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SCIENTIFIC INTELLIGENCE REPORT

LONG-RANGE CAPABILITIES OF THE SOVIET UNION IN MAJOR SCIENTIFIC FIELDS 1957-67

MONOGRAPH X
MEDICAL AND VETERINARY SCIENCES

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PREFACE

This monograph on Soviet medical and veterinary sciences is one of a series of estimates of the capabilities of the Soviet Union over the next ten years in major scientific fields. Monographs II through XI in the series are designed to support the conclusions found in Monograph I, which is an overall evaluation of Soviet science and will be published last. The intelligence provided in this volume (X) emphasizes the trends in Soviet medical and veterinary research. It also points out the significance of such research, estimates the probability of Soviet attainment of their stated goals within the next 10 years, and includes some comparison with Western efforts in strategic and priority areas of work. Medical sciences are treated in part I, and veterinary sciences are treated in part II of this monograph. The titles of all monographs in this series are as follows:

MONOGRAPH NO.	TITLE
I	Summary Estimate
II	Policy, Organization, Planning, and Control of Soviet Science and Technology
III	Scientific and Technical Manpower in the USSR
IV	Physics
V	Mathematics
VI	Geophysical Sciences
VII	Chemistry
VIII	Metallurgy
IX	Electronics
X	Medical and Veterinary Sciences
XI	Biological and Agricultural Sciences

FOREWORD

Part I (Medical Sciences) is designed to highlight those areas of research and development of immediate or potential concern to the national security. No attempt is made to portray a balanced and comprehensive picture of all aspects of Soviet medicine. The estimates and conclusions are evaluated in terms of Soviet intentions and goals, which may differ from those of the United States.

Part II (Veterinary Sciences) provides an assessment of veterinary research and also considers this research within the framework of veterinary practice.

Information available as of 1 January 1958 was used in preparing this report.

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LONG-RANGE CAPABILITIES OF THE SOVIET UNION IN MAJOR SCIENTIFIC FIELDS 1957–67

MONOGRAPH X
MEDICAL AND VETERINARY SCIENCES

PART I
MEDICAL SCIENCES

SUMMARY AND CONCLUSIONS

The responsibility for Soviet organization, planning, and control of medical research is highly centralized through the Academy of Medical Sciences of the Ministry of Health, USSR. Although there is strong control of all Soviet medical research, there remains sufficient flexibility for maximum use of research assets. The current trend toward decentralization of administrative authority to the republic level should provide increased local benefits from advances in medicine.

Research facilities engaged in priority investigations are located in the Moscow-Leningrad area. Most of these facilities are adequately equipped by U.S. standards. The majority of facilities outside of this area are poorly equipped. Within the next 10 years, a marked improvement in the quality and quantity of research facilities and equipment, both in the Moscow-Leningrad area and the Republics, will provide the material means for broadening research frontiers.

Some of the leading Soviet medical scientists are equal in competence to those of the West. However, the Soviets lack depth in numbers of outstanding scientists and, therefore, are unable to devote adequate attention to research of low priority. During the period of this estimate, increasing numbers of competent medical scientists will be trained. This increased scientific manpower, along with the increased facilities and equipment, will result in a broadening of research areas and permit moderate decentralization of research to the republic level.

Soviet research on space medicine now maintains a significant lead over that of the Western nations particularly in flight rocket physiology, space flight equipment, and preconditioning for gravitational stress. This advantage will increase as long as they maintain superior ability to test laboratory results under actual space conditions. Future Soviet leadership in space research will be contingent on resolution of the problems of propulsion systems, advanced space vehicles, and reentry. There is no aeromedical obstacle which prevents the Soviets from orbiting a human being for a period of hours or days within the next year.

Soviet accomplishments in nuclear medicine will continue to lag those of the Western world in health physics, in the use of radioisotopes for diagnosis and therapy, and in prevention of radiation injury. On the other hand, the USSR will continue to lead the West in the study of effects of radiation on the nervous system. At international meetings the Soviets will officially subscribe to low maximum radiation exposure, but they probably will not let rigid health standards hinder their nuclear energy activities.

The present Soviet emphasis on research on bacterial diseases will be deemphasized during the period of this estimate, except for refinements in bacterial vaccines. Increased emphasis will be placed on viral and rickettsial research and the development of broad-spectrum vaccines and antiviral antibiotics.

We believe that the Soviets will continue to emphasize the defensive aspects of human BW but also will maintain research and development which could support an offensive human BW program.

Maximum Soviet effort in the medical sciences will continue to be focused on attaining a greater understanding of the factors underlying human behavior, emphasizing the fields of neurophysiology and psychophysiology while rejecting psychodynamic principles. Although the Soviets will continue to be on a par with Western nations in the overall field of neurophysiology, they will maintain superiority in the study of conditioning and "functional" neuropathology and the application of these principles for:

(a) increasing the potential of the Soviet man with respect to his physical, social, and political environment.

(b) creating international distrust and anxiety through "unconditioning" and "reconditioning" techniques.

Soviet research and development work on antibiotics and therapeutic drugs for chemical warfare will parallel the West in approach, but the West will continue to maintain a lead in the development of these substances. In general, the USSR and the United States will probably be on a par in accomplishments in the field of whole blood, plasma, and plasma extenders.

Soviet production of drugs, biologicals, and medical equipment for civil defense purposes will lag that of the United States for the next 5 years but will approach U.S. levels by 1967. It is estimated that a moderate civil defense stockpiling program will be completed by this time.

U.S. advantages in civil defense, derived from decentralized medical centers and superior quality of professional personnel, will be offset by continued Soviet training of the civilian population in the management of mass casualties, coupled with an extensively organized and manned civil defense program.

Present capabilities of the Soviet Union in polar medicine are equal to those of the United States. The Soviets possess the essential medical principles concerned with protection against cold and will be able to control human factors in polar operations through the application of known bioengineering principles.

Soviet nutritional research is similar to Western work of more than a decade ago. While considerable progress will be made with respect to increasing the quantity and improving the distribution of food products, the Soviets will remain behind the West in the military and therapeutic application of advanced nutritional principles.

Soviet accomplishments in the field of basic protein chemistry generally are less noteworthy than those of Western scientists. However, the Soviets are currently engaged in unique investigations on changes in the properties of proteins which result from structural alteration by both chemical and physical means. These studies have considerable significance and could lead to major advances in the development of highly toxic substances, the formation of "universal" antigens and antibodies, and in understanding the role of intermediary metabolism in metabolic and degenerative diseases.

There is considerable basic research potential in the Satellite countries and Communist

China on which the Soviet Union may rely for medical support in the future. There is little chance, however, that these countries will institute any broad, full scale research program of strategic importance to Soviet medical sciences by 1967.

ORGANIZATION, PLANNING, AND CONTROL

ORGANIZATION

Research in medical science is conducted by three major groups under the Council of Ministers, USSR. These three are the Ministry of Health, with its Academy of Medical Sciences (AMS), medical schools, and Republic Ministries of Health; the Academy of Sciences, USSR, with its Union Republic Academies; and the Ministry of Defense, with its Main Medical Administration.

The AMS is an integral part of the Ministry of Health, USSR, and organizes, plans, and controls medical research in the Soviet Union. The Academy is a highly centralized organization which is subordinate to the Learned Medical Council of the Ministry of Health, USSR, in research matters and to the Collegium of the Ministry in administrative affairs. The AMS is composed of members elected from the leading Soviet medical scientists, some of whom are associated directly with institutions under the Academy and some of whom are associated with other institutions. Members of the Academy are designated active or corresponding, according to their scientific contributions. As of 15 August 1956, there were 88 active and 123 corresponding members.

Under the Ministry of Health, USSR, research is conducted by the Academy Institutes which emphasize basic research and by non-Academy Institutes of the Ministry, where more specific problems are pursued. Research institutes of the Ministries of Health of the Union Republics generally investigate local problems.

The AMS maintains liaison with the Academy of Sciences, USSR, the Academies of Sciences of the Union Republics, and the scientific institutes and societies of the USSR and foreign countries. This liaison is effected through commissions and conferences and by individual Academy members who hold positions in non-Academy Institutions. The Academy of Medical Sciences has no subordinate counterparts in the Union Republics.

Close liaison is maintained between the AMS and the military medical services of the Armed Forces. A specialist in military medicine is assigned as one of the vice presidents of the AMS and the Surgeon General of the Armed Forces functions as an active member of the AMS. In addition, there is a Military Commission of the AMS Presidium which organizes, plans, and controls the programming of military medical projects.

PLANNING

The Five-Year Plan of Medical Research of the Ministry of Health, USSR, is an integral and important part of national economic planning of the Soviet Union. The current 1956–60 plan will be replaced by a 1959–65 plan,* which must be submitted in draft form by 1 July 1958, and will be guided by research plans of the AMS, the medical institutes under the Ministry of Higher Education, and institutes under the Ministry of Health.

CONTROL

Planning bodies are required to check research progress continually at all levels of administration in order to assure the satisfactory progress of the plan. In addition, the Presidium appoints review commissions, who visit unannounced at the institutes to check plan fulfillment and to appraise the work of individual scientists.

The Communist Party maintains direct control of the AMS through the Party organization within the Presidium and its Secretariat. The Presidium, AMS, exercises con-

* According to some sources this plan may be extended to 1972.

trol through its Party bureau and directs the network of Party units operating at all levels.

The three key figures in the control of the AMS are the academician secretary, the president, and the secretary of the Communist Party Bureau. These three officials are generally Party members. To date, the presidents of the AMS also have been deputies to the Supreme Soviet.

As part of the current Soviet trend toward decentralization, directors of institutes and research groups working on local problems in outlying areas have been given greater authority in the formulation and execution of research projects.

Encouragement of ethnic pride will help to resolve regional medical problems and will tend to reduce dependence on Moscow and Leningrad facilities and personnel. This decentralization of authority does not mean autonomy and will become effective only as greater numbers of competent scientists become available at the republic level. We believe that centralized control of research and strong adherence to priority objectives will continue during the period of this estimate, and that this will enhance their ability to accomplish those national objectives which are considered vital to the security and economy of the Soviet Union.

EXTENT AND ADEQUACY OF PRESENT AND FUTURE RESEARCH FACILITIES

The major medical research facilities in the Soviet Union are located largely in the Moscow-Leningrad area. Of the 49 medical institutes and laboratories under the Academy of Medical Sciences and the Academy of Sciences, USSR, 32 are located in Moscow, 6 in Leningrad, 1 in Kiev, 1 in Sukhumi, and the remaining 9 among various universities.

FACILITIES

Many of the buildings housing research centers, such as those of the Institute of Serums and Vaccines imeni Mechnikov, the Military Medical Academy imeni Kirov, and the Institute of Blood Transfusion in Leningrad, are old and in varying degrees of dilapidation. Some of the older buildings are being replaced.

The poor appearance of many of the institute buildings does not necessarily reflect on the quality of equipment or the work emanating from them. Although the United States has a greater tendency to replace old buildings, the Soviets choose to do so only where better facilities are essential for adequate research.

EQUIPMENT

The quantity and quality of equipment assigned to an institute or laboratory usually reflect the priority of projects being pursued. For example, the Gamaleya Institute is adequately equipped to permit the necessary research support and experimental production of biologicals concerned with infectious diseases. The range of its activities can be compared in many respects with the support rendered by research components of U.S. commercial biological plants. The Military Medical Academy imeni Kirov is well-equipped, although housed in old buildings as are the Institutes of Experimental Medicine and of Tuberculosis in Leningrad. The Institute for the Production of Poliomyelitis Vaccine, now under construction, will be one of the best equipped institutes in the USSR. All of its production equipment was purchased from the United States and Canada.

