indicator" methods will undoubtedly be of great importance in modern toxicological laboratories. By observing a toxic agent by means of, say, a radioactive tracer in animal experiments, we can follow directly all of the paths of its movement, sorption, and participation in chemical processes. This will make it possible to reveal more precisely the "place of application" of the effect and, on the basis of the chemical behavior of these substances, to find ways of blocking or intercepting them.

Sometimes the selectively toxic agents differ, at first glance quite imperceptibly from actual substances that are biologically important for the body, and this makes them invulnerable to the enzyme system.

It goes without saying that in the area of chemical protection, just as in the area of radiation protection, it is extremely important to develop methods of "chemical reconnaissance". Here it is essential to use both the most subtle chemical methods as well as purely biological methods.

The problem of protection against the above-mentioned substances, from the chemical standpoint, is extraordinarily complex, and its complexity is connected not so much with the synthesis of the poisonous, selectively toxic agents as with the understanding of the mechanism of their action. Working out protective measures -- the discovery of "anti-agents" against the "anti-enzymes" -- requires a deep penetration into the secret corners of the chemical bases for the phenomena of life, of the spatial organization of living organisms, of the biochemistry and biophysics of the effect of innumerable enzymes and catalysts engaged in metabolic processes.

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The possibility of using so-called pathogens, i.e., disease-causing microorganisms and viruses, or the direct application of the toxins produced by the microbes, as a powerful biological weapon is being widely debated abroad, particularly in American literature. The contamination of the human body by microbes or by the products of their vital activity leads to poisonings. Involved here is the same selective "toxicity" discussed in the previous section. However, this poisoning is caused not by specially synthesized substances, but by the activity of the microorganisms.

There are microbial toxins, of which infinitesimal amounts are sufficient to infect the human body. These include, for example, botulin -- a toxin manufactured by a particular type of bacteria (botulinus). Theoretically, one gram of this toxin is sufficient to infect eight million people. It is calculated that it is 1,000 times stronger than, for example, potassium cyanide.

In foreign literature* it is emphasized that the preparation and testing of a bacteriological weapon can be carried out in deep secrecy under the semblance of work for ordinary medical institutions that produce bacterial preparations. In one month a

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* RAZHENTOVSKIY and ZHULKOVSKIY, Biological Warfare, Publishing House of Foreign Literature, 1960.

sufficiently large laboratory can easily produce up to 300 kilograms of plague bacilli in pure form and an even larger quantity of typhoid bacilli. Bacteriologists who consider these problems theoretically (ROSEBERRY, CABOT, and BALDWIN) have analyzed the peculiarities of the spreading of various infectious diseases and believe that out of some 70 infectious diseases at least 33 are suitable for use in bacteriological warfare. "These types of diseases are everywhere considered to be an 'ideal' weapon which provides a chance of achieving the biological destruction of the enemy and at the same time of capturing his material wealth intact. According to this point of view it is thought that the biological weapon, under known conditions, has an advantage over even the 'atomic bomb'." (Statement of the American General O. WELLER.)*

In fact, what is specifically new is that living microorganisms and viruses show, first of all, that the amount of them necessary for infection can be considerably less, by weight, than that of any toxic agent. Sometimes single microbes, or a few dozen of them, that weigh some hundred-thousandths or even millionths of a milligram, once they have entered the organism, are capable of producing infections as a consequence of the multiplying of those microorganisms or viruses in the human body. The infectious disease is its own type of system that automatically amplifies its own toxicity.

Once they have entered the cells and tissues of a living organism, bacteria and viruses become particularly active and, so to speak, virulent; they multiply very rapidly and, by creating the proper conditions for this multiplication, transform the organism they have contaminated into a mechanism of self-destruction. Moreover, virus particles generally cannot multiply outside living cells, and there is the point of view that each virus particle is, as it were, only the matrix or pattern against which the contaminated cell begins to produce similar virus particles instead of a normal synthesis of its own component substances.

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* Journal of Immunology, May 1947.

