

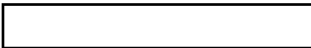
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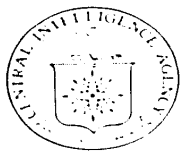
*Scientific  
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**The Soviet Bioastronautic Research  
and Manned Space Program**

**Organization, Personalities, and Facilities**

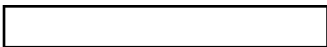
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## PREFACE

This compilation of basic data on the Soviet space program covers research institutes, cosmonaut training facilities, and sites for subsystem and capsule development. A discussion of the possible command structure of the program, along with the key people involved in the planning and research for the manned space program, is included. A summary of some important areas of Soviet bioastronautic research and development, along with some assessment of the extent and caliber of this work, is also provided. Available evidence concerning research and development trends which can relate to Soviet space objectives or emphasis is supplied.

This paper is based on all information that is presently available. The cutoff date for the information is 1 September 1964.

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THE SOVIET BIOASTRONAUTIC RESEARCH  
AND MANNED SPACE PROGRAM  
ORGANIZATION, PERSONALITIES, AND FACILITIES

PROBLEM

To collate data on the organization, personalities, and facilities involved in the Soviet bioastronautic research and manned space program.

SUMMARY

Responsibility for the direction of the Soviet space program apparently rests with an unknown authority directly under the Council of Ministers, USSR. Subsystem, space suit, and capsule development is largely the responsibility of the State Committee for Aviation Technology (GKAT). The Academy of Sciences, USSR, the Academy of Medical Sciences, USSR, and the Soviet Air Force provide basic research support for the program. Cosmonauts are trained by the Soviet Air Force, and the operational handling of the launching of the space vehicle is the responsibility of the Strategic Rocket Forces. The Chief Scientific Secretary of the Academy of Sciences, N. M. Sisakyan, is head of the bioastronautics or life-science aspects of the Soviet space program. Important roles also are played by M. V. Keldysh, who has been called the "Chief Theoretician"; V. V. Parin, in biomedical research support; V. I. Yazdovskiy, in the applied aspects of the program and

cosmonaut training; and V. N. Chernigovskiy, in experimental physiology and coordination between the Academy of Sciences and Academy of Medical Sciences. The Commission on Exploration and Utilization of Cosmic Space (CEUS), chaired by A. A. Blagonrovov, supports and coordinates Soviet space scientific activities.

The Soviets have used at least five aviation medical facilities (four of which are under the Ministry of Defense, USSR) in support of their manned space effort. The cosmonaut training facilities which have been identified are in the vicinity of Moscow. The training center is located in the Chkalovskaya-Monino area. Much of the theoretical training of the cosmonaut is at the Zhukovskiy Air Engineering Academy. A facility at Tomilino is concerned with the development of the space suit and an ejection system for cosmonaut recovery, and with the physiological testing of

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cosmonauts under conditions of stress by using the centrifuge and pressure chamber. The Central Aerohydrodynamics Institute (TsAGI) at Zhukovskiy probably is involved in the subsystem and space-capsule development; the branch of TsAGI at Moscow has tested the Soviet space suit.

Bioastronautic research supporting the Soviet space program is carried out at over 30 research institutes and facilities of the Academy of Sciences, USSR; the Academy of Medical Sciences, USSR; the Ministry of Health; and Moscow State University. A key institute is the Institute of Normal and Pathological Physiology, Academy of Medical Sciences, which is involved in the development of bio-instrumentation for monitoring cosmonauts and in research relating to the environmental

and life-support systems and pressure suits. Among the important scientists engaged in this work are G. M. Frank in radiobiology, A. A. Imshenetskiy in exobiology, O. G. Gazenko in the environmental and life-support systems, and several of the younger scientists, such as V. V. Antipov and A. A. Gyurdzhian.

The Soviets have supported their manned space effort with a program of research and development in such areas as bioinstrumentation, life-support and environmental control systems, exobiology, and the hazards of space flight (weightlessness, acceleration, and radiation). An early research effort and flight testing of equipment during the animal space flights resulted in the experience and equipment which have been used in the Vostok manned flights.

## DISCUSSION

### ORGANIZATION OF THE PROGRAM

The directing authority for the Soviet space program is considered to be under the Council of Ministers, USSR. Very little information is available concerning the existence or membership of such an authority. The Soviets do refer to a "State Commission charged to direct the new long manned space flight" or "the State Commission for the launching of the spaceship 'Vostok.'" (See figure 1.) This State Commission probably has both a decision-making and an operational authority for manned space flights.

The following Soviets may have some role in the decision-making process in the Soviet space program: D. F. Ustinov, now First Deputy Chairman, Council of Ministers, USSR, and the Chairman of the Supreme National Economic Council, USSR; K. N. Rudnev, Deputy Chairman of the Council of Ministers and Chairman of the State Committee for Coordination of Scientific Research; and L. V. Smirnov, Deputy Chairman of the Council of Ministers, USSR. All have been associated with

the defense industry and armaments production and technology. In 1961, both Ustinov and Rudnev received awards for rocketry and manned space flight achievements. At that time, Rudnev had been Chairman of the State Committee for Defense Technology and Ustinov had been a Deputy Chairman of the Council of Ministers with his role as deputy described recently by N. S. Khrushchev as "responsible for the defense industry." There was some speculation previously that Ustinov may have served as chief of a state committee for missiles and space.

The operational handling for the launching of the space vehicle is the responsibility of the Strategic Rocket Forces. At the time of Gagarin's selection as cosmonaut for the first manned space flight, a meeting was held of the "State Commission for the launching of the spaceship 'Vostok.'" At that time, movies recorded the affirmation of Gagarin's selection. Photographs available from a movie that apparently was taken during that same selection period reveal Marshal K. S. Moskalenko, then Commander-in-Chief of Rocket

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Forces, and USSR Deputy Minister of Defense, at one end of the table with V. I. Yazdovskiy and probably Admiral S. G. Gorshkov and Lt. General N. P. Kamanin along with cosmonaut Gagarin and his backup Titov. (See figure 2.) For this flight the Chairman of the State Commission was said to have arrived at the cosmodrome (i.e. Tyuratam) from Moscow 6 days before the flight.

The first deputy chairman of the State Committee for Aviation Technology (GKAT), S. M. Leshchenko, has been identified as having a coordinating role for GKAT space activities. GKAT has an important role also in the development of the environmental and life-support subsystems, the space suit, and the space capsule. Coordinating and basic research support for these activities is a function of the Academy of Sciences, USSR; the Academy of Medical Sciences, USSR; and the Soviet Air Force. All indications are that cosmonaut training is under the control of the Air Force. (See figure 3.)

N. M. Sisakyan is the head of the life science or bioastronautic aspects of the Soviet space program. Formerly Academician Secretary of the Department of Biological Sciences, he was named in 1963 Chief Scientific Secretary of the Academy of Sciences, USSR. Within the presidium level of the Academy is M. V. Keldysh, Academy President, who has been identified as the "Chief Theoretician," behind the Gagarin flight. (See figure 4.) Under the Academy of Sciences is the Commission on Exploration and Utilization of Cosmic Space (CEUS) whose chairman is A. A. Blagonravov; the Scientific Secretary is I. V. Milovidov. This is not considered to be a policy-making body, but rather its function is one of supporting and coordinating Soviet space activities. Recently, the role of the Institute of Machine Studies directed by Blagonravov has been described. Its work has included the development of the pressurization of the Vostok capsule, various prosthetic devices, and work on a prototype device employing the hard-suit concept for cosmonaut activity outside the space capsule. Blagonravov

also has played an important role in the preliminary arrangements for the US-USSR cooperative agreement in the area of bioastronautics.

Just below Sisakyan is V. V. Parin, Vice President of the Academy of Medical Sciences, USSR, and Director of the Institute of Normal and Pathological Physiology. Parin is responsible for basic biomedical research support of the manned space program. In addition, his Institute has been named the leading institute for cardiovascular physiology in the USSR. Cardiovascular research may well play a key role in the manned space program in the future because the Soviets have reported that the cosmonauts have experienced post-flight cardiovascular problems (orthostatic hypotension) and general cardiovascular deconditioning during flight, and have indicated concern for cosmonaut reentry after prolonged orbital flight. On the same level with Parin is V. I. Yazdovskiy, who is concerned with the applied aspects of the program. (See figure 5.) Described as Chief of Medical Services of the manned space program with responsibility in selection and approval of cosmonauts, Yazdovskiy is the military physician who is knowledgeable also in engineering and is directly involved with the hardware needed in the program. Direct contact is maintained between Yazdovskiy and Parin not only at the research level but also in the development and application of equipment such as that used in the cardiovascular monitoring of cosmonauts. Communication between the Academy of Sciences and the Academy of Medical Sciences probably is handled by V. N. Chernigovskiy. Chernigovskiy, a leading physiologist in the USSR, was one of those who was responsible for the early animal space flights. He is said to be about on the same level as Parin and Yazdovskiy in relation to the Soviet manned space effort. In addition to being an active member of the Academy of Medical Sciences and the Academy of Sciences, USSR, he is represented within the Presidium of the Academy of Sciences as Academician Secretary of the Department of Physiology.

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Key personalities who have important responsibilities in the Soviet manned space program are G. M. Frank, Director of the Institute of Biological Physics, Academy of Sciences, USSR, whose field is radiobiology; A. A. Imshenetskiy, Director of the Institute of Microbiology, who is consulted in matters relating to exobiology; O. G. Gazonko, who is involved in the evaluation and development of environmental and life support systems (see figure 6); and Chernigovskiy who is a key man in the field of experimental physiology. Detailed information on the key personalities who have important responsibilities in the Soviet manned space program appears in the appendix.<sup>1-12</sup> (See figures 29-35.)

#### SUPPORT FACILITIES

##### Aviation Medical Support Facilities

At least five aviation medical facilities are supporting or have supported the Soviet bioastronautic and manned space program. Three of them are under the Ministry of Defense, USSR: (i) the Scientific Research Testing Institute of Aviation Medicine, Moscow; (ii) the Central Scientific Research Aviation Hospital, Moscow; and (iii) the Military Medical Academy imeni S. M. Kirov, Leningrad. The Central Institute for the Advanced Training of Physicians in Moscow is under the Ministry of Health, USSR. The Scientific Research Institute of Aviation Hygiene at Chkalovskaya is probably also under the Ministry of Defense. Detailed information concerning the facilities follows.

##### Ministry of Defense

**Scientific Research Testing Institute of Aviation Medicine,\* Moscow** — The Scientific Research Testing Institute of Aviation Medicine (NIIAM) was organized about 1946 as the primary Soviet facility devoted to space medicine. (See figure 7.) (The Institute of Avi-

\*Alternate names include the Central Scientific Research Institute of Aviation Medicine, the Institute of Aviation Medicine imeni Pavlov, the Institute of Aviation Medicine, the Scientific Research Testing Institute of Aviation Medicine of the Soviet Air Force, and the Institute of Cosmic Medicine.

ation Medicine which had been set up in 1935 was closed during World War II.) NIIAM has conducted experimental studies and equipment development in the various areas of aeromedical research, including the development of a pressure suit and oxygen equipment, studies on the effects of decompression on the human organism, and research concerning stress effects (vibration, acceleration, and so on) on the nervous system, vestibular apparatus, and visual acuity of the human. In addition, it was this institute that probably trained the dogs for space flight.

NIIAM is equipped with an underground pressure chamber, a human centrifuge, an ejection test stand, and at one time had some 80 doctors, 12 aeronautical engineers and from 5 to 7 test pilots conducting research here.

There is almost no additional information concerning personnel and research conducted at this Institute since 1959. However, the director of the institute between 1956 and 1959 was A. V. Pokrovskiy, author and spokesman concerning many of the effects on animals during the early rocket flights in the upper atmosphere. (See figure 8.) The present director of NIIAM is unknown, but there is some suggestion that the institute receives research guidance from V. V. Parin.

Departments and laboratories at this institute in the 1946-59 period were:

1. Physiology Department — Head: A. G. Kuznetsov, and possibly now headed by O. G. Gazonko
2. Clinical or Psychology Department — Head: K. K. Platonov
3. Research Department for Testing Resistance of the Organism to Stress. This department was co-located in 1946 at NII VVS, Chkalovskaya and at the Koltsovo aerodrome near Sverdlovsk. It was to be moved sometime after 1946 to Monino
4. Acceleration Laboratory — Head: P. K. Isakov
5. Laboratory for High-Altitude Research — Head: I. Ya. Borshchevskiy

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Figure 1. Nikolayev possibly reporting to the Chairman of the State Commission prior to the launch of Vostok 3

Marshal K. S. Moskalenko, then the Commander in chief of the Strategic Rocket Forces, is the man at the head of the table with cosmonauts Gagarin and Titov shown on the far right. V. I. Yazdovskiy, chief of Medical Services is to the left of Gagarin. Going right to left are Lt. General Kamanin and Admiral S. G. Gorshkov.



Figure 2. Meeting of State Commission affirming Gagarin's selection for flight of Vostok 1

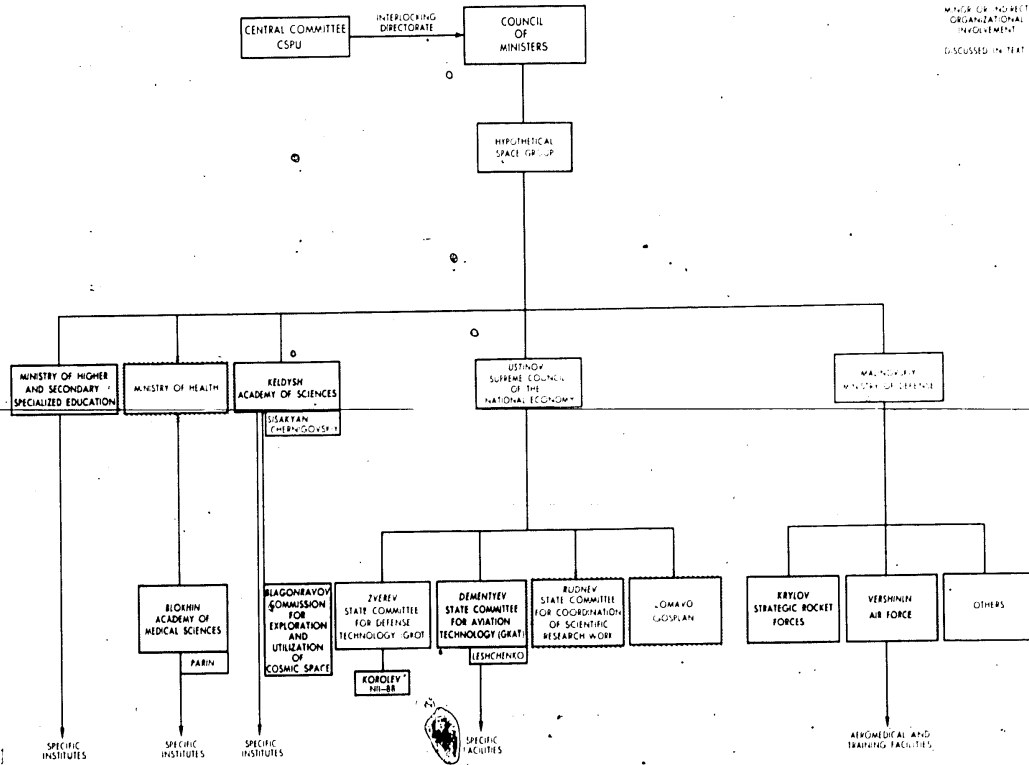
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ORGANIZATIONS CONCERNED WITH SOVIET BIOASTRONAUTIC RESEARCH AND MANNED SPACE PROGRAM

Figure 1

MINOR OR INCOMPLETE ORGANIZATIONAL INFORMATION DISCUSSED IN TEXT



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Figure 4. M. V. Keldysh at cosmodrome before launch of Popovich in Vostok 4

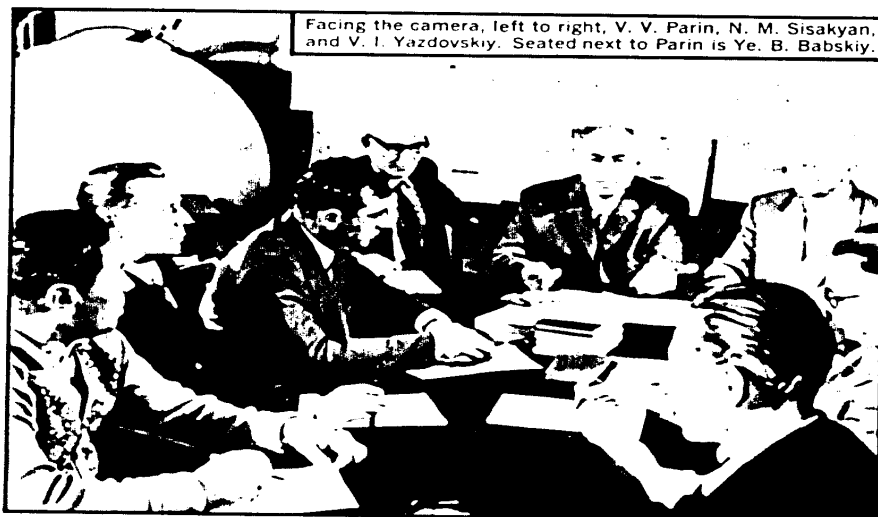


Figure 5. Biomedical conference at time of Gagarin's flight

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The following personnel have been located at NIIAM in addition to the above: V. V. Baranovskiy, G. A. Demedov, Ye. A. Derevyanko, O. G. Gazenko, D. I. Ivanov, P. N. Ivanov, A. A. Koreshkov, T. I. Lepenitsyna, V. G. Lerent'yev, V. B. Malkin, S. S. Markaryan, Yu. P. Petrov, R. A. Stasevich, G. G. Sturua, S. I. Subbotnik, M. I. Vakar, A. S. Vitenzon.

Those who have been associated with NIIAM include I. S. Balakhovskiy, A. V. Demidov, A. Ye. Ivanov, L. A. Mokhov, and N. V. Samukhin.

**Central Scientific Research Aviation Hospital, Moscow** — During World War II, the Clinical Department of the Scientific Research Testing Institute of Aviation Medicine (NIIAM) was converted into the Central Scientific Research Aviation Hospital (TsNIAG), which was involved in a system for evacuation and the care of flight personnel and the training of military flight surgeons. This facility also undertook studies directed toward the scientific elaboration of problems and criteria in the medical examination and selection of flight personnel. K. K. Platonov probably worked there during the war; during the post-war period this facility may have been incorporated again into the clinical department of NIIAM with K. K. Platonov as head. This also may be the facility at which Titov states he underwent his initial examinations for cosmonaut selection. The present director is unknown.

Other personnel at TsNIAG include A. Ya. Kavyrshin, Captain B. L. Pokrovskiy, and A. S. Usanov.

**Military Medical Academy imeni S. M. Kirov, Leningrad** — Primarily a training and advanced training institution for military medical cadres, the Military Medical Academy imeni S. M. Kirov in Leningrad is one of the foremost medical institutions of the USSR, both because of the character of military medical training it conducts, and because of its tradition as an important center of research. In 1943, a laboratory of aviation

medicine was organized at the Chair of Physiology of the Military Medical Academy imeni S. M. Kirov headed by M. P. Brestkin and under the guidance of L. A. Orbeli. Research has been conducted in such areas as the effect of phenamine on vision at reduced barometric pressure, and physiological problems encountered in hypoxia and high altitude.

The director is A. A. Sinitsky. Other personnel who have been identified with the institute and have published in the field of space medicine are R. M. Bayevskiy, Ye. A. Kovalenko, V. G. Petrukhin, V. I. Polyakov, A. N. Razumeyev, P. V. Vasil'yev, A. V. Yeregin, and A. G. Zhironkin.

**Scientific Research Institute of Aviation Hygiene (NIAG), Chkalovskaya-Monino** — Director: Unknown. Subordination: (Probably Ministry of Defense). Personnel includes Col. V. Ye. Danilov.<sup>17-27</sup>

#### *Ministry of Health*

**Central Institute for the Advanced Training of Physicians, Moscow** — Along with advanced training of the general physician, advanced medical training of aviation physicians takes place at the Central Institute for the Advanced Training of Physicians (TsIU), along with experimental studies in visual perception, anoxia, and physical stress. A Department of Aviation Medicine was organized at the Institute in 1939.

Personnel who have been identified with the institute and have published in the field of space medicine are R. M. Bayevskiy, I. M. Khazen, G. L. Komendantov, and V. I. Kopanev.

