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SCIENTIFIC INTELLIGENCE REPORT

SOVIET RESEARCH ON IMMUNOCHEMISTRY

CIA/SI 46-59
11 November 1959

CENTRAL INTELLIGENCE AGENCY

OFFICE OF SCIENTIFIC INTELLIGENCE

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Scientific Intelligence Report

SOVIET RESEARCH ON IMMUNOCHEMISTRY

NOTICE

The conclusions, judgments, and opinions contained in this finished intelligence report are based on extensive scientific intelligence research and represent the final and considered views of the Office of Scientific Intelligence.

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PREFACE

Immunochemistry * concerns the physical-chemical reactions of the body to the introduction of foreign substances. This field of study is essential to the understanding of mechanisms underlying (i) response processes of host animals, (ii) allergy and hypersensitivity, (iii) infections, and (iv) neoplasms. The biological aspects of host resistance to foreign substances and the applied aspects of vaccine and sera development are related closely to immunochemistry but are not discussed in this paper. Because medical microbiology historically introduced the idea of immunity, this field for many years has dominated the subspecialty of immunology. The new and broader ramifications of immunology, plus the incorporation of special biochemical techniques, have now resulted in the identification of immunochemistry as a separate specialty.

[redacted] (b)(1) (b)(3)

This study was completed on 1 August 1959 and is consistent with all information available to 1 October 1959. All sources of information were exploited.

* Principal technical terms are defined in the glossary.

CONTENTS

SOVIET RESEARCH ON IMMUNOCHEMISTRY

PROBLEM

To assess present and to estimate future Soviet capabilities in immunochemistry.

CONCLUSIONS

1. The USSR is farther behind the West in immunochemistry than probably any other field of medical science. The Soviets now recognize the importance of immunochemistry to public health and are aware of their quantitative and qualitative shortcomings in the field. Their current 7-Year Plan is expected to emphasize training, research, and development in immunochemistry. Nevertheless, so great an expansion and redirection of research and training are needed that at least 5 and possibly 10 years of maximum effort will be required for Soviet scientists to catch up with leading Western scientists.

2. A few Soviet investigators show ingenuity and foresight, have some unique theoretical concepts, and could occasionally make significant contributions to immunochemistry; but most of their findings are and will continue for some time to be of limited value. Soviet investigators in immunochemistry depend heavily on Western data and lack an understanding of fundamental immunological principles, modern physical and chemical research procedures, and production techniques. Some Soviet-developed drugs have resulted in such severe allergic reactions that they have been withdrawn from public use. Because of an inadequate knowledge of immunochemistry, the USSR has failed in several attempts to manufacture drugs in general use in the West.

3. In the future, the USSR will give greater attention to the physical-chemical aspects of immunology as related to infectious and malignant diseases, tissue transplantation, blood typing, blood disorders, and vaccine and sera development.

DISCUSSION

INTRODUCTION

In the Soviet Union, immunochemistry has not yet acquired the status of a distinct field of research. There are only a few immunochemists, although the USSR does maintain a number of laboratories of immunochemistry and biochemistry supporting immunological research. This deficiency seems to be primarily a result of insufficient emphasis on the field of biochemistry and biochemical techniques rather than the lack of classic immunological experience. As a result, the Soviet Union is probably farther behind the West in immunochemistry than any other

single field of medical science. Within the Soviet Bloc, Czechoslovakia leads in immunochemistry; the USSR ranks second.

As early as 1954, many leading Soviet scientists pointed out the necessity for improving biochemical and immunochemical research as rapidly as possible. The 5-Year Plan (1956–60) included provisions for research and the training of personnel in modern biochemistry, with major emphasis on the chemistry and immunology of macromolecules, such as proteins, carbohydrates, and nucleoproteins. The Soviets are making every attempt to exploit Western advances in this field. Nevertheless, a great deal remains to be accomplished, especially with respect to the biophysical characteristics of macromolecules. Western observers attending 1958–59 international meetings, such as the Stockholm Congress on Microbiology, the Prague Congress on Antibody Formation, the Geneva Conference on Peaceful Uses of Atomic Energy, and the International Union of Biochemistry meeting at Vienna have uniformly reported that the present level of research on biochemistry and immunochemistry of the Soviet Union is far behind that of the Western nations. This assessment has been confirmed by travelers within the Soviet Union.