Thus, what introduces the bacteriological and viral infection is primarily auto-reproduction, i.e., automatic self-production of the bacteria and viruses in the body until their number is sufficient to cause serious infection or death. The "self-propagation"* of a biological weapon in the infected organism provided the basis for a discussion on the comparative effectiveness of nuclear, chemical, and bacteriological weapons of destruction at the above-mentioned meeting of the American Chemical Society. Various comparative indices of these three elements are given in an article** published apropos of that occasion.

For the purpose of estimating, it is assumed that one B-52 bomber is capable of carrying one 20-megaton nuclear bomb or a full load of chemical or biological weapons.

On this basis the nuclear weapon would kill 78 percent of the (unprotected) people over an area of about 36 square miles; the chemical weapon would kill up to 30 percent over an area of up to 100 square miles, whereas the biological weapon, with considerably less weight of original material, would kill 25 to 27 percent of the people over an area of 34 thousand square miles.

In the article under discussion, which contains a pseudoscientific analysis of the comparative advantages of various forms of the business of death, there are two additional indices of the "advantageousness" of the biological weapon. First of all, its use can be organized to a great extent in secrecy and thus not be threatened with immediate countermeasures. Such a position on the matter reveals with surprising frankness the aggressive character of the problem posed by the American specialists. The second argument is that the nuclear weapon is "very expensive" to produce, the chemical weapon "expensive to a certain degree", and the biological weapon "comparatively inexpensive". Cheaper to produce, more expensive to knock down. No commentary is needed here.

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* RAZHENTOVSKIY and ZHULIKOVSKIY, Biological Warfare, p. 110.
** Science News Letter, 1960, 27, 16, 243.

In the problem of antimicrobial protection, in addition to questions on the methods of contamination, i.e., the penetration of microbes into the body with food, water or inhaled air, an estimate of the natural resistance of the body which prevents the development of infection under appropriate conditions is of great importance also.

As we know, this natural resistance of the body is called immunity.

Immunity may be nonspecific when there exists a "mechanism" that reacts to any appearance of a foreign body. This, however, is not a sufficient barrier. Nonspecific mechanisms can always let through some amount of active microbial cells or viral corpuscles, for which the road to multiplication is always open. The larger the amount of microbes participating in the initial infection, the greater the probability of subsequent development of a disease. However, so-called specific immunity is important. This "antidote", figuratively speaking, is directed against only a specific type of microorganisms and their toxins. This is associated with the formation in the body of strictly and precisely specific antibodies. Such a type of immunity, as we know, may also be produced by advance symptoms, when the weakened culture of a microorganism, or even one that has died but has retained its chemical properties, causes a protective reaction and induces the formation of these antibodies.

At the same time, a very strong factor in modern medicine is also the treatment with antibiotics and specific antimicrobial synthetic substances, the so-called chemotherapy agents. The number and "spectrum" of action of these agents is increasing more and more every year. Even though there is no immunity for certain particular diseases, for example plague, they are at present not such a catastrophic danger due to the availability of specific antibiotics which suppress the reproduction of the plague bacillus. Essentially, antibiotics are "selectively toxic" substances in relation to the pathogenic microbes.

The degree of effectiveness of the employment of biological (bacteriological) weapons is stipulated by the fact that they should be:

1) microorganisms that, to some extent, retain their vital activity when atomized in the air or when they contaminate water even when unavoidably exposed to various influences -- to sunlight, a change in temperature of the external environment, drying, etc;

2) microorganisms with high virulence, i.e., which have the ability to reproduce rapidly and to cause diseases quickly following infection;

3) infections capable of producing epidemic outbreaks, i.e., of being transmitted from a sick person to a healthy person even in the absence of very close contact, particularly in the form of a very slight infection.

However, certain American microbiologists write that a biological weapon does not have to produce epidemic outbreaks. From this point of view it is sufficient to have atomization or another method of dissemination of such forms of microorganisms that infect the human body directly, and which penetrate, without subsequent transmission, from person to person. Thus, FOGARTY, a scientific consultant of the American center for the development of biological weapons, names as biologically infectious agents the bacteria of tularemia, brucellosis, rickets, Q-fever, i.e., the causative agents of infections that cannot spread in epidemic form.*

4) infectious diseases against which there is insufficient natural immunity and for which the treatment and consequently even the halting of an epidemic outbreak by means of antibiotics cannot be easily achieved.