#### **Training and Spacecraft Development Sites**

Support facilities for training and the development of spacecraft equipment in the USSR include the Cosmonaut Training Center in the Monino-Chkalovskaya area, the Scientific Testing Institute of the Soviet Air Force at Chkalovskaya, the Tomilino research facility near Moscow, the Central Aerohydro-

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dynamics Institute at Zhukovskiy near Ramenskoye and at Moscow, and the Zhukovskiy Air Engineering Academy in Moscow.

#### *Cosmonaut Training Center*

The Cosmonaut Training Center of the USSR is located in the Monino-Chkalovskaya area. Monino has been described as the site of the cosmonaut training camp. This area is the base for the preliminary training of the cosmonaut. Reportedly, the equipment includes that used in the physical training of the cosmonaut such as the rotating wheel and trampoline; this facility is said also to have a centrifuge and at least one altitude chamber. (See figure 9.) One department of NIIAM was to have been moved to Monino sometime after 1946; the Aviation Command Academy also is located at Monino. Personnel of the Academy cannot gain admittance to the cosmonaut area and it is guarded with two security gates. Approximately 20 cosmonauts were noted in the secure area at a time early in the training program, along with numerous physicians and scientists.<sup>22 23 24 25 26</sup>

Little is known about the actual cosmonaut training and available equipment at Chkalovskaya. However, it is at this site that the cosmonaut maintains his flying skills in the MIG 17 and 21 and is given training under weightless conditions in the especially equipped TU 16 where weightlessness can be achieved for a period of 30 to 40 seconds. (See figure 10.) Reportedly, the cosmonauts live in the nearby town of Chkalovskiy.<sup>27</sup>

The Scientific Testing Institute of the Soviet Air Force (NII VVS) also is located at Chkalovskaya (Shchelkovo) and it has been stated that the training and recruitment of candidate cosmonauts is under the direction of NII VVS. The equipment which has been reported at this facility includes more than one pressure chamber, a human centrifuge, and an ejection seat catapult.<sup>28 29</sup>

Additional training equipment described by the Soviets, and which may be located at the Center, include an isolation or silence chamber, equipment for vestibular training, and

flight simulators or trainers. The isolation chamber is a pressure chamber with a total volume of 7 cubic meters equipped for maintaining a man for from 2 to 4 weeks. (See figure 11.) Some additional training in isolation is obtained in the Vostok-type cabin. Some of the standard equipment used for vestibular conditioning consists of the Barany chair, the Khilov swing, and a three-dimensional rotor which moves horizontally, vertically, and diagonally.<sup>30 31</sup> (See figures 12 and 13.)

The early cosmonauts were trained in the Vostok cabin under simulated flight conditions. (See figures 14 and 15.) A Vostok-type spacecraft used in the flight of Zvezdochka (Sputnik 10) in March 1961 was sent to the Center for training purposes. This device also was used to obtain the basic physiological background data on the cosmonaut during final preparation for flight and under the required flight parameters of pressure, humidity, and temperature for at least one diurnal cycle. Individual adjustments of the space suit were made along with final preparation for the attachment of electrodes and sensing elements for the physiological monitoring of the cosmonaut during flight.<sup>32</sup>

More recently, simulated flight training also has been conducted by using the Vostok 4 spacecraft of Popovich. This is used as a programmed flight simulator for the training of the cosmonaut in the simulated flight conditions of (i) noise during launch, (ii) communicating with the ground, (iii) checking of the spacecraft instruments and systems, (iv) orienting the spacecraft manually, (v) carrying out programmed tasks, (vi) determining position by using displays of the star fields and the earth, and (vii) making the necessary preparations for reentry of the spacecraft after orbital flight.<sup>33</sup>

#### *Tomilino Facility*

Tomilino, a research area using Post Office Box 1052 is located near Moscow. The chief of the facility is S. M. Alekseyev, the deputy chief is F. I. Gibkiy, and the chief medical

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Figure 6. O. G. Gzenko participating in Vostoks 5 and 6 flight

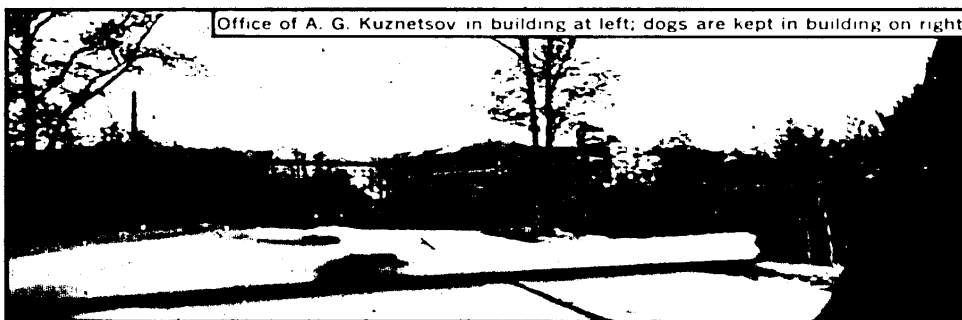


Figure 7. Scientific Research Testing Institute of Aviation Medicine (NIIAM), Moscow

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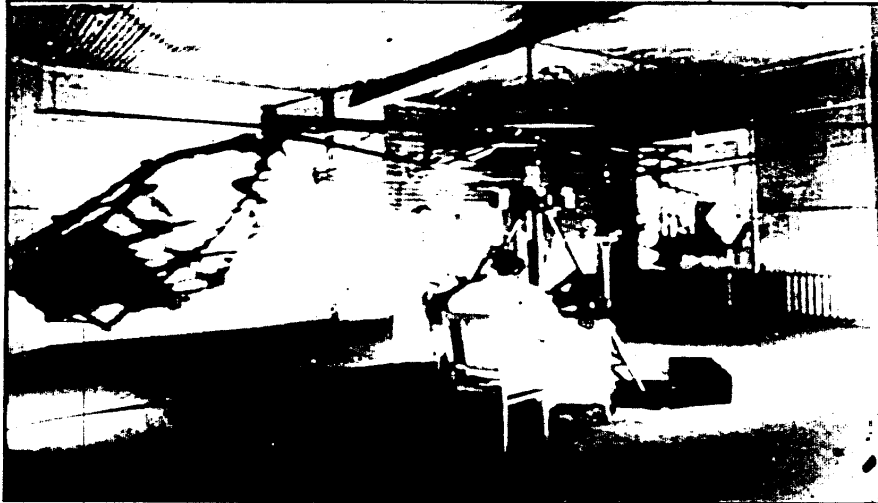


Figure 8. Centrifuge probably at NIIAM used in the training of dogs for space flight



Figure 9. Titov training on wheel at Cosmonaut Training Center

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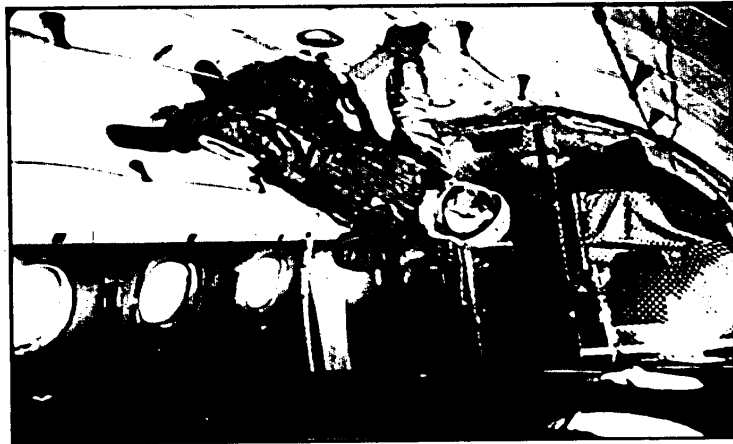


Figure 10. Training under weightless conditions in aircraft



Figure 11. Isolation chamber used in cosmonaut training

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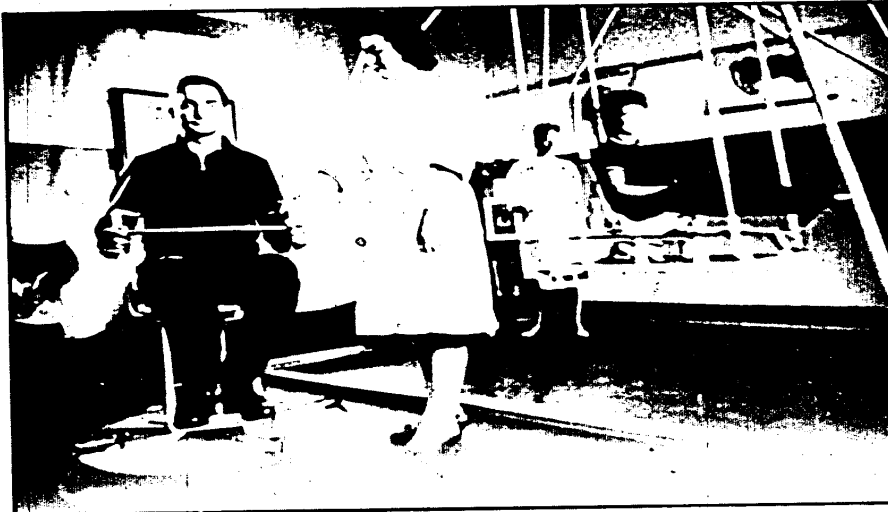


Figure 12. Bykovskiy and Tereshkova (cosmonauts 5 and 6) during vestibular training

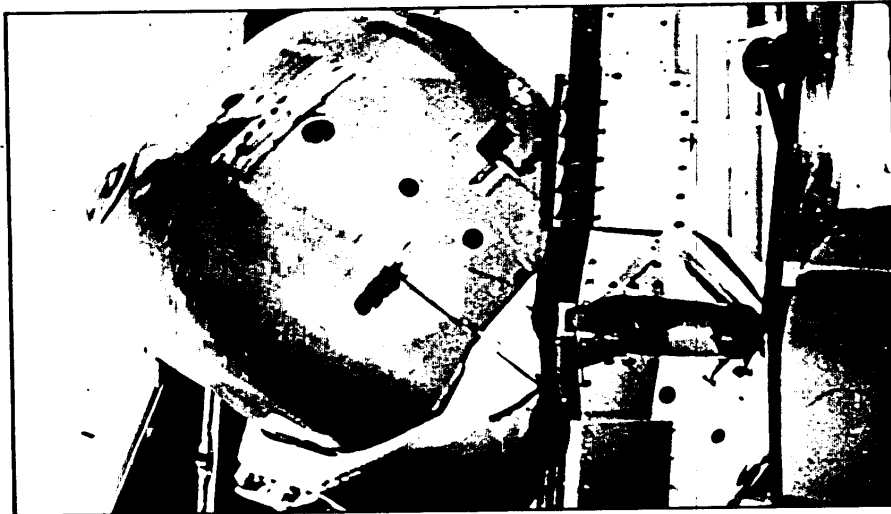


Figure 13. Rotor used in cosmonaut training

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Figure 14. Titov in Vostok cabin simulator



Figure 15. Ejection test stand identical to stand at Tomilino

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officer is probably A. S. Barer or possibly A. V. Pokrovskiy. The facility is concerned with the development of the space suit, the ejection system for cosmonaut recovery, and the physiological testing of humans under conditions of stress. Expansion of the Tomilino facilities appears to have begun in the latter part of 1960. (See figure 16.)

There are three research areas reportedly located at Tomilino; the area of Tupolev, the aircraft designer; the area of Mil', the helicopter designer; and the Tomilino area (Area A) for aerospace research. (See figure 17.) The latter area is the only secured area. Equipment at the Tomilino aerospace research area includes a centrifuge used by the previous cosmonauts in acceleration training and testing while wearing the pressure suit, an ejection test stand where testing of an ejection seat was observed (see figure 15), and a possible propellant test stand for the development of the rocket ejection system. In addition, the installation of a pressure chamber was initiated in 1963. Several smaller pressure chambers apparently are also located at this site.<sup>41-43</sup>

The centrifuge at Tomilino was purchased from West German manufacturers and accepted as operational early in March 1961. Gagarin went to Tomilino shortly before his orbital flight and was tested on the centrifuge. (See figure 18.) However, this centrifuge could not have been available for any extensive training before Gagarin's flight in Vostok 1 on 12 April 1961. Pressure continually was exerted, however, for early installation of the centrifuge and the need for it was described as urgent. Modification of the centrifuge was requested and made after the acceptance date with a change from the usual 8-G capacity to a higher acceleration force of 30 G's. The possible reason for the Soviet request is that abort profiles for simulating emergency and escape conditions may require acceleration up to 30 G's with average-rate-of-change of acceleration up to 12 G's per second. It was probably at this time also that the gondola arm was changed by the Soviets

and that the cosmonaut couch arm, which has a steering capability, was used. The arm uses compressed air tanks for positioning of the subject for resistance to a higher gravity force. (See figure 19.)

The centrifuge originally was supplied with four interchangeable arms:

1. A normal arm. An arm with an 8-meter radius was used with a free-swinging chair gondola. This was the arm the Soviets modified; it would also be adequate for a two-man capsule.

2. A second arm with turntable. An arm that was 150 centimeters in diameter. This arm was discarded by the Soviets and converted into a small floor centrifuge.

3. A swivel arm. The swivel arm was intended to simulate two degrees of freedom, which would have been obtained if a gimballed mount had been used. However, a structural defect caused the fork to break off and the vacuum cabin was damaged.

4. A 5-meter arm. The 5-meter arm was for the testing of equipment and for experimentation with animals. It was designed for use up to 100 G's.<sup>46-49</sup>

A large amount of biomedical equipment was supplied with the centrifuge. The impulses were designed to be transmitted through the gondola centrifuge arm into the control room for recording. The instrumentation was not designed for use in vehicles in space. The biomedical equipment included: that used for electrocardiograms (EKG), electroencephalograms (EEG), and electromyograms (EMG), and for measuring blood pressure and temperature; microphones for heart rate, respiration and voice; a double-oxymeter for a simultaneous measurement of oxygen saturation on two parts of the body, preferably the ear and one finger; an X-ray device; and a television camera.<sup>50</sup>

The research area at Tomilino, which was known as Alekseyev's OKB or Plant 1052, was originally under the direction of GKAT. There is no evidence which either updates

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this or changes this information. Reportedly, in the latter part of 1961, 600 construction workers and 1,400 civilians were employed at Tomilino.

The following people are or have been associated with the installation of Tomilino:

**ALEKSEYEV, Semen Mikhaylovich**

Chief of the Tomilino installation. He is almost certainly the space suit designer described in Soviet publications and was deputy chief designer of the S. A. Lavochkin Experimental Design Bureau in 1944. His publications include a book which reviews the state of the art of pilot escape from aircraft, including the design and construction of ejection seats and parachutes in addition to the protective clothing and facilities involved.

**BARER, (Fnu)**

Doctor of Medical Sciences and reserve captain, probably A. S. Barer, who was associated in 1960 with the Central Institute for Advanced Training of Physicians. At the present time, he is probably the chief medical officer at Tomilino. He is said to be knowledgeable in all phases of aeromedical research and his publications include an article in Volume II, *Problems of Space Biology*, on "Limit of Human Tolerance to Transverse Accelerations and the Physiological Reactions of the Body," where acceleration rates up to 15 G's were experienced by human subjects.

**POKROVSKIY, Aleksey Vasilyevich**

Doctor of Medical Sciences, Reserve Lieutenant Colonel, deputy to Popov. Formerly director of NIIAM in Moscow and author and biomedical spokesman for the animal space events. In his sixties, he is expected to retire soon.

**POPOV, (Fnu) (Probably Aleksey Pavlovich Popov)**

Major General, Medical Service, Red Army. Popov, now retired, was formerly the chief medical officer at Tomilino and was responsible for the physiological tests conducted at that institute. His publications include a

history of aviation medicine in the USSR and research in the fields of spatial orientation and aerospace physiology.

Others associated with the institute include:

**FOMIN, Aleksandr Nikolayevich**

Chief of the organization responsible for construction of the centrifuge and pressure chamber buildings.

**GIBKIY, Fedor Ivanovich**

A mechanical engineer who replaced Tatarskiy and was responsible for the installation of equipment at Tomilino.

**MISKARYAN, A. A.**

Chief of administration.<sup>40 51 52 54</sup>

**SEVERIN, Guy Ilich**

Engineer specializing in electromedical equipment.

**SHARKOV, Valenten Ivanovich**

A participant in the contract negotiations, he had been assigned to the Ministry of Machine Building, Moscow. An electrical engineer, he is now said to be located in Siberia as chief of a space testing station.

**TATARSKIY, Lev Petrovich**

Deputy to Alekseyev and prominent in the contract negotiations. A mechanical engineer, he reportedly was responsible for all equipment purchased outside of the USSR. He is said also to have been involved in the development and manufacture of the space capsule used in the dog flights. He has been replaced as deputy.

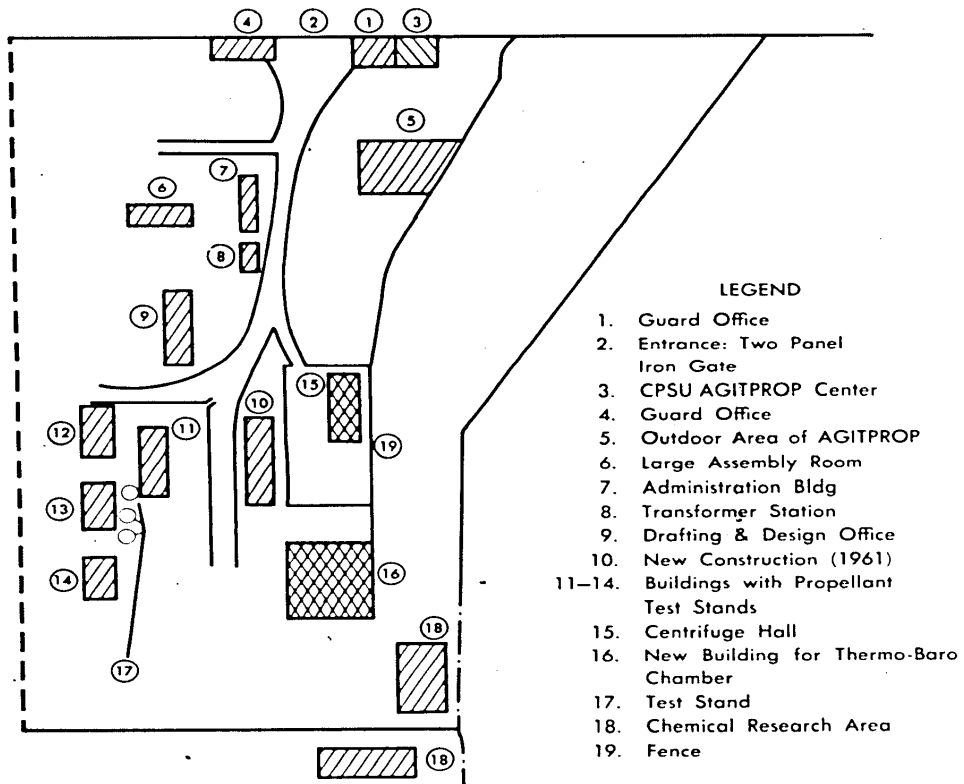
Negotiations with West Germany started in 1959 for the delivery of two pressure chambers to the USSR. One was destined for Tomilino and the installation of the chamber was to begin in early 1963. Part of the equipment for the pressure chambers was delivered and installation of the biomedical equipment in the control center of the chamber at Tomilino began at that time. However, contractual difficulties developed in July 1963 and the Soviets indicated they were no longer interested in obtaining delivery of the remaining environmental control equipment or in