Beginning about 1958, N. S. Khrushchev and other Soviet leaders emphasized the need for the infusion of physical sciences into biology and medicine. According to V. A. Engel'gardt, a leading Soviet biochemist closely associated with Soviet scientific planning, high-level Soviet scientific planners are convinced that research emphasis on basic disciplines (such as biochemistry) is necessary before the Soviet Union can acquire a favorable international standing in biology. I. Ye. Tamm, a Nobel prizewinning physicist, has called for wider use of physical principles in biological research. A. N. Nesmeyanov, President of the Academy of Sciences, USSR, in a speech on 1 December 1958, emphasized the necessity for understanding life processes, particularly those pertaining to proteins and their properties and reactions. The current 7-Year Research Plan (1959–65) is quite explicit in its emphasis on the necessity for increasing biochemical research, especially in areas supporting immunochemistry. This would suggest that an accelerated program of basic research in the field is now under way.

PROTEIN AND CARBOHYDRATE STUDIES

Protein Synthesis

In vivo and *in vitro* methods of synthesizing proteins and antibodies have been of major interest to Soviet investigators. This has led to research on the isotopic labeling of amino acids, as well as studies on the incorporation of these amino acids into proteins. Attempts are being made to determine whether or not amino acids are incorporated into proteins during their synthesis or during subsequent metabolism. Other research is aimed at determining the site of formation of different proteins and antibodies. The problem of whether the formation of a specific protein inhibits or facilitates formation of other proteins is also being studied. Attempts are being made to accelerate the incorporation of amino acids into tissue proteins and to determine if the rate of incorporation is related to cancer tissue metabolism. Additional studies have demonstrated that the physical-chemical state of deoxyribonucleic acid-protein complexes is important in immunological and enzymic processes. Earlier Soviet work on pressure enzymic resynthesis of proteins *in vitro* has been dropped for lack of progress, but planned studies on the biosynthetic mechanisms of formation of proteins may provide better models of enzyme or protein synthesis and revive this work. Soviet research will continue to be directed along the above lines with respect to macromolecules, such as nucleic acids and carbohydrates.

Much of the above Soviet research is relatively recent. Future attempts will be made to determine how antibodies are formed and whether or not the addition of various compounds to proteins will initiate production of different types of antibodies. Soviet success could lead to biosynthesis of artificial types

of antigen with varying specificities or perhaps even with dual or multi-types of specificity.

Fractional Analysis

The study of protein fractions of sera from immunized animals and antigenic components of microorganisms and toxins has also interested Soviet investigators. This fractional analysis of proteins has resulted primarily in the isolation of biologically active components and may lead to the preparation of purified, concentrated toxins, antigens, or antibodies, which in turn would lead to greater and more specific immunity.

Basic Composition

Another major area of research on proteins and carbohydrates concerns the actual chemical composition of bacteria, proteins, antibodies, antisera, and various protein complexes. Soviet medical investigators are attempting to relate chemical composition to toxicity, antigenicity, and microbial species specificity. The nucleic acid-nucleotide composition, the carbohydrate complexes, the amino acid content, the nitrogen content, the phosphorus content, as well as various reducing substances and polysaccharides have been studied. Soviet results do not indicate any correlation between the properties of the antigens and their chemical composition. Current Soviet efforts are being directed towards determining the sequential arrangement of amino acids within the protein molecule, an approach which is promising.

ANTIGENS

Theoretical studies on antigenic chemistry have been pursued by only a small number of Soviet investigators. During 1956–57 the Academy of Sciences, USSR, began to exert pressure on investigators to fill this significant gap in Soviet immunological studies. The gap arises from: a lack of physical and chemical talent in biological fields, a reluctance to apply modern theories in basic genetics, and a predilection to favor live vaccines. Soviet medical microbiological studies related to antigenic analyses have been concerned with a few narrow areas of vaccine development, primarily the isolation, purification, fractionation, and attempted synthesis of diagnostic preparations and infectious disease agents with poor or no demonstrated live vaccine possibilities. Soviet attempts to reproduce Western vaccines frequently have met with little success.

Recently, the very few Soviet investigators who have managed to maintain cognizance of the advances in the chemistry of antigens apparently are broadening their fields of interest. More reports have begun to appear on new chemical methods and techniques. There is new emphasis on training young investigators and reeducating established workers away from the "immunobiological" approach, which has dominated Soviet immunology, and orienting them toward immunochemistry.