Some of the newer laboratories and institutes, especially those built in the past 5 years, are still lacking in laboratory services, such as gas, but are otherwise well-equipped with microscopes, ultracentrifuges, electrophoresis apparatus, electroencephalographs, electrocardiographs, radioisotopes and Geiger counters. Some of the more elaborate scientific equipment in U.S. laboratories, such as flame photometers and scintillation counters, are found in only a few leading Soviet establishments.

Although much laboratory equipment has been purchased from the West, a considerable quantity is now produced in the USSR. Old U.S. lend-lease centrifuges and refrigerators are seen in laboratories along with new Soviet copies and other items of native design. Their policy is to attain national self-sufficiency in the design and production of research equipment. Equipment of native design is sometimes crude and cumbersome in appearance but appears serviceable. Examples of Soviet designed ionophoresis apparatus have been seen, and one observation, in 1955, was reported of a self-recording oxyhemograph. This was produced by the Krasnogordeyets Medical Instrument Plant * in Leningrad and was claimed to be superior to all similar foreign and domestic devices. The Institute of Blood Transfusion at Leningrad has foreign equipment, Soviet copies, and devices of native design, as well as crude equipment made at the laboratory.

Many Soviet institutes and laboratories construct some of their own equipment. The instruments are designed by technicians (equipment engineers) and, although crude, are of good mechanical design.

Institutes concentrating on clinical research are deficient in some of the necessary basic equipment although several unique pieces of apparatus have been seen. Examples include an instrument for increasing intracranial pressure and an apparatus for the study of kinesthetic analysers of the cerebral cortex.

It is estimated that the supply of good equipment and facilities will increase over the period of this estimate to meet the expanding program of medical research. Satisfactory and sufficient equipment will be made available to the major Soviet laboratories engaged in high priority projects but will not be available to others in the quantities found in most Western medical facilities.

QUALITY, QUANTITY, AND EFFECTIVE UTILIZATION OF MANPOWER

The Soviet Union is training medical scientists in ever increasing numbers, many equal in competence to those in the Free World. The lack of sufficient top research manpower to investigate adequately all medical problems of economic importance is being overcome by a rapidly expanding system of higher education. Graduates of the university system appear to possess sound theoretical knowledge in most fields and compare favorably with U.S. university graduates. The *Kandidat* degree in medical sciences is the near equivalent to the Ph.D. or D. Sc. in the United States. The Soviet *Doktor* is a higher degree and has no exact equivalent in the United States.

The Soviet Union is producing more than twice as many physicians per year as is the United States. Medical school training does not emphasize research in basic medical science to the same degree as does the university system.

Under the Ministry of Health, there are 78 medical schools which train medical practitioners and which are not affiliated with the regular universities. At least one medical school exists in each republic and each major city. Candidates for medical schools are selected by competitive examination from 10-year secondary school graduates. These examinations are supposed to insure that 94 to 96 percent of the candidates will complete the required curriculum. The medical course requires six years of study; the last two years are devoted to practical experience. Medical diplomas can be earned in the fields of sanitation, pediatrics, or general medicine. After graduation, the physician is assigned for approximately three years' practice in an institution or location designated by the State. After this, the physician may apply to one of approximately 12 postgraduate schools for specialization, or he can apply to an institute

* This is a major facility for the design and production of medical equipment and employs over 3,000 workers, including over 400 design engineers.

of the AMS for three years of graduate work leading to the *Kandidat* degree with a subsequent doubling of his salary. Beyond this, the physician with a *Kandidat* degree may apply for the *Doktor* degree, and upon a successful defense of his thesis, receives the degree; his salary is again doubled. Finally, if a physician renders outstanding contributions to medical science, he may be appointed to the Academy of Medical Science as corresponding member or academician, for which he receives additional compensation.

According to qualified Western observers, the teaching staffs at medical schools and postgraduate schools appear to be competent, and the students appear to receive training only slightly less effective than that of U.S. students. The opinion that Soviet medical workers are vastly inferior in quality to those in the United States can no longer be defended on unequivocal grounds. From the qualitative standpoint, the individual Soviet physician is only slightly less competent than his U.S. counterpart due to deficiencies in basic science and clinical medical training.

The USSR enrolled approximately 26,000 students in its medical schools in 1956, in contrast to 8,000 enrolled in the United States. The Soviet claim of 94 to 96 percent graduation of students enrolled in medical schools is partly borne out by the fact that 19,517 students were enrolled in the 6-year medical program in 1950, and an estimated 18,000 graduated in 1956.* The USSR has recently indicated that the supply of physicians is reaching the optimal point and that means of improving quality at the expense of quantity are being considered. At the end of 1956, there were 329,441 physicians in the USSR (70 percent of which were women) as opposed to 221,700 physicians in all categories in the United States as of 1 July 1956.

Soviet emphasis on quantity of medical manpower is due to the fact that the primary medical problems in the USSR are related to public health and preventive medicine. Therefore, the policy has been to saturate the population with large numbers of physicians who are trained to diagnose and treat illnesses which produce high morbidity rates. Research personnel have concentrated on developing better therapy for the large number of physicians to administer under circumstances prescribed by central authority. It is believed that, within the period of this estimate, the Soviets will curtail the presently expanding physician training program to maintain a level of one physician to about 500 population.

As of mid-57, the total number of individuals employed in health sciences in the USSR, including those with academic degrees, was 370,500, representing 25 percent of the total scientific and technical manpower. In the United States, approximately 448,300 individuals were employed in health sciences, representing about 34 percent of the total scientific and technical manpower. The Soviets have 17,600 persons working in health sciences, and an additional 7,600 working in biological sciences trained to the *Kandidat* or *Doktor* level, in contrast to the U.S. figures of 1,300 in health sciences, plus 16,900 in biological sciences trained to the Ph.D. and D.Sc. level. In practice, many of the Soviets holding health science degrees are actually working in biological research, while many U.S. holders of biological science degrees are working in health science areas. There are totals of 25,200 Soviet workers and 18,200 U.S. workers functioning in essentially the same area.

The USSR is now supplying sufficient competent personnel to broaden the frontiers of priority medical research, while minimizing work of lower priority. The continued training of medical manpower, however, will allow more competent workers to do research in lower priority areas.

The USSR will continue to emphasize training in the basic medical sciences and, by 1967, Soviet medical researchers generally will be on a par with those in the United States, and may be more advanced than the United States in certain priority fields such as space medicine and control of human behavior.

* The Soviet figures are believed to be correct, plus or minus 10 percent.

SOVIET OBJECTIVES, MAJOR ACHIEVEMENTS, TRENDS, AND FUTURE CAPABILITIES IN BASIC RESEARCH

SPACE MEDICINE

Objectives

Soviet scientists have clearly indicated their intention to solve those basic bioengineering problems which are associated with human operation of high-speed and high altitude aircraft and space vehicles.

Current Trends

By 1955, Soviet research in the field of space medicine indicated approaches which were novel and untried by Western scientists. Some of these approaches have led to important but as yet incompletely understood advances. The Soviet Union has an extremely active space flight program which includes biophysical and medical studies relating to upper atmosphere and space.

Basic Aspects of Space Medicine

Flight Rocket Physiology — Fundamental physiological data from animals exposed to space conditions are being obtained through the use of Soviet-designed equipment which is modified for telemetering biological data such as heart beat, blood pressure, temperature, and respiratory activity to ground receiving stations. The results of this animal research, during flights at 1,000 mile altitudes, can be correlated with simulated high altitude data and will afford the Soviets an earlier solution to the disturbances that are anticipated in manned space vehicles.

Perception of Movement — There is considerable effort by Soviet scientists to derive and apply formulae for computing such factors as position, acceleration, and G-forces which affect spatial vision as fixation points change. Special attention is given to plotting eye movements and internal eye processes relative to time. The amplitude of eye movement or timing angle has been studied quantitatively in order to derive an objective index of the awareness of test subjects in sensing and estimating distances. The experimental designs, research procedures, and conclusions by Soviet scientists are generally of good quality. Published laboratory data, however, is sometimes too meager to allow adequate evaluation. Adequate evaluation is also precluded by the absence of variance data.

Acceleration — New fundamental concepts on the biological effects of acceleration, if confirmed and extrapolated from current animal experimentation, will enable the USSR to simulate and eventually solve many bioengineering problems associated with rocket and space flight. The Soviets probably will lead in the study of acceleration effects on both peripheral sensory nerve functions as well as motor behavior thereby increasing the efficiency of various techniques for postponing or reducing the adverse physiological effects of acceleration under space flight conditions. Soviet scientists have drawn special attention to transverse accelerations by their launching and orbiting of the Sputnik II dog, Laika. The horizontal positioning of the dog, perpendicularly to the direction of acceleration, prevented substantial displacement of blood from vitally important organs, such as the brain. This positioning increases the resistance of the living animal to overloads by a large factor. Soviet experiments showed that a 40-fold transverse overload for 15 seconds failed to produce adverse physiological disturbances in chimpanzees. They also claim that a 10- to 12-fold acceleration overload is fully permissible for man. This use of transverse positioning materially reduces the problem of acceleration for living animals. The Soviets point out that only the involuntary delay in breathing, produced by rocket acceleration, limits the permissible time of action of an overload. The problem of involuntary delay in breathing can be overcome presumably through the use of forced breathing. *

* A human normally requires a conscious effort to exhale at altitude above 40,000 feet because of reduced barometric pressure.

Human Engineering

Physiological Data — Soviet scientists have demonstrated a high degree of capability in instrument development for bioengineering problems. Telemetering equipment has been adapted to transmit physiological data from rockets and space satellites to ground recording instruments. These ground instruments record physiological changes in animals during flight by oscillographic techniques as part of the study on environmental stresses of space travel. Their equipment is capable of measuring both qualitative and quantitative changes during flight as altitude and acceleration change. The availability of such equipment gives the USSR a technological advantage in their space medicine research program.

Human Space Flight Equipment — Soviet engineering and technological abilities are on a par with, or slightly ahead of, U.S. knowledge in most respects. In addition to the development of normal pressure cabins, in which pressure is maintained by means of a boost from the atmospheric air, there is evidence that the Soviets have developed a type of pressure cabin which maintains air pressure and the exchange of gases by regeneration devices inside the cabin without using external atmospheric air. Such a regenerative-type pressure cabin would be similar to a "sealed cabin" which is still under development in the United States.

Soviet pilots appear to use forced breathing techniques and probably acquire increased altitude tolerance by acclimatization training. This is supported by the observation that pressure and altitude suits are in use, not only for emergency situations, but also for longer periods of time at extreme altitudes. High pressure breathing and protection suits which are used in the United States, however, are generally considered only as emergency equipment.

Theoretical Research — Oxygen deprivation at high altitudes is of urgent interest in the USSR. In the field of protein biochemistry, the Soviet scientists have been studying the cytochrome enzyme system which is an essential means of oxygen activation in cellular respiration.