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Figure 16

FACILITIES OF AEROSPACE RESEARCH TEST AREA  
(ALEKSEYEV'S OKB-PLANT 1052) AT TOMILINO



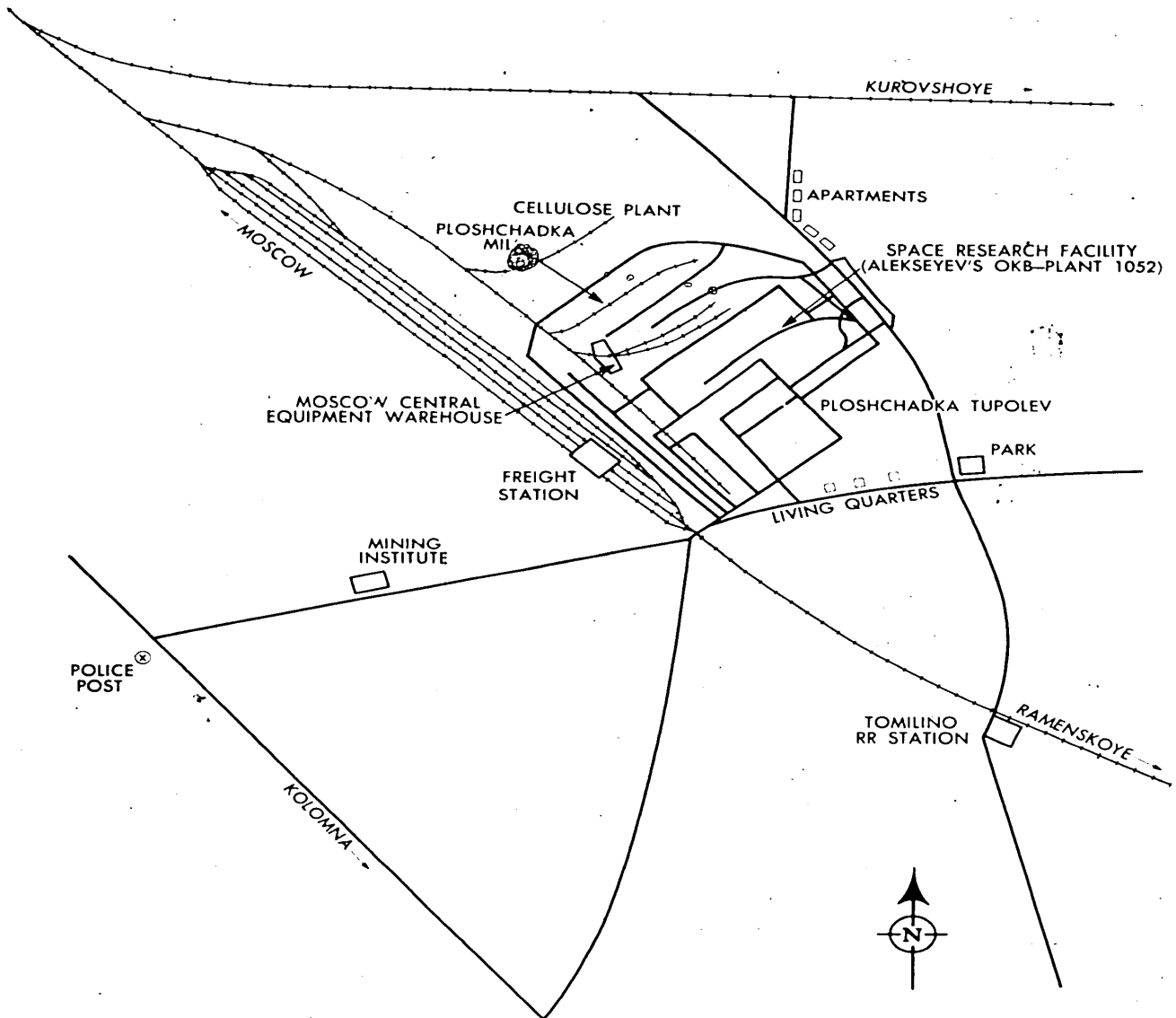
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LOCATION AND OUTLINE OF TOMILINO COMPLEX

° Figure 17



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Figure 18. Gagarin in centrifuge at Tomilino

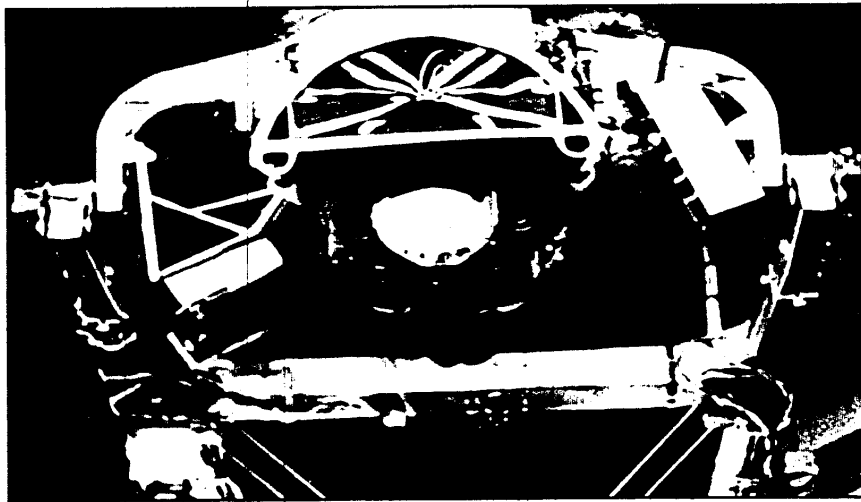


Figure 19. Closeup of centrifuge arm at Tomilino

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renewing the installation contracts. There is some suggestion that the Soviets would manufacture the remaining equipment and install the second chamber themselves. The specifications of the Tomilino chamber were as follows:

Size	6 meters long; 2.8 meters in diameter; working space, 10 cubic meters
Vacuum	100 kilometers or $10^{-4}$ Torr
Temperature range	-60° C to +300° C (temperature within chamber) -60° C to +200° C (air supplied to chamber) to +600° C (wall of cabin)
Radiation	Solar, ultraviolet, X-ray
Emergency provisions	40 seconds for repressurization; 40 seconds for opening door
Gaseous composition	Composition of air supplied to chamber could be selected and controlled for CO <sub>2</sub> , O <sub>2</sub> , CO, nitrogen, hydrogen, and ozone content
Miscellaneous	One end of the chamber had 3 quartz windows; the other end had 1 window along with an automatic door. One side contained 3 quartz windows; the other side 2 windows (150 x 30 millimeters in diameter); normal period of operation planned up to a maximum of 8 hours a day; continuous service up to 72 hours.

#### Central Aerohydrodynamics Institute

The second pressure chamber was destined for M. S. Yegorov's institute, which probably is the Central Aerohydrodynamics Institute (new TsAGI) located at Zhukovskiy near Ramenskoye. This facility reportedly was concerned with space capsules.<sup>51 60</sup> In 1958, Yegorov was one of the authors of a book on principles, construction, basic theories, and engineering design principles for determining equipment requirements for pressurized cabins, oxygen equipment, and pressure suits. The Flight Research Institute (LII) is also located at the Ramenskoye Airfield. Korolev, reportedly the chief designer for the booster used in the manned space program, is said to be a frequent visitor at Zhukovskiy. Alek-

seyev (almost certainly S. M. Alekseyev who is chief of the Tomilino installation) also visits Zhukovskiy often and is described as one of Korolev's chief design assistants.

Installation of the pressure chamber was to begin sometime about the middle of 1963. The specifications were as follows:

Size	14 meters long; 4 meters in diameter; working space, 56 cubic meters
Vacuum	40 kilometers or $10^{-2}$ Torr
Temperature range	-60° C to +500° C (temperature within chamber) -60° C to +400° C (air supplied to chamber) to +600° C (wall of test cabin)
Radiation	Solar, ultraviolet, X-ray
Emergency provisions	40 seconds for repressurization; 40 seconds for opening door
Gaseous composition	Composition of air supplied to chamber could be controlled for O <sub>2</sub> , CO <sub>2</sub> , CO, nitrogen, hydrogen, and ozone content
Miscellaneous	There is a door at either end of the chamber—one end has a sliding door locked by compressed air; within this door is a smaller door which can be operated only manually; windows, 6 quartz; windows 150 to 300 millimeters in diameter; normal period of operation planned up to maximum of 8 hours a day; continuous service up to 72 hours. <sup>53 62</sup>

A second centrifuge was also purchased by the Soviets. Nearly all specifications of the second centrifuge were similar to those of the first one. However, an automatic programmer was to be included in the design of the second centrifuge, along with a different motor. The centrifuge arms probably were not supplied, but were manufactured and designed in the USSR. The exact location of this second centrifuge is unclear. There is some possibility that it could have been installed at Tomilino. However, it probably was only stored at Tomilino and destined for Yegorov's institute, along with the second pressure chamber. Reportedly this centrifuge was installed in a building already in ex-

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istence, but which was enlarged for the centrifuge. The centrifuge was delivered early in 1963 and probably became operational several months later.<sup>51 63 64</sup>

The total cost of the two pressure chambers has been estimated as 21 million Deutschmark (DM) (\$5,250,000). The cost of the second centrifuge was estimated at 460,000 Deutsche mark (DM) (\$115,000), which was lower than the probable cost of the first centrifuge because it did not include the centrifuge arms, the instrumentation, and the control equipment.<sup>51</sup>

The facilities described are adequate for the environmental testing of equipment alone and also for integrated human-equipment testing. Even though the facilities are limited in some aspects of space simulation, this equipment could represent a compromise between cost and the useful amount of information that can be obtained, for example, during space-suit testing and development by using the more modest vacuum of  $10^{-4}$  Torr in the chamber at Tomilino. However, the facilities described (at Yegorov's institute) also bear a resemblance to those that are useful for high-altitude checkout of structural integrity for supersonic aircraft, and pilot training for supersonic flight. The second chamber could be used for capsule or subsystem engineering tests, but the required operational time of both chambers is limited to 72 hours, which suggests the development of aircraft more than spacecraft. However, the Soviet space development capability includes integrated capsule subsystems and man checkout at 40 kilometers for periods up to 72 hours, which is similar to the altitude used in the US systems-man checkout conducted in a pressure chamber at Cape Kennedy.

The Soviets have also received a centrifuge from Sweden; the destination of this centrifuge is unknown. This centrifuge was used for the later space flights, including the training of V. Tereshkova for her flight in Vostok 6. (See figure 20.) The Soviets have expressed

an interest in the rapid rate of buildup of acceleration, which is applicable to abort type studies. They are interested also in studying the effects of rapidly changing directions of acceleration, which is useful in training for the ejection method of recovery. The cabin of this centrifuge consists of aluminum and has a Plexiglass hood. The cabin is suspended in a steel gimbal frame and is free to move both radially and tangentially. At maximum current it can be accelerated to 30 G's.<sup>65 67</sup> (See figure 21.)

#### *Zhukovskiy Air Engineering Academy*

The cosmonaut receives much of his theoretical training at Zhukovskiy Air Engineering Academy in Moscow. He takes courses in subjects such as rocket engineering, astronomy, and geophysics at this Academy.<sup>68</sup> (See figure 22.)

#### *Other Facilities*

The location for the parachute training of the cosmonaut is unknown, but is described as a site far from Moscow. One facility which conducts research applicable to the recovery phase of manned space flight has been identified. Photographs of a model-testing basin in which a man wearing a space suit and helmet is being pulled through the water identify it as the model basin at Old TsAGI in Moscow. (See figures 23 and 24.) According to Soviet information of the mid-1940's, the basin was 200 meters long and 12 meters wide, the depth of the water in the basin was 6.5 meters, and the maximum carriage speed was 15 meters per second. In addition, the basin is equipped with a wave maker that is capable of producing waves that are 3 feet high. Problems to be undertaken at this institute are designated by the State Committee for Aviation Technology (GKAT). The role of Old TsAGI was probably the testing of the space suit in the event of landing by parachute in water after emergency re-entry and possibly also the testing of the suit as a flotation device.

A medical center is located at the launch site, Tyuratam. It is here that the cosmo-

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Figure 20. Tereshkova entering Swedish-built centrifuge

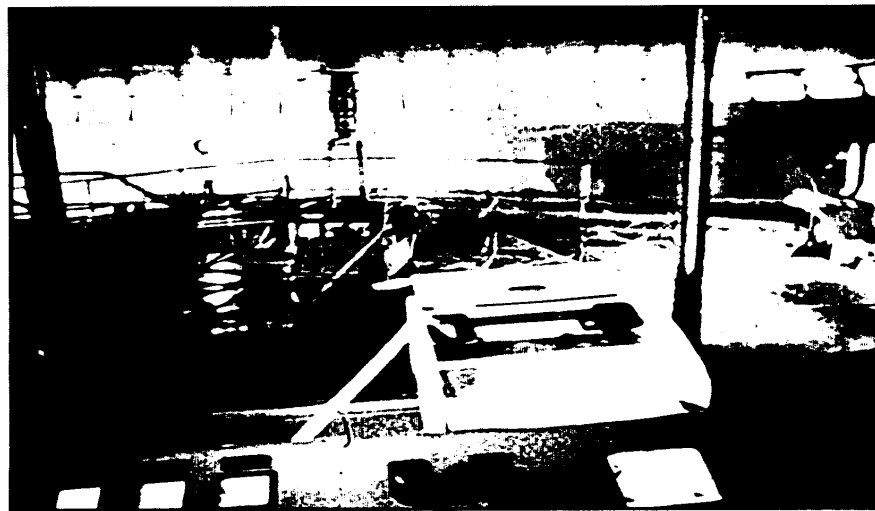
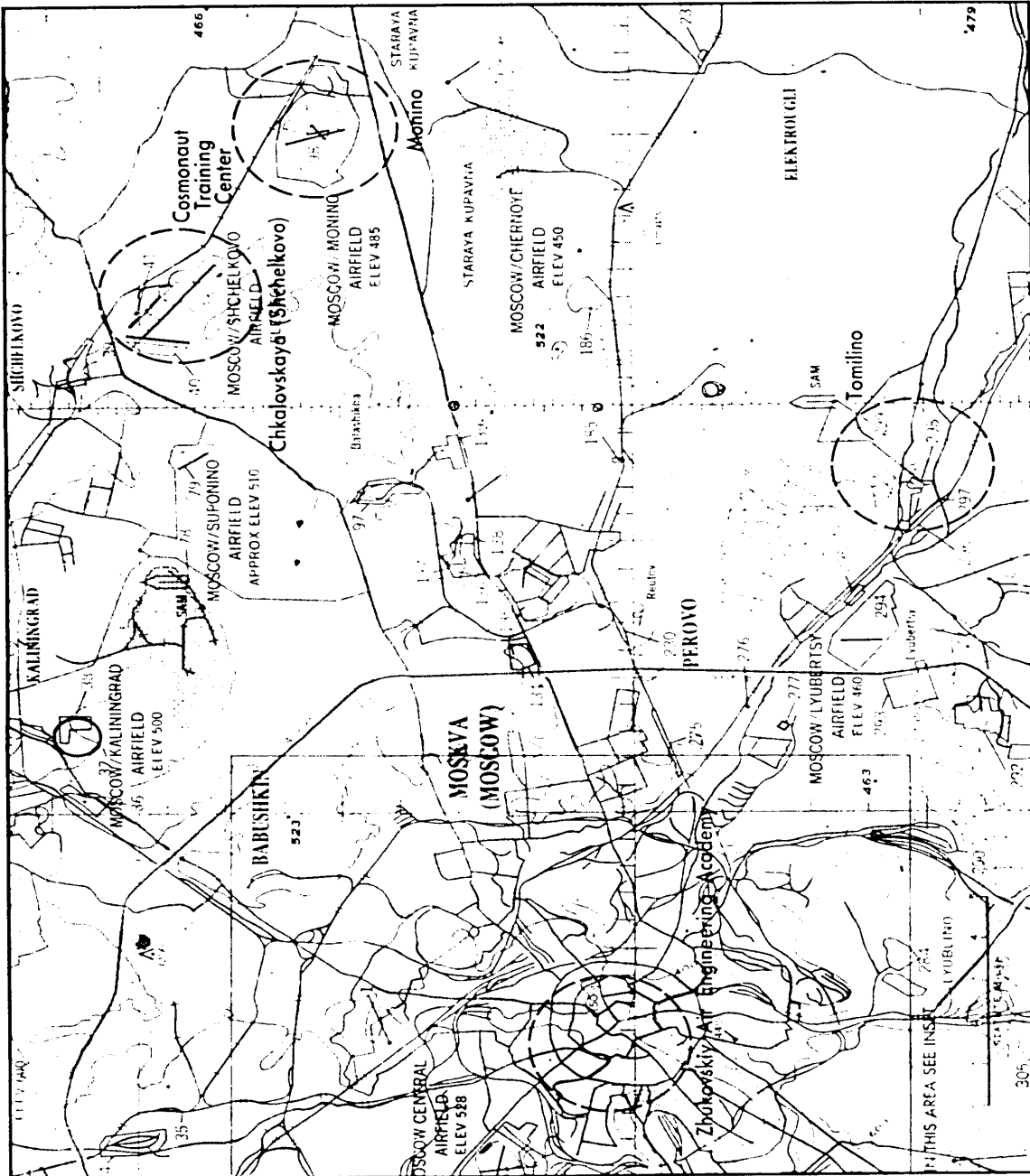


Figure 21. Swedish-built centrifuge in operation

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Figure 22. SOVIET COSMONAUT TRAINING FACILITIES.

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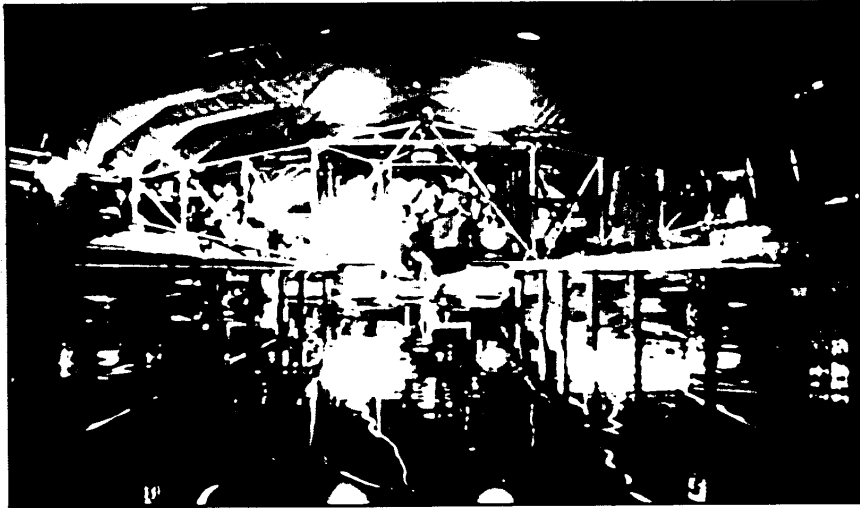


Figure 23. Model basin at Old TsAGI



Figure 24. Man wearing space suit and helmet being pulled through model basin

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naut receives his final preparation and check-out before flight, and dons his space suit for flight.<sup>70</sup>

#### *Soviets Involved in Cosmonaut Training*

All information indicates that the Cosmonaut Training Center is under the control of the Soviet Air Force. Marshal Vershinin, Commander-in-Chief of the Soviet Air Force, was a member of the cosmonaut examining commission and participated in the briefing of candidates for cosmonaut training. (See figures 25 and 26.) Titov states that three additional generals of the Air Force worked with the cosmonaut group. They are Colonel General F. A. Agal'tsov, Colonel General A. G. Rytov, and Lieutenant General N. P. Kaminin, who is probably a commanding officer in the cosmonaut training center.

The cosmonaut group commander was formerly Yuriy Gagarin. Recently Lieutenant Colonel Nikolayev was put in command of the group and Colonel Gagarin was promoted to another post.

Additional Soviets who can be identified with the Cosmonaut Training Center are:

#### **GYURDZHIAN, A. A.**

Candidate of Medical Sciences. May be chief of physiological training of the cosmonauts. Apparently works with Yazdovskiy and is one of the younger scientists participating in the program. He has published in the fields of the biological effects of cosmic radiation, the results of biological investigations of organisms and animals after space flight, and has been a coauthor of some of the applied work relating to the animal flights.

#### **PETROV, Colonel Ye. A.**

One of the commanding officers of the cosmonauts.

#### **VOLYNKIN, Yu. M.**

Lt. General, Military Medical Service. Headed a group discussing and publishing on the subject of cosmonaut training, physiological investigations, and post-flight examinations for the flights of Nikolayev and Popovich in Vostoks 3 and 4.<sup>71 72</sup>

#### **YAZDOVSKIY, V. I.**

Candidate of Medical Sciences; Col., Medical Service. He is Chief of Medical Services for the cosmonauts. He also has taught space medicine at the cosmonaut training school.

#### **Research Institutes and Facilities**

Over 30 research institutes and facilities of the Academy of Medical Sciences, USSR; the Academy of Sciences, USSR; the Ministry of Health, USSR; and the Moscow State University are engaged in bioastronautic research. Details concerning their activities follow. (See figure 27.)

#### *Academy of Medical Sciences, USSR*

**Institute of Normal and Pathological Physiology, Moscow** — The Institute of Normal and Pathological Physiology under V. V. Parin is a key Institute in the Soviet manned space program. Much of the research at the institute directly supports the space program. The results of this research are incorporated into the applied aspects of the program in the development of the bioinstrumentation used for monitoring the cosmonauts, the environmental and life-support system, and the pressure suit. In addition to these activities, this institute recently was designated as the center for cardiovascular research in the USSR.

Khayutin and his associates at a laboratory at the institute are attempting to correlate muscle activity (myographic measurement) with regional blood flow in determining the relationship of muscle work to circulation. They hope to establish the proper exercise tests and from this infer the expected blood flow. Research is also conducted on the effect of localized muscle activity on the circulation of other organs. These studies have an important bearing on some of the problems involved in weightlessness.

