FORTY YEARS OF SOVIET EXPERIMENTAL MEDICINE AND BIOLOGY

The forty years since that historic event, the Great October Socialist Revolution, have been years of vigorous growth in Soviet experimental medicine and biology.

It is scarcely possible in this article to cover more than the main developments in two such vast divisions of science; the field of experimental medicine is made up of many separate, special branches, encompassing as many problems as the field of clinical medicine. It is therefore impossible in an article of this sort to adequately treat every aspect of these developments. These insufficiencies, however, can be remedied by articles published in other journals which cover a more limited field.

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Before the revolution, there was only one scientific institution in Russia for research in experimental medicine — the Institute of Experimental Medicine in Petersburg — upon which other institutions of this sort were modeled after the revolution. It was the forerunner of the All-Union Institute of Experimental Medicine, which subsequently became part of the USSR Academy of Medical Sciences, and the prototype for certain institutes of the USSR Academy of Science.

However, the universities of Petersburg, Moscow, Kazan, Kharkhov, Kiev, Odessa, Permsk and several other universities carried out work in the region of experimental medicine and biology, as well as the Institute of Experimental Medicine. The Academy of Military Medicine played an important role in the genesis of experimental medicine research. The first experimental medicine research groups began to appear in the Academy of Sciences immediately before the revolution.

These few scientific institutions had the facilities for only limited research. The work, however, was on an extremely high scientific level.

Outstanding workers in experimental biology and medicine, I. M. Sechenov, I. I. Mechnikov, V. O. and A. O. Kovalevsky and K. A. Timiryazev, left the next generation of scientists the beginnings of material understanding of vital phenomena, as well as classic examples of scientific genius.

This unbroken chain of scientific ideas greatly facilitated the continuance of active work by many outstanding scientists in many scientific institutions even after the Great October Socialist Revolution.

Soviet physiology gratefully accepted from the older generation of physiologists and clinical physicians the extremely important conception of neurism, the foundations for which were laid by the works of I. M. Sechenov, S. P. Botkin and I. P. Pavlov. This idea was developed along two main lines: first, by broad and systematic investigation of the physiology of the nervous system, particularly of higher nervous activity, and second, by developing further I. P. Pavlov's classical conception of the idea of neurism, which was as a "physiological course attempting to spread the influence of the nervous system to a potentially greater number of physical activities."

During the post-October period, both of these aspects were developed according to the philosophy of dialectic materialism, and abundant material was obtained confirming the basic principles of the idea.

Higher nervous activity was investigated under the immediate direction of Pavlov until 1936, the year of his death, when his colleagues and students undertook to carry on this study.

During the years following I. P. Pavlov's death, special attention was given to the problem concerning the mechanisms of experimental neuroses and to investigations of cortical inhibition and the formation mechanisms of temporary associations. Work studying higher nervous activity types, the second signal system and the genetics of higher nervous activity was revived after a joint session of the AN SSSR and the AMN SSSR, which pointed out the errors which had been made in the development of the Pavlov scientific legacy.

In works of many outstanding scientific associations headed by P. S. Kupalov, E. A. Asratyan, K. M. Bykov, M. K. Petrova, Yu. V. Folbort, P. K. Anokhin, L. A. Orbeli, A. G. Ivanov-Smolensky, N. A. Rozhansky and many others, the basic rules of higher nervous activity have been examined in detail, as were the mechanisms of conditioned reflex formation, of conditioned association fixation and of neurosis development and successful attempts were made to use a series of new chemotherapeutic substances for experimental therapy in higher nervous activity disturbances. An extremely important achievement was the examination of neuroses in animals under conditions of free behavior. These studies showed that certain American scientists were wrong in asserting that neuroses developed in animals due to their separate confinement. The knowledge obtained regarding neuroses was widely and successfully used, moreover, in clinical practice. On the basis of this knowledge, a new conception of the pathogenesis of hypertonic and ulcerous diseases was introduced and developed (G. F. Lang, A. L. Myasnikov, M. V. Chernorutsky, K. M. Bykov, and I. T. Kurtsin).

The combined efforts of many researchers made serious attempts to understand the nature of inherent cortical inhibition. We are, however, far from solving this "damned question," as I. P. Pavlov called it. This is indicated by the discussion of it at the IX session of the AMN SSSR, which was specially dedicated to the problem of inhibition.

How little we know about it is demonstrated by the fact that there are at least three points of view regarding the mechanism of this process (P. S. Kupalov, I. S. Beritov, and P. K. Anokhin). The original conception, developed by P. K. Anokhin, has been criticized (P. S. Kupalov, 1957) and has not been recognized. Nor is the idea that cortical inhibition is of a parabiotic nature generally accepted (V. S. Rusinov, N. V. Golikov, and others).

Although the phenomenon of nerve link fixation has been the subject of constant research by physiologists for the past 40 years and the general, basic rules of this phenomenon can be considered as established, there is still a wide field for new studies on this subject.

Of great importance was the attempt to understand the complex forms of animal behavior ("situation reflexes"). However, we can now assume that, using the principal patterns established by I. P. Pavlov, the most complex forms of animal behavior can be explained and understood.

The studies which have shown the existence and significance of natural conditioned reflexes which are present in animals living under natural conditions also deserve great credit (A. D. Slonim and colleagues).

Much research has been done in the field concerning the types of higher nervous activity, a field founded by I. P. Pavlov. During the past 40 years, we have established new variations of the types, and new methods of procedure have been developed which make it possible to determine the type of higher nervous activity and, which is very important, to show the dependency of the development and duration of many pathologic processes on the typological group of the animal (A. G. Ivanov-Smolensky and others). Such studies have aided the practical use of knowledge concerning higher nervous activity types, which, in many cases, made possible the development of differentiated methods of treatment.

Recently, physiologists and physicians have been much occupied with the question of the protective and curative role of inhibition, and medicamental sleep has been widely used both experimentally and clinically (E. A. Asratyan, A. G. Ivanov-Smolensky, A. L. Myasnikov, A. A. Vishnevsky, N. V. Konovalov, and others). Although errors have been allowed in a series of cases and the use of sleep therapy for certain diseases is insufficiently substantiated, this type of scientifically grounded therapy has been definitely accepted for practical use. During the forty-year period, still another aspect of higher nervous activity has been successfully investigated, namely the central nervous system's actual role in compensating for damage and its compensating role in the development of pathologic processes (A. D. Speransky, E. A. Asratyan, P. K. Anokhin and colleagues). Research on the phenomena of nervous system plasticity and on certain general patterns of disturbed function compensation has made possible the extensive application of purely physiological aspects to practical, clinical problems and needs, particularly those of neurosurgery.

A particularly important branch of I. P. Pavlov's work was his position regarding the second signal system. I. P. Pavlov conceived the main theories and outlined their further development as a specific problem, which would help show the extent to which the basic principles of animal higher nervous activity apply in human higher nervous activity.

The intensive development of research on the second signal system after the joint session considerably deepened and broadened our knowledge of the characteristics of human higher nervous activity (A. G. Ivanov-Smolensky and colleagues, K. M. Bykov and colleagues, N. I. Krasnogorsky and colleagues). It can now be considered that firm, if rudimentary, foundations have been laid for the comprehension of human higher nervous activity. This aspect of research on higher nervous activity, only the principal outlines of which were suggested by I. P. Pavlov, has been entirely developed over the last 40 years.

Important results have also resulted from the research accomplished in the region of nervous system age physiology (N. I. Krasnogorsky, A. G. Ivanov-Smolensky, A. A. Volokhov, A. A. Markosyan, A. N. Kabanov, N. M. Shchelovanov and colleagues and others).