Preconditioning — The most outstanding feature of the Soviet space medical program is perhaps the degree to which space animals are preconditioned. It is quite possible that the vestibular apparatus of the Sputnik test dog was altered or modified by surgery or drugs prior to its prolonged space flight in order to study the positioning sense of the animal through other sensory organs. Since the vestibular apparatus is responsible for signaling the position of the body in space, disruption of this apparatus could provide significant data for future studies on the problems of weightlessness. In the past, Soviet scientists have meticulously followed prescribed regimens of compensating for altered position sense by adapting test animals to new types of coordinations and by conditioning animals to other orienting senses, such as sight and touch. Presumably if an animal could be oriented through use of sight and touch without vestibular orientation, it would not have much difficulty in a weightless state and would not be subject to motion sickness and accompanying digestive and circulatory disturbances. However, this technique of altered responses cannot be extrapolated directly to humans. Further research along these lines is undoubtedly in progress.

Superclean Environments — Soviet research on supercleanliness is only of peripheral medical interest, but it is a primary factor in the fabrication of high precision components ranging from the assembly of ballbearings for highly-sensitive, superprecise instruments to the assembly of floating gyros and accelerometers in inertial navigation components. Superclean conditions are necessitated by the fact that extremely minute particles of dust or airborne micro-organisms can cause a serious error in the accuracy of such equipment.

The Soviets appreciate the importance of supercleanliness and have worked out the theoretical aspects of contamination, even in very small particle-size ranges. Furthermore, they have developed air-monitoring devices which are claimed to be more than adequate for detecting particles of a size tolerated in the

assembly of Western superprecision components. Data on actual conditions in pertinent industrial enterprises is lacking, as is definite proof that Soviet concern with superclean-liness includes problems relating to superprecision assembly. The Soviets, however, have developed some equipment which is suitable for maintaining superclean conditions, and their standards are comparable to those prescribed in the West. The development of some of this equipment is connected with the Soviet nuclear energy program. As early as 1953, the Soviets published articles on nuclear research work rooms which had rounded points of intersection between walls, floors, and ceilings and the partitions were made of non-porous material, such as vinyl plastic, to minimize contaminations. These specifications are comparable to those of the West. Although the Soviets had pointed out that adequate air filtration apparatus is necessary, information on technical specifications of Soviet air filters is incomplete.

Estimate, 1967

Exclusive of material achievements, the accelerated status of Soviet exploratory research in aeromedicine and space medicine, through 1967, will result in an increased understanding of the fundamental mechanisms that underlie human performance and behavior in space and will encompass the broad range of space environments and space equivalent conditions in civilian and military operations. Soviet researchers will intensify their observations on biological effects of radiation, artificial environment, orientation in space, optical factors, gravity zero, and temperature and pressure tolerances.

During the next few years, the Soviets will continue to use animals for extremely high altitude research purposes, employing primates such as monkeys and chimpanzees. There is no aeromedical obstacle, other than a possible reluctance to take a calculated risk, to prevent them from orbiting a human being for a period of hours to days within the next year. Such a feat would depend on perfection of an ejectable "sealed capsule" for re-entry and/or re-ignition of non-expended fuel for re-entry of a manned rocket.

As a result of interpretation of physiological data telemetered from extremely high altitudes, the Soviets will overcome, within the next two years, many of the major theoretical gaps which exist in the understanding of animal and human physiological reactions to space hazards.

Through 1967, it is expected that the Soviet Union will modify animal and human responses so that space travelers may adapt themselves to extended or temporary intolerable conditions, such as might occur during launching, orbital flight, and re-entry.

Within the ten year period, the USSR will make significant advances in establishing the effects of physical factors (temperature, motion of the air, atmospheric and barometric pressure, radiation, ionization of air, etc.) on biological systems.

The Soviets will continue to propagandize achievements in space medicine in their psychological warfare effort against the West through 1967.

Military Implications

The USSR is currently (1957) training military airmen to withstand the adverse conditions which they may meet in space flight. A member of the Soviet delegation to the Eighth International Astronautical Congress, held during August 1957 in Barcelona, Spain, pointed out that Soviet studies on the effects of space travel on human beings already are far advanced. These studies, simulating extremely high altitude conditions, were devised following the study of space explorations using animal subjects. Scientists of the USSR and other countries now have confirmation of theories that living creatures can survive in space for extended periods.

Through 1967, consolidation of space research programs in the Soviet Union will include the military medical sciences, giving researchers new substantive ways to attack old problems and new opportunities for experiments in environments, such as a near-perfect vacuum, intense solar exposure, or bombardments by cosmic and other radiations. Problems of major military significance in space medicine will continue to be attacked

with considerable success by Soviet scientists. The degree to which this will aid them militarily will depend largely on technological advances in rocketry and the development of new weapons systems. The Soviets have the capability to apply the principles of space medicine to these new systems.

CONTROL OF HUMAN BEHAVIOR

The Nervous System: Regulation of the Organism

A discussion of Soviet physiological concepts requires the frequent use of the terms neurophysiology and neuropathology. The broader Soviet concept of neurophysiology includes psychology, especially association, whether the association arises from actions, impressions, words, or thoughts. Soviet neuropathology is concerned with the study of malfunction caused by any mechanism which disturbs analysis or synthesis of the unity of subjective or objective behavior or the loss of adaptation to the total environment.

Objectives — Soviet materialistic philosophy readily adheres to the principle that there is a demonstrable physical explanation for complex physiological and psychological functions called human behavior. Human behavior is thus regarded essentially as a conditioned reflex resulting from contact between the living organism and its internal and external environment. Soviet physiologists theorize that the cerebral cortex is the master mechanism for controlling both internal and external behavior. Research objectives are designed to prove this theory and to further determine the physical linkage between behavior and the body.

Current Trends — The Soviets design their experimental work in neurophysiology on the principles laid down by Sechenov and Pavlov. Conditioning techniques are used widely to study behavior mechanisms under controlled laboratory conditions. Experimental environments are impressed on the sensory organs and the resultant behavior is quantitatively measured. Conditioning is used experimentally to induce internal and external sensory linkage on a predetermined basis to predict behavior. The functional "receptivity" of the central nervous system is one great variable in such research, which, according to the Soviets, responds to modification within limits.

An important trend in their research is to determine the limits within which complicated physiological reactions, such as the total personality of the experimental subject, may be molded. Experimental work on environmental changes has shown that alterations in the excitation, inhibition, or delay in the response of the higher centers result in limited reactivity which is amenable to quantitative and qualitative measurement. The Soviets are thus opening the whole field of behavior to conditioning methodology, from which they anticipate demonstrable response with reasonable predictability.

Comparative Trends, U.S.–USSR — U.S.–USSR trends in all phases of physiological research show some measure of parallelism. In the available Soviet literature, it is difficult to perceive any lack of understanding or appreciation of recent Western advances, but there is a difference in scientific focus. In the West, physiology is advanced primarily according to academic interests whereas in the Soviet sphere physiological research appears to be centered on an intensive search for a method for controlling human behavior.

The advances in sensory physiology and psychology are predominantly in the possession of the Soviets, and they have established approaches to the organic aspects of behavior analysis and control which are not appreciated in the West.

The mastery of the cortical influence over both external and internal behavior has not been investigated in the West with the intensity, zeal, or thoroughness that it has in Russia. The West recognizes the association of sensory impulses from exteroceptive and interoceptive receptors at higher nervous levels. (This is the hypothesis of psychosomatic medicine.) The observations which the West has gathered on visceral stimulation have indicated that they are largely of unconditioned character. The conditioning of viscero-visceral or visceral-somatic reflexes has received only minimal attention in the West.

The Soviets regard conditioning as the only method for learning, while the United States views conditioning as one of several methods. This tends to minimize U.S. efforts to analyze experimental possibilities in the conditioning technique. External or exteroceptive conditioning is well understood the world over, but the appreciation of interoceptive conditioning and the advances in this area are distinctly Soviet. This type of investigation in Soviet hands has shown its importance in the modification of external or somatic reflexes by deliberate manipulation of the internal environment and emphasizes a facility for emotional excitation which is a potent source for personality alteration.

Estimate, 1967 — Personality Analysis and Manipulation — The effectiveness of subauditory stimulation on perception has been demonstrated and recently has been applied experimentally. This method will be studied by the Soviets in an attempt to assess its value for training the population or for its propaganda value.

Irradiation techniques will be developed to leucotomize ("lobotomize") local and specific brain areas. These effects will be reversible or non-reversible depending upon focalization, duration of application, and dosage. The technique will be relatively simple, bloodless, and without mechanical trauma and has definite applications in altering personality.

Electrodes implanted in specific cortical and sub-cortical areas produce, upon stimulation, abnormal behavior in laboratory animals. This technique will be used in humans for the purpose of reducing hysterias or psychotic behavior. The electrode will be wireless and activated by high frequency induction from outside the skull.

Anxiety states will be treated by specific conditioning of visceral receptors. A number of experimental conditions which utilize this type of conditioning will be published. In addition, anxiety states will be created by pertinent external stimuli.

The observations growing out of the visceral influence on personality will be advanced to the point of showing new approaches to diagnosis and treatment.

The Soviets will attempt to demonstrate the mastery of cortical control over visceral economy. This will include the direct and indirect control of the endocrine glands. Specific integrating mechanisms within cortical and sub-cortical centers which regulate viscero-somatic and somatic-visceral conditioning will be described. The Soviets consider this type of research essential for understanding all facets of personality.

The cardiovascular, respiratory, hematopoietic, and excretory systems are susceptible to conditioning. By specific conditioning, the individual will be better trained and adaptable to handle stresses imposed by industry, space travel, and physical training.

Conditioning "peaks," which may appear years or even hours after birth, have been recognized in children. Childhood training will be modified so as to make the best use of these "peaks," thereby enabling the Soviets to introduce more advanced educational training at an earlier age.

Anatomical and Neurochemical Advances — The histological study of sense organs, especially interoceptors, will be markedly advanced. These studies will confirm the presence of polyvalent receptors in brain tissue and will lead to new and more reasonable concepts for blood flow control within the brain.

Radioisotopes are being employed for a better understanding of neurochemistry and neuropharmacology in health and disease. Marked advances will show the nature of the processes of excitation and, more particularly, inhibition. Cortical inhibition is so important to the Soviet concept of cortical action that an all out effort will be made to understand it by both metabolic and electrophysiological techniques. Inhibition is one of the most poorly understood functions of the nervous system in worldwide neurophysiology.

Conditioned reflex pathways within the cerebral sub-cortex and cortical structures will be demonstrated and anatomically localized.

Military Implications — Soviet animal and human experiments have established that neuroses and other psychological (neuropathological) conditions can be created which cause predictable behavioral changes. We believe that they are attempting to translate these laboratory findings into methods for controlling human behavior.

Defensive Considerations — Advancing Soviet knowledge in the fields of physiological conditioning and physiological psychology may be applied to the direction and control of military and civil defense efforts and to social and political aims. Increased emphasis on supervised and controlled training programs can be expected to afford greater stability to the Soviet population in the event of war.

Offensive Considerations — Soviet psychological warfare reflects good psychophysiological techniques. The application of these techniques can be more clearly understood and appreciated through observation of their biological research. The Soviets will intensify the scope of their efforts in creating confusion, suspicion, and misunderstanding among foreign powers through speeches, international actions, and the veto; which in physiological terms represent unconditioning stimuli. Soviet successes in mass unconditioning can be measured by the degree of anxiety which is displayed periodically by large segments of the Western world. Soviet psychological strategy will incorporate reconditioning methods when they feel that anxiety and tension in the non-Communist world permits subtle modifications of Western ideology in the direction of Communism. For the immediate future, unconditioning techniques, manifested by states of anxiety and tension, will continue to be the fundamental weapons used in their psychological strategy.