Sinyakov is working on measuring heart action by ultrasonic flow meters and is miniaturizing much of the equipment and electronic components used in these studies. Babskiy

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and Karpman are involved in developing bio-instrumentation for measuring the electrical activity of the heart. This instrumentation was used in the cardiac monitoring of the cosmonauts. (See figure 28.) The animal work, research, and electronics development is done at the institute; after new equipment is developed it is taken to the Institute of Therapy for clinical evaluation. Marshak is interested in studying the effects of CO<sub>2</sub> on the circulation of the brain and coronary circulation. This relates to information that can be used in developing the environmental control system. Meyerson is involved in research in the nature of heart failure and studies of the adjustment of the heart to increased work demands and the response of the circulatory system to O<sub>2</sub> deprivation.

Some of the research and preparatory work with dogs for the early animal space flights was probably conducted at the Institute when V. N. Chernigovskiy was director (up to 1959). The present institute still has animal facilities available for research. Yazdovskiy has an office at this institute, but is said to conduct most of his work at another facility. Research activities and personnel at the institute are increasing. Khayutin's laboratory has expanded considerably in the last year. The electronics laboratory added another engineer and Pozdnyakov was brought in to develop an integrated morphology laboratory for the support of the other laboratories. As a whole, the heads of the laboratories belong to a younger group of scientists, and possible successors to Parin could be Khayutin or Meyerson.

The Institute of Normal and Pathological Physiology occupies several floors of a building in a two square block area in Moscow. The Institute of Experimental Biology and the Institute of Pharmacology and Chemotherapy are located in the same building. The building is guarded and several wings of the building are secure areas. Some of the laboratories in the institute are padlocked, including those of Khayutin and Babskiy.

The institute is made up of the following laboratories:

<u>Laboratory</u>	<u>Head</u>
Biinstrumentation	V. S. Sinyakov
Biophysics of Circulation	V. M. Khayutin
Clinical Physiology	Ye. B. Babskiy
Heart	F. Z. Meyerson
Morphology	O. M. Pozdnyakov
Physiology and Pathology of Digestion	S. I. Filippovich
Physiology of Circulation and Respiration	M. Ye. Marshak

Additional laboratories that are conducting neurophysiological research include the following:

<u>Laboratory</u>	<u>Head</u>
Comparative Physiology	S. I. Frankshteyn
Infectious Pathology of the Nervous System	A. Ye. Alymov
Neuropathology	Ye. K. Pleshkova
Physiology of Afferent Systems	P. G. Snyakin
Tropic Pathology of the Nervous System	O. Ya. Ostryy

Institute personnel who are conducting bioastronautic research include:

**BABSKIY, Yevgeniy Borisovich**

Active Member, Academy of Sciences, Member of the institute 1959-63, Head, Laboratory of Clinical Physiology, 1959-64. Physiology.

**FILIPPOVICH, Sofiya Iosifovna**

Doctor of Medical Sciences; Head, Laboratory of Physiology and Pathology of Digestion, 1957-62. Physiology.

**KARPMAN, V. L.**

Candidate of Medical Sciences; Member, Laboratory of Clinical Physiology, 1959-64. Cardiology.

**KAS'YAN, Ivan I.**

Member of the institute, 1960-62. Space Flight Physiology.

**KHAYUTIN, Vladimir Mikhaylovich**

Doctor of Medical Sciences; Member of the institute, 1957-63. Head, Laboratory of Biophysics of Circulation, 1962-64. Physiology.

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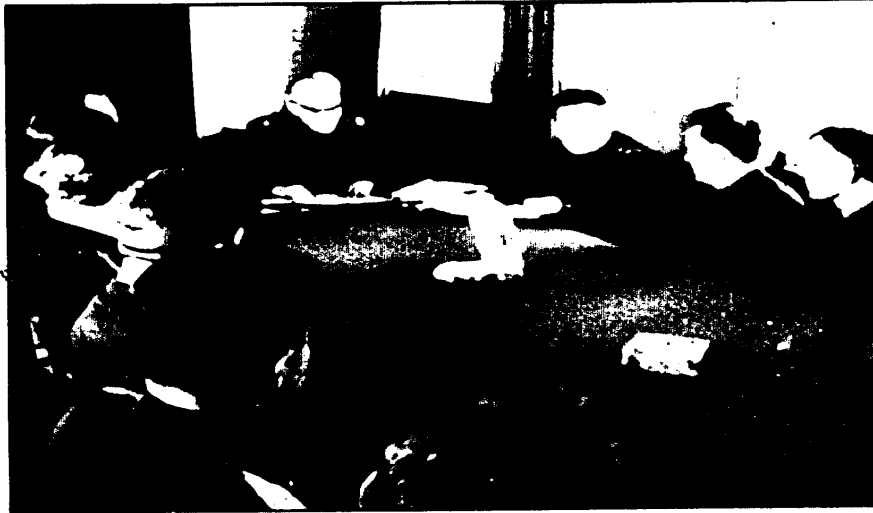
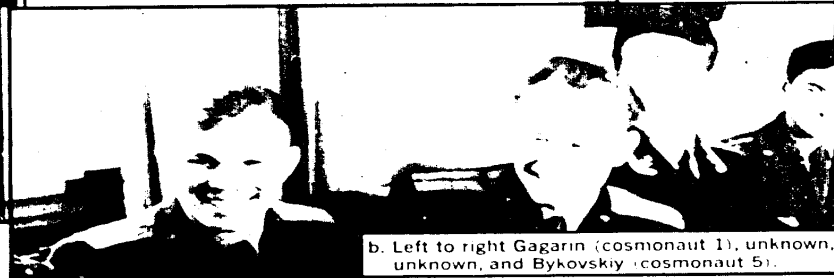


Figure 25. Marshal Vershinin at briefing of candidates for cosmonaut training before Gagarin's flight



a. Fifth man on Vershinin's right is Nikolayev (cosmonaut 3), second man is Popovich (cosmonaut 4).



b. Left to right Gagarin (cosmonaut 1), unknown, unknown, and Bykovskiy (cosmonaut 5).

Figure 26. Original group of cosmonauts with Marshal Vershinin

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Figure 27

CERTAIN SOVIET INSTITUTES AND FACILITIES INVOLVED IN BIOASTRONAUTIC RESEARCH  
AND THE MANNED SPACE PROGRAM

<u>MINISTRY OF HIGHER AND SECONDARY SPECIALIZED EDUCATION, USSR</u>	<u>ACADEMY OF MEDICAL SCIENCES, USSR</u>	<u>ACADEMY OF SCIENCES, USSR</u>	<u>STATE COMMITTEE FOR AVIATION TECHNOLOGY (IGAT)</u>	<u>MINISTRY OF DEFENSE, USSR AIR FORCE</u>
Moscow State University imni M. V. Lomonosov (radiation, space biology training program)	Institute of Normal and Pathological Physiology V. V. Parin (environmental and cardiovascular physiology including biotelemetric monitoring)	Institute of Biological Physics G. M. Frank (space biology including radiobiology)	Central Aerohydrodynamics Institute "TsAGI" (space suit, subsystem and capsule development and testing)	Cosmonaut Training Center Chkalovskaya-Moskva (conditioning, training)
	Institute of Experimental Biology I. N. Mayskiy (space biology)	Institute of Cytology laboratory of Cosmic Biology I. K. Lozina- Lozinskiy (extreme environments)	Tomsk (space suit development and testing; physiological testing and training)	Scientific Testing Institute of the Soviet Air Force (NIL VVS) (cosmonaut training weightlessness)
<u>MINISTRY OF HEALTH, USSR</u>	Institute of Labor Hygiene and Occupational Diseases, L. I. Medved (toxicology, radiobiology)	Institute of Microbiology A. A. Imshenetskiy (space microbiology exobiology)		Military Air Engineering Academy imni N. K. Zhukovskiy (theoretical study)
Central Institute for the Advanced Training of Physicians	Institute of Nutrition A. A. Pukrovskiy (foods for space flight)	Institute of Physiology imni I. P. Pavlov, V. N. Chernigovskiy (physiology)		Scientific Research Testing Institute of Aviation Medicine (NILIAM) (aerospace medical research)
Institute of Biophysics A. V. Lebedevskiy (Radi- ation)	Institute of Therapy, A. I. Myasnikov (clinical evaluation of biomedical monitoring methods)	Institute of Plant Physiology imni K. A. Timiryazev, A. I. Kursanov (closed ecological systems)		Military Medical Academy imni A. V. Kotov, A. A. Smirnov (aerospace medical research and training)
				Scientific Research Institute of Aviation Hygiene (NILAG) (aerospace research)

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Figure 28a Babitskiy in his laboratory at the Institute of Therapy

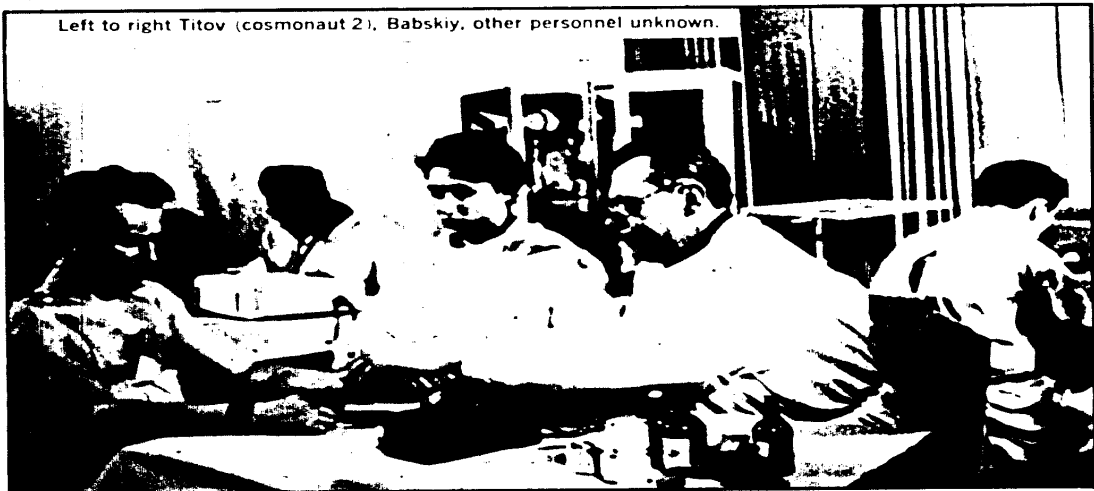


Figure 28b Babitskiy participating in physiological monitoring of Titov (cosmonaut 2)

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**MARSHAK, Moisey Yefimovich**

Corresponding Member, Academy of Medical Sciences, USSR; Doctor of Medical Sciences; Head, Laboratory of Physiology and Pathology of Respiration and Blood Circulation, 1956-62. Aviation Medicine.

**MEYERSON, Feliks Zalmanovich**

Doctor of Medical Sciences; Member, Laboratory of the Heart, 1960-64. Physiology.

**PARIN, Vasilii Vasil'yevich**

Active Member and Vice President, Academy of Medical Sciences, USSR; Doctor of Medical Sciences; Director, 1960-64; Head, Department of Clinical and Experimental Physiology, Central Institute for Advanced Training of Physicians, Moscow, 1956-60. Physiology.

**POZDNYAKOV, O. M.**

Head, Laboratory of Morphology, 1963-64.

**SINYAKOV, V. S.**

Head, Laboratory of Bioinstrumentation, 1961-64. Electrophysiology.

**TSIVILASHVILI, A. S.**

Lt. Colonel, Military Medical Service, USSR; Member, Institute of Normal and Pathological Physiology, Academy of Medical Sciences, USSR, Moscow, 1961.

**YAZDOVSKIY, Vladimir Ivanovich**

Doctor of Medical Sciences; Colonel, Medical Service, USSR; Member of the institute, 1960-64. Space Medicine.

**YUGANOV, Yevgeniy M.**

Lt. Colonel, Medical Service, USSR; Candidate of Medical Sciences; Member of the institute, 1960-62. Aviation Medicine.

Associated with this institute are:

**AGADZHANYAN, N. A.**

Lt. Colonel, Medical Service, USSR; Candidate of Medical Sciences; Member of the institute, 1961-62. Aviation Medicine.

**ANOKHIN, Petr Kuz'mich**

Active Member, Academy of Medical Sciences, USSR; Member of the institute, 1961-62; Head, Laboratory of General Physiology of the Central Nervous System, 1961; Head,

Chair of Physiology and Pathology of Higher Nervous Activity, Central Institute for Advanced Training of Physicians, Moscow, 1960; Head, Chair of Normal Physiology, First Moscow Medical Institute imeni I. M. Sechenov, 1955-61. Neurophysiology.

**VOROB'YEV, A. I.**

Associate, Institute of Normal and Pathological Physiology, Academy of Medical Sciences, USSR, Moscow, 1962; Medical Director, Aeroflot, Moscow, 1958-59; Member, Institute of Aviation Medicine, Moscow, 1960.<sup>5 11 73 74</sup>

**Institute of Experimental Biology, Moscow**

—The Institute of Experimental Biology, directed by I. N. Mayskiy, has a number of people working on the microbiological and cytological aspects of the Soviet bioastronautic program. This includes work on the biological package carried on Sputnik 5 in 1960 and on the biological experimentation carried on the Vostok manned space flights.

The purpose of these experiments was to study (i) the effect of vibration, weightlessness, and radiation on somatic (HeLa), as well as on reproductive tissues, (ii) the radiosensitivity of microorganisms related also to vibration, acceleration, and weightlessness effects, (iii) these same effects on immunogenicity, and (iv) automatically controlled investigation of reproduction and growth under varying conditions (vibration, weightlessness, radiation) by using bacteria.

Bioastronautic research at the institute is performed under the guidance and direction of N. N. Zhukov-Verezhnikov, head of the Department of Immunology. He is a competent microbiologist who initially developed the bioelement that was flight tested on Sputnik 5 and which is still undergoing development for use in the detection of extraterrestrial life.

This institute was established in 1945 and includes the following laboratories and departments:

Laboratory of Biochemistry and Radiobiology

Laboratory of Cytology

Department of Growth and Development

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Department of Immunobiology (with laboratories for the study for biological incompatibility of tissues, neuroinfectious immunology, genetics of microorganisms, immunology of embryology, and immunochemistry).

Institute personnel who are conducting bioastronautic research include:

**BUYKO, Ye. A.**

Member, Department of Immunobiology, 1961. Bacteriology.

**KAPICHNIKOV, Mikhail Mikhaylovich**

Candidate of Medical Sciences; Member, Laboratory of Antigen Biology, 1955-56; Member, Department of Immunology, 1957-62. Immunology.

**KLIMOV, V. Yu.**

Member of the institute, 1960. Biochemistry.

**MAYSKIY, Ivan Nikolayevich**

Doctor of Medical Sciences; Director, 1953-63; Head, Laboratory of Noninfectious Immunology, 1955-62. Immunology.

**NEFED'YEVA, Nataliya P.**

Member, 1961; Member, Institute of Nutrition, Academy of Medical Sciences, USSR, Moscow, 1953-63. Microbiology.

**PEKHOV, Aleksandr Petrovich**

Doctor of Biological Sciences; Member of the institute, 1956-63; Member, Department of Immunobiology, 1958-61; Head, Laboratory of Genetics of Microorganisms, 1963. Microbiology.

**PODOPLELOV, I. I.**

Candidate of Medical Sciences; Member, Department of Immunobiology, 1959. Microbiology.

**RYBAKOV, Nikolay Ivanovich**

Candidate of Medical Sciences; Member of the institute, 1957-62; Member, Department of Immunobiology, 1957-60; Member, Laboratory of Noninfectious Immunology, 1961. Microbiology.

**TRIBULEV, G. P.**

Colonel, Medical Service; Candidate of Medical Sciences; Science Director, Institute of

Experimental Biology, Academy of Medical Sciences, USSR, Moscow, 1962. Microbiology.

**YUDIN, Ye. V.**

Associate, Institute of Experimental Biology, Academy of Medical Sciences, USSR, Moscow, 1963.

**ZHUKOV-VEREZHNIKOV, Nikolay Nikolayevich**

Active Member, Academy of Medical Sciences, USSR; Doctor of Medical Sciences; Member of the institute, 1955-63; Head, Department of Immunobiology, 1955-61. Microbiology.<sup>14 16 81 82</sup>

**Institute of Labor Hygiene and Occupational Diseases, Moscow** — This institute is the largest scientific research establishment in the USSR for industrial hygiene and occupational diseases, employing some 620 persons. The director of this institute is L. I. Medved. There are three principal departments: clinical, hygiene, and radiology. Two sections also function within the frame of the institute: the laboratory for labor physiology, and the pathomorphological laboratory.

This institute can be said to support the Soviet space program with its experience in determining toxic substances in the environment, in studying effects of harmful levels of noise, and with research related to the setting of industrial toxicological standards. More specifically, however, there has been some effort by the institute in the field of radiobiology. Scientists there have studied the biological effects of protons in animals, and have attempted to find radioprotective agents in mice against whole body radiation with high-energy protons.

Institute personnel who are conducting research related to bioastronautics include:

**AVRUNINA, G. A.**

Associate, Laboratory of Radiotoxicology, Institute of Labor Hygiene and Occupational Diseases, Academy of Medical Sciences, USSR, Moscow, 1961. Radiation biology.<sup>15 81 84</sup>

**GOVORUN, R. D.**

Associate, Laboratory of Radiotoxicology, Institute of Labor Hygiene and Occupational

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Diseases, Academy of Medical Sciences, USSR, Moscow, 1961. Radiation biology.

**KURLYANDSKAYA, Ettel' Borisovna**

Doctor of Biological Sciences; Member of the institute, 1943-63; Head, Laboratory of Radiobiology, 1958; Head, Laboratory of Radiotoxicology, 1962. Industrial hygiene.

**SHASHKOV, V. S.**

Candidate of Medical Sciences; Associate, Institute of Labor Hygiene and Occupational Diseases, Academy of Medical Sciences, USSR, Moscow, 1961. Pharmacology.

**YARMONENKO, S. P.**

Member of the institute, 1961-63; Member, Laboratory of Radiotoxicology, 1962. Radiation biology.

**Other Institutes** — Some additional institutes of the Academy of Medical Sciences, USSR, that are conducting bioastronautic research include:

<u>Institute</u>	<u>Director</u>
Institute of Epidemiology and Microbiology imeni N. F. Gamaleya, Moscow	P. A. Vershilova
Institute of Experimental Medicine, Leningrad	D. A. Biryukov
Institute of Experimental Pathology and Physiology, Sukhumi	B. A. Lapin
Institute of Nutrition, Moscow	A. A. Pokrovskiy
Institute of Therapy, Moscow	A. L. Myasnikov
Institute of Virology imeni D. I. Ivanovskiy, Moscow	V. M. Zhdanov

*Academy of Sciences, USSR*

**Institute of Biological Physics, Moscow** —

The Institute of Biological Physics has the following laboratories:

<u>Laboratory</u>	<u>Head</u>
Biophysics of Vision	N. D. Nyuberg
Complex Processes	V. S. Gurfinkel
Computer Applications	(Fnu) Fomin
Living Structures	G. M. Frank
Photobiology	M. V. Sokolov
Radiation Genetics	N. P. Dubinin
Radiobiology	A. M. Kuzin
Ultrasonics	I. Ye. El'piner

In 1963, the following laboratories were designated as laboratories to be established in the future: Laboratory of Scientific Methods and Equipment for Biological Investigations, Laboratory of Automatics, Laboratory of Radioinstrument Making, and Laboratory of Electronic and Vacuum Instruments.

The Institute of Biological Physics has participated with a relatively large number of personnel in the biological experiments conducted in Soviet space flights. G. M. Frank, director of the institute, is a key man responsible for the radiobiological aspects of these space studies. This group has attempted to establish the biological effect of cosmic radiation under space-flight conditions. However, most of the experimental results can only be discussed as induced by a combination of space-flight factors such as acceleration, vibration, and weightlessness. *Drosophila* was used to determine mutation effects; actinomycetes were analyzed for characteristics of growth and development during flight; seeds of wheat, peas and corn (maize) were used in cytological studies of chromosome aberrations; and two types of seeds (spring onion and nutmeg flower) varying in radiosensitivity were examined for genetic effects of cosmic radiation. Investigations were also made at the institute to compare the acute and long-term effects of radiation on the central nervous system of rats. Research applicable to a biological closed environmental system was carried on by investigating the growth properties of *Chlorella* by determination of the absorption coefficient of light during various periods of growth.

Scientists who are conducting bioastronautic research at the institute include:

**ABELEVA, Ye. A.**

Member, Institute of Biological Physics, Academy of Sciences, USSR, Moscow, 1960-63. Member, Laboratory Radiation Genetics, 1960. Radiation biology.

