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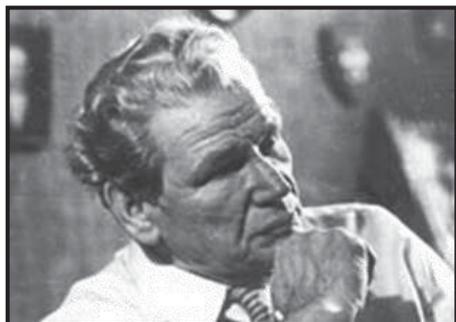
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**P.K. ANOKHIN IS THE FOUNDER OF THEORY
OF FUNCTIONAL SYSTEMS
(to 120th birthday anniversary of academician Pyotr Kuzmich Anokhin)**

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The article is dedicated to 120th birthday anniversary of a well-known Soviet scientist, the author of theory of functional systems, academician of Academy of Medical Sciences of the USSR and Academy of Sciences of the USSR, Pyotr Kuzmich Anokhin (1898-1974). In the article the main milestones of his life, of his scientific and pedagogical activity are considered.

P.K. Anokhin was among the talented pupils of academician I.P. Pavlov. Having gained a substantial physiological knowledge under his guidance, Anokhin very early showed his worth as an independent original researcher developing a new important section of physiology.

P.K. Anokhin is one of leading physiologists of the XX century. He inherited the best traditions of the classic Russian physiology and created his scientific school.

P.K. Anokhin focused his research work on investigation of neurophysiological mechanisms underlying the activity of the nervous system, but the main direction of his theoretical and experimental work was a study of an organism as an integral formation. The theory of functional systems proposed by P.K. Anokhin is widely recognized in the world science, and he is the founder of the systemic approach in physiology and biology.

Results of his research, his many-sided heritage and productive ideas proposed and developed by him during more than 50 years of his activity are used not only in physiology, but also in other fields of knowledge: biology, mathematics, pedagogics, philosophy... Works of P.K. Anokhin gained him recognition and acknowledgement in the international science which is evidenced by numerous references to his works in the modern scientific medical literature.

Keywords: Pyotr Kuzmich Anokhin, biography, normal physiology, scientific works.

Pyotr Kuzmich Anokhin was born on January 14 (26) 1898 in Tsarytsin (after 1925 – Stalingrad, after 1961 – Volgograd) in the family of a railway worker. In 1913 he finished the higher primary college and, to help the family, started working as a clerk in the railway office, and then passed an exam for the position of a post-telegraph worker. Dissatisfaction with the work stimulated P.K. Anokhin to pass exam for 6 classes of non-classical secondary school without attending classes and in autumn 1915 he entered geodesic-agronomical school which he finished in January 1918 with a diploma and a qualification of a geodesist [2]. At that time, he chanced to read a collection of articles issued by Institute of the Brain headed at that time by V.M. Bekhterev, and he felt a great interest in natural sciences, especially in functions and secrets of the human brain [2].

However, events of 1917 followed by the Civil war in which P.K. Anokhin actively participated, did not permit him to realize that dream. In January-February 1918 P.K. Anokhin was inducted into the Red Army and soon was enrolled into the Defense Staff of Tsarytsin as an inspector for building fortifications around the city.

In summer 1918 he volunteered to enter the Dono-Stavropolsky guerilla regiment that was fighting in the northern part of Tsarytsin front where he participated in military actions for defense of Tsarytsin, at first being the head of the operative department and after that the head of topographical department (the senior military topographer) of the Red Army Headquarters (Tsarytsin) [3]. There in the guerilla regiment he joined All-Union Communist Party Bolsheviks.

From the end of 1919 to 1921 inclusive P.K. Anokhin was an acting commissioner for press of Donskoy region and after that a responsible editor of “Krasny Don” newspaper (Novocherkassk). A casual acquaintance with A.V. Lunacharsky who was going round the troops of the South front in a propaganda train and the conversation about the desire to engage in investigation of the brain to understand “material mechanisms of a human soul” became a landmark in the life of Pyotr Kuzmich [4]. In autumn 1921 he was called

to Petrograd and got an assignment to State Institute of Medical Knowledge of Leningrad (SIMK) headed by V.M. Bekhterev. As early as in the first year of study P.K. Anokhin, under the guidance of V.M. Bekhterev, carried out his first scientific research work “Influence of Minor and Major Vibrations of Sounds on Excitation and Inhibition in the Brain Cortex”. V.M. Bekhterev involved the student into scientific work and entrusted him with managing patients with different forms of melancholy. “I did not work long in the Institute of Brain – recollected P.K. Anokhin later. – Being dissatisfied with psychiatry, I decided to devote my life to research work in physiology” [2].