Physiology and Pathology of Higher Nervous Activity

Objectives — Physiology — The objective of Soviet neurophysiology is to prove that higher centers are the sole interpreters of all external and internal environmental stimuli; therefore, changes in the environment become conditioning stimuli. The living organism must reach equilibrium with its environment to survive even in a complex changing environment. This is accomplished through physiological adaptation under the direction of higher nervous centers.

Pathology — The objective of Soviet neuropathology is to prove that functional abnormalities are induced by "overload" or "collision" of cortical processes. It is claimed that practical demonstrations have been made experimentally in both man and animals with weak or with strong but unbalanced nervous systems.*

Current Trends — Physiology — The most recent neurological techniques used in the West are also used by the Soviets with equal facility and understanding. Research emphasis in Soviet physiology is on conditioning, cerebral blood flow, neurochemistry, and neuropharmacology.

Neurophysiology is also being applied to special industrial training and educational methods in the USSR.

Pathology — Extensive use is being made of the techniques developed for inducing mental aberrations. Abnormal conditioning has been effective in the development of anxieties, neuroses, and hysterias. The techniques for doing this incorporate excessive stimulation, prolonged monotony, inhibitory conditioning, conversion of inhibition into excitation, and the interference of antagonistic reflexes or "collision."

Intensive unconditioning and reconditioning is being used on neurotic and psychotic patients. Practice of strong positive conditioning in individual and group training, as a primitive measure, is being developed as a standard technique.

Comparative Trends, U.S.–USSR — Physiology — The Soviets are continuing to explore every facet of the conditioning technique, both academically and from the standpoint of practical application. At present, U.S. scientists are quite uninterested in this area. The Soviets are continuing to emphasize an-

* According to Soviet terminology, the weak nervous system is not readily influenced by conditioning, while the strong nervous system is amenable to rapid and decisive conditioning.

alysis of environmental stimuli more than are U.S. scientists. Animal and human ecology is of great interest to Soviet physiologists but is receiving little attention by their U.S. counterparts. The trends in electrophysiology and neurochemistry are similar in both countries.

Pathology — Abnormal conditioning and unconditioning is increasing in Soviet usage. The United States is doing little in this area as an approach to functional pathological behavior. The United States is stronger in analytic techniques which are frowned on by the USSR. The West has the advantage of more experience with shock treatment and brain surgery in the treatment of mental and nervous diseases.

Estimate, 1967 — Physiology — Understanding of local and general factors which regulate cerebral circulation will be substantially advanced. The Soviets have developed one of the most promising leads in this area; namely, brain chemoreceptors which are responsive to slight changes in blood chemistry.

Great advancement will be made in the understanding of cerebral inhibition through inhibitory conditioning, enzyme chemistry, and neuropharmacology.

Major advances will be made in the identification of receptor organs which regulate the metabolism of the brain directly.

There will be advances in the concepts of "overloading" and "collision" in cortical physiology and pathology. These advances will provide a clearer understanding of the functional mechanisms which are responsible for better or poorer transmission of nerve impulses in the higher brain centers.

Pathology — The causation and treatment of certain neuroses by conditioning, unconditioning, and reconditioning will be accomplished.

It will be shown that suitable electrical stimulation of the brain, in conjunction with conditioning, will facilitate the production and/or treatment of abnormal brain function.

Radiation illness will be shown to involve the nervous system to a greater extent than is now believed. Radiation illness will be found to be due partially to the alteration in the flow of nerve impulses into the higher centers.

It will be shown that functional neuropathology is perpetuated by abnormal visceral reflex activity once it has become established, although visceral conditioned reflexes have been shown to be slow to form and resistant to the methods known for extinction.

There will be advances in the understanding of cerebral vascular control, from the physiological and pathological standpoints.

There will be advances in the use of high-frequency induction, strong electromagnetic fields, and the use of anodal electronic currents in cerebral areas to facilitate local and general inhibition, anesthesia, and alterations in vascularity.

Clinical Aspects of Human Behavior

Psychiatry is considered less important than neurology in the Soviet Union. Soviet psychiatrists state that their methods of treatment are based on Pavlovian ideas, but they employ almost all modern methods of treatment, with slight variations. Until recently, psychiatric research on reflexes and conditioning capabilities of mental patients has been their major interest. None of this work has significantly clarified the understanding of human behavior nor has it been of any particular clinical value. Recently, Soviet investigators in the fields of psychiatry and neurophysiology have been permitted more latitude in research. Pavlovian concepts of conditioned reflexes are now being supplemented clinically by incorporating ideas of feed-back, cerebral modulation of sensory input, and the information theory (cybernetics) as described by Wiener.

By 1967, Soviet neurophysiologists will make significant clinical advances in clarifying the nature and causation of mental disease. The results of their neurophysiological and neuropathological research will not reduce human behavior to a simple mathematical equation or to an electronic circuit which can be altered by varying the input or changing connections. The Soviets appear to understand the unconscious and conscious

forces that motivate groups and nations although they deny Western psychoanalytic theories of behavior.

NUCLEAR MEDICINE

Objectives

Radiobiology — Soviet objectives in radiobiology are: to provide substances for the prevention and therapy of radiation injury, to study the pathogenesis of radiation sickness and to relate changes of immunological processes to pathogenesis, to determine the cancerigenic role of ionizing radiation in tumor development, to intensify work in radiation genetics and the biophysical aspects of radiation biology, and to apply radiobiology to an understanding of fundamental problems of living systems.

Radiotherapeutics — Soviet objectives in radiotherapeutics are: to perfect radiotherapeutic techniques, to avoid excessive exposures to radiation of human beings in the reproductive ages and of developing embryos, to study the effects of small doses of internal and external ionizing radiation, to study the facilitation of excretion of internally deposited radioisotopes, and to develop the production and medical use of radioisotopes.

Current Trends

After the 1955 Geneva Conference on Peaceful Uses of Atomic Energy, the Soviets admitted they were rather far behind in the development of radiobiology. Thus, the 1956–60 AMS Five Year Plan emphasizes the above objectives. In 1957, the Soviets established a new institute known as the Institute of Radiation and Physico-Chemical Biology, in the Department of Biological Sciences, Academy of Sciences, USSR, headed by the world renowned biochemist, V. A. Engel'gardt. This Institute is primarily concerned with studies on radiation genetics and on the mechanism of action of ionizing radiation on the living organism.

Soviet investigations include most areas being emphasized by Western scientists. The use of radioisotopes for diagnosis and therapy is increasing rapidly. Although some Soviet therapeutic claims have been exaggerated, it is apparent that they use most of the forms of radiotherapy available in the West. Work on methods and instrumentation occasionally shows new ideas. The infrared light-diffraction red blood cell size determination method, for example, has interesting possibilities in detection of radiation damage. Their radiobiology research strongly emphasizes radiation effects on the central nervous system but is currently expanding to include research projects on other fields under study in other countries.

Comparative Trends, U.S.–USSR

The quantity of Soviet research on the use of radioisotopes for diagnosis and therapy is now approximately on a level with 1949–52 U.S. efforts. The quality tends to be somewhat better than similar 1949–52 U.S. work, because the Soviets are able to use results of Western work as a starting point. Soviet diagnostic and therapeutic methods, however, are not on a par with those of the United States, probably as a result of inadequate application of their medical research and development. Soviet scientists are giving more emphasis than Western scientists to the response of the central nervous system to local and general irradiation. A major point of departure from Western research is Soviet work on the effect of radiation on the nervous system and its importance in future radiobiological studies. Soviet irradiation studies on microorganisms have been described by Western observers as at least equal to current U.S. work. In other aspects, however, their research is 3–5 years behind that of the West.

Estimate, 1967

By 1967, the Soviets will have extended their radiobiological program to include most areas presently considered important from a research standpoint. Their work will be of much higher quality and, although many of the same problems will be under attack, the Soviet approach will become more sophisticated and will be directed toward more basic understanding of physical-biological processes. No significant advances are anticipated except possibly in the use of radiobiological techniques for localization and precise manip-

ulation of specific functions and segments of the central nervous system. It is expected that the USSR will be ahead of the United States in radiobiological research on the nervous system, and possibly will also lead in the effects of cosmic radiation on organisms. The USSR will lag slightly behind the United States in the general field of radiobiology and in the use of radioisotopes for diagnosis and therapy.

Military Implications

By 1967, the Soviets will not have developed a method for the prevention or therapy of radiation injury, which can be applied to civil defense against nuclear warfare attack.

HEALTH PHYSICS

Objectives

The prime objective of all health physics organizations is the minimization of human exposure to ionizing radiation. Ancillary to this goal are the following tasks: development of administrative and procedural controls for workers in industries which have radiation hazards, provisions for shielding and protective clothing, adequate working space ventilation, personnel dosimetry, working space dosimetry, worker education, early detection of personnel exposure to radiation, prophylactic chemicals, and therapy for absorbed radioisotopes or for ionizing radiation.

Current Trends

Although the USSR officially subscribes to a policy of maximum permissible radiation exposure which is at least as low as that of the United States, the Soviets are lax in the application of rigid radiation health standards in their nuclear energy research and operations. The United States prescribes a maximum exposure of approximately 0.1 rem/6-day week. The provisions for personnel protection in one of the Soviet atomic power plants observed by Western visitors are completely inadequate by U.S. standards. The shielding of therapeutic radiation devices also is insufficient to permit operating personnel to work an 8-hour day.

Present Soviet information on the relative biological effectiveness of different types of radiation for injuring living tissue is based on Western literature published from 5 to 8 years ago. A few of the more advanced Soviet workers are aware of 1956–57 U.S. research in this area. Soviet principles for establishing maximum permissible concentration of radiation appear to be the same as those used in the United States. Routine Soviet medical examinations for workers who are exposed to radiation emphasize neurological examination but are otherwise similar to those used in the United States.

Comparative Trends, U.S.–USSR

From the theoretical standpoint, the Soviets are aware of current Western trends and practices, although they have contributed nothing original in health physics. Soviet practice of personnel protection apparently is inferior to that in the United States; the Soviets rely on practices unacceptable to the West.

Estimate, 1967

The Soviets will maintain close surveillance of U.S. and other Western advances in health physics. In international meetings they will subscribe to the greatest possible avoidance of exposure to radiation. However, the Soviets will, on a practical level, subordinate health physics practices to the development of their nuclear energy program and probably will not provide any significant advances in health physics by 1967.

Military Implications

(See Radiobiology)

INFECTIOUS DISEASE RESEARCH AND DEVELOPMENT

Objectives

The underlying motivation for Soviet research on infectious disease is to reduce the worktime lost to the national economy because of debilitation and illness. Thus, almost all medical microbiological research and development, planning, and budgeting is con-

centrated on those infectious diseases which directly or indirectly cause losses in labor potential.

Current Trends

There have been few significant changes in the past 10 years in Soviet research and development related to infectious diseases. Soviet efforts are concerned mainly with the development of new and improved vaccines, serums, antibiotics, and chemotherapeutic agents; the collection of data necessary for epidemiologic intelligence; and evaluation studies concerned with the efficacy of available diagnostic, preventive, and therapeutic biologicals and clinical procedures. Basic research in medical microbiology is insignificant when compared with developmental efforts.