**APANASENKO, Z. I.**

Member, Institute of Biological Physics, Academy of Sciences, USSR, Moscow, 1961-62.

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**ARSEN'YEVA, Militsa Alfredovna**

Candidate of Biological Sciences; Member of the institute, 1958-62. Radiation genetics.

**BRANDT, Andrey B.**

Member, Institute of Biological Physics, Academy of Sciences, USSR, Moscow, 1958-63.

**DELONE, N. L.**

Member, Institute of Biological Physics, Academy of Sciences, USSR, Moscow, 1956-63. Member, Laboratory of Radiation Genetics, 1959.

**DUBININ, Nikolay Petrovich**

Corresponding Member, Academy of Sciences, USSR; Member of the institute, 1955-63; Associate, Institute of Cytology and Genetics, Siberian Department, Academy of Sciences, USSR, Novosibirsk, 1958-62. Genetics.

**EYGES, N. S.**

Member, Institute of Biological Physics, Academy of Sciences, USSR, Moscow, 1961. Radiation biology.

**FRANK, Gleb Mikhaylovich**

Corresponding Member, Academy of Sciences, USSR; Corresponding Member, Academy of Medical Sciences, USSR; Doctor of Biological Sciences; Director, 1958-63. Biophysics.

**GENEROZOVA, I. P.**

Member, Institute of Biological Physics, Academy of Sciences, USSR, Moscow, 1963.

**GLEMBOTSKIY, Ya. L.**

Candidate of Agricultural Sciences; Member, Institute of Biological Physics, Academy of Sciences, USSR, Moscow, 1960-61. Associate, Laboratory of Radiation Genetics, 1960. Genetics.

**KHVOSTOVA, Vera V.**

Candidate of Biological Sciences; Member, Institute of Biological Physics, Academy of Sciences, USSR, Moscow, 1956-64. Member, Laboratory of Radiation Genetics, 1959-64. Genetics.

**KORSHUNOVA, V. S.**

Member, Institute of Biological Physics, Academy of Sciences, USSR, Moscow, 1961-63.

**KUZNETSOVA, M. A.**

Member, Institute of Biological Physics, Academy of Sciences, USSR, 1961.

**LAPKIN, Yu. A.**

Member, Institute of Biological Physics, Academy of Sciences, USSR, Moscow, 1957-62. Genetics.

**MOZHAYEVA, V. S.**

Member, Institute of Biological Physics, Academy of Sciences, USSR, Moscow, 1961. Radiation genetics.

**NEFEDOV, Yuriy G.**

Candidate, Medical Sciences; Associate, Institute of Biological Physics, Academy of Sciences, USSR, Moscow, 1960. Radiation biology.

**NEVZGODINA, L. V.**

Member, Institute of Biological Physics, Academy of Sciences, USSR, Moscow, 1959-62. Member, Laboratory of Radiation Genetics, 1959. Genetics.

**SHAMINA, Z. B.**

Member, Institute of Biological Physics, Academy of Sciences, USSR, Moscow, 1959-61. Space biology.

**SIDOROV, Boris N.**

Member, Institute of Biological Physics, Academy of Sciences, USSR, Moscow, 1960-63. Space biology.

**SOKOLOV, Nikolay Nikolayevich**

Member, Institute of Biological Physics, Academy of Sciences, USSR, Moscow, 1959-63. Space biology.

**TAGEYEVA, Sofiya Viktorovna**

Member, Institute of Biological Physics, Academy of Sciences, USSR, Moscow, 1957-63. Among the scientists who are associated with this institute is G. P. Parfenov.<sup>14-16 83 80</sup>

**Institute of Cytology, Leningrad** — The Laboratory of Cosmic Biology of the Institute of Cytology in Leningrad, directed by L. K. Lozina-Lozinskiy, has done research on the adaptation of cells and organisms to extreme environmental conditions, such as low tem-

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perature, ultraviolet, ionizing radiation, low pressure, and oxygen deficiency. Established in 1961, this Laboratory was set up to study (i) the probability and forms of life on other planets and (ii) the behavior and adaptation of cells and organisms to extreme environmental conditions.

Institute personnel who are conducting bio-astronautic research include:

**LOZINA-LOZINSKIY, Lev Konstantinovich**

Doctor of Biological Sciences; Head, Laboratory of Cosmic Biology, 1961-63; Head, Laboratory of Cell Adaptations, 1959-61. Cytology.<sup>15 75</sup>

**Institute of Microbiology, Moscow** — The Institute of Microbiology under A. A. Imshenetskiy's direction is the leading institute involved in the field of exobiology and in some of the work relating to the sterilization of space vehicles. Imshenetskiy is oriented more toward basic research in exobiology than toward direct involvement in the applied or hardware end of the space program. For example, he did not participate directly in the sterilization of Lunik II. More recently, however, some technical facilities have been added to the research activities of the institute. A small engineering laboratory and electronics shop have been engaged in the designing and building of electronic components for a multivibrator used in sampling extraterrestrial life. This engineering facility is limited, however, by lack of experience in dealing with space-oriented problems in instrumentation. Imshenetskiy is also a consultant and reportedly can make recommendations to the space council in the field of exobiology.

Some of the space-oriented research conducted at the institute which relates to the problem of sterilization of space vehicles includes a study on the stability of terrestrial microorganisms in deep vacuum done in cooperation with the Physico-Technical Institute of Low Temperatures, Academy of Sciences, Ukrainian SSR. Recent publications from personnel of the institute include a re-

port on the possibility of the existence and methods of detection of extraterrestrial life. The report discusses terrestrial unicellular organisms and the limits of their ability to withstand (i) low temperatures, (ii) heat, and (iii) cosmic and ultraviolet radiation in the absence of oxygen. Methods of recording life forms on another planet are also discussed. At the 1964 COSPAR meeting a paper was given concerning a technique for and the results of meteorite microbiological investigations.

Several others at the institute are engaged in research relating to exobiology. M. N. Meysel, an expert on light and electron microscopy who also does his research at the Institute of Physico-Chemical Biology, has contributed to the method of fluorescent microscopy for detecting extraterrestrial life. Iyerusalimskiy, deputy director and department head at the institute, has been concerned with the decontamination of space vehicles. In 1962, Iyerusalimskiy was to become director of the Institute of Physiology and Biochemistry of Microorganisms at Pushchino, a biological complex under construction near Moscow.

The institute is made up of the following departments:

Department	Head
Adaptation of Microorganisms	Yu. N. Karasevich
Bacteriophage and Actinophage	Ya. I. Rautenshteyn
Experimental Variability of Microorganisms	A. A. Imshenetskiy
Geological Activities of Microorganisms	S. I. Kuznetsov
Marine Microbiology	A. Ye. Kriss
Microorganisms Interaction	N. A. Krasil'nikov
Photosynthetic Microorganisms	S. V. Gorunova
Physico-Chemical Methods in Research	Unknown
Physiology of Chemoautotrophic Microorganisms	G. A. Zavarzin
Physiological Cytology of Microorganisms	M. N. Meysel

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<u>Department</u>	<u>Head</u>
Physiology of Growth and Development of Microorganisms	N. D. Iyerusalimskiy
Soil Microorganisms	Ye. N. Mishustin
Technical Microbiology	V. N. Shaposhnikov
Thermophilic Microorganisms	L. G. Loginova
Transformation of Steroids and Other Compounds	G. K. Skryabin
Type Culture Collection	V. I. Kudryavtsev
Viruses	V. L. Ryzkov

Institute personnel who are conducting bioastronautic research include:

**ABYZOV, S. S.**

Member, Institute of Microbiology, Academy of Sciences, USSR, Moscow, 1958-60; Associate, All-Union Institute of Agricultural Microbiology, All-Union Academy of Agricultural Sciences imeni V. I. Lenin (VASKhNIL), Leningrad, 1961. Microbiology.

**IMSHENETSKIY, Aleksandr Aleksandrovich**

Active Member, Academy of Sciences, USSR; Doctor of Biological Sciences; Director, 1949-63. Microbiology.

**IYERUSALIMSKIY, Nikolay Dmitriyevich**

Corresponding Member, Academy of Sciences, USSR; Member, Institute of Microbiology, Academy of Sciences, USSR, Moscow, 1935-64 (Deputy Director, 1950-61; Head, Department of Physiology, Growth and Development of Microorganisms, 1961-63); Deputy Academician-Secretary, Department of Biological Sciences, Academy of Sciences, USSR, 1962; Member, International Union of Biological Sciences (IUBS) and Executive Council, Committee on Space Research (COSPAR) 1964; Member, Editorial Board, *Mikrobiologiya*, 1956-63. Microbiology.

**MEYSEL, Maksim Nikolayevich**

Corresponding Member, Academy of Sciences, USSR; Associate, Institute of Chemistry of Natural Compounds, Academy of Sciences, USSR, Moscow, 1964; Member, Institute of Microbiology, Academy of Sciences, USSR, Moscow, 1934-63 (Deputy Director, 1937-49;

Head, Section on Physiological Cytology of Microorganisms, 1962); Head, Laboratory on Functional Morphology of the Cell, Institute of Radiation and Physico-Chemical Biology, Academy of Sciences, USSR, Moscow, 1959-62; Member, Moscow State University imeni M. V. Lomonosov, 1946-62; Member, Institute of Biological Physics, Academy of Sciences, USSR, Moscow, 1955-62 (Laboratory Head, 1962); Member, Editorial Board, *Tsitologiya* (Cytology), 1960-64. Microbiology.

**Institute of Physiology imeni I. P. Pavlov** — The Institute of Physiology imeni I. P. Pavlov is located in three principal areas in or around Leningrad. The following laboratories are located outside Leningrad in the village of Koltushi (this facility is undergoing expansion with some of the laboratories at Leningrad moving to Koltushi):

<u>Laboratory</u>	<u>Head</u>
Interceptive Conditioned Reflexes (This facility may be a new laboratory or only an expansion of the laboratory of Ayrapet'yants.)	V. A. Kislyakov
Comparative Ontogenesis of Higher Nervous Activity	G. A. Obratsova
Comparative Physiology of Interceptive Conditioned Reflexes	E. Sh. Ayrapet'yants
Ecological Physiology	A. D. Slonim
Higher Nervous Activity of the Child	M. M. Kol'tsova
Pharmacology of Central Nervous System	G. I. Izokallo
Physiology and Biochemistry of Lactation	I. A. Baryshnikov
Physiology and Genetics of Types of Higher Nervous Activity	V. K. Krasuskly
Physiology and Pathology of Direction and Blood Circulation	A. Y. Solov'yev
Physiology of Circulation	G. P. Konradi
Physiology of Endocrine Glands	Ye. N. Speranskaya
Physiology of Higher Nervous Activity	V. B. Pavlov
Physiology of Lower Animals	N. G. Lopatina
Primate Studies	L. A. Firsov

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These laboratories are located in the main institute building in Leningrad:

<u>Laboratory</u>	<u>Head</u>
Corticovisceral Physiology and Pathology	I. T. Kurtsin
Electrophysiology	V. Ye. Delov
Functional Biochemistry of the Nervous System	N. N. Demin
General Physiology	V. N. Chernigovskiy
Morphology	N. G. Kolosov
Physiology and Experimental Pathology of Higher Nervous Activity	F. P. Mayorov
Physiology of the Autonomic Nervous System	A. V. Tonkikh
The Visual Analyzer	V. D. Glezer

The following laboratories are located in another part of Leningrad on the Petrovsky Embankment:

<u>Laboratory</u>	<u>Head</u>
Biochemistry of the Nervous System	N. N. Demin
Higher Nervous Activity in Children	M. M. Koltzova
Neurophysiology	P. A. Kisselev
Physiology and Pathology of Age in Man and Ontogeny of Endocrines	V. G. Baranov
Physiology of the Auditory Analyzer	G. V. Gershuni

The location of the following laboratory is unknown:

Laboratory of Biophysics and Complex Processes—Head: M. L. Garfunkel' (Although this laboratory was set up by Chernigovskiy, it may well be located at the Academy of Sciences in Moscow.)

V. N. Chernigovskiy, director of the institute, has been a respected spokesman and leader in the Soviet space program since its inception. In 1959, he was cited as director of training and preparation of animals for space flight. Recently he has been named Academician-Secretary of the Department of Physiology, Academy of Sciences, USSR. He appears to coordinate the bioastronautic activities of the Academy of Medical Sciences and the Academy of Sciences.

As one of the leading physiological institutes in the USSR, this Institute has approximately 700 people working in the Leningrad area. In addition to the research activities with dogs for the early animal flights, the institute reportedly established a secret laboratory in 1962 under Kislyakov and Ayrapet'yants for the study of the labyrinth and vestibular apparatus. This research probably was used in the reported changes in the training program of the cosmonauts after Titov's experience of space sickness and for a basic understanding of the vestibular problem. Another laboratory was set up recently by Chernigovskiy, the Laboratory of Biophysics and Complex Processes, headed by M. L. Garfunkel', to study the movement of muscle mass and how these muscle masses are coordinated with other muscle activity. This group also is working on the significance of oculographic measurements. These measurements have been taken on four of the cosmonauts during space flight.

N. A. Rokotova and her group, who do primate behavior work with rhesus monkeys, have published their research on the effect of prolonged limitation of motor activity on the activity of monkeys in *Problems of Space Biology*, volume 2. An investigation related to future communication problems during prolonged flight is described in the same publication series by L. A. Chistovich and V. A. Kozhevnikov. Their article concerns the significance of the physiological studies of the speech process in the design of systems for the automatic decoding of human speech.

Institute personnel who are involved in bioastronautic research include:

AYRAPET'YANTS, Ervand Shamirovich

Doctor of Biological Sciences; Member of the institute, 1949-63; Head, Laboratory of Interoceptive Conditioned Reflexes, 1952-63; Head, Laboratory of the Physiology of Higher Nervous Activity, Scientific Research Institute of Physiology imeni A. A. Ukhtomskiy, Leningrad State University imeni A. A. Zhdanov, 1956-61. Neurophysiology.

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**BOLOTINA, O. P.**

Candidate of Biological Sciences; Member, Laboratory of Comparative Physiology of Higher Nervous Activity, Institute of Physiology imeni I. P. Pavlov, Academy of Sciences, USSR, Leningrad, 1952-60. Physiology.

**CHERNIGOVSKIY, Vladimir Nikolayevich**

Active Member, Academy of Sciences, USSR; Active Member, Academy of Medical Sciences, USSR; Academician-Secretary, Department of Physiology, Academy of Sciences, USSR; Doctor of Medical Sciences; Member of the institute, 1952-63, Director, 1961-63; Director, Institute of Normal and Pathological Physiology, Academy of Medical Sciences, USSR, Moscow, 1953-60; Head, Laboratory of General Physiology, 1958-62. Physiology.

**CHISTOVICH, L. A.**

Head of a laboratory of the Institute of Physiology imeni I. P. Pavlov, Academy of Sciences, USSR, Leningrad, 1963.

**DEMIN, Nikolay Nikolayevich**

Doctor of Biological Sciences; Head, Laboratory of Functional Biochemistry of the Nervous System, 1963; Member, Institute of Biological Physics, Academy of Sciences, USSR, Moscow, 1962. Biochemistry.

**GORBUNOVA, Irina M.**

Member, Institute of Physiology imeni I. P. Pavlov, Academy of Sciences, USSR, Leningrad, 1958-62 (Member, Laboratory of Neurophysiological Problems, 1959-60). Physiology.

**KISLYAKOV, V. A.**

Candidate of Biological Sciences; Member, Laboratory of Interoceptive Conditioned Reflexes, 1953-60. Physiology.

**KOZHEVNIKOV, V. A.**

Director of Biological Sciences; Member, Laboratory of Physiology of Auditory Analyzer, Institute of Physiology imeni I. P. Pavlov, Academy of Sciences, USSR, Leningrad, 1953.

**KUCHERENKO, T. M.**

Member, Institute of Physiology imeni I. P. Pavlov, Academy of Sciences, USSR, Leningrad, 1954-61 (Member, Laboratory of Experimental Pharmacology, 1954-56; Member, Laboratory of Experimental Genetics and Higher Nervous Activity, Experimental Pharmacology Group, 1957-58; Member, Laboratory on Pharmacology of the Central Nervous System, 1959-61). Pharmacology.

**MITYUSHOV, Mikhail Ivanovich**

Candidate of Biological Sciences; Member, Institute of Physiology imeni I. P. Pavlov, Academy of Sciences, USSR, Leningrad, 1954-60 (Associate, Laboratory of Neural-Regulation: Endocrine Functions, 1954-56; Associate, Laboratory of Physiology: Internal Glandular Secretions, 1955; Acting Deputy Director, 1960). Physiology.

**ROKOTOVA, N. A.**

Doctor of Biological Sciences; Member of the institute, 1952-63; Member, Laboratory of Neurophysiological Problems, 1959-60. Neurophysiology.<sup>11 14-16 87-93</sup>

**Institute of Plant Physiology imeni K. A. Timiryazev, Moscow** — The Institute is directed by A. L. Kursanov and consists of 11 laboratories and 4 sections, as follows:

<u>Laboratory</u>	<u>Head</u>
Accumulation of Storage Products	A. A. Prokof'ev
Cold Resistance	I. I. Tumanov
Evolutionary and Ecological Physiology	A. A. Shakhov
Growth and Development	M. Kh. Chaylakhyan
Heat Resistance and Dormancy	P. A. Genkel'
Photosynthesis	A. A. Nichiporovich
Physiology of Drought and Salt Resistance	P. A. Genkel'
Root Nutrition	Z. I. Zhurbitskiy
Stimulation and Inhibition	Yu. V. Rakitin
Translocation and Metabolism	A. L. Kursanov
Water Relations	N. S. Petinov

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Section	Head
Biomagnetism	A. L. Kursanov
Morphogenesis	A. S. Kruzhilln
Seed Physiology	K. Ye. Ovcharov
Tissue and Organ Culture	A. L. Kursanov

The institute also has a facility designed for the study of extreme environments. In 1963 the facility was making extensive tests of various light sources.

The Institute of Plant Physiology is one of the important Soviet facilities that is doing basic research in biological regenerative systems for prolonged space flight. Under the leadership of A. A. Nichiporovich, head of the Laboratory of Photosynthesis, investigations have been made of the algae *Chlorella*. This is the algae that the Soviets have indicated could be used in fulfilling biological gas-exchange requirements for a biological closed ecological system. However, recently the Soviets have indicated that *Chlorella* is no longer the algae of choice for this system. This laboratory is said to be well equipped for its research work. The quality of the work has been described as varying from excellent to poor.

Research activities have centered upon determining the growth characteristics of *Chlorella* under both laboratory and space-flight conditions. A model has been developed for laboratory use in standardizing the method of cultivation of *Chlorella*. The Soviets are interested also in the automation of cultivation for flight conditions and have described an automatic device for regulating the composition of the media and for measuring photosynthesis by an infrared gas analyzer. Studies have been made on the algae *Chlorella* under the conditions of space flight to determine the effect of these conditions on external characteristics, the microscopic appearance, and the extent of photosynthesis. In determining the effect of radiation on the organism during flight the Soviets have made further studies on the growth characteristics of this algae.

Institute personnel who are involved in bioastronautic research include:

**CHUCHKIN, V. G.**

Institute of Plant Physiology imeni K. A. Timiryazev, Academy of Sciences, USSR, 1963.

**KHAZANOV, V. S.**

Candidate of Technical Sciences; Member, All-Union Scientific Research Institute of Lighting Engineering, Moscow, 1955-62 (Member, Laboratory of Light Measurement, 1957-61, Head, 1961); Associate, Institute of Plant Physiology imeni K. A. Timiryazev, Academy of Sciences, USSR, Moscow, 1959-62; Associate, Pamir Botanical Garden, Academy of Sciences, Tadzhik SSR, 1962. Luminescence.

**NICHIPOROVICH, Anatoliy Aleksandrovich**

Doctor of Biological Sciences; Member, 1943-63, Head, Photosynthesis Laboratory, 1958-61. Plant physiology.

**SEMENENKO, V. Ye.**

Member, Institute of Plant Physiology imeni K. A. Timiryazev, Academy of Sciences, USSR, Moscow, 1957-61 (Member, Photosynthesis Laboratory, 1961). Botany.

**SHAKHOV, Aleksandr Aleksandrovich**

Doctor of Biological Sciences; Member of the institute, 1955-63; Head, Kola Peninsula Expedition, 1962; Head, Mount Aragats Biological Station, 1962. Botany.

**STANKO, S. A.**

Associate, Institute of Plant Physiology imeni K. A. Timiryazev, Academy of Sciences, USSR, Moscow, 1959-62; Associate, All-Union Scientific Research Institute of Lighting Engineering, Moscow, 1959-62; Associate, Pamir Botanical Garden, Academy of Sciences, Tadzhik SSR, 1962. Space botany.