These studies disclosed the principal features of higher nervous activity in children, as well as the genesis of the second signal system. Many of the results from these studies have been utilized in pediatric practice.

Finally, there is yet another important aspect of higher nervous activity research which did not exist at all forty years ago and has been developed during this forty-year period. We have in mind the use of electroencephalography to examine certain features of higher nervous activity.

These studies developed rapidly after their initiation thirty years ago and soon took definite shape. This research in the Soviet Union was developed by comparing electroencephalographic data with those obtained by the conditioned reflex method. Certain foreign scientists (Gasto) have now adopted this up-to-date method.

Thanks to the works of many scientists (S. A. Sarkisov, L. G. Trofimov, M. N. Livanov, E. A. Zhirmunskaya, V. S. Rusinov, I. S. Beritashvili and colleagues, A. B. Kogan, G. V. Gershuni and colleagues and others), adequate correlations have been established between electroencephalographic changes and higher nervous activity in animals, and valuable new data has been obtained.

Finally, one must observe that scientists working in this field (L. G. Trofimov, O. S. Adriapov, S. Ya. Rabinovich and others) have obtained significant results by comparing electroencephalographic changes with the delicate morphology of the cerebral cortex as well as with higher nervous activity.

The extensive development of the works most characteristic to Soviet physiology, i.e., those on the physiology and pathology of higher nervous activity, has been paralleled by the development of research on the general physiology of the central and peripheral nervous systems. The amount of work accomplished in this field is enormous, and significant progress has been made over this forty-year period.

To begin with, the studies directed toward the development of N. E. Vvedensky's ideas have assumed great importance during the last forty years. His highly talented pupil, the outstanding physiologist A. A. Ukhtomsky, developed research on lability and introduced an extremely important principle of nervous coordination – the principle of the dominant. This principle is very important to the dynamic understanding of Sherrington's laws of nervous coordination. It has been adopted by a wide circle of pathophysiologists and is often used to explain the mechanisms of pathologic processes (A. D. Speransky, A. N. Magnitsky, I. A. Arshavsky and others).

The works of the Leningrad University school of physiologists (N. V. Golikov, E. K. Zhukov, P. O. Makarov, L. V. Latmanizova, Yu. M. Uflyand, L. L. Vasilyev, F. P. Petrov, D. N. Lapitsky, V. E. Delov, I. A. Arshavsky and many others) developed an unusual and original approach to the study of the excitation and inhibition processes involving the extensive use of the parabiotic theory to explain excitation and inhibition processes in all parts of the nervous system. However, certain concepts developed by this school (the notion of the role played by perielectrotonic changes in the activity of the nervous centers and the idea of impulseless signalization) still need extensive experimental verification.

During the years of Soviet rule, neurophysiology has grown and improved, encompassing a wide circle of problems resulting from the study of both the general rules of central nervous system activity and the specific physiology of its different sections. The numerous works of a series of Soviet physiologists (D. S. Vorontsov and

colleagues, I. S. Beritashvili and colleagues, L. A. Orbeli and colleagues, P. A. Anokhin and colleagues, N. A. Rozhansky, E. A. Asratyan and colleagues, N. F. Popov and colleagues, N. A. Yudenich, F. N. Serkov, D. G. Krasov, P. E. Motsny, D. M. Gedevani and others) have investigated specific physiological problems regarding various sections of the nervous system and suggested general conclusions from the results obtained.

Specifically, we should like to mention the development of the physiology of the cerebellum and the study of how this section of the central nervous system influences the vegetative processes, also, the study of the dynamic localization of functions in the spinal cord and the theory developed by I. S. Beritashvili concerning the neuronal-neurophilic structure of the nervous system. Although I. S. Beritashvili's views have been subject to criticism, an attempt to comprehend the function of the central nervous system as a whole cannot be ignored. The point is that, as early as 1936 and 1938, I. S. Beritashvili introduced the idea concerning the regulating significance of the reticular formation, anticipating subsequent studies in this direction. Note should be taken of P. K. Anokhin's studies on the interrelations of the center and periphery, as they enabled him to introduce a series of original theories regarding the mechanisms of integration.

The important works of E. A. Asratyan on the dynamic localization of functions in the spinal cord and describing the consequences of total resection of the cerebral cortex are well and widely known.

Finally, we wish to mention the extensive research which has been done (L. A. Orbeli and colleagues) on the physiology of the sympathetic nervous system. The adaptation-trophic theory of sympathetic nervous system activity has been very important to the comprehension of the functions of this section of the nervous system. The data obtained by L. A. Orbeli's school is particularly important now in the light of new data obtained by foreign scientists showing the efferent influences on the function of the receptors.

L. A. Orbeli's development of the evolutionary approach to the analysis of physiological processes and the work done by K. M. Bykov on the problem of the functional interrelations between the cerebral cortex and internal organs are among the most outstanding theoretical contributions to this past period.

The well-known works of K. M. Bykov and his colleagues, continuing and developing the ideas of I. M. Sechenov and I. P. Pavlov, have created a new chapter in contemporary physiology, closely associated with contemporary practical medicine. The works of K. M. Bykov have demonstrated the influence of the cerebral cortex on the condition of the body viscera (and therefore, how the internal condition is affected by the outer world) and also how cerebral cortex activity is influenced by the internal condition of the body. This established a firm foundation for the clinical study of vegetative neuroses and made it possible to suggest the corticovisceral theory in a series of illnesses. Although this theory cannot be considered to be a universal "theory of medicine," in many cases it is very useful in understanding the pathogenesis of certain diseases and can help in their treatment.

Among the outstanding workers in neurophysiology, A. F. Samoilov and N. A. Mislavsky must be gratefully named. The brilliant experimentor, A. F. Samoilov, made an important contribution to research on spinal cord coordinations, and N. A. Mislavsky, who founded the extensive school of physiologists in Kazan, enriched science with magnificent studies on the vegetative nervous system and on nervous regulation of vascular tonicity.

We should mention that A. F. Samoilov was one of the first to express the idea that stimulation in neuromuscular synapses is chemically transmitted.

The studies of L. S. Shtern and her colleagues have contributed much to research on the stability of internal body conditions. Although these works contained some exaggerations (which have been criticized) in their development of ideas concerning the hemato-encephalic and histohematic barriers, they did play a definite part in the development of our opinions on nervous system nourishment and indicate new methods of directed action on its function.

Much has been done during this period toward the formulation of a general theory of stimulation. As well as the above-mentioned achievements of the Vvedensky-Ukhtomsky school, there have been attempts to discover the very nature of the excitation process (D. N. Nasonov, Kh. S. Koshtoyants). The enzymo-chemical theory of excitation introduced by Kh. S. Koshtoyants was valuable as an attempt to connect physiological and biochemical processes.

The brilliant studies of D. N. Nasonov, V. Ya. Aleksandrova and their colleagues A. S. Troshin and B. P. Ushakov deserve special note as they developed and proved a new, denaturation theory of stimulation. The importance of these studies should be especially clear from the fact that this theory is successfully competing with the well-known membranous theory of excitation, almost universally accepted abroad.

Finally, an equally important role in the development of ideas concerning the transmittance of nervous excitation was played by the studies of a group of Soviet scientists on mediators of nervous excitation (L. A. Orbeli, K. M. Bykov, A. V. Kibyakov, A. G. Ginetsinsky, I. P. Razenkov and colleagues and M. Ya. Mikhelson).