In 1922 after having visited I.P. Pavlov’s lectures in Military Medical Academy, he started working in Pavlov’s physiological laboratory. P.K. Anokhin attracted attention “as a man of a wide reading and as a forming physiologist with a subtle and exact observation and initiative”. Thus, his destiny appeared to be connected with that laboratory for the entire life.

Working in I.P. Pavlov’s laboratory, Pyotr Kuzmich carried out a number of research works on cerebral circulation and influence of acetylcholine on vascular and secretory functions of the salivary gland [5]. Being a student, P.K. Anokhin became a scientific worker of Physiological Institute of Academy of Sciences in 1924.

After finishing SIMK in 1926 Pyotr Kuzmich was elected a senior assistant of the Department of Physiology of Zootechnical Institute on a competitive basis, and in 1929 received a special lecture course.

In 1930 P.K. Anokhin was elected Head of the Department of Physiology of medical faculty of University in Nizhny Novgorod. After separation of the faculty out of University and formation on its basis of Medical Institute he simultaneously headed the Department of Physiology of the biological faculty of University of Nizhny Novgorod [6].

In that period P.K. Anokhin proposed principally new methods for studying conditioned reflexes: secretory-motor method, and also an original method with sudden substitution of an unconditioned reinforcement. This

permitted P.K. Anokhin to come to the conclusion about formation in the central nervous system of a special apparatus incorporating parameters of the forthcoming reinforcement (“anticipated excitation”) [7]. Later on this apparatus was termed “acceptor of the result of action” (1955).

In 1935 P.K. Anokhin introduced the concept of “authorizing afferentation” (since 1952 – “reverse afferentation”, in cybernetics – “feedback”). At the same time, in the introduction to the collective monography “Problems of Center and Periphery in Physiology of Nervous Activity”, P.K. Anokhin gave the first definition of the functional system.

Later on he wrote in his autobiography: “In that period of my life when I was already a professor, an idea emerged that determined my scientific and research interests for all my life: I formulated the theory of the functional system showing that systemic approach is the most progressive way for salvation of physiological problems” [2].

During work in Nizhny Novgorod P.K. Anokhin showed himself an excellent pedagogue who created a model department that was rewarded in the All-Union competition of higher education institutes.

In 1933 on the basis of those departments a branch of All-Union Institute of Experimental Medicine (AUIEM) was opened in Nizhny Novgorod as Division of Evolutionary Physiology of Higher Nervous Activity, and professor P.K. Anokhin was appointed Director of the Institute and Head of the Division (1933-1935).

In 1934, according to Decree of the Council of People’s Commissars the Nizhny Novgorod Branch of AUIEM was moved to Moscow. In 1935 P.K. Anokhin organized a department of neurophysiology in All-Union Institute of Experimental Medicine in Moscow which conducted research work jointly with the Department of Micromorphology headed by B.I. Lavrentyev, and with neurological clinic of M.B. Krol.

In 1935 P.K. Anokhin was assigned a scientific degree of Doctor of Medical Sciences without defense of dissertation. In 1936-1940 P.K. Anokhin was giving a private course of selected lectures on physiology of

nervous system in the 1st Moscow University. In 1936 he was appointed to the position of Head of the Department of Physiology and Pathology of Nervous System in Central Extension Institution for Medical Practitioners (CEIMP).

In 1938, P.K. Anokhin was invited by N.N. Burdenko to head the psychoneurological sector of Central Neurosurgical Institute where he started working over the theory of nervous scar. At that time, he performed joint works with the clinic of A.V. Vishnevsky on procaine block.