Antigen problems that appear to be receiving emphasis include: the specificity, nonspecificity, and serological activity of nucleic acid, protein and carbohydrate antigenic complexes and fractions; the genetic aspects of nucleic acids; experimental alteration and synthesis of proteins; antigenic competition in the host; the relation of the infectious process to host metabolism; chemical components of brucella, tularensis, cholera, Salmonella-Shigella, and a number of other toxin-producing microorganisms; and the distribution and fate of antigens in the host. The Soviets also are beginning to make increased use of more sophisticated immunochemical techniques such as ultracentrifugation and electrophoretic analysis, antigenic purification by sonification, chromatographic applications, gel diffusion analysis, and isotopic labeling.

ANTIBODIES

Current research on antibody analysis is concerned with familiarizing Soviet investigators with modern physical, chemical, and biological methods. The recent literature has emphasized the diffusion analysis of antigens and antibodies, the fluorescent antibody technique, protein enzyme detection in sera, and quantitative evaluation of an antibody by means of chromatographic and labeled antigen techniques. Many Soviet investigators

are studying non-specific stimulation of antibody production using various drugs, surgical procedures, and mechanical or electrical stimuli. This line of research has indicated possible ways for supplementing protective responses, although the value of Soviet data and conclusions is doubtful and the underlying concepts require verification. Since 1957, some unrefined attempts have been made to study mechanisms and sites of antibody formation in the reticulo-endothelial system, liver, and lymphoid tissues, but these investigations appear to be of a routine nature and consistently involve inadequate data and misinterpretations. A strong effort is being made to develop methods for the purification of antibody protein, but this work is related to the manufacture of serum preparations and has little fundamental research value. Various Soviet attempts to clarify the role of non-antibody systems related to protection against infectious disease are unimpressive.

Although Soviet investigators have long been interested in the role of antibodies in immunity to disease, they have made no original contribution of consequence to fundamental theory. There have been few studies of value pertinent to antibody chemistry, the nature and function of complement, the properdin system, and autoantigen-autoantibody reactions.

PATHOPHYSIOLOGICAL AND NEUROHUMORAL ASPECTS

Various types of disease or disturbances in body function have provided avenues of research for studying the immunological process. The Soviets recognize that the synthesis of antibodies is related directly to the synthesis of other body proteins but is influenced by the state of nutrition. Soviet investigators are examining the means by which the immunological activity of the body is strengthened by diets that permit increased body protein synthesis. Also receiving attention is the possibility that the adrenal and other endocrine glands are closely related to the processes of immunology and general body reactivity; if so procedures affecting these glands (e.g., adrenalectomy, denervation of the adrenals, or administration of adrenal cortical hormones or hormones stimulating the adrenal) would have major effects upon immunogenesis. The Soviets have also conducted studies on immunological changes during cardiovascular diseases and various metabolic and endocrine diseases. Aspects of pathophysiological research which receive special consideration include cancer immunology and the immunology of radiation disease.

Cancer Studies

The viral etiology of many types of cancer is considered most likely by many Soviet investigators. For several years a group of investigators under L. A. Zilber has consistently claimed an ability to demonstrate that a common antigen is found in all types of tumor in a given organism or species. Other Soviet and most Western investigators have been unable to demonstrate this as a consistent phenomenon. Soviet scientists have also investigated toxins secreted by tumors; the use of tissue culture to study the etiology of cancer; antigenic relationships between different types of tumors of the same kind of tissue; the use of living tumor tissues to provide vaccines for the treatment of tumors; the role of the central nervous system in the etiology and growth of tumors; and the heterological transplantation of tumors. This Soviet research is far behind Western development; Soviet investigators are just starting the use of newer techniques such as tissue culture and are only now beginning a program of advanced research in the neoplastic diseases. Adequate training for the study of cancer and allied problems is just beginning.

Burn Studies

Soviet work on the immunotherapy of burns has made little progress since it was initially discussed at the International Congress of Hematology in 1956.

Radiation Studies

Soviet immunochemical studies with radiation include: the depression of immunogenesis; the denaturation of proteins and its effect on antibody or antitoxin titers; the anaphy-

lactic properties of different types of proteins; and the denaturation of nucleic acids and of protein complexes containing nucleic acids, fats, or carbohydrates. Other studies on the relation between radiation and immunity concern the depression or inhibition of natural resistance to infection; vaccination at various stages of irradiation disease; possible stimulatory effects of extremely low doses of radiation on immunogenesis; effects of radiation on the Schwartzmann phenomenon; irradiation-produced changes in the activity of complement; the use of passive versus active immunization after irradiation; the effects of direct irradiation on vaccines or antigens themselves; the production of the autoallergic phenomenon by irradiation; and the use of abnormal tissue antigens produced by irradiation for the treatment of radiation disease.