During the past forty years, the physiology of the sensory organs has been extensively studied in Soviet physiology. There was practically no research in this important field in Russia before the Great October Socialist Revolution, if one excludes the studies and famous traditions left by I. M. Sechenov. Thanks to the combined efforts of many researchers (L. A. Orbeli, L. A. Andreev, S. V. Kravkov, G. V. Gershuni, P. O. Makarov, N. I. Grashchenkov and colleagues, P. G. Snyakin, A. V. Lebedinsky), important information on the physiology of the sensory organs has been obtained. The sciences of physiologic optics and acoustics, which are now separate and independent divisions of physiology in our country, are based on these studies.

Important progress has also been made during the last 40 years in the development of ideas concerning the nervous regulation of functions. The length of this paper does not permit us to summarize here the enormous number of works done in this field during the past 40 years.

The systematic study of the physiology of digestion has become a tradition of Soviet physiology. During this forty-year period, much important data has been accumulated on the nervous regulation of digestive tract activity (K. M. Bykov and colleagues, I. T. Kurtsin and colleagues, A. N. Bakuradze and colleagues, G. V. Folbort and colleagues), especially data regarding cortical influences; valuable information has also been obtained on the physiology of human digestion by means of observations on people with operative fistula. K. M. Bykov's theory on the gastric secretory fields has found clinical approval.

The broadly conceived and successful studies of I. P. Razenkov and a group of his colleagues have enriched our knowledge of digestive changes caused by lowered barometric pressure, and I. P. Razenkov's significant monograph, "New Data on the Physiology and Pathology of Digestion" raised and solved many questions on neuro-humoral regulation of digestive tract motor and secretory activity.

These studies, which were conducted in close association with the clinic, found the answer to a series of clinical problems and should be regarded as a definite chapter in the study of the physiology and pathology of digestion.

We should also mention the important results obtained from research on metabolism and on the physiology of nutrition (O. P. Molchanova, G. K. Shlygin and colleagues). The works of this collective made possible the scientific development of a series of medicinal diets and regimes.

The famous legacy in the study of nervous regulation of circulation left to us by I. P. Pavlov has been developed considerably in the past forty years (A. I. Smirnov, V. V. Parin, A. P. Polosukhin, N. A. Mislavsky, G. P. Konradi, M. E. Marshak, K. M. Bykov, M. G. Udelnov, I. N. Davydov, P. M. Starkov). These studies furnished new and valuable facts on nervous regulation of heart activity and made it possible to study cortical regulation of cardiac and vascular activity, to solve the problem regarding the reflex autoregulation of circulation both as a whole and in separate vascular regions (brain, heart), as well as to obtain important data concerning the vasomotor regulation of individual organs.

V. N. Chernigovsky and his colleagues studied in detail the influences of the various reflexogenic zones on circulation, respiration, the blood system and the locomotive functions; they established the basic pattern of these reactions, made an electrophysiologic analysis of the afferent impulses from the interoceptors and showed the corticocerebral zones related to the latter.

We wish to mention, however, that research on the problem of "pure" hemodynamics has not made much progress due to the greater attention given by physiologists to the problem of nervous regulation of circulation. Only recently have successful attempts been made to work out this problem systematically (V. V. Parin, E. B. Babsky).

Soviet physiologists have made definite progress in the study of respiration regulation. Thanks to the efforts of various collectives directed by M. V. Sergievsky, M. E. Marshak, L. L. Shik and others, valuable data have been obtained on the physiology of human respiration during labor and athletic activity. M. V. Sergievsky discovered important facts concerning central regulation of respiration and studied in detail the activity of the respiration center.

Valuable data on the condition of the respiration in patients from whom part or all of a lung had been removed were obtained by P. K. Anokhin and his colleagues.

Proven results were obtained by Soviet physiologists from research on the nervous regulation of excretion. The works of many researchers (G. M. Shpuga and colleagues, K. M. Bykov and colleagues, L. A. Orbeli and colleagues, etc.) examined the mechanisms of nervous and hormonal regulation of kidney activity. These studies made it possible to explain many features of kidney participation in the general system of neuro-humoral body regulations. Some attention has also been given to the problems involved in the physiology of urine excretion. In this context, we note the extremely important work conducted by A. G. Ginetsinsky and colleagues, who are progressively and successfully developing this difficult division of physiology.

There is still another aspect of physiology which has been developed during the past forty years – age physiology. Through the efforts of several scientists in this field (I. A. Arshavsky, A. A. Volokhov, L. A. Orbeli and colleagues, A. G. Ginetsinsky, A. A. Markosyan, N. I. Kasatkin and others), the ontogenic formation of the motor apparatus and that of several vegetative functions have been successfully traced.

These valuable studies established scientific facts on which physical education and hygienic measures could be based.

Finally, during the years of Soviet rule, the physiology of sport and labor has been developed through research (D. Slonim, V. S. Farfel, N. K. Vereshchagin, G. P. Konradi, S. A. Kosilov, N. V. Zimkin, K. M. Smirnov and others). However, although knowledge of the physiology of sport has advanced considerably, the progress in the study of labor physiology leaves much to be desired.

During the years of Soviet power, active research work by physiologist collectives was instituted in the national republics and is now being carried on. In Uzbekistan, a large collective of physiologists are actively developing the studies of A. Yu. Yunosov. A. I. Karaev and a group of associates are conducting extremely vital work in Azerbaidzhan. The work of Turkmen's A. I. Venchikov in electrogastrography is well known. In Kazakhstan, there is A. P. Polosukhin, who founded and trained large research collectives and published many valuable studies on age physiology and on the physiology of the lymphatic system. V. L. Lashas is directing the energetic development of research in Lithuania, as E. G. Kyaer-Kingisep is doing in Estonia. In the Tatar Republic, where such outstanding physiologists as N. A. Mislavsky and A. F. Samoilov worked, much research has been done on the chemical transmittance of nervous impulses under the direction of A. V. Kibyakov. In Kirgiz, A. D. Slonim, G. P. Konradi and S. M. Dionesov have made great contributions to the development of physiologic research.

In Belorussia, work has been energetically developed by A. A. Zubkov, I. A. Vetokhin and I. A. Bulygin, who heads the USSR Academy of Sciences Institute of Physiology. A. A. Zubkov has done much work in Moldavia, and, in Armenia, a group of physiologists (R. Kh. Bunyatyan, G. P. Oganesyan and many others) are engaged in investigating problems of higher nervous activity, as well as of nervous system physiology and cortico-visceral physiology. In Latvia, research on hemodynamics is being directed by N. V. Danilov, who was largely responsible for training Uzbekistan's national cadre of physiologists.

In Bashkir, V. V. Petrovsky is conducting effective research on the physiology of the lymphatic system.

In the Ukraine, I. P. Pavlov's pupil, G. V. Folbort, and A. M. Vorobyev, whose untimely death we mourn, have turned out a massive work on the physiology of digestion.

Of course, in a brief summary such as this, we cannot begin to cover the mass of research which has been carried out and the many separate problems which have been solved by Soviet physiologists during this period. Due to the wide range of research and the ever increasing number of physiologists, physiology will continue to progress in the Soviet Union.

In summarizing the development of physiology, we have involuntarily touched upon certain questions of pathologic physiology. This shows the close association of these two branches and their genetic affinity.

Actually, one of the first pathophysiologists in pre-revolutionary Russia, V. V. Pashutin, was a student of I. M. Sechenov. I. P. Pavlov also left us brilliant examples of work in pathology and founded a new branch of pathophysiology – the pathology of higher nervous activity.