After the beginning of the Great Patriotic war in autumn 1941 AUIEM was evacuated to Tomsk where P.K. Anokhin was appointed Head of Neurosurgical Department of Traumas of Peripheral Nervous System. Later on the results of the pre-war theoretical works and neurosurgical experience were generalized by P.K. Anokhin in his monography “Neuroplasty in Military Injury of Peripheral Nervous System” (1944). On the basis of the data obtained he formulated the theory of nervous scar which was used for diagnosis and treatment of military traumas. During the Great Patriotic war P.K. Anokhin summarized his research on mechanisms of traumas of peripheral nervous system, created the theory of pathogenesis of causalgias, of central paralyses, amputation pains and applied it in his work in evacuation hospitals. Treatment proposed by him is widely used by surgeons in our country and abroad.

In 1942 P.K. Anokhin returned to Moscow and was appointed the head of physiological laboratory in the Institute of Neurosurgery. He gave consultations and performed operations and together with N.N. Burdenko continued research on surgical treatment of military traumas of the nervous system. The result of their joint work was the article “Structural Peculiarities of Lateral Nerves and Their Surgical Treatment”.

In 1942 P.K. Anokhin was elected a professor of the Department of Physiology of the First Moscow State University. In 1944 on the basis of the Division of Neurophysiology and laboratories of AUIEM, Institute of Physiology of Academy of Medical Sciences of the USSR was created, and Pyotr Kuzmich was appointed Head of the Department of

Physiology of Nervous System (and in different years was simultaneously working as Deputy Director for scientific work (1946) and Director of the Institute).

In 1945 P.K. Anokhin was elected an academician of Academy of Medical Sciences of the USSR, and in 1946 – a Presidium member of the Academy of Medical Science of the USSR. From August to September 1945 he was working in Berlin (Germany) on errand of Ministry of Defense.

In 1947 P.K. Anokhin became Head of the Department of Normal Physiology of Moscow Medical Institute of Ministry of Health of RSFSR instead of purged academician V.V. Parin.

In autumn 1950 in a famous scientific session dedicated to the physiological theory of I.P. Pavlov, new scientific trends developed by his pupils – L.A. Orbeli, I.S. Beritashvili, A.D. Speransky and others, were subject to criticism. The theory of functional systems formulated by P.K. Anokhin, was acutely rejected. He was accused of revision of the platform of the materialistic doctrine of I.P. Pavlov and was removed from all his positions, including his work in the Institute of Physiology.

At this very period by decision of the Government, Moscow Medical Institute of Ministry of Health of the Russian SFSR was moved to the motherland of academician I.P. Pavlov and was renamed into academician I.P. Pavlov Medical Institute of Ryazan. In 1950-1952 P.K. Anokhin was Head of the Department of Normal Physiology of acad. I.P. Pavlov Medical Institute of Ryazan [8]. P.K. Anokhin and his colleagues (associate professors V.L. Gubar, V.A. Shidlovsky, postgraduate student V.F. Polezhaev and others) laid the foundation of the pedagogical process and scientific research in Ryazan Medical Institute. They elaborated curricula taking into account potentials of the department, equipped two chambers for working out of conditioned reflexes and proposed plans of scientific research for the nearest future. The main direction of scientific research was a study of systemic organization of physiological functions on the basis on the achievements of I.P. Pavlov's scientific school [9].

In 1952 P.K. Anokhin returned to Moscow and headed the Department of Physiology and Pathology of Higher Nervous Activity in the Central Extension Institution for Medical Practitioners in the period from 1953 to 1955. Starting from 1955 Pyotr Kuzmich was Head of the Department of Normal Physiology of I.M. Sechenov 1st Moscow Medical Institute (now I.M. Sechenov First Moscow State Medical University). At that time he formulated the theory of sleep and awake, biological theory of emotions, proposed the original theory of hunger and satiety, completed the theory of functional systems, proposed a new interpretation of the mechanism of internal inhibition (biological theory of inhibition) described in his monography "Internal Inhibition as a Problem of Physiology" (1958) [10].

In 1966 P.K. Anokhin was elected an academician of Academy of Sciences of the USSR. In 1968 his monography "Biology and Neurophysiology of Conditioned Reflex" was published where the author generalized the results of his own research works and works of his numerous pupils concerning investigation of higher nervous activity of animals and humans. In 1972 this work was marked with the highest award of the USSR – the Lenin prize [11].