**VLADIMIROVA, M. G.**

Member, Institute of Plant Physiology imeni K. A. Timiryazev, Academy of Sciences, USSR, Moscow, 1960-61. Space biology.<sup>14 16 18</sup>

**Other Institutes** — The following institutes of the Academy of Sciences, USSR, are also engaged in bioastronautic research:

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<u>Institute</u>	<u>Director</u>
Institute of Biochemistry imeni A. N. Bakh, Moscow	A. I. Oparin
Institute of Botany imeni V. L. Komarov, Leningrad	A. A. Fedorov
Institute of Cytology and Genetics, Siberian Depart- ment, Novosibirsk	D. K. Belyayev
Institute of Evolutionary Physiology imeni I. M. Sechenov, Leningrad	Ye. M. Kreps
Institute of Genetics, Mos- cow	T. D. Lysenko
Institute of Physics, Siberian Department, Krasnoyarsk	L. V. Klrenskiy
Institute of Physiology imeni A. A. Bogomolets, Kiev	A. F. Makarchenko
Institute of Radiation and Physico-Chemical Biology, Moscow	V. A. Engel'gardt

*Ministry of Health, USSR and RSFSR*

**Institute of Biophysics, Moscow** — Little is known about the activities and personnel of the Institute of Biophysics in Moscow. A. V. Lebedinskiy, director of the Institute, was a member of the editorial board and an author in the major Soviet publications relating to the Soviet bioastronautic program, *Problems of Space Biology*, volumes 1 and 2.

Major research activity of this institute appears to be centered around an elaboration of problems pertaining to the pathogenesis of radiation sickness and the study of the mechanism of biological action of ionizing radiation. Lebedinskiy probably was one of the Soviet scientists who was instrumental in determining the Soviet standards of the level of acceptable risk in the exposure of the cosmonauts to radiation. Research has been conducted at the institute on protective agents against radiation and in determining the toxic effect of beryllium on animals. Dosimetric monitoring equipment has also been produced in a workshop in the institute. Details concerning Lebedinskiy follow.

**LEBEDINSKIY, Andrey Vladimirovich**

Doctor of Medical Sciences; Major-General, Military Medical Service, USSR; Active Mem-

ber, Academy of Medical Sciences, USSR; Head, Department of Physiology, Moscow State University imeni M. V. Lomonosov, 1961-63; Director, Institute of Biophysics, Moscow, 1955-62. Physiology.

Other Institutes — The following institutes are also engaged in bioastronautic research:

<u>Institute</u>	<u>Head</u>
All-Union Scientific Research Institute of Antibiotics, Moscow (USSR)	A. G. Baychikev, Director
Central Institute of Hema- tology and Blood Trans- fusion, Moscow (USSR)	A. Ye. Kiselev, Director
First Moscow Medical Insti- tute imeni I. M. Sechenov (RSFSR)	V. V. Kovanov, Rector
Institute of Experimental Biology and Medicine, Novosibirsk (RSFSR)	Yu. I. Borodin, Act- ing Director <sup>11 14 16</sup>

*Facilities of the Moscow State University  
imeni M. V. Lomonosov, Moscow*

Ivan Georgiyevich Petrovskiy is the head of the Moscow State University imeni M. V. Lomonosov, Moscow, which is under the Ministry of Higher and Secondary Specialized Education, USSR.

Certain of the activities of the University have to do with the study and evaluation of the radiation hazard for space flight. The expected radiation level is determined before each manned space flight and includes solar-flare studies. At the 1964 COSPAR meeting, personnel of the University discussed the radiation level during the flights of Vostoks 3, 4, 5, and 6.

Within the last several years a space biology training program has been initiated at the University. Classroom work begins there and then progresses to the major institutes in Moscow. This program is to shift soon to the new biological center at Pushchino. This course is a graduate program for individuals who will go into key laboratories as heads of laboratories or sections. It is estimated that

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from 90 to 100 students are involved at a given time. Yazdovskiy, a leading figure in the Soviet manned space program, is responsible for this space-biology program at the University.

University staff members who are contributing to bioastronautic research include:

**NESTEROV, V. Ye.**

Member, All-Union Scientific Research Institute of Fertilizers and Agro-Soil Science, Moscow, 1958-62; Member, Scientific Research Institute of Nuclear Physics; Moscow State University imeni M. V. Lomonosov, 1961-62.

**PISARENKO, N. F.**

Member, Institute of Biochemistry imeni A. N. Bakh, Academy of Sciences, USSR, Moscow, 1961; Member, Scientific Research Institute of Nuclear Physics, Moscow State University imeni M. V. Lomonosov, 1961-62.

**SAVENKO, Ivan Andreyevich**

Member, Scientific Research Institute of Nuclear Physics; Moscow State University imeni M. V. Lomonosov, 1961-63; Member, Consultative Group on Potentially Harmful Effects of Space Experiments, Committee on Space Research (COSPAR), 1962-63.

**SHAVRIN, P. I.**

Member, Scientific Research Institute of Nuclear Physics, Moscow State University imeni M. V. Lomonosov, 1958-62.

**YAZDOVSKIY, V. I.**

Candidate of Medical Sciences, Colonel, Medical Service; Member, Institute of Normal and Pathological Physiology, Academy of Medical Sciences, USSR, 1960-63; Head, Cosmic Laboratories, Moscow State University imeni M. V. Lomonosov, since 1959; space medicine; born 24 June 1913; Stalin Prize.<sup>11 12 53</sup>

#### BIOASTRONAUTIC RESEARCH AND DEVELOPMENT

The many institutes involved in Soviet bioastronautic research and development are concerned with exobiology, biotelemetry, environmental and life-support systems, and space physiology.

#### Exobiology

There is apparently no well-organized exobiology program as part of the Soviet space effort. While an exobiology program reportedly has been recommended to the Soviet decision-making body, there has been little implementation and indication of priority interest in such a program.

The principal research in exobiology is conducted at the Institute of Microbiology under Imshenetskiy's direction. (See "Institute of Microbiology" section.) Several other institutes are engaged in supporting research with a small number of personnel involved. There is a report also that Tomilino is concerned with the investigation of elements on other planets and the study of earth contamination by extraterrestrial substances.<sup>2 4 13 51 76 80</sup>

#### Institutes

Soviet institutes involved in exobiology are:

- \*1. Institute of Microbiology, Academy of Sciences, USSR
2. Institute of Cytology, Academy of Sciences, USSR
3. Institute of Experimental Biology, Academy of Medical Sciences, USSR
4. Central Scientific Research Institute of Disinfection, Ministry of Health, USSR
- \*\*5. Tomilino, State Committee for Aviation Technology (GKAT)
- \*\*6. Institute of Physiology and Biochemistry of Microorganisms, Pushchino, Academy of Sciences, USSR
7. Institute of Radiation and Physico-Chemical Biology, Academy of Sciences, USSR
8. Institute of Biochemistry imeni A. N. Bakh

\*Leading institute.

\*\*Possible involvement.

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### Leading Personalities

Leading Soviet personalities who are working in the field of exobiology include:

Name: Imshenetskiy, A. A.  
Affiliation\*: 1  
Specialty: Leading spokesman and director of exobiological research

Name: Abyzov, S. S.  
Affiliation\*: 1  
Specialty: Microbial investigations of meteorites

Name: Chernov, V. N.  
Affiliation\*: 1  
Specialty: Engineering in the welding of life-detection equipment

Name: Iyerusalimskiy, N. D.  
Affiliation\*: 1,6  
Specialty: Decontamination of space vehicles

Name: Lozina-Lozinskiy, L. K.  
Affiliation\*: 2  
Specialty: Extraterrestrial life on Mars

Name: Meysel, M. N.  
Affiliation\*: 1,7  
Specialty: Fluorescent microscopy in detection of extraterrestrial life

Name: Oparin, A. I.  
Affiliation\*: 8  
Specialty: Extraterrestrial life

Name: Vashkov, V. I.  
Affiliation\*: 4  
Specialty: Sterilization techniques

Name: Zhukov-Verezhnikov, M. N.  
Affiliation\*: 3  
Specialty: Space microbiology, development of bioelements

### Biotelemetry

The Soviet biotelemetry program has been a considered, methodical, and careful one. Initial requirements and biotelemetric instrumentation for in-flight medical control and experimentation were determined in the early animal space flights. This started in November 1957 with the dog Laika (Sputnik 2) and with the first comprehensive experimentation that used biotelemetry on the dogs Belka, Strelka, Pshelka, and Muska (Sputniks 5 and 6) in 1960. The methods were concerned with the cardiovascular system (electrocardiography, phonocardiography, and seismocardiography), respiration (pneumography), the

\*The number refers to the institute location shown in the previous section on "Institutes."

motor reactions of animals (electromyography), and heat regulation (temperature).

The main units of biotelemetry used in the Vostok manned space flights underwent flight tests in early 1961 with the dogs Chernushka and Zvezdochka (Sputniks 9 and 10). The validation of biotelemetric equipment by flight testing had been preceded by refinement of requirements, laboratory research and development, clinical evaluation, and equipment testing under simulated flight conditions.

R. M. Bayevskiy, Ye. B. Babskiy, and V. L. Karpman are leading Soviet medical specialists in space-oriented biotelemetry. Medical radioelectronic considerations in the design, development, and application of biotelemetry for space flight have been undertaken by I. T. Akulinichev and his group. The key institute involved in the research and development of bioinstrumentation used for the monitoring of cosmonauts has been the Institute of Normal and Pathological Physiology. This is a competent group that is doing research and instrument development applicable not only to the medical control of the cosmonaut, but also to experimental studies relating to the response of man under such conditions as weightlessness.

The Soviets have been ready to incorporate instrumentation needed for successive flights as determined by the results and problems encountered on previous flights. For example, Titov's experience of in-flight sickness necessitated the use of the oculogram on the next flights. Instrumentation for future flights is undergoing improvement and development. The Soviets indicate that detachable electrodes will be needed for prolonged flight for the periodic examination and medical control of the cosmonaut. This would also be needed for possible extra-vehicular activity. Work is continuing on on-board recording; an autonomous recorder is now used for monitoring the pulse and respiration of the cosmonaut at ejection and during descent by parachute. Bayevskiy is working on an on-board diagnostic machine for rapid and real-time evaluation of all biomedical data from the cosmonaut and the environmental control system.

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*Institutes*

Soviet institutes involved in the field of biotelemetry are:

- \*1. Institute of Normal and Pathological Physiology, Academy of Medical Sciences, USSR
2. Institute of Physiology imeni I. P. Pavlov, Academy of Sciences, USSR
- \*\*3. Scientific Research Testing Institute of Aviation Medicine, Ministry of Defense, USSR
4. Institute of Evolutionary Physiology imeni I. M. Sechenov, Academy of Sciences, USSR
5. Institute of Therapy, Academy of Medical Sciences, USSR

*Leading Personalities*

The leading personalities involved in biotelemetry in the USSR are:

- |                 |   |
|-----------------|---|
| Name:           | Agadzhanian, N. A.  |
| Affiliation***: | Associated with 1   |
| Specialty:      | Placement and method of attachment of electrodes  |
| Name:           | Akulnischev, I. T.  |
| Affiliation***: | Associated with 1   |
| Specialty:      | Design, development, and application of bioinstrumentation for space flight (including galvanic skin response, vectorcardioscope) |
| Name:           | Anokhin, P. K.  |
| Affiliation***: | 1   |
| Specialty:      | Electroencephalogram  |
| Name:           | Babskiy, Ye. B.   |
| Affiliation***: | 1   |
| Specialty:      | Instrumentation for cardiovascular monitoring   |
| Name:           | Bayevskiy, R. M.  |
| Affiliation***: | 1   |
| Specialty:      | Phonocardiogram, seismocardiogram, blood pressure, ballistocardiogram   |
| Name:           | Filippovich, S. I.  |
| Affiliation***: | 1   |
| Specialty:      | Digestive physiology  |

\*Leading institute.

\*\*Possible involvement.

\*\*\*The number refers to the institute location shown in the previous section on "Institutes."

- |                 |   |
|-----------------|---|
| Name:           | Garfunkel', M. L.                                       |
| Affiliation***: | —   |
| Specialty:      | Oculographic measurements                               |
| Name:           | Gazenko, O. G.  |
| Affiliation***: | 3   |
| Specialty:      | Support on methods and techniques of bioinstrumentation |
| Name:           | Karpman, V. L.  |
| Affiliation***: | 1   |
| Specialty:      | Dynamocardiogram cardiac measurements                   |
| Name:           | Khayutin, V. M.   |
| Affiliation***: | 1   |
| Specialty:      | Electromyogram  |
| Name:           | Marshak, M. Ye.   |
| Affiliation***: | 1   |
| Specialty:      | Environmental and respiratory physiology                |
| Name:           | Meyerson, F. Z.   |
| Affiliation***: | 1   |
| Specialty:      | Weightlessness effects on cardiovascular system         |
| Name:           | Moskalenko, Yu. Ye.                                     |
| Affiliation***: | 4   |
| Specialty:      | Electroplethysmogram                                    |
| Name:           | Parin, V. V.  |
| Affiliation***: | 1   |
| Specialty:      | Ballistocardiogram, all cardiac measurements            |
| Name:           | Sinyakov, V. S.   |
| Affiliation***: | 1   |
| Specialty:      | Bioinstrumentation electronics                          |

**Environmental and Life-Support Systems**

The Soviets began experimentation and testing of their present environmental life-support system in the early 1950's with the work of A. D. Seryapin and his use of chemical compounds (superoxides) for regeneration of oxygen. Work related to this problem may well be the reason for Seryapin's sharing the Stalin Third Prize with A. V. Pokrovskiy, V. I. Popov, and V. I. Yazdovskiy "for work in the technical field" in 1951. Testing of this method was carried out with dogs by using the criteria of an oxygen content range of 40 percent, CO<sub>2</sub> content 0.5-1.5 percent or less, and the normal life span of the system as 14 days. This method was flight tested with the dog Laika in Sputnik 2 on 3 November 1957.

Detailed information on the location of facilities and on personnel concerned with



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environmental life-support equipment development is sparse, but much of the basic research work is probably done at the Institute of Normal and Pathological Physiology. Experimental evaluation and development work is done at NIILAM in Moscow. The key men in this field are O. G. Gzenko and A. M. Genin, in coordination with V. I. Yazdovskiy. Space suit development has been undertaken at Tomilino under S. M. Alekseyev. Possible subsystem-capsule development is done at new TsAGI. The Soviets also have conducted a basic research program that is oriented toward closed ecological systems under the Academy of Sciences with A. A. Nichiporovich directing a group at the Institute of Plant Physiology imeni K. A. Timiryazev.

Indications are that the present Vostok environmental life-support system consists of a two-gas system with potassium superoxide as the oxygen source, along with partial carbon-dioxide absorption. Lithium hydroxide is used as an additional carbon-dioxide absorber and the atmospheric pressure level of the cabin is 14.7 pounds per square inch (psi); the suit inflates to one-half an atmosphere (7.5 psi). This superoxide system at one time was said to be prime during flight and secondary during launch; during reentry high-pressure oxygen was used. However, final testing of the environmental system was said to be concluded before the flights of Vostoks 3 and 4. For those flights the system was put into operation 1 hour before launch for Vostok 3, and 4 hours prior to launch for Vostok 4. This life-support system is adequate for flights of 10 to 14 days. In future missions, the Soviets are considering raising the level of oxygen from 20 to 29 percent up to 40 percent and lowering the nitrogen level accordingly down to the 60 percent range. The Soviets also may be ready to incorporate a water regeneration system in subsequent flights. For future prolonged space missions, the Soviets are conducting research and have indicated the need for developing a completely closed ecological environmental life-support system.<sup>14 16 25 31 98 100</sup>

#### *Institutes*

Some of the leading Soviet institutes involved in environmental and life-support research and development are:

1. Scientific Research Testing Institute of Aviation Medicine (NIIAM), Ministry of Defense, USSR
2. Institute of Normal and Pathological Physiology, Academy of Medical Sciences, USSR
3. Institute of Plant Physiology imeni K. A. Timiryazov, Academy of Sciences, USSR
4. Tomilino, State Committee for Aviation Technology (GKAT)
- \*5. The Central Aerohydrodynamics Institute (TsAGI), GKAT

#### *Leading Personalities*

Leading personnel working in environmental and life-support research and systems in the USSR are:

Name:	Alekseyev, S. M.
Affiliation**:	4
Specialty:	Space suit and equipment
Name:	Gzenko, O. G.
Affiliation**:	1
Specialty:	Life-support research and development
Name:	Genin, A. M.
Affiliation**:	—
Specialty:	Life-support research and development
Name:	Nichiporovich, A. A.
Affiliation**:	3
Specialty:	Closed biological ecological systems
Name:	Serapin, A. A.
Affiliation**:	—
Specialty:	Chemical method for the regeneration of oxygen
Name:	Sergeyev, N. P.
Affiliation**:	—
Specialty:	Space capsule environments
Name:	Yazdovskiy, V. I.
Affiliation**:	—
Specialty:	Life-support research and development

\*Possible involvement.

\*\*The number refers to the institute location shown in the previous section on "Institutes."

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### Weightlessness

The Soviets have considerable flight experience for the study of the problem of weightlessness. They began more extensive study of the effects of weightlessness during the suborbital or vertical flights with dogs during the early 1950's. Biological experiments have been conducted and Soviet cosmonauts have experienced weightlessness for periods up to 5 days. Experiments under laboratory conditions are conducted at Chkalovskaya (Shchelkovo) on planes flying parabolic curves lasting from 30 to 40 seconds. The Soviets are aware of the increasing problems for man in the weightless condition during prolonged flight and have an expanding and highly competent basic research program oriented toward the study of this problem. The center for the study of the cardiovascular effects of weightlessness is the Institute of Normal and Pathological Physiology under V. V. Parin.

Selection procedures for Soviet cosmonauts have not always demonstrated the correctness of such procedures under the weightless condition, as for example in the case of G. Titov, or an extensive experimental approach to the selection process. More recently, the Soviets have conducted experiments on some 200 humans and have separated out those who are able to adapt to the weightlessness state during these tests and have categorized them by the degree of adaptation. Those with considerable flight experience (82 percent) were able to adapt to weightlessness and only 17 percent without flight experience were able to adapt. The results of adaptation to weightlessness were found to be similar for both men and women. After the experience of Titov in Vostok 2 basic research also has been expanded in the study of the vestibular system. A laboratory was established at the Institute of Physiology imeni Pavlov under Kislaykov and Ayrapet'yants. Another group under A. V. Lebedinskiy has been studying the autonomic nervous system reactions from stimulation of the vestibular analyzer for an understanding of this problem in relation to space flight. Research in artificial gravity will be discussed under the section on acceleration.<sup>11 14 16 194</sup>

### Institutes

Some of the leading Soviet institutes and facilities involved in the study of weightlessness are:

1. Institute of Normal and Pathological Physiology, Academy of Medical Sciences, USSR
2. Chkalovskaya (Shchelkovo)
- \*3. Scientific Research Testing Institute of Aviation Medicine (NIIAM), Ministry of Defense, USSR
4. The Institute of Physiology imeni Pavlov, Academy of Sciences, USSR

### Leading Personalities

Some of the leading personalities who are doing research in weightlessness are:

Name:	Kas'yan, I. I.
Affiliation**:	1
Specialty:	Research in weightlessness
Name:	Kislyakov, V. A.
Affiliation**:	4
Specialty:	Study of labyrinth and vestibular apparatus
Name:	Kitayev-Smyk, L. A.
Affiliation**:	1
Specialty:	Effects of weightlessness on animals and humans
Name:	Khayutin, V. M.
Affiliation**:	1
Specialty:	Research in correlating muscle activity with blood flow (effect of in-flight exercise on circulation of blood through other organs of the body)
Name:	Meyerson, F. Z.
Affiliation**:	1
Specialty:	Effects of prolonged weightlessness on cardiovascular system
Name:	Parin, V. V.
Affiliation**:	1
Specialty:	Cardiovascular physiology during weightlessness
Name:	Yazdovskiy, V. I.
Affiliation**:	—
Specialty:	Study of weightlessness problem
Name:	Yuganov, Ye. M.
Affiliation**:	1
Specialty:	Research in weightlessness

\*Possible involvement.

\*\*The number refers to the institute location in the previous section on "Institutes."

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Other Soviets who are studying problems associated with weightlessness include M. A. Cherepakhin, O. G. Gzenko, A. I. Gorshkov, Yu. G. Grigor'yev, G. L. Komendantov, V. I. Kopayev, A. V. Lebedinskiy, R. M. Lyubimova-Gerasimova, B. I. Polyakov, Yu. V. Vanyushina, B. A. Zhuravlev, and A. T. Zverev.