Much of this Soviet research on radiation has suffered from a lack of reliable data, a failure to plan or evaluate experiments statistically, and a tendency to overgeneralize conclusions. So far, the Soviets have produced nothing unique on this subject, but the amount of effort being spent and the increased emphasis on training investigators for future work in these areas mean that the Soviets will probably make relatively significant progress soon.

Neurophysiological Studies

For the past 10 years, many Soviet investigators have attempted to prove that the nervous system and particularly conditional reflex mechanisms regulate immune and infectious processes. They consider physiological mechanisms to be at least as important as specific defensive cellular and humoral reactions in protection against infection or the progression of pathological processes. They have overgeneralized conclusions based on poorly designed experiments, inadequate data, and questionable hypotheses and have failed to prove that direct conditional reflexes can be used to regulate natural reactions or to induce immune, infectious, and allergic reactions.

The Soviets have made some efforts to examine the influence of hormone and adrenal-hypophyseal-hypothalamic factors in infection immunity. They have also gathered some recent experimental information which, upon reevaluation and confirmation, may indicate that nervous system mechanisms are at least indirectly associated with or participate in the quantitative aspects of antibody production, the intensity of the infectious processes, phagocytic activity, and the depression or activation of localized allergic reaction. Recent Soviet emphasis on chemical and physical mechanisms related to neurophysiological association with host resistance and susceptibility may elicit some basic information of value to preventive medicine, experimental transplantation, allergy, and psychosomatic medicine.

Hypersensitivity

Soviet workers emphasize the concept of the neurophysiological basis for allergic phenomena. Some information is also available on specific allergens associated with the flora and fauna of Soviet geographic areas. Since 1956, interest has been shown in studies on auto- and homo-allergens and antigen-antibody reactions associated with allergic reactions. Many studies have been concerned with the plethora of post-inoculation side reactions encountered as a result of the use of live vaccines, antibiotics, sera, and other preparations where purity may be critical. There is no evidence that side reactions have been significantly averted by any of the methods studied or proposed in the USSR. The "general" and "local" post-vaccine and serum inoculation reactions considered allowable by Soviet standards are not permissible in the United States. Soviet investigators recognize that research on allergy and hypersensitivity in the USSR is backward, and the 7-Year Plan calls for corrective action.

BLOOD AND BLOOD GROUPS

The Soviets are carrying on two major investigations of allergic and immunological phenomena of blood. The first consists of studies of reactions from blood or blood substitutes; the second concerns blood group typ-

ing. The Soviets have tried several blood substitute products which produce allergic or anaphylactic type reactions. The antireticulocytotoxic serum (ACS) of A. A. Bogomolets was one of the first of these, and reactions were so severe that the serum was withdrawn from production and distribution. The therapeutic serum of N. G. Belen'kiy (LSB) also had to be withdrawn (as recently as March, 1959); it too produced severe anaphylactic type reactions in an appreciable number of patients. A more recently developed material, BK–8 (V. A. Belitser and K. I. Kotkova), is currently in use as a blood substitute or plasma expander. Like the LSB, the BK–8 is a product obtained by partial hydrolysis of cattle blood serum. The indications are that BK–8 is definitely less anaphylactogenic than earlier materials of the same type. The Soviets claim to have used cadaver blood without causing allergic reactions, but this material is presently in use in only one institute, the Sklifosovskiy First Aid Institute in Moscow. Soviet dextrans have also been investigated; one called polyglukin seems to be superior to U.S. dextrans because of its apparent freedom from anaphylactogenic properties and because U.S. tests show that it does not prolong bleeding time.

The Soviets include in their preserving solutions for transfusion materials several types of compounds which are claimed to suppress immunological reactivity and to minimize reactions from blood and blood substitutes. The most frequently used is novocaine. The effectiveness of these compounds is not clear, since Soviet criteria for an anaphylactic reaction are poorly defined by U.S. standards.