In descending order of emphasis, the key Soviet medical microbiological research and development efforts pertain to bacillary dysentery, influenza, brucellosis, poliomyelitis, tuberculosis, childhood infectious diseases, the encephalitides, tularemia, the hemorrhagic fevers, plague, and Q fever. Investigations of other important diseases receive modest support. In recent years, desultory efforts have been put on glanders and melioidosis, sandfly fever, mycotic infections, infectious mononucleosis, and dengue and yellow fever.

The USSR maintains some active research and development interest in almost every disease of international importance and Soviet scientists are highly knowledgeable concerning several diseases of worldwide interest, such as brucellosis, tularemia, and the encephalitides.

There is considerable responsible microbiological investigation in the USSR which is influenced by a growing nucleus of able men. Concentration of resources and personnel has resulted in abatement and/or control of major outbreaks of diseases, such as typhus, cholera, plague, and smallpox, which sapped the Russian economy before 1930.

At present, USSR development and mass application of live vaccines (such as those used for influenza, Spring/Summer encephalitis, brucellosis, tularemia, tuberculosis, and plague), in combination with a widespread vector control program where applicable, are used to temporize the continuing problems resulting from insufficient sanitary hygiene practices and services. The net protective effect of mass immunization with live vaccines is limited by poorly evaluated vaccine trials and inept epidemiological analyses.

Comparative Trends, U.S.–USSR

Related Sciences — Soviet efforts in basic disciplines underlying the study of infectious diseases are generally inferior to those of the United States. The best Soviet ideas and work are sometimes comparable to U.S. studies but there is a relatively low volume of such work in the USSR.

Basic medical microbiological research is almost completely dependent on open Western sources, although certain information from USSR workers is of great interest to U.S. investigators.

Specific Disease Studies — Wherever USSR investigators are expending quantitatively greater efforts than U.S. workers, such as in the fields of bacillary dysentery, the zoonoses, and childhood infections, it reflects inadequate Soviet application of known environmental sanitary measures.

Concentration of about 80 percent of Soviet viral research and development on influenza has resulted in a USSR program which only in recent years can be called similar to the U.S. effort. The 1955–57 Soviet purchase of U.S. and Canadian equipment and the exchange of medical virologists only recently made feasible a significant USSR poliomyelitis research, development, and vaccine production program. The only examples where USSR investigators have had more experience than their U.S. counterparts are their work with exotic diseases, such as atypical encephalitides and hemorrhagic fevers, the trend towards more emphasis on rickettsial studies, and the study of medical entomology. Even in these areas, Soviet investigators have not produced any biologicals, methods, or theories which are superior to those available in the United States.

Prevention and Control — The Soviet preventive medicine program is centrally controlled. Prominent authorities are assigned to infectious disease commissions and epidemiological survey teams in order to collect and collate information coincident to laboratory research. Soviet investigators and public health officials make some use of every U.S. diagnostic, preventive, and therapeutic tool applicable to human infectious diseases. Nevertheless, the lack of uniform application of environmental sanitation measures, the high incidence of occupational diseases, the existence of sizably populated yet underdeveloped areas, and the presence of a number of semiprimitive indigenous population groups, place the USSR public health system at a serious disadvantage. Although public health services are far from ideal, they are usually available to all population groups.

Clinical laboratory support as practiced in the United States is practically non-existent in the USSR. Projects such as the zoonoses and influenza control programs vary in quality and quantity. Despite large-scale efforts, influenza is responsible for loss of 7 to 21 working days per man-year. As many as 4 million Soviet meat and dairy industry workers may lose an average of 30 work days per man year from brucellosis. Annual losses total many millions of dollars for these two infectious diseases alone.

Military Aspects — Specific military research and development projects at the Scientific Research Institute of Epidemiology and Hygiene of the Military Services, Kirov (NIIEG VS) and the Military Medical Academy imeni Kirov, Leningrad (MMAK) play a small but important role in the study of infectious diseases. A number of closely coordinated interagency medical committees serve both the civilian and military communities. Most leading USSR medical research personalities have military affiliation.

In the USSR, the study and control of infectious diseases of military importance have two basic functions: (1) protection and treatment of troops, and (2) a program for military and civil defense against biological warfare agents. A relatively small part of the total military and civilian medical research and development effort is intended for BW defense. As of 1957, Soviet BW development efforts are largely concerned with immunization, pathogen air sampling, experimental epidemiology, theory of aerosols, rapid detection procedures, and studies on efficacy of various aerosol and surface decontamination methods. Soviet information has been heavily supplemented by World War II Japanese, German, and open published Western BW data. Research and development on bacterial zoonoses appear to have been emphasized in the past. However, recent (1956–57) studies on influenza virus aerosols and air sampling (by investigators now working at the Institute of Virology, Moscow) are applicable to BW research and development, and indicate their increasing interest in the viral and rickettsial field.

Although Soviet authorities have been cognizant of the military weapons system possibilities of pathogens for over 20 years, current efforts appear to be largely motivated by the need for preparation against weapons which may result from the considerable U.S. BW effort. Soviet materiel required for medical defense against pathogenic aerosols are comparable to, and have limitations similar to, those of U.S. equipment. Soviet equipment applicable to BW research and development is usually less complex and often crude in comparison with similar U.S. apparatus. Infectious disease studies of special human BW significance follow the U.S. pattern but lack the complexity, engineering, and concentration associated with U.S. BW efforts.

The USSR BW defense effort relies on the utilization of available personnel for military and civil defense plans, training, and organization. In the USSR, both the military and civil sanitary epidemic systems have the major responsibility during and after a BW attack. All medical laboratories and personnel have a detection and identification mission, and the available zoonose vaccines have been specifically authorized for immunization of civilians and troops when BW attack is expected.

Estimate, 1967

Research — Research on bacterial diseases will be substantially deemphasized in favor of concentration on the viral and rickettsial diseases. There will be greater and better quality biochemical and biophysical support. More medical microbiological research will be basic and specific infectious disease research will decrease substantially. There will be a large effort in the field of physiological stress related to both infectious and non-infectious diseases. New information on the mechanisms of immunity and infection may result in this area, but significant advances on the nature of antigen and antibody will more likely be derived from Western work. Soviet studies of potential broad spectrum antigens will probably provide them with a capability in immunochemistry and related fields which should be sufficient for possible characterization of antigens giving simultaneous protection against a number of infections.

Development — The development and refinement of live attenuated vaccines for zoonoses, influenza, and the spotted fever group will continue for the next 5 to 10 years. However, by 1967, the major emphasis will shift to development of purified antigens and/or adaptation of Western vaccines. The refinement of an orally-administered live, attenuated polio vaccine will be an exception.

Better chemotherapy and new or improved procedures for detection and isolation of microorganisms could come from increased Soviet emphasis on related biophysical and biochemical applications. It is more likely, however, that most of these advances will result from Western investigations.

Within the next ten years, the important infectious disease research institutes will be modernized and well-equipped. Though fewer in number, all major medical microbiological research, development, and production facilities will be comparable to similar U.S. facilities. The quality control of biologicals will be much improved, but these products will continue to be inferior to U.S. products. Many of the outmoded or poorly evaluated biologicals now on the USSR market will have been eliminated.

Control of Infectious Diseases — By 1967, the centrally-controlled antiepidemic approach now employed in the USSR will have been minimized in favor of improved local environmental sanitation, such as potable water supply and adequate waste disposal facilities. The organizational structure of the Soviet infectious disease control system will result in a stronger regional research and support laboratory system. Treatment of chronic stages of the infectious diseases will be emphasized. A token force of a nation-wide antiepidemic network will be retained for possible emergency situations.

Military Implications

In the next ten years, Soviet medical microbiologists will continue to attack problems of serious public health significance. Minor portions of this effort can be directly applied to BW. Unless investigators accomplish deliberate mass infection of man in a manner useful to a military commander, the USSR will do little more than orient paramilitary, civil defense, and military personnel on routine measures for meeting a BW attack. Mass immunization, specifically as a defensive measure against potential BW agents, will not be attempted unless a BW emergency is imminent. Those medical services which are applicable to defense against BW will continue to be maintained on a semi-alert basis. Antibiotic and chemotherapeutic stockpiles for epidemic emergencies will be available in areas of greatest military and industrial importance. A network of air and fluid sampling stations in key areas will be in operation and mass distribution of microorganism sampling equipment to key stations will be accomplished.

CIVIL DEFENSE

Defense Against Nuclear Weapons Attack

Objectives — Soviet objectives include the provision of adequate physical facilities to treat the largest possible number of persons injured in radiological warfare (RW); the stockpiling of appropriate antibiotics, drugs, blood and plasma extenders, blood fractions, fluids for injection, dressings, and ancillary

equipment, such as radiation detection meters and dosimeters; the provision of sufficient numbers of trained medical personnel; the training of the general population in procedures designed to minimize the number of persons injured as well as to assist the injured during and after attacks; and the minimization of the psychological vulnerability of the population to RW.

Current Trends — In December 1956, Soviet DOSAAF, Red Cross, and Red Crescent committees were reported to have completed their task of educating the populace concerning antiatomic defense. Beginning 1 January 1957 and continuing to 31 December 1958, the MPVO, with the assistance of the above societies, is conducting a compulsory program of instruction for everyone above 16 years of age. This program consists of 22 hours of instruction and a test of the knowledge acquired on 14 themes for air, atomic, chemical, and bacteriological defense. There is extensive published material available to supplement such training. The "USSR Training Manual For Local Antiair Defense" is one of the better and more complete publications. The number of medical personnel is rapidly nearing the point where future training will be able to emphasize quality rather than quantity. The emphasis on the medical aspects of defense is an important facet of training for these medical workers.

Production and stockpiling of equipment and pharmaceuticals for the defense program currently takes precedence over civilian consumption requirements. The capacity of the Soviet Union for pharmaceutical production is sufficient to provide for stockpiling, plus a moderate amount of materials for current use. It is unlikely, however, that the Soviets are presently manufacturing sufficient radiation monitoring and protection devices to meet the needs of the atomic weapons program. It is doubtful therefore if enough such equipment is available for stockpiling and civilian consumption.

Comparative Trends, U.S.–USSR — The Soviet Union is definitely ahead of the United States in psychological and medical civil defense training, but the United States is in a better position to treat a large number of patients due to the extensive geographical distribution of many excellent medical centers. The United States is far ahead of the USSR in production capacity and stockpiling of pharmaceuticals and equipment.

Estimate, 1967 — By 1967, most of the Soviet production, distribution, and stockpiling programs will have been completed. The Soviet population will continue to be more knowledgeable in defensive measures than the population of the United States. The Soviets will increase the quality of their medical personnel training and of the care available in emergencies. There will be a greater number of good facilities for the care of mass casualties. Effective therapy for radiation injury probably will remain an unsolved problem, both in the United States and the USSR.

Military Implications — The Soviets will continue to excel in training, control, and attitude of the population toward civil defense. It will be possible for the Soviet Union to equal any U.S. civil defense stockpiling effort by 1967. The current high level of U.S. medical practice, however, will partially offset the Soviet psychological lead during the early part of the 10 year period. The greater U.S. production and distribution of drugs, instruments, and other medical supplies will give the United States a slight advantage for about the first five of the next ten years.

Defense Against CW Attack

Objectives — Soviet objectives in the medical aspects of CW defense are to provide personnel with protective equipment, adequate and rapid medical treatment for CW injury, and adequate civil defense measures for training and protecting the population against CW attack.