#### Acceleration

A large amount of the background work in acceleration research on animals and humans was done at the Scientific Research Testing Institute of Aviation Medicine (NIIAM) in Moscow under P. K. Isakov. Research that can be applied to the dog flights was conducted in 1957 by A. R. Kotovskaya and Ye. M. Yuganov. They conducted experiments on the effect of transverse acceleration on the cardiovascular and respiratory system of dogs. The results indicated that dogs could withstand from 2 to 10 G's during a 6-minute period satisfactorily.

The Soviets have indicated that the centrifuge is of considerable value in the selection and training of cosmonauts. A. S. Barer has conducted tests on the centrifuge at Tomilino on the limits of human tolerance to transverse accelerations. The cosmonauts are known to have undergone training and testing on this centrifuge. Recently the Soviets have expressed the need for artificial gravity for prolonged space flights. Preliminary experiments on rats and mice have been conducted to determine the minimally effective level of an artificial force of gravity for maintaining normal body position and coordination. This level was found to be 0.3 G. The Soviets have also indicated that the cosmonaut may alleviate deconditioning during prolonged flight by periodic acceleration on an on-board centrifuge.<sup>14-16 105 107</sup>

#### Institutes

Some of the leading institutes or facilities involved in acceleration research are:

1. Scientific Research Testing Institute of Aviation Medicine, Ministry of Defense, USSR

2. Institute of Normal and Pathological Physiology, Academy of Medical Sciences, USSR
3. Tomilino, the State Committee for Aviation Technology (GKAT)

#### Leading Personalities

Some of the leading personnel doing acceleration research include:

Name:	Barer, A. S.
Affiliation*:	3
Specialty:	Physiological testing of humans during acceleration on a centrifuge
Name:	Isakov, P. K.
Affiliation*:	1
Specialty:	Acceleration research
Name:	Kas'yan, I. I.
Affiliation*:	2
Specialty:	Acceleration research
Name:	Yuganov, Ye. M.
Affiliation*:	2
Specialty:	Acceleration research

Others involved in acceleration studies include N. A. Agadzhanian, V. I. Babushkin, V. Ye. Belay, O. G. Gzenko, G. D. Glod, S. A. Gozulov, O. V. Graunov, A. A. Gyurdzhian, G. V. Izosimov, G. F. Khlebnikov, A. A. Kiselev, S. P. Kolchin, Yu. N. Kopayev, A. R. Kotovskaya, Ye. F. Kotovskiy, S. I. Lobashkov, G. P. Mirolyubov, Yu. Ye. Moskalenko, A. N. Rozumeyev, D. Ye. Rozenblyum, S. F. Simpura, P. M. Suvorov, N. N. Timofeyev, P. V. Vasil'yev, and V. G. Yeliseyev.

#### Radiation

Since the inception of the space program, the Soviets have expressed concern and interest in determining the biological effects of cosmic radiation. Beginning with Sputnik 2 through Sputnik 5 in the period prior to manned flight, an array of biological specimens was carried aboard the spaceships. Much of this work was conducted at the Institute of Biological Physics, Academy of Sciences, USSR, and the Institute of Experimental Biology, Academy of Medical Sciences.

\*The number refers to the institute location in the previous section on "Institutes."

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USSR. These experiments were not able, however, to separate the effects of radiation from those of other space flight factors, such as vibration, acceleration, and weightlessness.

The manned space program has continued the biological experimentation in near-earth orbit and the concern for radiation safety of the man during flight with a solar-flare detection program. The monitoring of the cosmonaut has indicated a level of radiation exposure of from 8 to 15 millirads per day. The Institute of Biophysics, Ministry of Health, USSR, under A. V. Lebedinskiy has studied the biological effects of ionizing radiation in determining the acceptable level of risk for Soviet cosmonauts and also has done some basic research in protective agents against radiation. N. F. Pisarenko, I. A. Savenko, P. I. Shavrin, and V. Ye. Nesterov from the Moscow State University and Keirim-Markus, et al., have been involved in the study and evaluation of the radiation hazard during flight. The key Soviet consultant in radiobiology is G. M. Frank, with V. V. Antipov playing an increasingly important role in the field of radiobiological research. For future prolonged flights the Soviets are continuing their research in attempting to find drugs that will be effective against radiation. They have also indicated a willingness to increase the level of risk to be assumed by the cosmonaut in the exposure to radiation during flight.<sup>11 14 16 83 108 169</sup>

#### Institutes

Some of the leading Soviet institutes involved in radiation studies are:

1. Institute of Biological Physics, Academy of Sciences, USSR
2. Moscow State University named after M. V. Lomonosov, Ministry of Higher and Secondary Specialized Education, USSR
3. Institute of Biophysics, Ministry of Health, USSR
4. Institute of Experimental Biology, Academy of Medical Sciences, USSR

#### Leading Personalities

Some of the leading personnel doing research in radiation are:

Name:	Antipov, V. V.
Affiliation*:	—
Specialty:	Key researcher in radiobiology
Name:	Dobrov, N. N.
Affiliation*:	—
Specialty:	Cosmonaut dosimetry
Name:	Frank, G. M.
Affiliation*:	1
Specialty:	Key administrator in the field of radiobiology
Name:	Ivanov, V. I.
Affiliation*:	—
Specialty:	Cosmonaut dosimetry
Name:	Keirim-Markus, I. B.
Affiliation*:	—
Specialty:	Cosmonaut dosimetry
Name:	Kovalév, E. E.
Affiliation*:	—
Specialty:	Cosmonaut dosimetry
Name:	Lebedinskiy, A. V.
Affiliation*:	3
Specialty:	Biological action in ionizing radiation
Name:	Nesterov, V. Ye.
Affiliation*:	2
Specialty:	Cosmonaut dosimetry and radiation measurements in the study of flights
Name:	Pisarenko, N. F.
Affiliation*:	2
Specialty:	Cosmonaut dosimetry and radiation measurements in the study of safety of flights
Name:	Saksonov, P. P.
Affiliation*:	—
Specialty:	Cosmonaut dosimetry
Name:	Savenko, I. A.
Affiliation*:	2
Specialty:	Cosmonaut dosimetry and radiation measurements in the study of safety of flights
Name:	Shavrin, P. I.
Affiliation*:	2
Specialty:	Cosmonaut dosimetry and radiation measurements in the study of safety of flights
Name:	Uspenskiy, L. N.
Affiliation*:	—
Specialty:	Cosmonaut dosimetry

\*The number refers to the institute location in the previous section on "Institutes."

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**Other Physiological and Psychological Problems**

G. D. Glod and N. N. Timofeyev are working in the area of increasing the resistance of the body to environmental hazards. To determine the effect of increased G-load, they conducted studies on rats in a state of deep hypothermia. Glod and Timofeyev experimented with transverse G effects of the magnitude of 75 G's lasting for 3 to 5 minutes. They were able to restore the cardiac activity partially, and in some cases they completely

restored the cardiac, respiratory, and motor activity of the rats.

V. G. Denisov has responsibilities in engineering psychology or man-machine relationships. He has studied the interrelationships between the man and the vehicle control panel to determine the optimum arrangement for information assimilation and manual control of the vehicle.

V. I. Myasnikov has investigated the effects of prolonged isolation on the central nervous system and the motor reaction time of man.<sup>15 16 110</sup>

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Figure 33. V. V. Parin



Figure 34. N. M. Sisakyan



Figure 35. V. I. Yozdovskiy

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Figure 29. V. N. Chernigovskiy



Figure 30. G. M. Frank



Figure 31. O. G. Gazenko



Figure 32. A. A. Imshenetskiy

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## APPENDIX

### Scientists Involved in the Soviet Bioastronautic and Manned Space Program

#### KEY SCIENTISTS

The key scientists in the Soviet bioastronautic and manned space program are V. M. Chernigovskiy, G. M. Frank, O. G. Gazenko, A. A. Imshenetskiy, V. V. Parin, N. M. Sisakyan, and V. I. Yazdovskiy. Detailed information concerning their backgrounds and activities follows.<sup>13-16</sup> (See figures 29-35.)

**CHERNIGOVSKIY, Vladimir Nikolayevich**— Born 16 February 1907, Sverdlovsk, RSFSR. Active Member, Academy of Medical Sciences, USSR; Active Member, Academy of Sciences, USSR.

*Current position:* Academician-Secretary, Department of Physiology, Academy of Sciences, USSR, 1963-64; Director, Institute of Physiology imeni I. P. Pavlov, Academy of Sciences, USSR, Leningrad, 1959-64; Member, Editorial Board, *Byulleten' Eksperimental'noy Biologii i Meditsiny*, 1954-64 (Chief Editor, 1954-60); Member, Editorial Board, *Fiziologicheskii Zhurnal SSSR imeni I. M. Sechenova*, 1960-64 (Assistant Editor, 1960-62).

*Role in Soviet space program:* Played an important role in research with test dogs; cited as director of training and preparation of animals for experimental space flights. Probably is link between the Academy of Medical Sciences and the Academy of Sciences for communication in the area of bioastronautics.

*Education:* Graduate, Medical Faculty, Perm' University, 1930; Doctor of Medical Sciences.

*Career:* Assistant, Chair of Physiology, Orenburg Veterinary Institute, 1930-32; Member, Chair of Physiology, Sverdlovsk Medical Institute, 1932-37; Senior Scientific Associate, General Physiology Division, All-Union Institute of Experimental Medicine imeni A. M. Gor'kiy (VIEM), Leningrad, 1937-41; Member, Naval Medical Academy, Leningrad, 1951-53; Member, Institute of Experimental Medicine, Academy of Medical Sciences, USSR, Leningrad, 1946-c1952 (Head, Laboratory of Physiology of Receptors, General Physiology Division, 1946); Head, Laboratory of Physiology of Receptors, Institute of Physiology imeni I. P. Pavlov, Academy of Sciences, USSR, Leningrad, 1949-59; Member, Institute of Surgery imeni A. V. Vishnevskiy, Academy of Medical Sciences, USSR, Moscow, 1953; Associate, Leningrad

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CHERNIGOVSKIY (Continued)

Scientific Research Tuberculosis Institute, 1953-58 (Scientific Director, 1953); Vice-President, Academy of Medical Sciences, USSR, 1953-57; Member, Institute of Normal and Pathological Physiology, Academy of Medical Sciences, USSR, Moscow, 1953-61 (Director, 1953-59; Head, Laboratory of General Physiology, 1961); Member, Bureau, Department of Medical and Biological Sciences, Academy of Medical Sciences, USSR, 1957; Member, Bureau, Department of Biological Sciences, Academy of Sciences, USSR, 1960; Chairman, Coordinating Council for the Complex Problem "Physiology," Presidium, Academy of Sciences, USSR, 1962-63.

*Scientific specialties:* Internal receptors; chemoreceptors; mechanoreceptors; pulmonary emphysema and the nervous system; interoceptive analyzer; nervous regulation of circulation; interoceptive reflex arch; space biology and physiology.

*Travel:* Hypertension Symposium, World Health Organization, Prague, May 1960; International Symposium on Basic Environmental Problems of Man in Space, Paris, October 1962.

*Honors:* Prize imeni I. P. Pavlov 1944; Order of Labor Red Banner 1957; Member, Rumanian Society of Medical Sciences, 1960.

FRANK, Gleb Mikhaylovich — Born 24 May 1904. Corresponding Member, Academy of Sciences, USSR; Corresponding Member, Academy of Medical Sciences, USSR.

*Current position:* Member, Institute of Biological Physics, Academy of Sciences, USSR, Moscow, 1952-64 (Head of a laboratory, 1953-58; Director of Institute, 1958-64); Member, Editorial Board, *Priroda (Nature)*, 1962-64; Chief Editor, *Biofizika (Biophysics)*, 1956-64.

*Role in Soviet space program:* Consulted in matters relating to radiobiology.

*Education:* Graduate, Crimean State University, Simferopol' 1925; Doctor of Biological Sciences.

*Career:* Member, Leningrad Physico-Technical Institute imeni A. F. Ioffe, Academy of Sciences, USSR, 1929-46; Member, All-Union Institute of Experimental Medicine imeni A. M. Gor'kiy, 1934-35; Member, Institute of Physiology imeni I. P. Pavlov, Academy of Sciences, USSR, Leningrad, 1945-50 (Member, Biophysics Laboratory, 1950); Head, Biophysics Laboratory, Institute of Experimental Biology, Academy of Medical Sciences, USSR, Moscow, 1946-50; Director, Institute of Biophysics, Academy of Medical Sciences, USSR, Moscow, 1948-53; Member, Physics Faculty, Moscow State University imeni M. V. Lomonosov, 1955-56.

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**FRANK (Continued)**

*Scientific specialties:* Radiation biology; mechanical properties of the nerve; structural and physical-chemical processes during muscle contraction; radioisotopes; auto-regulation of cellular processes; Mullerian cells of the retina; transverse striated muscles.

*Travel:* Berlin, East Germany, January 1961; Second International Congress of Radiation Research, Harrogate, England, August 1962; International Symposium on Basic Environmental Problems of Man in Space, Paris, October 1962; Council Meeting, International Organization of Pure and Applied Biophysics, Paris, May 1963.

*Honors:* Order of Labor Red Banner, 1945; State (formerly Stalin) Prize, third class 1950; Order of Lenin, 1964.

**GAZENKO, Oleg Georgiyevich** — Born 1918. Lt. Colonel, Military Medical Service, USSR.

*Current position:* Associate, Institute of Normal and Pathological Physiology, Academy of Medical Sciences, USSR, Moscow, 1963; possible association with Scientific Research Testing Institute of Aviation Medicine (NIIAM), Moscow; Member, Working Group Five on Space Biology, Committee on Space Research (COSPAR), 1963; Senior Scientific Associate, Department of Biological Sciences, Academy of Sciences, USSR, 1960-62; Member, Editorial Board, *Nauka i Zhizn'*, 1961-64.

*Role in Soviet space program:* Involved in the evaluation and development of environmental life-support systems.

*Education:* Doctor of Biological Sciences, 1961; Candidate of Medical Sciences.

*Career:* Member, Barothermic Laboratory, Chair of Physiology, Military Medical Academy imeni S. M. Kirov, Leningrad, 1954.

*Scientific specialties:* Biological and physiological investigations during space flights; biological telemetry; blood circulation in the brain under conditions of changes in gravitational field; vestibular nuclei and stimulation of vestibular receptors; protective adaptation of body in conditions of maximal overstrain and weightlessness; pressure-chamber training; artificial environments in space vehicles.

*Travel:* Second World and Fourth European Congress on Aviation and Space Medicine, Rome, October 1959; Plenary Meeting and International Symposium, Committee on Space Research, Florence, Italy, April 1961; Seventh Plenary Meeting, Committee on Space Research, Florence, May 1964.

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IMSHENETSKIY, Aleksandr Aleksandrovich — Born 8 January 1905, Kiev, Ukrainian SSR. Active Member, Academy of Sciences, USSR.

*Current position:* Director, Institute of Microbiology (INMI), Academy of Sciences, USSR, Moscow, 1949-64; Chief Editor, *Mikrobiologiya*, 1950-64; Member, Editorial Board, *Zeitschrift fur Allgemeine Mikrobiologie* (an East German publication), 1964; Member, Editorial Board, *Vestnik Akademii Nauk SSSR*, 1964.

*Role in Soviet Space program:* Chief spokesman in matters relating to exobiology and sterilization of space vehicles.

*Education:* Graduate, Voronezh University, 1926; Doctor of Biological Sciences, 1939.

*Career:* Member, INMI, 1939-64 (head of a department 1941, 1945; Deputy Head, Division of Ecology of Microorganisms, 1948; Director, 1949-64; Head, Department of Experimental Variability of Microorganisms, 1957-62); Associate, All-Union Scientific Research Institute of the Alcohol Industry, Moscow, 1946, 1953; Member, International Society of Soil Science, 1960; Chairman, All-Union Microbiological Society, 1960-63; Member, Editorial Board, *Antibiotika*, 1952-59.

*Scientific specialties:* Myxobacteria; physiology and biochemistry of microorganisms; yeast adapted to phenol and mercuric chloride; *Azotobacter chroococcum*; citric-acid-producing *Aspergillus niger*; life at high temperatures; nitrifying microorganisms; interspecies transformation in microorganisms; *Fusarium* variants; sterilization by radiation and vitamins.

*Travel:* Lectured at US Academy of Sciences, Washington, D. C. April 1960; visited Cairo, Egypt, January 1961; Plenary Meetings and Working Group Sessions, Committee on Space Research (COSPAR), Washington, D. C., April 1962; Third International Space Science Symposium, COSPAR, Washington, D. C., May 1962; Fourth International Space Science Symposium, COSPAR, Warsaw, June 1963; COSPAR, Florence, May 1964.

*Honors:* Order of Labor Red Banner, 1945; Order of Lenin, 1953.

PARIN, Vasilii Vasil'yevich — Born 18 March 1903, Kazan', RSFSR. Active Member, Academy of Medical Sciences, USSR.

*Current position:* Vice-President, Academy of Medical Sciences, USSR, 1963-64; Director, Institute of Normal and Pathological Physiology, Academy of Medical Sciences, USSR, Moscow, 1960-64; Member, Editorial Board, *Meditinskiy Referativnyy Zhurnal*, 1957-64; Member, Editorial Board, *Vestnik Akademii Meditsinskikh Nauk SSSR*, 1957-64; Member, Editorial Board, *Nauka i Zhizn'*, 1962-64; Chief Editor, *Byulleten' Eksperimental'noy Biologii Meditsiny*, 1960-64 (Assistant Editor, 1957-60).

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PARIN (Continued)

*Role in Soviet space program:* Key role in the area of biomedical research support for the manned space program.

*Education:* Graduate, Medical Faculty, Perm' University, 1925; Doctor of Medical Sciences.

*Career:* Member, Physiology Department, Perm' University, 1925-32; Member, Physiology Department, Sverdlovsk Medical Institute, 1932-41; Director, First Moscow Medical Institute, 1941-42; Head, Physiology Department, Third Moscow Medical Institute, 1943-47; Deputy People's Commissar of Health, USSR, 1942-45; inmate, Vladimir Prison, 1947-53; Head, Physiology Laboratory, Institute of Therapy, Academy of Medical Sciences, USSR, Moscow, 1954-56; Head, Department of Clinical and Experimental Physiology, Central Institute for Advanced Training of Physicians, Moscow, 1956-60; Chairman, Scientific-Technical Council, Presidium, Academy of Medical Sciences, USSR, 1958; Chief, Section Medical Application of Electronics, All-Union Scientific and Technical Society of Radio Engineering and Electrical Communications imeni A. S. Popov (VNORiE), 1959; Chairman, Cybernetics and Animate Nature Section, Scientific Council on the Complex Problem "Cybernetics," Academy of Sciences, USSR, 1963.

*Scientific specialties:* Ballistocardiography; electronics in biology and medicine; hypertension; pulmonary ventilation; cybernetics and physiology in medicine; biological telemetry; protective adaptation of the body and the limits of adaptation in conditions of maximal overstrain and the state of weightlessness.

*Travel:* Hypertension Symposium, World Health Organization, Prague, May 1960; Third International Conference on Medical Electronics, London, July 1960; 10th European Congress on Aviation and Cosmonautical Medicine, Paris, September 1961; Plenary Meeting and Working Group Sessions, Committee on Space Research (COSPAR), Washington, D. C., April 1962; Third International Space Science Symposium, COSPAR, Washington, D. C., May 1962; Symposium on Pulsatile Blood Flow, Philadelphia, April 1963; Seventh Plenary Meeting and Fifth International Space Science Symposium, COSPAR, Florence, Italy, May 1964.

*Honors:* Order of Labor Red Banner, 1943; Order of Lenin, 1963.

SISAKYAN, Norayr Martirosovich — Born 12 January 1907, Ashtarak, Armenia. Active Member, Academy of Sciences, USSR; Corresponding Member, Academy of Sciences, Armenian SSR.

*Current position:* Chief Scientific Secretary, Academy of Sciences, USSR, 1963-64; Member, Editorial Board, *Biokhimiya*,

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**SISAKYAN (Continued)**

1946-64 (Assistant Editor 1949-64); Chief Editor, *Izvestiya Akademii Nauk, Seriya Biologicheskaya*, 1959-64; Assistant Editor, *Kosmicheskiye Issledovaniya*, 1963-64.

*Role in Soviet space program:* Head of life science aspects of Soviet space program.

*Education:* Graduate, Yerevan State University; Graduate, Moscow Agricultural Academy imeni K. A. Timiryazev, 1932; Doctor of Biological Sciences.