While substantiating the strategic and tactical employment of bacteriological weapons, certain bourgeois scientists cite the historical experience of catastrophic epidemics which have enveloped the earth. Aside from plague and smallpox, for which there are now radical methods of prophylaxis (inoculation), including treatment of plague with antibiotics, the most serious consequences for mankind in our time have come from influenza epidemics. Several tens of millions of people have died from influenza in the periods 1889-1892 and 1918-1920. It is assumed that "skilfully used viruses of influenza could be a powerful biological weapon, suitable for reducing or even completely

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* Public Health Reports, 1957, 72, 10, 865.

paralyzing the defense capabilities of the countries of entire continents."*

As American microbiologists note with unusual cynicism, the problem of "organizing" the outbreak of an infectious disease in the event of war or sabotage is technically not very easy to solve. For this reason, according to published information, considerable attention is being devoted to the intermediate carriers of the corresponding diseases. As we know, some diseases, for example bubonic plague, are carried by fleas that transmit the disease from contaminated rodents. A whole series of diseases, including viral diseases, are carried by ticks and mosquitoes, and enteric diseases by flies.

In order to achieve the intended goal in a practical manner, it is preferable not only to scatter or disperse the appropriate microorganisms or viruses, but also to make use of the above-mentioned disease carriers, thereby preserving the vital activity and virulence of the initial infection.

In this connection, the defensive measures during a threat of bacteriological warfare should be directed not only toward catching and rendering harmless the disseminated microorganisms, but also toward combating the various types of carriers. This should be one of the most important measures of antibacteriological protection.

Under these conditions, the detection, first of all in the air and then on the surface of objects, of the minutest quantities of the disseminated microbes or viruses and the development of rapid methods of identifying them are of extreme importance.

Just as radiation monitoring and radioactivity reconnaissance must quickly signal the presence of radioactive substances, so must bacteriological reconnaissance report the presence of the danger of a bacteriological or viral contamination in a given area.

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* RAZHENTOVSKIY and ZHULIKOVSKIY, Biological Warfare, p. 152.

It goes without saying that the potential danger of one or another bacterial or viral culture and the data obtained in the laboratory regarding the required doses for infection (even if the amount of substance is very small) by no means guarantees the success of the employment of a biological weapon. Technically, the contamination of large spaces is not so simple as far as the atmosphere and contamination of water are concerned. Modern epidemiological measures make it possible to localize the outbreak of infection and prevent its spreading.

We should also keep another very important matter in mind. While certain American microbiologists are writing with amazing frankness, at present work is being conducted on the search for new microorganisms and viruses through the treatment of cultures by radiation and obtaining so-called radiomutants with entirely new properties. They point out that the properties and even the specific character of microbes can be altered by treatment with nucleic acids extracted from other types of microorganisms. In these speculative statements reference is made to known experiments in which, with the above-mentioned methods, penicillin-resistant strains can be obtained from penicillin-sensitive strains. In other words, by this method it is possible to derive cultures that are not subject to the effect of antibiotics, which in the event of an epidemic outbreak represent an obvious danger.

A decisive factor in the defense against similar new infections is the rapid identification of the biological and immunological peculiarities of these strains, the development of therapeutic serums and the selection of antibiotics. Here, there must be an operative system for rapid use of the methods of modern bacteriology and immunology.

It must be pointed out that the military specialists of the capitalist armies are planning the use of bacterial weapons not only directly against people. Artificial propagation of agricultural plant diseases, leading to the destruction of crops, could be very important. History knows of the tragic case when in Europe in 1849 an epiphytotic blight (epidemic disease of plants) of potatoes broke out -- the so-called phytophthora (black leg). This had particularly serious consequences for Ireland, where the population in those years was practically living on potatoes alone: nearly one million people died of

starvation, and another million were forced to emigrate in subsequent years.

Therefore, in considering problems of defense and of biological warfare we must keep in mind the possibility of not only outbreaks of epidemics among people but also of infectious plant contamination.

Up until the present time biological methods have prevailed in the analysis of immunity phenomena. A primary role here is played by direct bacteriological testing of the antibacterial properties of the blood proteins, in particular one of the protein components -- gamma-globulin, which is considered to be the carrier of the properties of immunity.