The general pathology set forth in the works of V. V. Podvysotsky, L. A. Tarasevich, A. I. Talyantsev and A. B. Fokina definitely influenced the works and research of Soviet pathophysiologists active in the post-revolutionary period.

Until recently, pathologic physiology was only taught as a separate and specific branch of science in the USSR. In other countries, this branch was combined with either physiology or pathologic anatomy.

During the years of Soviet power, certain outstanding original lines of work were initiated, broadly developing various problems of pathologic physiology.

The ideas of neurism found brilliant and original expression in the works of Academician A. D. Speransky, his students and followers.

His study of the nervous system's role in the development of infectious processes, his extensive development of the question of nerve trophics and his analysis of the dystrophies have placed A. D. Speransky in the front rank of world scientists developing questions of general pathology. His conception of the correlations between the specific and nonspecific effects of stimuli was of great practical use. A scientific basis was established for methods of nonspecific therapy, some of which have long been in practical use.

Ideas introduced by A. D. Speransky made possible the re-evaluation of the part played by the nervous system in body immunology and reactivity. His theories on the mechanisms of disease, convalescence and health and on subsequent reactions are an outstanding contribution to the science of disease and have brought him great fame here and abroad.

The research directed by N. N. Anichkov deserves an honorable place in the development of Soviet pathophysiology. He introduced and perfected the contemporary conception of atherosclerosis – an outstanding contribution to science. The experimental resolution of the atherosclerosis problem made it possible to evolve the practical prophylactics, treatment and diagnosis of this disease (G. F. Lang and colleagues, A. L. Myasnikov and colleagues). N. N. Anichkov obtained interesting data from a study on the problem of auto-infection.

I. P. Petrov, P. N. Veselkin and P. P. Goncharov have done important work on the pathology of circulation, the role of the nervous system in the pathogenesis of fever, shock and oxygen deficiency. Finally, the important research done on reactivity and narcosis by V. S. Galkin, who untimely death we mourn, and his colleagues, I. I. Fedorov, A. G. Bukhtiarov and others, must be mentioned.

A. A. Bogomolets occupies an outstanding place in the development of Soviet pathophysiology, as do his colleagues and students (N. N. Siritonin, N. B. Medvedeva, N. N. Gorev, R. E. Kavetsky, R. E. Perelman, Ya. G. Uzhansky and others). A scientist of great scope, he worked out a wide circle of problems – immunity, anaphylaxis, the pathogenesis of shock, questions of constitution, endocrinology, the problem of aging, the problem of blood transfusion and many others. The theory he introduced regarding the role of the active mesenchyme in the realization of a series of physiologic body functions was further developed by his students and colleagues.

The problem of physical reactivity, research on which was based on the studies of I. I. Mechnikov on immunological reactivity, also occupies an extremely important place in the works of Soviet pathophysiologists. This line of research was developed in the work of A. A. Bogomolets and his school (N. N. Sirotinin, I. M. Neiman, R. E. Kavetsky, N. B Medvedeva, R. E. Perelman and others). Important in this context were the studies of G. P. Sakharov, who was one of the first to establish several properties of allergy manifestation (Arthus-Sakharov phenomenon). The influence of the nervous system on the body and the ways in which the body manifests reactivity in a series of pathologic processes were studied by A. D. Speransky and his colleagues, A. D. Ado, D. E. Alpern, V. V. Voronin, A. N. Gordienko, S. M. Pavlenko, Ya. M. Britvan, N. N. Zaiko and others.

The idea introduced by Soviet pathophysiologists concerning the evolution of the body's defense mechanisms is of great importance (A. A. Bogomolets, N. N. Sirotinin and others). This evolutionary approach made possible a better understanding of how certain of the body's defense functions develop.

Finally, we wish to mention the important part played by A. A. Bogomolets in the development of endocrinology in our country.

The problem of functional compensation is closely connected to the problem of reactivity. Investigation of this problem has also been conducted from the point of view that the nervous system plays the leading role. More and more researchers are studying this problem, examining the mechanism and character of compensation in different disturbances (infection and immunity – A. D. Ado, G. V. Peshkovsky; fever – P. N. Veselkin; injured nervous system – E. A. Asratyan, S. Frankshtein; respiratory disturbance – Ya. M. Britvan; loss of blood – R. A. Dymshits, R. E. Kavetsky, D. I. Goldberg and others). Important places in the work of our pathophysiologists are also allotted the study of inflammation (A. A. Bogomolets, D. E. Alpern, A. D. Ado, V. V. Voronin, T. A. Piontkovsky, I. M. Neiman, I. A. Oivin and others) and that of malignant tumors (A. D. Timofeevsky, R. E. Kavetsky and others). Much research investigating the effect of specific factors (electric current, radiant energy) on the body has been conducted by G. L. Frenkel, P. D. Gorizontov and others. Extremely important data on the pathophysiology of the reflex interrelations of the internal organs have been amassed by S. S. Poltyrev and his colleagues.

Soviet pathophysiologists have done work of great practical significance on the problems of hypnoxia and traumatic shock. These problems, as well as blood transfusion methods, were studied by I. R. Petrov, N. N. Sirotinin, N. A. Fedotov, M. E. Marshak, R. E. Kavetsky, A. N. Gordienko, Ya. G. Uzhansky, G. A. Ionkin and others.

The works of G. P. Sakharov, S. S. Khalatov, S. M. Leites, A. M. Charn, S. G. Genes, N. B. Medvedeva and others have done much to develop research on the pathology of metabolism and endocrine regulations.

The groundwork for solving the problem of physical resuscitation has been laid by works of Russian physiologists and pathophysiologists (A. A. Kulyabko, F. A. Andreev). This division of pathophysiology has grown particularly during the years of Soviet rule. V. A. Negovsky and his colleagues studied the basic rules for the removal and restoration of the body's vital functions and created a complex method for treating patients in a critical condition which proved to be of great practical use.

The study of the problems of external pathology is an essential stage in the development of pathologic physiology (M. N. Khanin, O. S. Glozman and others).

The pathogenesis of radiation sickness has been extensively studied by pathophysiologists (P. D. Gorizontov, I. A. Piontkovsky and others). The part played by the nervous system and by the toxic factor has been investigated, and the change in the hematopoietic system and metabolism has been studied as well as the role of the endocrine glands in radiation sickness. Much new data has been already obtained which make it possible to solve certain questions regarding the pathogenesis of this disease. The problems of radiation sickness are attracting more and more attention from pathophysiologists, whose efforts are concentrated in two directions – on one hand, toward the development of the prophylactics and experimental therapy for radiation diseases, and, on the other hand, toward the explanation of the mechanical basis for the therapeutic effect of the radiation factor in a series of pathologic processes.

In 1950, the All-Union Society of Pathophysiologists was organized, uniting the many divisions and departments in different corners of our country. During the forty years of Soviet rule, the number of pathologic physiology departments in the medical institutes has increased considerably. Recently, thanks to the help and support of Soviet Union pathophysiologists, pathologic physiology departments have been included in a series of medical institutes in the countries of the People's Democracy: China, Czechoslovakia, Albania, German Democratic Republic, Bulgaria, Viet Nam and others.

During the years of Soviet power, a new division of pathophysiology, experimental oncology has been developed and instituted as an independent branch of science. Now this new branch has become a border zone in science, attracting the attention of immunologists and biologists as well as that of pathologists.

As early as 1924, A. A. Bogomolets, one of the most outstanding scientists of our country, introduced the theory that malignant tumors cannot develop in a body when that body's active mesenchyme retains its normal resistance. The function of the active mesenchyma is reduced by age, metabolic disturbances, endogenic and exogenic intoxications and incretion disorders.