Current Trends — Research on the physiological effects of CW agents and a search for effective counteragents are being emphasized. Civil defense posters are advising the populace where to seek shelter and what to do in the event of CW attack.

Estimate, 1967 — By 1967, the Soviets probably will have developed improved shelters, personal equipment, and drugs of therapeutic

value for the treatment of CW casualties caused by conventional war gases and G- and V-agents. Stockpiling of important medical materiel will result in improved capabilities for defense against CW attack.

Adequate amounts of drugs for the therapy of CW casualties and antibiotics for the prevention and treatment of secondary infections are expected to be available in the USSR by 1967.

The USSR is expected to continue its current effort in the construction of underground shelters to provide protection during a CW attack. Formation of well-indoctrinated cadres to care for CW casualties will be complete by 1967 and mandatory instruction of the general populace on the dangers of CW will continue during this period.

Military Implications — At present, total Soviet medical defensive capabilities against CW attack do not exceed those of the United States. It is believed that the United States has a slightly greater medical defensive capability against G- or V-agents due mainly to the greater U.S. logistic capability in support of medical defense.

By 1967, the United States will have greater capability for the preventive and therapeutic treatment of CW casualties than the USSR. However, the possible Soviet discovery of new synthetic types of biological compounds from their efforts on the alteration and rearrangement of toxic proteins may present a serious threat to the United States.

Whole Blood, Plasma, and Plasma Extenders

Objectives — Soviet objectives are to prepare and make available whole blood, plasma, and plasma extenders in amounts adequate for the treatment of burns, shock, radiation syndrome, and for use in pre- and post-operative care and for mass casualty supportive therapy.

Current Trends — Current Soviet research is aimed at increasing the usable life of stored whole blood and the development of plasma volume expanders. Another trend, although currently on the decline, is the clinical use of animal blood plasma as a substitute for human blood. Soviet plasma volume expanders may be divided into two groups; the synthetic expanders, and the natural expanders which are prepared from animal tissue. Among the synthetic expanders are Polyglukin, Sinkol (glucose polymer type), and PVP (polyvinylpyrrolidone). In general, these compounds have a high molecular weight, are colloidal in nature, and possess properties similar to human plasma. Among the natural expanders are BK-8 and LSB (earlier referred to as VNS), the latter being a species non-specific serum. Frozen blood, in the form of cylinders inserted between the fractured ends of long bones, has been used successfully in the rapid healing of such fractures.

Comparative Trends, U.S.-USSR — The USSR and the United States are attempting to increase the usable life of stored whole blood. Soviet scientists are approaching this problem through the addition of chemical substances while U.S. workers are using low temperatures. Soviet claims of significant progress in this field have not been confirmed. Although U.S. research has been partially successful in extending the preservation of blood at low temperature, the method presently is not industrially feasible because of the extremely high cost. The Soviets are also using low temperatures along with their own chemical additive techniques to preserve whole blood. A detailed manual on the technique of blood transfusion is now available to Soviet civil defense personnel.

Estimate, 1967 — By 1967, it is expected that the storage of whole blood will have been extended beyond its currently accepted limits by the USSR and the United States. The efficiency and number of Soviet blood banks will have increased. The Soviets will exert greater control over civilian blood donors, though donations will be at less frequent intervals.

Recent Soviet research is directed at inactivating some of the enzymes associated with the breakdown of whole blood and is expected to be successful. This will result in extending the time of blood storage.

In general, the USSR and the United States will probably be on a par in accomplishments

in the field of whole blood, plasma, and plasma extenders.

Military Implications — The Soviets had considerable experience in blood collection during World War II, when logistic problems were solved by using basic materials in a crude but effective manner. Adequate amounts of whole blood are believed to be stockpiled for emergency usage. Dried plasma and plasma extenders are also available.

By 1967, the Soviets will have perfected techniques for increasing the storage time of whole blood and for increasing the quality of plasma and plasma extenders. As a result, they will be able to provide more adequate care for the military services who require whole blood or plasma extenders for the treatment of burns, shock, and trauma.

The distribution and utilization of blood and plasma extenders are closely allied to priority military requirements in the USSR. The ready availability of these products is a distinct advantage in Soviet medical defense.

New Antibiotics and Drugs *

Objectives — Soviet objectives are to increase drug production and distribution; to develop new and better native drugs for replacement of imported drugs; to stimulate research on new antibiotics for viral diseases, cancer, tuberculosis, and diseases resistant to presently used antibiotics; and to search for drugs useful in defense against chemical, atomic, and bacteriological warfare.

Current Trends — Soviet pharmacological and pharmaceutical research includes: investigations into more effective analgesics which are sufficiently safe to permit use in full-scale warfare, better treatment for burn therapy, antibiotics for common as well as exotic diseases, prophylaxis against chemical and radiological agents, and therapeutic and decontaminating compounds for these same agents.

The Soviet definition of an antibiotic is much broader than that of the United States and includes such materials as tissue extracts, serum derivatives, enzymes, and proteins. As a result, research in this field includes work on bacteria, yeast, fungi, protozoa, and plant and animal tissue. Among the newer (1957) antibiotics available are Penicillin V and Bicillin, both of which are identical to the U.S. compounds. Other antibiotics which were developed earlier include Ekmonovocillin, Colimycin, and Bin-chaga, the latter being prescribed as a cure for cancer, ulcers, and gastritis. In general, however, only limited success has been obtained in the development of mycin-type antibiotics.

Comparative Trends, U.S.–USSR — The major portion of Soviet pharmaceutical research reflects a continued exploitation of U.S. and other Western developments. Many foreign drugs are adopted, renamed, and produced by the Soviets to avoid importation. Soviet pharmacology, particularly neuropharmacology, has some lines of original research, but it generally lags 5 years behind that of the United States. In the last 2 years the Soviets have begun to close this research gap but they will not approach the position of the United States for many years.

Estimate, 1967 — The Soviet research effort on antibiotics will become more original but continued emphasis will be placed on the exploitation of Western developments. The U.S. will probably retain a clear lead in research, development, and application of antibiotics.

It is unlikely that a significant scientific advance will result from current Soviet antibiotic research. The Soviets hope to develop antiviral and anticancer antibiotics but they are not neglecting the potentialities of the chemical approach to these problems.

POLAR MEDICAL RESEARCH

Objectives

Soviet objectives are to determine how best to utilize polar nutritional resources and how best to avoid the attendant special health hazards.

Current Trends

The present lines of research include studies on special polar meteorological conditions and their impact on human beings, and

* The section on pharmaceutical research in Monograph VII, Chemistry, provides data on Soviet pharmaceutical capabilities.

studies on cold injury, clothing, nutrition, sanitation, and disease vectors.

Comparative Trends, U.S.–USSR

The USSR is definitely behind the United States in theoretical aspects of the pathogenesis of cold injury. The two countries are nearly on a par in therapy of cold injury. The Soviet rapid rewarming technique and the use of ultra-high frequency ("super" diathermy) are unusual aspects of Soviet therapy. Such techniques are not currently in use in the United States. A facet of Soviet preventive practice is the emphasis on cold "conditioning." U.S. scientists are opposed to this type of exposure to cold.

Estimate, 1967

By 1967, the Soviets will have achieved sufficient experience in polar medicine so that current problems will be reduced to prevention of cold injury. No major scientific advances are necessary for such progress. It does not seem likely that the Soviets will make major advances in understanding the pathogenesis of cold injury. The Soviets probably will be on par with the United States from a practical applied standpoint.

Military Implications

At the present time, the USSR is just as capable as the United States in polar military maneuvers from the medical viewpoint. The Soviets will probably maintain this position through 1967.

NUTRITION

Objectives

Soviet objectives include improving nutritional standards for athletes and school-age children; improving therapeutic nutrition programs in hospitals; establishing nutritional requirements in polar and subtropical regions; establishing living and nutritional requirements of industrial employees who work with nuclear energy and radioactive substances; increasing studies on avitaminoses which result from the use of antibiotics; determining the effect of heat-processing on nutritional values of food; developing of special rations; understanding the relation between dietary intake and disease; providing more adequate distribution of milk and dairy products; and improving quality controls on vitamin and hormone preparations.

Current Trends

Soviet emphasis is on the use of therapeutic diets for patients. Studies on the effect of vitamins on higher nervous activity are in progress but no significant data have been reported. The search for new sources of dietary essentials is increasing. Animal experiments, where used, are not statistically valid and experimental designs are generally poor.

The Soviets have only token representation at international meetings on nutrition and there is virtually no participation. Large-scale nutritional surveys, such as those which are carried out by the United States, are not being made.

Soviet nutritional research is similar to Western work of more than a decade ago. The greatest Soviet problems are not in nutritional research but are generally in basic fields of food technology such as growing, harvesting, preserving, marketing, and distribution of food products.

Estimate, 1967

By 1967, the USSR will make few advances in the applied aspects of nutrition over those achieved in 1957; advances in basic research are more probable. New sources of vitamins will be found in indigenous plants but these will be exploited primarily for their propaganda value. The Soviets will devote some effort to training additional scientific personnel in the field of nutrition.

There is presently little indication that the Soviets will incorporate into their military services a nutritional program comparable to that of the United States. The Soviets will probably not make any advances of major importance in the field of nutrition within the period of this estimate; they will continue to depend primarily on Western advances.

BASIC PROTEIN RESEARCH

Objectives

Soviet objectives in the field of protein research are to determine the amino acid composition of tissue, the sequence of amino acids in various protein molecules, the portion of the protein molecule which is biologically active, the shape and dimension of protein molecules, the properties and mechanism of action of hormones of protein nature, and the properties of specific pure antigens and antibodies. The isolation of toxins is also an objective. In addition, the *in vivo* and *in vitro* synthesis of proteins is one of the most important objectives.

Current Trends

The Soviets are emphasizing studies of the protein and amino acid composition of important organisms causing diseases such as cholera, typhoid, diptheria, and brucellosis in order to determine whether a relation exists between pathogenicity and the nature of amino acid content. They are also attempting to reconstitute partially-denatured proteins for the purpose of duplicating the structure of living tissue. There is emphasis also on the use of radioisotopes for study of the role of proteins in the normal and diseased organism.

Comparative Trends, U.S.–USSR

Research on the composition and properties of new proteins is similar in scope in both the USSR and the United States. Some Soviet research on the protein and amino acid composition of bacteria may have future applications to BW or CW. Little Soviet effort seems to be directed toward the nutritional aspects of proteins and amino acids while considerable U.S. effort is being expended in this direction. Soviet research in immunochemistry is concerned with isolating those particular fractions of proteins which are responsible for producing immunity in the human and animal organism. The ultimate goal of this work is to obtain a wide spectrum antigen which will confer immunity to many diseases.

Estimate, 1967

By 1967, the Soviets probably will have made significant progress toward clarifying the relationship between protein composition of microorganisms and their disease-producing properties. Soviet attempts to modify partially-denatured proteins and to effect their resynthesis may be successful. If this research is successful, the Soviets may be able to alter natural proteins to form compounds with greater therapeutic or toxic properties than known natural compounds. Soviet use of radioisotopes will result in a more complete understanding of intermediary metabolism of proteins and amino acids and may answer some of the problems on origin of degenerative diseases.