Soviet research on blood groups is relatively primitive in comparison with good hospital practice in the United States. The personnel at major research institutes of hematology and blood transfusion are, in some cases, not familiar with Western research or practices in blood grouping and cross matching. Yet there are indications that the Soviets appreciate the Rh factor as well as its implications in transfusion reactions and erythroblastosis fetalis. Only in 1958–59 has Soviet attention turned to some of the other subgroups of blood such as A, M, or N. At present, the Moscow Institute of Hematology and Blood Transfusion is probably the only Soviet research institution which is adequately prepared to do significant research in the field of blood subgroups. Greatly increased training and research will be necessary in order for the Soviets to attain the present U.S. level of accomplishment in this area.

ORGAN AND TISSUE TRANSPLANTATION

The application of immunological methods to experimental embryology and transplantation problems is a relatively new technique for the USSR, but this approach has already attracted the attention of many Soviet investigators. A planned program (under the Institute of Experimental Biology) is expected to provide additional personnel, facilities, and equipment for this research. Current studies emphasize serological analysis of antigenic cell structure of normal tissues and neoplasms, as well as wider utilization of immunological techniques in the study of antigenic incompatibility associated with homotransplantation and the pathology of pregnancy.

E. A. Zotikov has shown that tissue homotransplantation may result in the emergence of antibodies in the recipient's serum which can agglutinate the donor's erythrocytes. He believes that this indicates the need for preliminary screening of donors and recipients for Rh, M, and N factors, in contrast to the views of various Western investigators. Bilenko and others have been very interested in the immunological aspects of lyophilized organ and tissue transplants and have reported successful use of stored dried tissues of various types. P. N. Kosyakov, L. S. Volkova, and others are concerned with antigenic and immune response patterns associated with phylogenetic and ontogenetic tissue differences. L. A. Zilber and others report that tumor or normal tissue transplants can be successfully carried out in animals which have acquired tolerance to normally damaging tissue antigens, if the animals are subjected to previous exposure to the specific transplant tissue cell preparations. Zilber further claims

that preliminary inoculation of strongly heterologous or partially homologous antigens into animals during embryogenesis can induce tolerance to later administration of similar antigens. Other Soviet investigators have reported overcoming tissue incompatibility by various other ill-defined methods.

Expert Western observers believe that Soviet claims derived from experimental transplantation studies are often overstated. Their results in this field are considered inferior to those of the West. Available information on the specific immunological aspects of Soviet studies would not refute this view. Nevertheless, the Soviets are pursuing certain lines of research which are of great interest to U.S. investigators.

VACCINES AND SERA DEVELOPMENT

The Soviets have shown some ingenuity and foresight in devising and adapting vaccines and sera for mass use in human beings, but this is not enough to ensure reliable progress. They have a poor grasp of fundamental immunochemical concepts and methods and do not understand the engineering techniques for large scale manufacture and storage of biologicals of high quality. Hence, the quality of presumably standardized Soviet preparations frequently is not dependable. Repeatedly, Soviet investigators have undertaken human trials with experimental vaccines and sera on the basis of questionable laboratory findings. They are often remiss in the proper application of mass inoculation procedures and the subsequent evaluation of immunization programs in large populations. As a consequence, no prophylactic or therapeutic vaccine or serum now in use in the USSR is superior to its U.S. counterpart; the Soviet preparations do not meet U.S. standards of stability, purity, safety, and efficacy.

Soviet investigations of derived prophylactic antigens requiring chemical or physical research methods are backward. The USSR has had great difficulty in developing vaccines for pediatric purposes, including those which already are routinely used in the West. The Soviet program for development of vaccines from antigens of enteric organisms has had a marked lack of success. Yet the Soviets are ahead of others in the use of live bacterial, viral, and rickettsial vaccines for large scale immunization and could make significant contributions. Most Western investigators hesitate to use live vaccines because of the hazards inherent in immunization of man with live organisms.

A number of Soviet investigators are attempting to develop multiple combinations of vaccines and toxoids. At the present time, this work primarily involves empirical methods for combining and testing available preparations in laboratory animals. As yet, no new fundamental ideas have come from these investigations, and no Soviet polyvalent vaccine has been shown to give adequate protection in man.

Soviet attempts to modify inoculation methods and combine questionable vaccines cannot circumvent basic Soviet shortcomings. The necessary progress in Soviet vaccine research and development for the present and immediate future is dependent upon their ability to overcome their deficiencies in the physical-chemical aspects of medical microbiology and related fields.