A new and original trend in experimental oncology was developed in A. D. Speransky's collective (S. I. Lebedinskaya, A. A. Solovyev and others). This trend is genetically connected with the observations of M. K. Petrova, who experimented with the effect of animal neurotization on malignant growth and shows the importance of the nervous system to tumorous growth and metastasis, thereby connecting this "uncontrollable" growth also with the theory of neurism.

R. E. Kavetsky, his students and colleagues have also recently accumulated much data indicating the role of central nervous system disturbances in the pathogenesis of malignant tumors.

The works of N. N. Petrov, the oldest oncologist of our country, made a real contribution to the development of Soviet oncology. His polyetiologic theory of malignant tumor development has found many advocates both here in the Soviet Union and abroad. This theory contained much that was valuable and useful to the problems concerned with explaining the nature of cancerous diseases and was also helpful in the prevention of the so-called occupation cancers.

A very important step was the work of L. F. Larionov, which is being intensively developed. His trophic theory of malignant tumor development is based on the idea that malignant changes can be considered as an adaptive metamorphosis phenomenon of the tissues of higher organisms. Scientists like A. D. Timofeevsky, L. A. Zilber, L. M. Shabad and their students have also made great contributions to research on the etiology of malignant tumors.

An outstanding contribution was made by A. D. Timofeevsky in his works on prolonged cultivation of human tumors which indicated the possibility of the differentiation of malignant cells in a tissue culture. At the same time, A. D. Timofeevsky introduced many new facts germane to the problems of malignant tumor etiology. With the help of the tissue culture and the electron microscope methods, the very important fact that virus-like corpuscles are present in cultures of certain human tissues was established in his laboratory.

L. A. Zilber has done much work on the problems concerning the viral etiology of tumors. He showed that, in certain tumors – Rous's chicken sarcoma and Shope's rabbit papilloma, for example – there are two specific antigens, the tissue and the virus antigens, which are not present in the tissues of healthy bodies. He and his colleagues conducted systematic studies in order to isolate the virus source in other tumors. These data could be very important to the resolution of cancer immunology problems.

L. M. Shabad made a significant contribution to Soviet oncology. He showed that in certain organs and tissues, there are endogenic blastomogenic substances which can cause a tumor to form when introduced into an animal's body. He also developed the idea of a malignancy factor which is detachable from the tissues. Research on carcinogenic substances has been very helpful to cancer prophylactics, since it has made it possible to determine and remove carcinogenic agents from the environment in time, especially the chemical carcinogenic substances.

Lately, Soviet scientists have begun to develop theoretically and experimentally a new branch of the medical-biological division of medicine. N. N. Zhukov-Verezhnikov, I. N. Maisky, P. N. Kosyakov and V. S. Gostev have made significant contributions to this branch. Anti-cancer serums which react in immunological reactions only with the cancer antigen and not with any other antigen have been obtained.

Recently, research in experimental vaccination against malignant tumors has been developed.

Certain new anti-tumor preparations compounded by Soviet scientists (dopan, sarcolysin,* certain antibiotics, etc.) have had notable clinical success.

Observations made on patients treated with dopan make it possible to consider the recommendation of this product for introduction into practical medicine as a treatment for lymphogranulomatosis and the leukoses. Sarcolysin is most effective in the treatment of such tumors as seminomas.

In spite of these achievements, however, the problem of how to treat cancer patients is still far from being decisively solved. Although progress has been made in research on the nature of malignant tumors, why

* Russian trade name.

they occur and how they may be recognized, the treatment of tumors is still one of the main problems of medical science.

In connection with the study of malignant growth immunology, a new medical-biological department has been formed and developed – the immunology of normal and pathologic growth of cells and tissues (non-infectious immunology).

The research done by the main divisions of this department has recently been concentrated in the USSR Academy of Medical Sciences Institute of Experimental Biology. To this institute are referred: embryogenic immunology, research on the immunological mechanisms of tissue incompatibility in transplantations and combinations and the above-mentioned immunology of malignant growth (N. N. Zhukov-Verezhnikov, I. N. Maisky, P. N. Kosyakov, V. S. Gostev, O. E. Vyazov and others). In the course of this research, the presence of immunological interrelationships during the development of both normal and pathologic cells was established to be the general rule. These interrelationships distinguish certain aspects in the development mechanisms of normal cells and underly a series of pathologic phenomena. At the same time, other branches of the new department have been organized to study, for example, the immunology of radiation sickness, the immunology of blood groups and types, etc. Recently, noninfectious immunology has become an important division of not only pathology but experimental biology as well.

In pre-revolutionary Russia, animal biochemistry as a more or less developed science did not exist. There were few scientific workers in biochemistry, although there were some laboratories in Leningrad, Moscow and Kharkov which worked with problems of animal biochemistry and were headed by outstanding scientists (B. I. Slovtsov, S. S. Salazkin and E. S. London in Leningrad, V. S. Gulevich in Moscow and A. V. Palladin in Kharkov). During the first years after the revolution, the rate of biochemistry development in the USSR was mainly determined by the speed with which biochemists could be trained. Active in this task were the laboratory of V. S. Gulevich, part of the Moscow University Department of Medical Science, the Biochemical Institute of Narkomzdrav, organized soon after the revolution under the direction of the outstanding biochemist, Academician A. N. Bakh, and the Ukrainian Biochemical Institute in Kharkov, headed by Academician A. V. Palladin. These laboratories and institutes became the main biochemical schools in the Soviet Union, which produced the most prominent biochemists whose works commanded universal recognition. Somewhat later, a similar school of young cadres was established at the Biochemical Department of the All-Union Institute of Experimental Medicine in Moscow, which was subsequently reorganized to become the USSR Academy of Medical Sciences Institute of Biological and Medical Chemistry. Thanks to these scientific institutions, biochemistry in the USSR began to rapidly overtake the leading countries of Europe and America in this field in respect to both the scope and significance of research and gained a prominent place in world biochemistry.

Early in the thirties, the aerobic resynthesis process connected with cellular respiration of adenosine triphosphoric acid (oxidizing phosphorylation) was discovered by Academician V. A. Engelgardt – a most important discovery. Subsequently, the problem of oxidizing phosphorylation became one of the central problems of biochemistry; V. A Belitser particularly obtained very important data on this problem. At the end of the thirties, V. A. Engelgardt and M. N. Lyubima made another outstanding discovery. They established that the protein myosin, which is responsible for muscle contraction, has the same properties as the enzyme adenosinetriphosphatase (ATP), i.e., that myosin catalyzes the reaction liberating the energy-rich phosphate from ATP, which reaction represents the proximate source of muscular contraction energy. The immense significance of this fact to the physiology of muscular contraction became particularly clear when, after this (V. A. Engelgardt and colleagues), it was established that myosin does not only break down ATP but is itself affected, changing its mechanical and physicochemical properties upon its combination with ATP.

These works initiated a new field of research which was called "the mechanochemistry of the muscle."

D. L. Ferdman established the presence of a specific enzyme, closely linked with myosin, which possessed the ability to deaminize the adenylic acid which forms when ATP is split up; A. M. Utevsky did work of great merit when he solved the important problem of adrenalin and sympathin metabolism in the body.

I. I. Ivanov also conducted research of great importance on the biochemistry of the contractions of various organs.

Of exceptional importance to biochemical research on nitrogen metabolism was A. E. Braunshtein's discovery in 1937 of the reaminization process of amino acids and his subsequently formulated theory concerning

the integration of the intermediate nitrogen metabolism in the animal body. The importance of the reaminiza tion process discovery to the development of the most important problems of nitrogen metabolism becomes more evident each year.