The last work published within the lifetime of Pyotr Kuzmich was the article "Systemic Analysis of Integrative Activity of Neuron" (1974) where the main ideas about intraneuronal processing of information were presented and the theory of convergent termination of temporal connection in a separate neuron was stated [12].

P.K. Anokhin was one of talented pupils of academician I.P. Pavlov. Under Pavlov's guidance P.K. Anokhin passed through a substantial physiological school and very early showed his worth as an independent original researcher who developed a new and important section of physiology. His merit was development of the original secretory-motor method of investigation of the higher activity that enlarged potentials of the classic I.P. Pavlov's method in understanding of mechanisms of a conditioned reflex.

P.K. Anokhin developed physiological trend for studying the classic properties of the central nervous system and opened new regu-

larities of relationships between the center and periphery, of restructure of nerve centers and significance of afferent systems in this restructure. He reinforced his scientific achievements by setting up detailed experiments on comparative physiology and achieved exceptional results in operations on the nervous system of embryos of mammals and amphibia (intrauterine destruction of the central nervous system of embryos and subsequent investigation of the nervous activity of a newborn animal). P.K. Anokhin's works in this field stimulated scientific works both in the Soviet Union and abroad (Paul Weiss, Ten-Kate and others).

The works of P.K. Anokhin made him known and recognized by the international science that is evidenced by numerous references to his works in modern scientific medical literature.

The talent and passion of a researcher, wide erudition and physiological preparation made P.K. Anokhin a first-class researcher and a famous physiologist. He undoubtedly created an independent trend in physiology and managed to orient the science at new investigations and new prospects. P.K. Anokhin is the author of more than 260 works, including 9 monographies. He was an advisor of more than 130 dissertations including 27 doctoral dissertations. He was the editor of more than 7 collections of scientific works.

P.K. Anokhin was the chief editor of the journal "Achievements of Physiological Sciences" and of a number of Soviet and international journals, President of I.P. Pavlov Scientific Physiological Society, an Honored Member of Y. Purkinje International Scientific Society (Prague), a member of I.P. Pavlov National Society (USA), a member of Central Council of International Brain Research Organization of UNESCO (Paris) and others.

Pyotr Kuzmich Anokhin died on March 5, 1974 in Moscow and was buried in the No-

vo-Dyevitchiye cemetery. The scientific activity of P.K. Anokhin and his contribution to the world science were highly appreciated by the Government and the scientific community. P.K. Anokhin was awarded I.P. Pavlov Gold Medal (1968), two Orders of the Red Banner of Labor, Order of the Badge of Honor, and medals.

In 1974 by Decree of the Council of Ministers of the USSR, the Research and Scientific Institute of Normal Physiology of AMS of the USSR was assigned the name of P.K. Anokhin (now P.K. Anokhin RSI of Normal Physiology), on one of its buildings a memorial plaque was installed (4, build. 11, Mokhovaya str., Moscow). In 1974 Academy of Medical Sciences established P.K. Anokhin prize for the best work in the field of normal physiology. In 1977 Ministry of Communications of the USSR issued a stamped envelope dedicated to P.K. Anokhin. In his memory scientific "Anokhin's readings" have been held since 1976. The name of Anokhin was assigned to one of streets in Moscow (Troparyovo-Nikulino district).

To 100th anniversary of birthday of academician P.K. Anokhin, on January 27, 1992 in the Scientific-Research Center "Medical Museum" of AMS (3, build. 1, Sukharyovskaya square, Moscow) the memorial room was opened – P.K. Anokhin's museum, exhibition "Theory of Functional Systems in Physiology and Medicine" and Final scientific session of P.K. Anokhin RSI of Normal Physiology were conducted.

Memorial plaques dedicated to P.K. Anokhin are installed in Moscow and in other cities. On February 28, 1990 a memorial plaque was installed on the physiological building of academician I.P. Pavlov Medical University in Ryazan with the inscription: "Academician P.K. Anokhin, a laureate of the Lenin Prize, an outstanding Russian physiologist, headed the Department of Normal Physiology in 1950-1952" [13,14].

Authors have no conflict of interest to declare.

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