GLOSSARY

Adrenal-hyphophyseal-hypothalamic: refers to the two endocrine glands, the adrenal and the pituitary, and the hypothalamic (floor of the third ventricle) portion of the brain. There may be a joint endocrine-neural relationship in the immune responses to infection.

Agglutination: the aggregation or clumping of antibodies by a specific immune serum.

Allergen: a specific substance, usually protein in nature, which upon ingestion, inhalation, or infection is capable of producing the manifestations of allergy.

Allergy: hypersensitivity of the body cells to a specific substance (protein, lipid, carbohydrate, etc.). Autoallergy is hypersensitivity to a substance derived from the same body; homoallergy is hypersensitivity to a substance derived from the same animal species; and heteroallergy is hypersensitivity to a substance derived from other animal species or other external sources.

Anaphylactogenic: capable of producing anaphylaxis.

Anaphylaxis: a loss of once-acquired immunity, or an increased susceptibility, to an infection or foreign substance. May be viewed as the extreme degree of allergy and may result in death.

Antibody: a substance which exerts a specific restrictive or destructive action on bacteria or other foreign materials. An autoantibody is an antibody which exerts its action against a normal component of the host tissues.

Antigen: a substance which, on introduction into the animal body, provokes the production of a specific type of antibody. An autoantigen is an antigen derived from the tissues of the host.

Antiserum: a serum containing a specific antibody.

Chromatography: the separation of biological and chemical materials by differential or selective adsorption.

Complement: a thermolabile substance in normal serum. It is destructive to bacteria and other cells with which it is brought in contact.

Conditional reflex: to produce by training an automatic response to a given stimulus or to a substituted stimulus.

Counter-current distribution: a method for separation or purification of liquid or dissolved substances by taking advantage of solubility differences in two solvents.

Denaturation: modification of a protein so that it no longer has all its original properties.

Denervation: removal of the nerve supply.

Deoxyribonucleic acid: a nucleic acid present in animal and vegetable cells, especially in the nuclei. It is a tetranucleotide containing the sugar deoxyribose, phosphoric acid, and a purine or pyrimidine base.

Electrophoresis: movement of charged ions or particles in an electric field. The method is especially useful for detecting impurities in proteins and for separating proteins.

Embryogenesis: formation of embryos.

Enzymic end-group analysis: the use of enzymes to determine the terminal components of the long chains comprising proteins or other macromolecules.

Erythroblastosis fetalis: a hemolytic blood disease of the newborn, arising from development in the mother of an anti-Rh factor in response to the Rh positive blood of the infant.

Gel diffusion: a method of separation or analysis of chemical substances depending on rates of diffusion in such gels as agar.

Heterologous: derived from an animal of another species.

Homologous: derived from an animal of the same species.

Humoral: pertaining to the extracellular fluids (blood and lymph) of the body.

Immune: exempt from infection or allergy by reason of having had the disease or having been inoculated with antigen to promote antibody production.

Immunity: the natural or acquired resistance of the body to disease; may be temporary or permanent.

Immunization: the process of rendering immune. Passive immunization is achieved by injection of the serum of an animal which has acquired an active immunity. Active immunization results from having suffered and overcome an attack of a pathogenic organism of normal or modified virulence or of the toxin of such an organism.

Immunobiology: the study of the biological reactions following the introduction of foreign antigenic substances into the body.

Immunochemistry: the study of the chemical reactions following the introduction of foreign antigenic substances into the body.

Immunogenesis: the formation of immune bodies, or antibodies, after injection of an antigen.

Immunology: the science dealing with the phenomena of immunity.

Immunospecificity: the highly specific reactions mediated by the immune process.

Incompatibility: the inability of a tissue to survive and grow when transplanted.

In vitro: in a test tube or other artificial container.

In vivo: within a living being.

Isotopic labeling: the marking of a compound or substance by incorporation of an isotope (radioactive or non-radioactive).

Lyophilization: the drying of biological materials by a process of vacuum freeze-drying.

Nucleoprotein: a complex of nucleic acid and protein; often seen as components of cell nuclei.

Nucleotide: a simple nucleic acid combined with one base only.

Ontogenesis: development of the individual animal or plant organism.

Phagocyte: a cell possessing the ability to ingest bacteria, foreign particles, and other cells.

Phylogenesis: evolutionary development of a species.