Soviet basic research on the origin of life is centered in the field of protein chemistry and particularly in enzymology. Western scientists are only slightly more advanced than the Soviets in this field and a major advance may occur by 1967 from either group. The potential application of a major advance in understanding the role of proteins and their constituents in intermediate metabolism is vast and would affect specifically the fields of nutritive, infectious, metabolic, mental, and degenerative diseases, and the economy generally.

Military Implications

Synthesis of modified proteins with highly toxic properties would have definite military implications, particularly in the chemical warfare field. Success in determining the fraction of a microorganism which produces immunity would alter many of the procedures currently employed in immunization. As a result, military campaigns would not be hindered by loss of manpower resulting from certain diseases. Advances in protein chemistry also could solve many problems related to blood substitutes, storage of blood, mechanisms of shock, and therapy for burns and blast injuries.

SATELLITE AND CHINESE COMMUNIST SUPPORT IN BASIC MEDICAL RESEARCH AND DEVELOPMENT

The USSR is scientifically independent of its Satellite countries and Communist China in the field of medical research. Satellite efforts in the field of public health, however, have benefited the USSR by lowering the number of man-hours lost through disease, thereby rendering economic exploitation more profitable. East Germany and Czechoslovakia furnish many instruments and materials for medical research. Several Satellite countries are also doing research which will add slightly to Soviet medical knowledge. East Germany contributes in the fields of nuclear medicine, pharmacology, and biochemistry. Hungary has competence in biochemistry, particularly in enzymology and protein studies, and in pharmacology. Poland may possibly contribute to hematology, physiology, biochemistry, and microbiology. Czechoslovakia will make contributions in microbiology and technical apparatus; this country also has some capability in aviation medicine and has a sound pharmaceutical industry. The remaining Satellites are not expected to add significantly to Soviet medical knowledge.

Communist China is in no position at present to contribute to Soviet basic medical research since problems of public health are still occupying first priority. The exploitation of traditional Chinese medicine does not fit into the scheme of Soviet medical research, and aside from certain work in the biochemistry and neurophysiology of the digestive tract, little basic work is being done. The much publicized "brain washing" indicates Chinese Communist field research in certain aspects of control of human behavior, but no evidence of original basic work has appeared.

Although there is limited basic research potential in the Satellite countries and Communist China, there is little likelihood that they will institute any broad, full-scale research programs of strategic importance to Soviet medical science by 1967.

PART II—VETERINARY SCIENCES

SUMMARY AND CONCLUSIONS

There has been a continuous advancement and expansion of veterinary research capabilities and resources in the Soviet Union since World War II. The Soviets are expected to reduce the overall lead of the United States in veterinary sciences in the next decade.

Veterinary research in the USSR is well organized and controlled. Despite the increased responsibilities being delegated to lower levels, centralized control is being maintained at the Ministry of Agriculture level. Although the average Soviet veterinarian has a lower competency than his Western counterpart, some veterinary research investigators are equal to the best in the world. More veterinarians are believed to be engaged in research activity in the USSR than in the United States. Also, the rate of growth of veterinary manpower is greater in the USSR.

Basic veterinary research is being given less emphasis than applied and developmental research. The majority of Soviet applied research is devoted to pressing livestock problems, and the veterinary program is stressing the development of biological products and techniques for the immunization, diagnosis, and treatment of animal diseases. Livestock health has been at a low level in the USSR, but a major attempt is being made to correct this situation through disease control, rather than eradication.

We believe that Soviet research capabilities in the veterinary sciences will increase considerably during the next ten years and that the lag between research achievement and practical application will diminish. Long-range improvements will undoubtedly result from better application of research findings and the continuation of present research competency in such fields as parasitology, epizootiology, and microbiology. The resultant effect on livestock productivity will be definite, but gradual, gains which, nevertheless, will fall short of currently envisioned goals. By 1967, there may be a shift from control to eradication of many of the major livestock diseases.

Basic veterinary research is expected to increase in stature and volume, and more research attention will be placed on chronic infections and non-infectious diseases. There will also be more support of public health and comparative medical studies. The continuation of present research efforts will lead to the availability of more effective and refined biological agents. Some of the best veterinary advances may be expected in the field of virology, where efforts to develop large-scale tissue culture techniques for virus propagation will probably increase significantly.

The continued expansion of veterinary research resources and scope of interests will give the USSR a formidable scientific capability to support antilivestock biological warfare efforts. The present Soviet potential in this regard is already strong, and facilities for mass-production of veterinary biologicals could be readily converted to production of antianimal agents. Veterinary services will probably be expanded to provide greater auxiliary medical and research support for the Soviet civil defense system.

ORGANIZATION, PLANNING, AND CONTROL

Veterinary research in the USSR is the responsibility of the Ministry of Agriculture and is conducted primarily in 62 central and peripheral scientific research veterinary establishments which are under the jurisdiction of the Ministry.

The leading central veterinary research installation, the All-Union Institute of Experimental Veterinary Medicine, organizes and coordinates the programs undertaken by Soviet veterinary research institutes. The other five central institutes specialize in various fields of veterinary research and provide technical guidance to the peripheral research establishments. The latter conduct research as centrally directed but carry out investigations which pertain to regional veterinary problems. In addition, a substantial amount of fundamental research in the animal sciences is conducted by institutions of the All-Union Academy of Agricultural Sciences imeni Lenin, the Academy of Sciences, USSR, and various zoological institutes. Veterinary schools and veterinary faculties of agricultural schools of the USSR engage in research investigations to a lesser extent.

Overall plans for veterinary research are coordinated at the Ministry of Agriculture level and are designed to deal with the most important livestock problems. The veterinary research program is first submitted to the Council of Veterinary Affairs, an advisory group to the Minister of Agriculture, and then is forwarded to the Minister for approval and inclusion in the state agricultural plan for the forthcoming year.

Centralized research control in the veterinary sciences is expected to continue during the period of this estimate. As greater responsibilities are delegated to the republic levels, the bureaucratic practices which have hampered the successful application of veterinary research will probably be reduced in the USSR. Research activity in the Soviet veterinary establishment will continue its expansion at all levels, and regional veterinary problems will be given increased research attention.

EXTENT AND ADEQUACY OF PRESENT AND FUTURE RESEARCH FACILITIES

There has been a continuing expansion of Soviet veterinary research facilities, equipment, and physical plants in recent years, designed for a rapid improvement of the Soviet veterinary capability. Significant improvement is apparent in the quality and quantity of laboratory equipment and materials being produced in the USSR and less reliance is being placed on procurement of these products from Western or Satellite sources.

Most inadequacies continue to exist in those institutions engaged in veterinary research projects of lower priority, despite the expansion of facilities and improved distribution of equipment at local levels since 1954. The proportion of the facilities allocated for research of a fundamental nature remains relatively small as compared with the proportion of facilities allotted to applied veterinary research devoted to the solution of pressing livestock problems. As a result of the rapid expansion, it is believed that more adequate and modern supplies, equipment, and facilities will be made available in the next ten years, and will be more evenly distributed throughout various levels of the veterinary organization.

QUALITY, QUANTITY, AND EFFECTIVE UTILIZATION OF MANPOWER

The training of high quality personnel for research endeavors has marked the expansion of veterinary science in the USSR. Also, the current Soviet emphasis on improved livestock productivity is placing increased demands on the training of veterinarians, zoo-

technicians, and their assistants. The present basic training of Soviet veterinarians is roughly comparable to that given to Western veterinarians. Formerly, Soviet veterinary training tended to emphasize narrow and selected aspects of the science with the result that the general competency of the average Soviet veterinarian appears to be somewhat below his Western counterpart. Some Soviet veterinarians, however, have achieved a level of research ability which compares favorably with that of leading veterinary scientists in other parts of the world. These men provide an expanding nucleus of highly skilled veterinarians in key positions. Moreover, expansion of the educational system is forcing changes in veterinary curricula which will favorably affect the future quality of veterinary scientific manpower in the USSR.

In the last few years, there has been a major shift in the distribution of Soviet veterinary personnel. Large numbers have been transferred from administrative positions to posts more closely associated with livestock problems. If current trends continue, more men of high calibre will be freed from day-to-day administrative responsibilities and will be available for Soviet veterinary research and practice.

The exact number of Soviet veterinarians engaged in research is not known, but over 1,800 individual scientific investigators in the USSR have been identified through their authorship of veterinary articles which were published from 1950–55. In comparison, between 1,300 and 1,400 veterinarians are estimated to be currently engaged in research and teaching in the United States.

The position of Soviet manpower in veterinary medicine will probably improve more than the position of U.S. manpower, despite the establishment of seven new U.S. veterinary schools since World War II. Current rates of growth of veterinary manpower are greater in the Soviet Union than in the United States. There are no indications that these rates will slacken, especially in view of pressures being applied by the Soviet government to accelerate livestock productivity. There are only 17 U.S. veterinary schools compared to 35 Soviet graduate level institutes for veterinary medicine and 110 schools for the training of veterinary technicians.

OBJECTIVES, MAJOR ACHIEVEMENTS, TRENDS, AND FUTURE CAPABILITIES IN VETERINARY SCIENCES

OBJECTIVES

The Soviet veterinary research program is designed to increase the production of economically essential livestock and livestock products by reducing losses resulting from livestock diseases and husbandry problems which most influence short-term productivity and expansion of the livestock industry in the USSR. The shortage of livestock is generally recognized by Soviet leaders to be a major agricultural problem, and veterinary research has assumed an increasingly prominent role in the Soviet national economy.

CURRENT TRENDS

Research

The status of veterinary research and technology in the USSR has improved significantly since World War II. Applied veterinary research is receiving strong emphasis and definite, but gradual, improvement may be expected in the Soviet livestock situation. Implementation of Party directives regarding increases in livestock numbers and productivity has been noted at all levels of the Soviet veterinary establishment.

Soviet ability for research in veterinary medicine is being enhanced. The capability of veterinary research workers for original contributions is not outstanding but is improving. Soviet veterinarians have conducted competent research, some of which compares favorably with Western research. Basic veterinary research is given less emphasis than are applied and developmental investigations. Although Soviet interest in basic veterinary

research has risen in recent years, it has been hampered by political support of scientifically unsound concepts and strong encouragements by the State for applied research.

Promising lines of endeavor have appeared in Soviet veterinary research since the recent reorientation toward increased scientific exchange with Western and Satellite countries. Past restrictions on scientific information has, in large measure, contributed to the delayed progress of veterinary research in the USSR. There has been a trend away from the entity known as "Soviet veterinary medicine" and toward a return to conventional research, uncomplicated by pseudo-scientific ideologies such as those of Lysenko and Bosh'yan. Until these dogmas were publicly renounced, progress of veterinary research in such fields as animal genetics, microbiology, and nutrition suffered. Soviet capability to exploit Western research and development no doubt will continue to improve with the removal of unorthodox doctrines and with greater freedom of international exchange.

The application of the principles of Pavlov to most phases of the livestock industry and to basic zoological research has also been a predominant trend in the Soviet veterinary effort. Since 1953, however, the Soviets, while promoting the same generally accepted principles, have been less dogmatic and more practical with some evidences being noted of open disagreement on "Pavlovianism."