The research of Academician A. V. Palladin and his colleagues deserves an important place in the biochemistry of the central nervous system. The results he obtained from his many years of research studying the chemical composition of morphologically and functionally different parts of the brain and the rules he discovered in the processes of substance metabolism attending the stimulation and inhibition of nervous system functions are the basis for all contemporary central nervous system biochemistry. An important contribution was made by the studies on the biochemistry of the nervous system which were carried out in laboratories under the direction of G. E. Vladimirov. These works explained several pressing questions concerning the metabolism of nucleinic acids and other compounds in the brain and in other sections of the central nervous system.

The research in the field of muscular extractive substances which made V. S. Gulevich world famous continued to be effectively developed in V. S. Gulevich's laboratory even after the revolution. Here we wish to mention N. F. Tolkachevsky's discovery of anserine, concurrent with but independent of Akkerman's discovery of it. After the death of Academician V. S. Gulevich, the leading place in world literature on muscle extractives was taken by the works of S. E. Severin, who conducted extensive research on carnosine and anserine metabolism in the muscles and the role of these compounds in muscle function.

Research on the chemistry and biochemistry of protein began to be rapidly developed in the Soviet Union during the thirties. The works of D. L. Talmud, S. E. Bresler and A. G. Pasynsky on the chemistry and physicochemistry of protein are widely known. V. N. Orekhovich discovered a new type of connective tissue proteins which was called "procollagens." These studies attracted the prolonged attention of many outstanding scientists in different countries, and recently, the question of the role and function of the procollagens has become the subject of lively discussion. Research on protein metabolism with different physiologic and pathologic conditions of the body has developed very rapidly. S. R. Mardashev and his colleagues conducted extensive and profound research on the metabolism of aspartic acid, asparagine and other amides of amino acids in bacteria and in animal bodies; new methods of determining these compounds were developed and their role in the processes of nitrogen metabolism in the body explained.

In works conducted by S. Ya. Kaplansky and his colleagues investigating the mechanism of metabolic disturbance in protein deficiency, much light was thrown on the pathogenesis of disorders due to different forms of exogenic and endogenic protein deficiencies and the changes in the metabolism of the amino acids and other compounds underlying these pathologic phenomena were explained. Extremely important work has also been done explaining the changes in the interrelations between blood serum and liver proteins in various diseases.

B. I. Zbarsky and A. I. Parshin, Yu. M. Gefter conducted extensive research on protein and amino acid metabolism in various tissues, which helped to explain the mechanism of metabolic disturbances in various diseases, especially in malignant neoplasms.

Recently, research in the chemistry and biochemistry of various hormones, a branch of research which has been relatively neglected in the Soviet Union has made progress, especially where the hormones of the suprarenal cortex are concerned. In this context, we must note the studies conducted by N. A. Yudaev in the USSR Academy of Medical Sciences Institute of Biological and Medical Chemistry, which have already given results valuable to the explanation of the synthesis mechanism of various corticosteroids in animal bodies.

Finally, we must mention the important work in the field of comparative biochemistry directed by E. M. Kreps.

From the data presented, it is clear that animal biochemistry has developed rapidly in the Soviet Union since the revolution and that it has been of much help in solving various important questions of physiology, pathology and medicine.

In this short outline, it is difficult to give a sufficiently comprehensive description of how Soviet pharmacology has developed over this forty-year period. In order to give a general idea of the trend of this development, we shall limit outselves to a description of the main problems which confronted pharmacologists during this period, which largely determined the course of pharmacological development as well as the present state of pharmacology.

The development of Soviet pharmacology is closely linked with the name of one of its founders, N. P. Kravkov. Much attention was given in his works to the problems of research methods, especially methods of isolating organs. These studies were not an end in themselves; they were only a necessary stage in the process of solving the main problems. Based on these studies, a series of interesting works were subsequently completed which examined an isolated heart, isolated endocrine glands, coronary and other vessels and also treated the smooth musculature (intestines, uterus) and other objects. The data obtained from these studies established a series of important rules for the change in the reactivity of various animal (and human) organs under different experimental conditions. N. V. Kravkov's work was further developed in research conducted by V.V. Savich, G. L. Shkavera, M. I. Gramitsky, A. I. Kuznetsov, S. V. Anichkov, V. V. Zakusov, B. V. Sentyurin, S. Ya. Arbyzov and others.

During the past forty years, special attention has been given to the development of the pharmacology of the nervous system (V. V. Zakusov, S. V. Anichkov and colleagues). For this purpose, it was found necessary to investigate the reactivity of separate sections of the reflex arc in different pathologic conditions and to study the pharmacological effect on the disease process when the pathologic impulses in various sections of the reflex arc are weakened or temporarily removed; gangliolytics, spasmolytics, curare-like substances, neuroplegic substances, anesthetizing substances and others have been investigated in this connection (S. V. Anichkov, V. V. Zakusov, M. Ya. Mikhelson, V. A. Sanotsky).

Still another field of pharmacological research must be mentioned – one which I. P. Pavlov considered very important. This is experimental therapy. This field has been successfully and productively developed in different directions (A. I. Cherkes, V. A. Sanotsky, P. V. Rodionov, N. V. Lazarev, S. Ya. Arbuzov and others).

As well as the study of different medicinal preparations in conditions of "pathologic pharmacology," research on the combined effect of such medicinal preparations is very important from both the theoretical and practical points of view. Much interesting and useful work has been done in this connection (Ya. Kh. Nolle, K. D. Sargin, V. V. Vasilyevich, M. P. Nikolaev, N. V. Lazarev and others).

Questions of age pharmacology have also been investigated in the works of Soviet scientists (I. S. Tsitovich, I. A. Arshavsky and others).

Another branch of pharmacology, experimental chemotherapy, has made great progress. Many preparations for the treatment of various infectious diseases have been obtained and examined (P. F. Gauze, Z. V. Ermoleva, Sh. D. Moshkovsky, G. N. Pershin, Kh. Kh. Planelyes and others).

Toxicology has developed parallel with pharmacology. In works by several Moscow, Kiev, Leningrad and Kharkov scientists, extremely important general rules for the toxic effect of chemical substances have been partially established, and a considerable number of individual examples have been studied in the plan (A. A. Likhachev, S. V. Anichkov, A. I. Cherkes, Z. M. Yavich, V. A. Sanotsky, N. V. Lazarev, Yu. V. Drugov, D. Ts. Zakutinsky, N. S. Pravdin and many others).

The results effected by the pharmacological use of medicinal substances and poisons are undoubtedly influenced to a high degree by the internal conditions of the body. Biochemical research has long been conducted in order to develop this aspect of the question, as well as to discover the way in which the effect of such medicinal substances on the body is realized; biophysical and electrophysiological research has recently also been conducted for this purpose. Many interesting and extremely important findings were obtained from these studies. This research is still being developed and is gradually increasing in range (V. V. Savich, V. I. Skortsov, A. I. Cherkes, V. M. Karasik, G. V. Vasilyeva, G. N. Pershin, G. A. Ponomarev, M. A. Angarskaya, K. A. Shmelev and others).