Properdin: a protein in normal blood serum, believed to be a factor in natural immunity. It acts in conjunction with complement and magnesium ions and causes destruction of bacteria, lysis of certain red blood cells, and neutralization of some viruses.

Reticulo-endothelial system: a group of cells found in various organs and tissues (spleen, lymph glands, bone marrow, liver, adrenal, pituitary, and blood), chiefly concerned with phagocytosis and production of immune bodies.

Rh factor: an agglutinating factor present in the red blood cells of the Rhesus monkey and in red cells of about 85 percent of human subjects.

Schwartzmann phenomenon: a reaction produced when an animal is given an intradermal injection of a filtrate from a bacterial culture, and 24 hours later is given an intravenous injection of the same material. At the site of the original injection a hemorrhagic lesion appears.

Serology: the branch of science dealing with blood serums, especially with specific immune serums.

Sonification: treatment of substances with sonic vibrations.

Titers: concentrations of components in solutions.

Tolerance: specifically in this paper the failure to produce immune antibodies against a foreign substance.

Toxoid: a toxin treated so as to remove its toxicity but retain its ability to engender or produce antibodies.

Transplantation: grafting of one organ or tissue onto another organ or tissue. Homotransplantation is grafting within the same species. Heterotransplantation is grafting between species.

Ultracentrifugation: subjection of biological materials to very high centrifugal speeds, either to separate components or to determine physical characteristics such as purity, molecular weight, and viscosity.

X-ray diffraction: the bending of X-rays by atoms in a crystal; the pattern produced is photographed to give a relative, three-dimensional diagram of the crystal atoms.

APPENDIX A

The More Important Soviet Institutes in Which Immunochemical Research is Conducted

1. Institute of Epidemiology and Microbiology imeni N. F. Gamaleya, AMS, USSR, Moscow. Director: S. N. Muromtsev
2. Institute of Biological and Medical Chemistry, AMS, USSR, Moscow. Director: V. N. Orekhovich
3. Institute of Experimental Biology, AMS, USSR, Moscow. Director: I. N. Mayskiy
4. Institute of Biochemistry imeni A. N. Bakh, AS, USSR, Moscow. Director: A. I. Oparin
5. Institute of Biophysics, AS, USSR, Moscow. Director: G. M. Frank
6. Institute of Normal and Pathological Physiology, AMS, USSR, Moscow. Director: V. N. Chernigovskiy
7. Institute of Experimental Pathology and Therapy of Cancer, AMS, USSR, Moscow. Director: N. N. Blokhin
8. Institute of Oncology, AMS, USSR, Leningrad. Director: A. I. Serebrov
9. Institute of Experimental Medicine, AMS, USSR, Leningrad. Director: D. A. Biryukov
10. Central Order of Lenin Institute of Hematology and Blood Transfusion, Ministry of Health, USSR, Moscow. Director: A. A. Bagdasarov
11. Central State Scientific Control Institute of Vaccines and Sera imeni L. A. Tarasevich, Ministry of Health, USSR, Moscow. Director: S. I. Didenko
12. Moscow Institute of Vaccines and Sera imeni I. I. Mechnikov. Director: A. P. Muzychenko

APPENDIX B

A Selected List of Scientists Engaged in Research Related to Immunochemistry

Ado, A. D.
Aleksandrov, N. I.
Annenkov, G. A.
Batyuk, I. F.
Chistovich, G. N.
Dubrovskaya, I. I.
Gefen, N. Ye.
Gostev, V. S.
Grigoryan, D. G.
Gurvich, A. Ye.
Kiselev, P. N.
Klemparskaya, N. N.
Konyukhov, B. V.
Korosteleva, V. S.
Kosyakov, P. N.
Kuzin, A. M.
Orekhovich, V. N.
Oyvin, I. A.
Pigalev, I. A.
Shevelev, A. S.
Sigal, M. Z.
Spirin, A. S.
Svet-Moldavskiy, G. Ya.
Troitskiy, V. L.
Tsuverkalov, D. A.
Uchitel', I. Ya.
Vol'kenshteyn, M. V.
Volkova, M. S.
Vol'pe, I. M.
Vygodchikov, G. V.
Zdrodovskiy, P. F.
Zil'ber, L. A.
Zotikov, E. A.

BIBLIOGRAPHY NOTE

A bibliography on immunochemistry is published as a separate list. Copies of the list are available to authorized personnel and may be obtained from the originating office through regular channels. Requests for the bibliography should include the publication number and date of this report.