Major emphasis is being put on improved field application of research findings. Slow and incomplete utilization of the practical benefits of veterinary research is a major deficiency which has contributed to the relatively low level of animal health in the USSR. There is a major attempt being made to remedy this situation and some immediate benefits should be realized. Long-range improvements, however, will be based on continuation of the reasonably good capability which currently exists in the research on infectious livestock diseases, disinfection, and parasitology. Steady progress has been made in veterinary virology since World War II. Soviet veterinary viral research often assumes a crash character. As a result, it is developing more rapidly than many of the other veterinary disciplines, presumably because most of the livestock diseases of prime economic importance to the USSR are of viral etiology.

Disease Control

The approach to problems of livestock disease through control rather than eradication has been an important trend. This philosophy has been predominant largely because of the relatively high prevalence of serious diseases, such as brucellosis, foot-and-mouth disease, and hog cholera, which appear to render programs of disease eradication economically infeasible in the USSR. As a result, Soviet veterinary research is emphasizing the development of biological products and methods for improved immunization, diagnosis, and treatment of animal diseases.

Veterinary scientists have tended to concentrate their disease studies on the applied aspects of epizootiology, microbiology, immunology, parasitology, and toxicology. Efforts to control foot-and-mouth disease, brucellosis, hog cholera, Newcastle disease, anthrax, the encephalitides, and parasitic diseases are receiving the major attention in Soviet livestock disease efforts.

Biologicals

Soviet production of biologicals has improved measurably, and over 26 bioplants are known to be producing some 80 biological products for veterinary use. Major emphasis has been placed on the development of live, dry vaccines and improved diagnostic agents, particularly those of an allergenic nature. Despite the enhanced capabilities currently demonstrated by the Soviet veterinary bioindustry for lyophilization and mass-production, shortages of vitally needed veterinary products, such as certain broad-spectrum antibiotics, continue to exist for field use. There is widespread veterinary interest in the development and extensive usage of antibiotics, but veterinary research in antibiotics, though promising, appears to be repetitive of Western research.

COMPARATIVE TRENDS, U.S.–USSR

Research

Although strong efforts are currently underway in Soviet veterinary research, the USSR lags the United States in practically all fields of livestock research and production. This lag is gradually narrowing as veterinary medicine in the USSR continues its rapid advancement, particularly in the application of knowledge gained through research on the prevention and control of animal diseases. They have achieved excellent results in recent years in the reduction of some of the most serious livestock infectious diseases. Soviet research has equaled and at times excelled U.S. efforts in such basic fields of veterinary science as helminthology, entomology, and other sub-fields of parasitology; physiology; toxicology; and some areas of epizootiology. Soviet veterinary research in immunology, microbiology, and pathology, has reached acceptable levels of proficiency but generally is inferior to U.S. research.

The quality of Soviet reporting in the veterinary sciences appears to be poor, as does the general understanding and use of sound scientific methodology and laboratory discipline. Published veterinary research in the USSR is frequently of inferior quality by U.S. standards, and avowed scientific accomplishments are often insufficiently supported with factual material to permit verification.

Despite a decentralization trend in recent years, Soviet research programs in veterinary medicine continue to be governed from the national level. In contradistinction, U.S. veterinary research is not federally controlled although a major amount of investigative work is conducted by federal employees or through government grants or contracts. A considerable number of able veterinarians are employed by U.S. manufacturers of biological, pharmaceutical, feed, and other commercial products. These firms support research in their own installations and also make grants to agricultural experiment stations.

Veterinary specialization is roughly comparable in both countries although private practitioners, which are a feature of U.S. veterinary medicine, are not known in the USSR. There are more veterinarians and veterinary personnel believed to be engaged in research activity in the USSR than in the United States. Veterinary practice in the United States is so lucrative that it is difficult to interest many capable personnel in the lesser-paying fields of veterinary research and teaching. As a result, the shift to economically insignificant fields, such as small animal medicine, has decreased the U.S. number of veterinary research workers. In the USSR, this scientific manpower is not lost and a high proportion of veterinarians engage in research pursuits for remunerative and recognition reasons.

Although Soviet veterinarians are extending their fields of research interest, U.S. veterinary investigators are doing considerably more work in such fields of comparative medicine as radiobiology, pathology, surgery, pharmacology, epidemiology, and aviation medicine.

Disease Control

Absolute eradication of the serious livestock diseases of economic importance is the ultimate goal of veterinary research in both countries. Whereas the Soviet veterinary establishment is completely geared to the agricultural economy, there are definite organizational and research trends in U.S. veterinary medicine directed towards greater activity in public health fields. Diagnostic capability is considered to be inferior in the Soviet Union where laboratory services and adequate diagnostic agents are not as readily available as in the United States. Animal disease reporting has improved tremendously in the United States in recent years, but such reporting is better controlled in the USSR as a result of collectivization and domination by central authority. The progress shown by the Soviets in the recently improved control of important infectious diseases of livestock has been very great. Furthermore, this progress has been achieved in a country whose hygienic practices in animal husbandry border on a primitive level in most areas. Despite the lower general competency of Soviet veterinarians, more professional attention, by sheer

weight of numbers and better distribution of veterinarians and trained technicians, has been made available for the economically significant species of animals.

Biologicals

No Soviet biological products or techniques for practical veterinary use have been developed which can be considered superior to those now available in the United States. Soviet veterinary investigators have demonstrated a proficiency for exploiting research achievements from other parts of the world. For example, the U.S. Strain #19 vaccine for brucellosis prophylaxis in cattle (used since 1940 in the United States) has had widespread usage in the USSR since 1954. Recently, this vaccine has been adapted for large-scale immunization of people who are in close occupational contact with sheep and goats in endemic areas. While they have been slow in adopting foreign work in the past, current trends indicate that sound U.S. and other Western accomplishments are being incorporated rapidly into Soviet veterinary and livestock programs.

Considerable reliance continues to be placed on large-scale use of dry, live vaccines in the USSR. Because of the potential hazard of spread to unaffected areas, widespread use of these live bacterial and viral strains has been accepted reluctantly in the United States and then only for diseases for which no other satisfactory immunogenic agent has been developed.

ESTIMATE, 1967

Research

We believe that Soviet veterinary research capabilities will increase considerably during the next ten years. Soviet leaders will remain keenly aware of the importance of veterinary research to economic development and will continue to support it vigorously. By 1967, the Soviet Union will command greater respect for its veterinary research ability.

There is no indication that the current encouragement of applied science will cause a neglect of basic or long-range veterinary research. The long existing discrepancy between veterinary research and practical application will continue for the foreseeable future, although we expect the lag to diminish. The resultant effect on livestock productivity and numbers will not be great but will gradually benefit Soviet food potential. The impressive goals set by Khrushchev and the current Five-Year Plan, however, are unrealistic. "Crash-type" efforts will continue in veterinary research for improved means of protecting livestock from serious infectious diseases, parasitisms, and nutritional disorders which are prevalent in the USSR. More veterinary research will be directed to studies of livestock nutrition, genetics, artificial insemination, reproductive disorders, regional epizootiology, food technology, antibiotic development, and broader utilization of antibiotics in the livestock and food industries.

Some of the best achievements are expected in the field of virology which will stress an increasing number of fundamental investigations, such as the study of protein structure and synthesis, purification, recombination, controlled variability, effect of ultrasonics, and intracellular "multiplication."

It is probable that Soviet efforts to develop large-scale tissue culture methods for virus propagation will increase significantly during the period of this estimate. Stress may be placed on studies relating to the immunogenesis, synergistic relationships, host interactions, latent infection, and virulence of viral organisms. The Soviets can be expected to continue their efforts for improving lyophilization techniques and for screening exotic and indigenous strains of viruses for their various properties.

Support to human medical research by Soviet veterinary workers will be expanded as it has in the United States in recent years. Veterinary research for experimental animal data for extrapolation to man will be provided on a greater scale in studies such as those on

physiological stress, pathogenesis, wound infection, and space medicine.

Disease Control

Whereas problems of livestock productivity will continue to dominate the veterinary research program in the USSR, veterinary investigations on those diseases communicable from animals to man will be increased. The zoonotic diseases not only will receive increased research attention, but more Soviet veterinarians will become active in public health efforts. The present program to make husbandry personnel more aware of proper hygienic and management practices will probably be intensified.

By 1967, there may be a shift in the direction of Soviet veterinary medicine from control of major epizootic infections to ultimate eradication. Although study of the acute infectious diseases of animals will continue on a large scale and substantial progress in their control will be demonstrated, increased research emphasis will be given to control of non-infectious and chronic diseases of livestock.

Biologicals

Increased veterinary research potential probably will lead to the availability of more effective and refined immunizing, diagnostic, and therapeutic agents by 1967. The heavy reliance on the use of vaccines and other prophylactic biologicals will continue but not, as now, to the point of sacrificing good sanitary measures. Soviet development of a single immunogenic agent which is protective against a combination of animal diseases is considered improbable within the period of this estimate although advances in this direction will be achieved. Assay of veterinary biological and pharmaceutical products prior to utilization in the field will be improved over the rather crude testing which has characterized Soviet quality control of these products. Therapeutic agents with viricidal properties, particularly among the antibiotics, will occupy a prominent part of future veterinary research activity.

MILITARY IMPLICATIONS

Improving Soviet capabilities for veterinary research, development, and production will give the USSR a stronger potential for antilivestock biological warfare efforts. The scale and orientation of effort in certain areas of animal disease research, as well as the general level of competence, are sufficient to contribute significantly to future developments in antilivestock BW. In particular, Soviet facilities for production of veterinary biologicals could be converted readily to production of antianimal agents. This Soviet scientific potential for support of an antianimal program, considered together with the extreme vulnerability of the U.S. livestock industry, constitutes a real threat to the United States in a cold or active war.

The increasing capability for original research in various fields of veterinary medicine may result in improved Soviet defense for livestock against nuclear, biological, and chemical weapons that will at least parallel U.S. progress in these fields. Continuation of the active veterinary effort to produce immunogenic, diagnostic, and therapeutic agents will improve Soviet defensive capabilities and may progressively override many of the deficiencies in livestock management in the USSR. Considerable indoctrination and refresher training will continue to be carried out on the veterinary aspects of defense against mass destruction weapons. This will result in improved hygienic, disinfection, and quarantine practices as well as more effective efforts by those agencies responsible for animal disease control.

It is expected that the role of veterinary services in the widely organized Soviet civil defense system in such areas as animal care, sanitation, and decontamination will be extended to give greater auxiliary support for human defense. Certain products, such as antianthrax serum and vaccine, will continue to be prescribed and stockpiled for emergency human use. Research on bovine and other animal plasma as blood extenders for human transfusion and other purposes may be more actively pursued although their use in clinical human medicine has been on the decline.

SATELLITE AND CHINESE COMMUNIST SUPPORT IN VETERINARY RESEARCH AND DEVELOPMENT

The USSR is not dependent upon the scientific veterinary capabilities of the Satellite countries or Communist China although certain of their capabilities which complement Soviet research are exploited.

East Germany, Czechoslovakia, and Hungary have made outstanding contributions to world knowledge of the veterinary sciences. The achievements of internationally recognized veterinary scientists and institutions in these countries will add to Soviet knowledge, particularly in such fields as microbiology, biochemistry, and pharmacology, and in the development of technical equipment. Increasing enrollments in higher educational institutions, reorganization of research institutes, and preferential treatment of scientists appear designed to increase the general veterinary capabilities of Satellite countries.

The increased flow of scientific information and visits between veterinary scientists in these countries and the Soviet Union will probably result in broadening the base of veterinary research in the USSR. The Satellites and Communist China, however, can be expected to give only limited support in veterinary research of strictly military significance.