*Career:* Member, Institute of Biochemistry imeni A. N. Bakh, Academy of Sciences, USSR, 1939-59 (Scientific Secretary, 1945; Deputy Director, 1949-59; Head, Laboratory of Cellular Anatomy and Function, 1957-58; possibly Head, Laboratory of Enzymology, 1944-63); Associate, Institute of Viticulture and Vini-culture, Academy of Sciences, Armenian SSR, 1947-50; (Head, Laboratory of Biochemistry, 1947); Deputy Chief Scientific Secretary, Academy of Sciences, USSR, 1953-59; Academician Secretary, Department of Biological Sciences, Academy of Sciences, USSR, 1959-63; Member, Commission for International Scientific Relations, Presidium, Academy of Sciences, USSR, 1957-61 (Chairman 1957); Member, International Advisory Committee on Research in the Natural Sciences, UNESCO, 1957-58; Head, Committee on Natural and Exact Sciences, USSR, Commission for UNESCO, 1958; Member, Executive Board, UNESCO, 1959.

*Scientific specialties:* Amino acids; biochemical properties of plastids; radiobiology; protein synthesis; synthesis of the peptide bond; mitochondrial factors affecting glycolysis; action of X-irradiation on oxidative phosphorylation in plant mitochondria; intracellular respiration; phosphorylating and nonphosphorylating oxidation reactions; *Chlorella pyreudoidosa*; proteins in chloroplasts; peptides and nucleotide peptides; adenosinetriphosphoric acid and protein synthesis in chloroplasts; nucleotide composition of microsomal and soluble ribonucleic acid (RNA) in insects.

*Travel:* UNESCO Executive Council Meeting, Paris, October 1960; Peaceful Coexistence Conference, Hanover, New Hampshire, October 1960; Conference on Stability in a Demilitarized World, Santa Barbara, California, September 1961; Seventh Pugwash Conference, Stowe, Vermont, September 1961. Fourteenth International Astronautical Congress (IAF), Paris, September 1963.

*Honors:* Order of Banner of Esteem, 1944; Order of Labor Red Banner, 1945, 1954; Prize imeni A. N. Bakh, 1949; State (formerly Stalin) Prize, Third Class, 1952; Medal "For Labor Valor," 1953; Presidium Prize, Academy of Sciences, USSR, 1958.

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YAZDOVSKIY, Vladimir Ivanovich — Born 24 June 1913, Ashkhabad, Turkmen SSR. Colonel, Military Medical Service, USSR.

*Current position:* Head, Cosmic Biology Program, Moscow State University imeni M. V. Lomonosov, 1959-63; Associate, Institute of Normal and Pathological Physiology, Academy of Sciences, USSR, Moscow, 1960-63; Deputy Director of a scientific research institute, 1963.

*Role in space program:* Has been directly involved in Soviet space program for at least 12 years; active in the applied aspects of the program; once reported to be Chief of Medical Services for the "man-in-space" program.

*Education:* Candidate of Medical Sciences; Doctor of Medical Sciences.

*Scientific specialties:* Muscle tone during weightlessness; sensory reactions and voluntary movements in man under conditions of weightlessness; microbiological and cytological experiments in space; effect of explosive decompression on the organism; tolerance of animals to shock overloads acting in the direction close to the long axis of the body; effect of prolonged weightlessness; effect of pure oxygen respiration on the lungs and heart of white rats; biological aspects of the theory of relativity.

*Travel:* Twelfth International Congress of the International Aeronautical Federation, Washington, D. C., October 1961.

*Honors:* State (formerly Stalin) Prize, Third Class, 1951; Medal, International Academy of Aviation Medicine, 1962.

#### SCIENTISTS WITH A POTENTIALLY IMPORTANT ROLE

In addition to the Soviet scientists who play a key role, three others have a potentially important role in the Soviet manned space program. They are V. V. Antipov, R. M. Bayevskiy, and A. A. Gyurdzhian. Details concerning their activities follow.

ANTIPOV, Vsevolod V. — Born 1923.

*Current position:* Associate, Institute of Normal and Pathological Physiology, Academy of Medical Sciences, USSR, Moscow, 1963.

*Education:* Candidate of Medical Sciences, Central Institute for Advanced Training of Physicians, Moscow, 1956.

*Career:* Associate, Central Scientific Research Institute Experimental Military Medicine, Moscow, 1959; Member, Physiology Group of A. I. Smirnov, Academy of Medical Sciences, USSR, Moscow, 1959-60.

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**ANTIPOV (Continued)**

*Scientific specialties:* Problems of radiation safety of space flights; problems of space microbiology and cytology; use of tryptamine in mice with acute radiation sickness; medicobiological investigations in the second and third spaceships; changes in the haemopoietic organs of mammals under the influence of space flight; biological effect of high-energy protons.

*Travel:* 14th International Astronautical Federation Congress, Paris, September 1963. Committee on Space Research (COSPAR), Florence, May 1964.

**BAYEVSKIY, Roman Markovich** — Captain, Military Medical Service, USSR.

*Current position:* Member, Institute of Normal and Pathological Physiology, Academy of Medical Sciences, USSR, Moscow, 1962-63.

*Education:* Candidate of Medical Sciences, Central Institute for Advanced Training of Physicians, Moscow, 1959.

*Career:* Member, Clinic Propaedeutic Therapy, Saratov Medical Institute, 1954; Member, Chair of Faculty Therapy, Military Medical Academy imeni S. M. Kirov, Leningrad, 1959; Member, Chair of Clinical and Experimental Physiology, Central Institute for Advanced Training of Physicians, Moscow, 1959-60.

*Scientific specialties:* Ballistocardiography; biomedical methods and techniques under space-flight conditions; integral phonocardiography; sphygmograms; cybernetics in medicine and physiology; blood circulation in conditions of weightlessness.

**GYURDZHIAN, Armen Aramovich** — Born 30 June 1924, Kizlyar, RSFSR. Captain, Military Medical Service, USSR.

*Current position:* Member, Department of Biological Sciences, Academy of Sciences, USSR, 1961-62; possibly Chief of Training and Physiological Control of the USSR Cosmonaut Program, 1962.

*Role in Soviet space program:* Reportedly worked for V. I. Yazdovskiy in 1963.

*Education:* Candidate of Medical Sciences.

*Career:* Member, Main Military Hospital imeni N. N. Burdenko, Leningrad, 1954-59 (Head, Experimental Laboratory, 1957-59); Member, Institute of Physiology imeni I. P. Pavlov, Academy of Sciences, USSR, Leningrad, 1956.

*Scientific specialties:* Weightlessness; radiation sickness; microbiological and cytological experiments in space; metabolism in animals which have undergone a space flight; physiology of light and color sensitivity of the eye; sanitary appliance in a space capsule; prolonged flight of mice in a spaceship; biological effect of cosmic radiation.

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**GYURDZHIAN (Continued)**

*Travel:* 10th European Congress on Aviation and Cosmonautical Medicine, Paris, September 1961; 22nd International Congress, International Union Physiological Sciences, Leiden, Holland, September 1962; International Symposium on Basic Environmental Problems of Man in Space, Paris, October–November 1962.

**LEADING SCIENTISTS**

Some leading Soviet scientists who support the key figures and the potentially important scientists in the bioastronautic research and the manned space program include the following:

**AGADZHANYAN, N. A.**

Candidate of Medical Sciences; Lt. Colonel, Medical Service, USSR, Associate, Institute of Normal and Pathological Physiology. Biotelemetry—method and placement of electrodes.

**AGAL'TSOV, F. A.**

Deputy Commander-in-Chief, Soviet Air Force, possible Deputy Commander-in-Chief in charge of cosmonaut training.

**AKULINICHEV, I. T.**

Lt. Colonel, Military Medical Services, USSR; Associate, State Institute of Health Resorts and Physiotherapy, Moscow, 1961; expert in cardiac instrumentation; design, development, and application of bioinstrumentation for space flight.

**ANOKHIN, P. K.**

Professor, Doctor of Neurophysiology; Director of Sechenov Institute of Neurophysiology, Moscow; Associate, Institute of Normal and Pathological Physiology; physiological monitoring of cosmonauts in training and orbital flights.

**DENISOV, Viktor Grigor'yevich**

Candidate of Technical Sciences; Associate, Moscow Aviation Institute imeni S. Ordzhonikidze, 1959; engineering psychology; space-flight conditions.

**DOBROV, N. N.**

Radiobiological problems of space flight; chemical protection from radiation.

**GENIN, A. M.**

Doctor Biological Sciences; probable associate, Institute Normal and Pathological Physiology; medical and biological aspects of space flight.

**GILEVA, E. A.**

Institute of Biology, Ural Affiliate, State Committee for Coordination of Scientific Research, RSFSR; biological accumulation and metabolism of radioisotopes; waste purification.

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GUROVSKIY, N. N.

Candidate Medical Sciences; Lt. Col., Medical Service; possible teacher of cosmonauts; life-support system.

KAMANIN, N. P.

Lt. Gen., Aviation; Chief Officer, Soviet Air Force Cosmonaut Training Program.

KAS'YAN, Ivan I.

Member, Institute of Normal and Pathological Physiology, Academy of Sciences, USSR, Moscow, 1960-62; space flight physiology.

KUZNETSOV, Andrey G.

Candidate, Medical Sciences, Colonel, Military Medical Services, USSR; Member, Scientific Research Testing Institute of Aviation Medicine, Moscow, 1957-60 (Head, Department of Physiology, 1958-60); physiological effects of high altitude and weightlessness on the organism.

PROKOF'YEVA-BEL'GOVSKAYA, A. A.

Institute of Radiation and Physico-Chemical Biology, AN, SSSR; cytogenetics, cytogenetic effects of cosmic flight factors on *Drosophila* and man.

SAKSONOV, P. P.

Lt. Colonel, Military Medical Service, USSR; Associate, Academy of Sciences, USSR, 1963; radiobiological problems of space flight.

SERYAPIN, Aleksandr Dmitriyevich

Doctor, Medical Sciences; Chairman, Scientific and Technical Committee on Biology of Cosmic Flight, Astronautics Section, Central Aeroclub, USSR imeni V. P. Chkalov; physico-chemical means of regenerating a gaseous environment in a small cabin.

SHUVATOV, Lev Petrovich

Head, Laboratory of Biochemistry, unidentified institute 1961; devised a radio kit that was used operationally during Gagarin's flight.

VOLYNKIN, Yuvenally Mikhaylovich

Lt. General, Military Medical Service, USSR; possible Associate, Institute of Normal and pathological physiology, Academy of Medical Sciences, USSR, Moscow, 1961; physical conditions of space flight and their biological characteristics.

YUGANOV, Yevgeniy M.

Candidate, Medical Sciences; Lt. Colonel, Military Medical Service USSR; Member, Institute of Normal and Pathological Physiology, Academy of Sciences, USSR, Moscow, 1960-62; interaction of the senses in space-flight conditions, weightlessness, acceleration.

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OTHER SCIENTISTS

Over a hundred Soviet scientists at various research centers are also involved in the Soviet bioastronautic and manned space program. The research centers include institutes of the Academy of Medical Sciences, USSR; the Academy of Sciences, USSR; and the Ministry of Defense, USSR. An alphabetical list of these scientists, by institute or other affiliation is shown in the table.

TABLE

Soviet Bioastronautic Personalities by Institute Affiliation

<u>Name</u>	<u>Institute Affiliation*</u>	<u>Name</u>	<u>Institute Affiliation*</u>
ABELEVA, Ye. A.	10	GYURDZHIAN, A. A.	2
ABYZOV, S. S.	9	IMSHENETSKIY, A. A.	9
AGADZHANYAN, N. A.	4	ISAKOV, P. K.	1
AGAL'TSOV, F. A.	2	IYERUSALIMSKIY, N. D.	9
ALEKSEYEV, S. M.	3	KAMANIN, N. P.	2
ANOKHIN, P. K.	4	KAPICHNIKOV, M. M.	5
APANASENKO, Z. I.	10	KARPMAN, V. L.	4
ARSEN'YEVA, M. A.	10	KAS'YAN, I. I.	4
AVRUNINA, G. A.	6	KHAYUTIN, V. M.	4
AYRAPET'YANTS, E. S.	11	KHAZANOV, V. S.	12
BABSKIY, Ye. B.	4	KHVOSTOVA, V. V.	10
BARER, A. S.	3	KISLYAKOV, V. A.	11
BOLOTINA, O. P.	11	KLIMOV, V. Yu.	5
BORSHCHEVSKIY, I. Ya.	1	KORSHUNOVA, V. S.	10
BRANDT, A. B.	10	KOZHEVNIKOV, V. A.	11
BUYKO, Ye. A.	5	KUCHERENKO, T. M.	11
CHERNIGOVSKIY, V. N.	11	KURLYANDSKAYA, E. B.	6
CHISTOVICH, L. A.	11	KUZNETSOV, A. G.	1
CHUCHKIN, V. G.	12	KUZNETSOVA, M. A.	10
DELONE, N. L.	10	LAPKIN, Yu. A.	10
DEMIN, N. N.	11	LEBEDINSKIY, A. V.	7
DUBININ, N. P.	10	LOZINA-LOZINSKIY, L. K.	8
EYGES, N. S.	10	MARSHAK, M. Y.	4
FILIPPOVICH, S. I.	4	MAYSKIY, I. N.	5
FRANK, G. M.	10	MEYERSON, F. Z.	4
GENEROZOVA, I. P.	10	MEYSEL, M. N.	9
GLEMBOTSKIY, Ya. L.	10	MITYUSHOV, M. I.	11
GORBUNOVA, I. M.	11	MOZHAYEVA, V. S.	10
GOVORUN, R. D.	6	NEFEDOV, Y. G.	10

\* The Key to Institute or Other Affiliation appears at the end of the table.

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<u>Name</u>	<u>Institute Affiliation*</u>	<u>Name</u>	<u>Institute Affiliation*</u>
NEFED'YEVA, N. P.	5	SHAKHOV, A. A.	12
NESTEROV, V. Ye.	13	SHAMINA, Z. B.	10
NEVZGODINA, L. V.	10	SHASHKOV, V. S.	6
NICHIPOROVICH, A. A.	12	SHAVRIN, P. I.	13
PARFENOV, G. P.	10	SIDOROV, B. N.	10
PARIN, V. V.	4	SINYAKOV, V. S.	4
PEKHOV, A. P.	5	SOKOLOV, N. N.	10
PETROV, Ye. A.	2	STANKO, S. A.	12
PISARENKO, N. F.	13	TAGEYEVA, S. V.	10
PLATONOV, K. K.	1	TRIBULEV, G. P.	5
PODOPLELOV, I. I.	5	TSIVILASHVILI, A. S.	4
POKROVSKIY, A. V.	3	VLADIMIROVA, M. G.	12
POPOV, A. P.	3	VOLYNKIN, Yu. M.	2
POZDNYAKOV, O. M.	4	VOROB'YEV, A. I.	4
ROKOTOVA, N. A.	11	YARMONENKO, S. P.	6
RYBAKOV, N. I.	5	YAZDOVSKIY, V. I.	2, 4, 13
RYTOV, A. G.	2	YUDIN, Ye. V.	5
SAVENKO, I. A.	13	YUGANOV, Ye. M.	4
SEMENENKO, V. Ye.	12	ZHUKOV-VEREZHNIKOV, N. N.	5

**Key to Institute or Other Affiliation of Soviet Bioastronautic Personalities**

1. Scientific Research Testing Institute of Aviation Medicine (NIIAM), Ministry of Defense, USSR
2. Cosmonaut Training Center, Soviet Air Force, Monino-Chkalovskaya area
3. Tomilino, State Committee for Aviation Technology (GKAT)
4. Institute of Normal and Pathological Physiology, Academy of Medical Sciences, USSR
5. Institute of Experimental Biology, Academy of Medical Sciences, USSR
6. Institute of Labor Hygiene and Occupational Diseases, Academy of Medical Sciences, USSR
7. Institute of Biophysics, Ministry of Health, USSR
8. Institute of Cytology, Academy of Sciences, USSR
9. Institute of Microbiology, Academy of Sciences, USSR
10. Institute of Biological Physics, Academy of Sciences, USSR
11. Institute of Physiology imeni I. P. Pavlov, Academy of Sciences, USSR
12. Institute of Plant Physiology imeni K. A. Timiryazev, Academy of Sciences, USSR
13. Moscow State University imeni M. V. Lomonosov, Ministry of Higher and Secondary Specialized Education, USSR

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7. FBIS. *USSR and Eastern Europe*, no 157. "Space Committee Head's Remarks," 13 Aug 62
8. JPRS: 21,133, Sep 63. *Vestnik Akademii Nauk SSSR*, no 7, Jul 63, p 33-39
9. AID. Report 62-129, "Soviet Manned Space Flight. Individuals and Components of the USSR Space Command System," 12 Sep 62
14. NASA. TT-F-174, Nov 63, "Problems of Space Biology," v 1, 1962
15. JPRS: 18,395, 27 Mar 63. "Problems of Space Biology," v 2, 1962
16. JPRS: 25,287, 29 Jun 64. "Problems of Space Biology," v 3, 1964
17. JPRS: 19,125, 9 May 63. "Outlines Of the History of Aviation Medicine," by A. A. Sergeev, 1962, p 206-232, 289-298
18. Pokrovskiy, A. V. "Study of the Vital Activity of Animals During Rocket Flights Into the Upper Atmosphere," presented in Paris, 1956
19. Air. IR-1147-47, "Guarding Flyer's Health," 12 Feb 57
35. JPRS: 19,953, Jun 63. "Human Reactions in Simulated Space Environment," Jun 63
36. JPRS: 11,431, Dec 61. "The Training of Cosmonauts," Sep 61
37. AID. Report 62-25, "Soviet Manned Space Flight—Part I—The Soviet Cosmonaut Training System," 28 Feb 62
38. Air. FTD-TT-62-1619/1-2, Dec 62, "The First Manned Space Flights," 1962
39. FBIS. *Weekly Summary of World Broadcasts*, no 183, 12 Oct 62, Part I—Second Series
40. JPRS: 24,579, May 64. "Cosmonaut Program," *Soviet Military Translations*, no 142, 11 Mar 64
44. JPRS: 20, 100, 10 Jul 63. "The Soviet Cosmonauts," by Col. Ye. Petrov, *Krasnaya Zvezda*, 16, 17 Feb, 22 Mar 62
66. Air. no 1521036163, "Swedish Centrifuge for the Training of Cosmonauts," 7 Jan 63
67. Gotzlinger, J. "A Human Centrifuge for Research Into Physiological Flight Stresses," *ASEA Journal* no 28, 1955
68. Petrov, Ye. "Cosmonauts, Notes of the Group Leader," *Sovetskaya Rossiya* Publishing House, 1962
75. Unsigned Article. "Laboratory of Cosmic Biology," *Leningradskaya Pravda*, 29 Jul 61, p 4
80. Abyzov, S. S. and Imshenetskiy, A. A. "Methods and Some Results of Microbiological Investigations of Meteorites," COSPAR Symposium, Florence, Italy, May 64
81. JPRS: 15,687, 15 Oct 62. "The USSR Academy of Medical Sciences—Organization and Structure," 1962, p 1-143
82. Air. no 1471300, "Research on Space Biology," 4 Apr 61
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87. JPRS: 20,857-63. "A Visit to the Institute of Physiology imeni I. P. Pavlov," *Nauka i Tekhnika (Science and Engineering)*, Riga, no 5, 1963, p 28-31
97. JPRS: 24,682, 20 May 64. "Vestnik of USSR Academy of Medical Sciences," v 19, no 2, 1964
98. JPRS: 25,272, 29 Jun 64. "First Group Flight Into Outer Space, 11-15 Aug 62," 1964, p 1-156
99. Genin, A. M.; Gazenko, O. G.; and Sergeev, N. P. "Some Principles of the Formation of Artificial Environments in Manned Space Ships," IAF Meeting, Paris, Sep 62
104. JPRS: 23,917, 27 Mar 64. "Physiological Reactions of Cosmonauts During the Action of G-Loads and Weightlessness," by V. I. Yazdovskiy, et al., *Bulletin of the Academy of Sciences*, v 29, no 1, 1964, p 12-31
107. FTD-TT-64-140 1-4, Kasyan, I. I. and Kopanev, V. I. "The State of Weightlessness and Artificial Gravity," *Izvestiya Akademii Nauk SSSR, Seriya Biologicheskaya*, no 6, 1963, p 880-891
108. Frank, G. M.; Saksonov, P. P.; Antipov, V. V.; and Dobrov, N. N. "Radiobiological Problems of Space Flights," IAF, Paris, Sep 62 ©
110. Izosimov, G. V. and Myasnikov, V. I. "An Electroencephalographic Investigation of the Functional State of the Central Nervous System of a Person in Prolonged Solitary Confinement," *Iskusstvennye Sputniki Zemli*, no 5, 1963, p 120-123