We had no native pharmaceutical industry before the revolution; the large majority of medicinal preparations came from neighboring countries. We now, however, have several pharmaceutical factories and, more important, a few chemicopharmaceutical institutes, which are systematically working out problems of pharmaceutical chemistry – the Ordzhonikidze All-Union Institute for Scientific Research in Chemicopharmaceutics (VNIKhFI) in Moscow, its affiliate in Sverdlovsk and similar institutes in Kharkov and Tbilisi. Moreover, a great deal of interesting work is being done in other institutions on the synthesis of medicinal substances – in the USSR Academy of Sciences, in the Armenian SSR Academy of Sciences, etc. Much work has been done on the utilization of medicinal substances extracted from plants.

To show how effectively work has developed in this field, we can only mention that the Pharmacological Scientific Committee of the USSR Ministry of Public Health Medical Council has authorized the issue of more than 600 preparations in the last five years alone.

To accomplish all this, great and profound work has been required on the chemical synthesis of various types of chemical compounds (R. M. Mndzhoyan, V. R. Khromov, N. S. Kochetkov and others).

Besides the mass of experimental and organizational work which has been done during the years of Soviet power, an immense amount of literary work has been accomplished. Textbooks, practical handbooks, reference books, every kind of outline, manuals, etc. have been written.

Therefore, our native pharmacology has been developed during this period and has made great progress.

There are problems before experimental pharmacology, the solution of which is of both practical and theoretical importance. The primary mechanisms of pharmacological action, the mechanisms of pharmacological effect on the nervous regulation of functions, the mechanisms of changes in body reactivity induced by pharmacological substances and many other problems require more extensive investigation.

At the same time, work must be intensified on the search for and the examination of new, more effective medicinal substances from different series of chemical compounds for use in the treatment of angina pectoris, radiation diseases, malignant neoplasms, infectious diseases and other affections.

It would be extremely difficult to describe all the achievements made during the past forty years in experimental biology. Since experimental biology is a most extensive branch of science with numerous divisions, we will consider in this article only the part of experimental biology which can be termed medical experimental biology or which is definitely related to the latter.

We shall not, therefore, discuss the progress of the new "michurine biology" or what has been done to develop the evolutionary theory.

The answers to all the main questions concerning the other branches of experimental biology can be found on the pages of the special biological, botanical and zoological journals.

Soviet biology, like other branches of Soviet science, was developed from the famous traditions laid down in the pre-revolutionary period. The ideas of I. I. Mechnikov, the brothers Kovalevsky, K. A. Timiryazev and K. Ber were not only studied but developed by Soviet biologists. The materialistic traditions of Russian biology have matured and developed in the post-October period. This was aided by the organization of many specialized scientific research institutes during the early years of Soviet power. In 1917, the Institute of Experimental Biology was organized, later renamed the Institute of Cytology, Histology and Embryology. The Institute of Experimental Morphogenesis was active from 1930 to 1941 and in 1945 the USSR Academy of Medical Sciences Institute of Experimental Biology was organized. Besides this, there were several laboratories conducting research in experimental biology: the AN SSSR Laboratory of Experimental Zoology and Morphology, the Moscow Zoological Gardens Laboratory of Experimental Biology, several laboratories in the AMN SSSR Institute of Experimental Medicine, etc.

One of the first to organize research in experimental biology was N. K. Koltsov, who founded the Narkomzdrav Institute of Experimental Biology. In this Institute, physicochemical and embryologic studies were conducted. N. K. Koltsov himself is responsible for important research concerned with how the delicate structure of cells is affected by the chemism of their environment. Many prominent researchers, who were subsequently to head new directions in science, were closely associated with N. K. Koltsov (M. M. Zavadovsky, A. S. Serebrovsky, S. N. Skadovsky and others).

M. M. Zavadovsky, who did important work on the role of the internal secretion glands in the formative processes, had a real influence on the development of experimental biology in the USSR. M. M. Zavadovsky organized the Laboratory of Experimental Biology at the Moscow Zoological Gardens and the Chair of Development Dynamics at the Moscow State University, as well as teaching a course in experimental biology at the university for many years. He had numerous students and colleagues (L. Ya. Blyakher, M. A. Vorontsova, N. A. Ilyin, B. A. Kudryashov, I. A. Eskin, V. F. Larionov and others).

Thanks to their works and to the works of B. M. Zavadovsky and his co-workers, great progress was made in the experimental analysis of the postembryonal development processes, including metamorphasis and moulting.

Experimental embryology began to develop rapidly, in the thirties especially, and this rapid development was mainly due to the works of D. P. Filatov and his many students (V. V. Popov, T. A. Detlaf, G. V. Lopashov and others). D. P. Filatov started the comparative morphological research on developmental mechanics, which was closely associated with the evolutionary theory. A series of works on experimental embryology were conducted under the direction of I. I. Shmalgauzen (B. I. Barinsky, N. I. Dragomirov and others) and also by G. A. Shmidt, L. V. Polezhaev, P. S. Chanturishvili, Z. S. Katsnelson and others. The attention of embryologists has recently been drawn to the development of fish, with emphasis on the early stages of development, the fertilization process (T. A. Detlaf, A. S. Ginzburg) and the effect of hormonal factors on fish development (N. L. Gerbilsky and his co-workers). At the same time, extensive investigation of regeneration was begun. This research was conducted in the Laboratory of Experimental Zoology and Morphology, directed by N. V. Nasonov (P. G. Svetlov, L. N. Zhinkin and others), in the laboratories of the Institute of Experimental Morphogenesis and at the Department of General Biology of the Second Moscow State Medical Institute (L. Ya. Blyakher, M. A. Vorontsova, L. D. Liozner, M. I. Efimov, L. V. Polezhaev and others), in the K. A. Timiryazev Biological Institute (B. P. Tokin) and also at Kharkov University under the direction of E. E. Umansky.

At the end of this forty-year period, Soviet researchers had introduced new ideas on regeneration, in which the principles of the michurine doctrine and the opinions of I. P. Pavlov were used, which considerably advanced this field of research, presently being intensively developed (M. A. Vorontsova, A. N. Studitsky and their colleagues, L. V. Polezhaev).

Much work has been done on the problem of transplantation, analyzing the results of transplanting the internal secretion glands. Certain divisions of the science of transplantation, connected with restorative (conservative) surgery are being successfully developed (transplanted vessels, bones, skin grafts, etc.). A method of corneal transplantation was developed in the USSR (V. P. Filatov). The question of nerve regeneration has been extensively studied (B. S. Doinikov, L. A. Falin, M. L. Borovsky).

The works of A. G. Gurvich, who with his colleagues (L. D. Gurvich, G. M. Frank, S. Ya. Zalkind, A. A. Gurvich and others) worked out the problem of mitogenetic radiation, constitute an unusual aspect of histology and cytology.

The mitotic division of cells is still being intensively studied (S. Ya. Zalkind, G. S. Strelin, I. A. Alov, V. N. Dobrokhotov and others).

Much discussion has arisen around O. B. Lepeshinskaya's idea that cells develop from noncellular living matter. This discussion helped to clarify debatable opinions and to accumulate new data. Since 1948, research in the plan of the michurine doctrine has been developed; there have been experiments tracing acquired characteristics, experiments with vegetative hybridization, tracing the influence of mixed sperm on succeeding generations, etc. for the most part concentrated in the A. N. Severtsov Institute of Animal Morphology, the AMN SSSR Institute of Experimental Medicine and the embryology departments of the universities. Considerable progress has also been made in the histological branch of biology.

After the Great October Socialist Revolution, histology was transformed from a largely static and descriptive science into a dynamic science. This is shown by the fact that evolutionary histology was initiated and developed, and cells and tissues were studied with a view to their functional conditions and to the functional significance of different structures. Histology connects with physiology and biochemistry and uses histochemical methods. The basic problem with which Soviet histologists are occupied is the phylogenic and ontogenic development of cells and tissues and how the cells and tissues are changed by different conditions of body subsistence. In connection with this functional aspect of histology the experimental method is widely used and histology has become a primarily experimental science.