We see that here too considerable importance is achieved by restructuring the methods of biological research, which requires the extensive employment of modern physics and chemistry and the introduction of new physical methods for an in-depth knowledge of the very essence of the processes being studied.

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To what has been said we must add that a completely different area of biology and physiology is closing in on the problems of defense. Human psychology, the immediate reaction of the human being to external stimuli, particularly in the case of weapons of mass destruction leading to catastrophic results, may extraordinarily complicate the matter of defense, the preservation of order, or the organization of operations for restoring productive activity in places of destruction.

From this point of view the matters involving the higher nervous activity of the human being require particular study.

For the study of the nervous activity of humans, based on the most important wartime tasks, and the study of the necessary mobilization of all the forces of the nervous system, we must find more effective methods than those presently being employed by neuropathologists, psychiatrists, etc.

The use of contiguous disciplines, primarily electronics, opens up unlimited possibilities in relation to the objective

analysis of human behavior, the reaction to various stimuli, the diagramming of the functions of the central nervous system, and extensive machine processing of the data obtained from physiological analyis. This problem is being discussed actively in foreign literature.

At the present time, for example, recordings of brain waves at 50 to 100 points simultaneously are beginning to be used. However, the pattern obtained during the observation of the flickering dots on the screen of the oscilloscope gives the experimenter only certain general impressions. There is no doubt that, qualitatively, a new step will be made in the study of the function of the central nervous system with the inclusion into the processing of such data of a continually operating electronic computer showing the distribution of the amplitudes and frequencies, plus the nature of the spatial correlation of the processes.

Such machine processing of objectively obtained data should help toward rapid diagnosis in the case of various diseases, including even mechanical injury, infectious diseases and various types of poisonings. Methods must be developed for massive machine studies of the condition of the human organism, primarily for the automation of the different analyses.

Thus, the problems of biology, in order for them to provide greater service to the problems of defense, must be developed with a view toward a close relationship with the exact sciences and modern technology, primarily with electronics.

In this article we have pursued, as far as is possible, the task of showing that at the present stage of the development of technology, and with the advent of the danger of the employment of new methods of mass destruction of people, present-day biology is faced with entirely new problems.

Biology is not only the basis of diagnostics and therapy. Biology in the present instance penetrates deeply into all the problems of modern military science for the simple reason that man is the main character, controlling numerous mechanisms. To the same degree as the military contingents, the entire population of the country is exposed to the danger, which greatly expands the possibilities and ways of encroaching upon human

life. The problems of defense and protection cannot be solved fundamentally by the use of various simple protective measures, but are in their entirety based on a profound understanding of the essence of the phenomena of life. This understanding of the essence of the phenomena of life will lead us to the still hidden material bases of the life processes. Particularly in the chemical phenomena of metabolism, associated with the molecular structure of living tissues and organs and with their physical and physiological peculiarities, are hidden those possibilities of controlling the life processes (knowledge of which is required for an understanding of the mechanisms involved in the effect of various new types of weapons that threaten man) and the formulas of future protection means: substances that will stop the development of radiation damage; substances that will block the toxicity of poisonous agents; substances that will provide extensive immunity against various producers of diseases and new means of instantaneous limitation, i.e., stopping these diseases.

There is no doubt whatever that the decisive factor in the protection against biological warfare is the development of biology itself on an entirely new basis. This new basis has already been mentioned in the directives of the 21st Congress of the CPSU, where it was said that the importance of the complex of biological sciences will increase all the more as the achievements of physics and chemistry are utilized in biology. However, a particularly striking and concrete expression of this was in the program of the CPSU approved by the 22nd Congress which foresees the elucidation of the essence of the phenomena of life, the discovery of the biological laws of the development of the organic world, the study of the physics and chemistry of living organisms, the development of the various methods of controlling the life processes, particularly metabolism, and the heredity and directed changes in organisms as the main tasks of the entire complex of biological sciences. The development of biochemistry, biophysics, microbiology and other biological sciences is the most important theoretical and national economic task, the solution of which will raise the defense capability of our country.