The appearance of many important theoretical works and monographs is characteristic of Soviet science, of morphology especially, as it shows both the high theoretical level of science in the USSR and the extraordinarily favorable conditions for scientific development which exist in this country. In this context, we wish to mention the "Essays on Evolutionary Histology" by A. A. Zavarzin and the "General Biological and Experimental Principles of Histology" by N. G. Khlopin, both of which outline systems of evolutionary histology but from different positions and by different research methods. The book of D. N. Nasonov and V. Ya. Aleksandrov, "The Reaction of Live Matter to External Influences (Denaturation Theory of Damage and Stimulation)," belongs

in the same group of outstanding theoretical generalizations in cytophysiological research. The conception of paranecrosis presented in this work, describing the definite physicochemical and morphological properties of live matter, coincides with N. E. Vvedensky's physiological conception of parabiosis.

Important articles have been written by Yu. M. Lazovsky and M. A. Baron, describing results obtained from research on the functional histology of the stomach and of the serous and other membranes.

The work which has been done on the plasticity of histological structures (S. I. Shchelkunov and colleagues) is a very important branch of histological research.

Important research using the tissue culture method to explain the ability of the cells of various tissues for morphological transformation has been conducted by N. G. Khlopin and A. D. Timofeevsky.

An original method for studying the properties of cells and tissues in changed conditions of existence was developed by F. M. Lazarenko who proposed that particles of celloidin be mixed with crushed tissues for implantation purposes.

Neurohistological research has been given special attention since the October Revolution; these studies were being conducted at separate chairs even before the revolution (A. S. Dogel, K. A. Arnshtein, D. A. Timofeev).

We should mention the outstanding morpho-physiological studies of A. N. Mislavsky and B. I. Lavrentyev on the autonomic and sensory innervation of internal organs, which include contemporary observations on the peripheral neurons. These studies have been successfully continued in the direction of research on afferent inner innervation by a pupil of B. I. Lavrentyev, E. K. Plechkova, as well as by N. G. Kolosov, B. A. Dolgo-Saburov, N. I. Zazybin and their students. In this research, which explains the sensory innervation of most of the internal organs and of certain tissues, much attention was given to the changes in different sections of the afferent systems (the receptors, fibers, synapses) in different functional conditions, both normal and pathologic.

Research on the morphology of the central nervous system has also developed considerably, especially after the organization of the Brain Institute in Moscow.

The works of this institute's collective (E. P. Kononova, I. N. Filimonov, G. I. Polyakov and others), conducted by various methods under the general direction of S. A. Sarkisov, were completed in the field of cytoarchitectonics by the publication of an atlas showing the architectonics of the human cerebral cortex — a unique work which has received high acclaim from both native and foreign specialists. We must also mention the substantial research published by B. N. Klosovsky on the morphology and physiology of the blood supply and the circulation of the blood to the brain.

Interesting work has been done on the histochemistry of the nervous system by A. L. Shabadash, who studied the histochemistry of the carbohydrate metabolism in order to examine the biological organization of the nervous system and also by V. V. Portugalov, who used the histochemical method to study the histophysiology of nerve endings.

Numerous works on the physiology of interoceptors, conducted by Soviet physiologists (K. M. Bykov, V. N. Chernigovsky and colleagues and others), have been morphologically based on the morphological research accomplished concerning the afferent innervation of internal organs. Finally, we must mention the basic research on the anatomy of the lymphatic system which was developed by D. A. Zhdanov and the study of indirect blood circulation (V. N. Tonkov and colleagues, B. A. Dolgo-Saburov and colleagues).

Like normal morphology, pathologic morphology has been essentially reorganized during the last forty years. The question of pathogenesis, always important in pathologic morphology has become the predominant interest of pathomorphology during this period. This fact led to the expansion of experimental research in the field of pathomorphology, usually conducted in conjunction with research on material from autopsies and surgical operations in order to maintain the connection between experimental and human pathology. One of the tasks of experimental research is the creation of experimental models of human diseases in animals, with special attention given the pathogenic, as well as the etiologic, relation of the experimentally induced disease to the corresponding human disease. N. N. Anichkov and his collective of colleagues have done much of the work in creating such experimental models.

Several models of autoinfectious diseases of various organs (the bile ducts, the bladder and liver, the respiratory tracts and lungs, the urinary tracts, the appendix) have been developed, which are caused by injuries leading to disturbances in the organ's function, i.e., with no introduction of microbes.

Comparative pathological studies, which have developed considerably during the Soviet era, have also been represented in pathomorphology. The course indicated by the classic works of I. I. Mechnikov has been followed in these studies.

Soviet pathomorphologists have participated in the experimental resolution of the pathologic and medical problems most necessary to the preservation of public health in this country. Here, we should mention the basic research of I. V. Davydovsky, studying the pathologic anatomy of epidemic typhus, and his original monograph on the science of the wound. The facts which have been obtained have hastened the resolution of such problems. Allergy is one such problem and has been the object of much research, the results of which have given information of the morphology of allergic phenomena in various kinds of organs under different conditions (A. I. Abrikosov and colleagues, B. N. Migunov, D. N. Vyropaev and others). On a model of hyperergic inflammation, D. N. Vyropaev demonstrated clearly the significance of the nervous system in the inflammatory reaction.

Great attention has been paid the reticulo-endothelial system and its significance in normal and pathologic conditions to analyzing the inclusion process of colloid substances and suspensions and to blockade of the reticulo-endothelial system (N. N. Anichkov and colleagues, F. F. Sysoev, N. G. Khlopin).

Among the works on inflammation, the important works of V. G. Garshin must be mentioned; they showed the active participation of the epithelium, its eliminative function in inflammation, which fact explained the nature of the so-called atypical epithelial growth. These works also illuminated many other problems in the pathology of epithelial tissue (metaplasia, for example).

Research on infections processes occupied a significant place in experimental pathomorphology: brucellosis (M. B. Ariel), bone tuberculosis (M. E. Mandelshtam and A. N. Chistovich), intestinal infections (A. A. Valdman, L. S. Bibikova), poliomyelitis (N. A. Robinzon and others), neuroviral encephalitides (S. M. Derizhanov), pneumonia (V. D. Tsinzerling and colleagues, B. I. Ugryumov and others), etc. The research conducted by P. P. Dvizhkov and colleagues on labor pathology and that conducted by N. A. Kraevsky and colleagues on radiation sickness also deserves mention.

The pathogenic trend united pathologic morphology with experimental pathology, physiology and biochemistry and led to complex research, using histochemistry, electron microscopy and analytical roentgenography. As an example of such complex research, we cite the works studying connective tissue (A. I. Strukov, G. V. Orlovskaya), which are of great help in explaining the changes of this tissue which occur with rheumatism.

The outline of research which we have presented gives some idea of the great progress and scope achieved by experimental biology and medicine during the past forty years. Soviet science rapidly recovered from the serious damage dealt by the Fascist invasion and was of great help to the country during the years of the Great National War. This progress was made possible through the great popular respect and support enjoyed by Soviet science and because of the constant attention given Soviet scientists by both the Communist Party and the Soviet government.

The continual progress of Soviet science during the past forty years has been due to the fact that Soviet scientists are directed in their research by the most advanced philosophy – the philosophy of dialectic materialism.

The progress which our country has made during these forty years in experimental medicine and biology guarantees an even greater and more vigorous development of science in the future.