Michael V. UGRUMOV*

INNOVATIVE POLICY OF THE RUSSIAN ACADEMY OF SCIENCES WITH REFERENCE TO MEDICINE**

Abstract: Industrial countries characteristically possess so-called scientific-technological-industrial complex serving to obtain new knowledge, to develop novel technologies basing on new knowledge, and to produce innovative product with novel technologies. In the USSR, the respective functional elements were represented by the Academy of Sciences, departmental applied institutes, and industry which were coordinated by the State Committee for Science and Technologies. A transition from the planned economy to the market economy after „perestroika" was accompanied by the revolutionary transformation of the applied institutes and industry that was followed by their essential degradation. In contrast to these organisms, the Academy of Sciences has followed the evolutionary way on basis of historical succession thereby maintaining a high scientific potential. Indeed, RAS remains to be the main source of new knowledge (60% of all the Russian papers published in international peer reviewed journals) and one of the most important source of novel technologies (25% of all the Russian patents). However, the novel technologies developed in Russia including the RAS cannot be used in Russia for producing the innovative products for the reasons mentioned above. Therefore the novel Russian technologists are used in other countries, i. e. an investment in Russian science is profited by a competitor of the open market. Over recent years, there are certain attempts in our country to reproduce the applied institutes and industry as „state corporations" and on basis of high schools (universities) though no essential results are evident. As follows from the historical experience, a number of applied institutes and industrial branches, e. g. the instrument engineering, might be developed in the RAS as it happened in the frame of industrialization of our country in 30-40 ties. Actual accumulation of the RAS experience in the development of novel technologies in a wide range of fields including medicine (instruments for diagnostics and treatment, diagnosticums, drugs, etc.) is in favor of this idea

Thus, the RAS could serve for reproduction of applied institutes and some industrial branches thereby promoting the reanimation of Russia as an industrial country.

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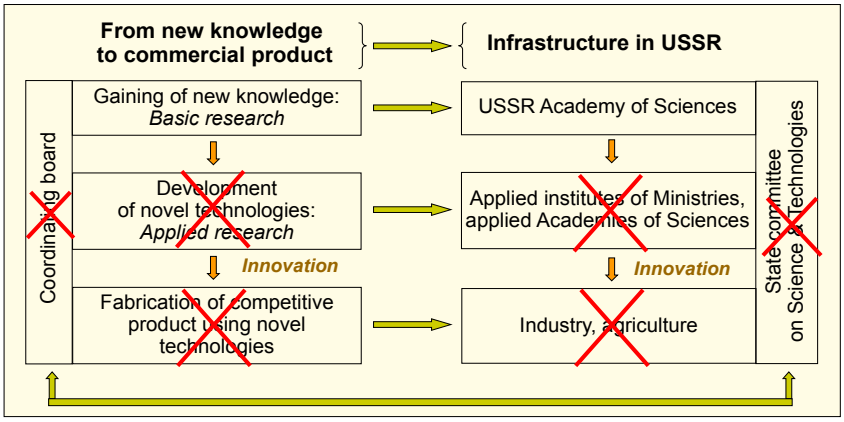
** The paper is given in terms of PowerPoint presentation.

ACTUAL STATE OF SCIENCE, TECHNOLOGIES AND INNOVATIONS IN RUSSIA



Consequences:

Minor development of novel technologies and fabrication of competitive products

Major problem:

How to create a new infrastructure for the development of new technologies and fabrication of competitive products

How to create a new infrastructure for the development of new technologies and fabrication of competitive products

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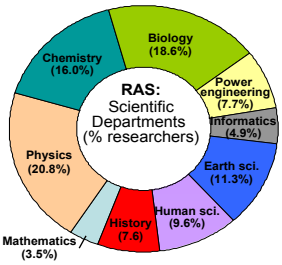
- State or private enterprises (RUSNANO, etc.);
- Universities;
- Technological and scientific platforms (Skolkovo, etc.);
- Russian Academy of Sciences

Russian Academy of Sciences, a state self-governed non-commercial organization



Objectives:

- Gaining of new knowledge in Basic Sciences;
- Development of new technologies and their transferring to industry;
- Training of students and young researchers;
- Coordination and expertise of the investigations in Basic Sciences in Russia.

Indicators of Scientific Efficiency:

- ✓ Papers in peer-reviewed international journals;
- ✓ Patents.

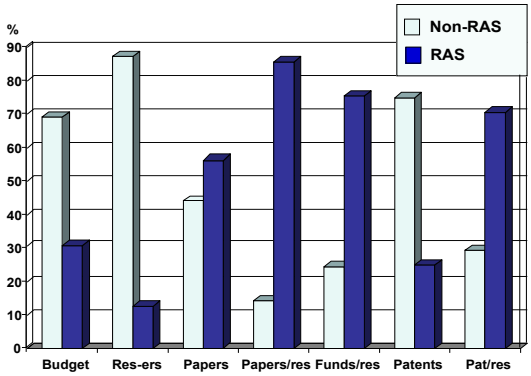
Financing of the RAS Institutes and Laboratories from the budget of RAS:

- ✓ Basic
- ✓ Under competition.

EFFICIENCY OF BASIC AND APPLIED RESEARCH IN RUSSIA: RAS AND NON–RAS ORGANIZATIONS

Competitiveness of RAS and non-RAS organizations

Organization / Characteristic	Non-RAS	RAS	% RAS
Number of institutes	3 525	432	11 %
Number of researchers	342 873	49 683	13 %
Number of papers	18 776	16 641	57 %
Number of patents	1726	572	25 %



Conclusions

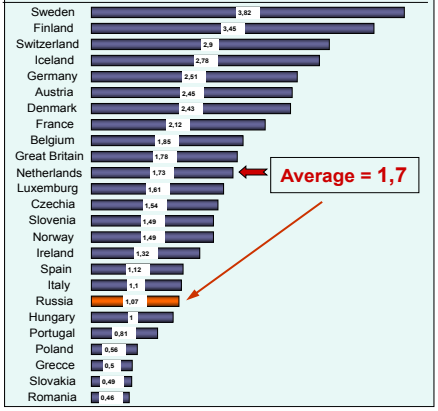
- The efficiency of RAS is higher than of non-RAS organizations despite lower human and financial recourses that is partly explained by:
  - ✓ Long-term traditions (*"scientific schools"*);
  - ✓ Well-developed human resources, management, and infrastructure;
  - ✓ Long-term and wide international cooperation;
- RAS targeted programs according to competition is the crucial mechanism for approaching the open market

RUSSIAN ACADEMY OF SCIENCES: PROBLEMS IN THE DEVELOPMENT OF BASIC SCIENCES, INNOVATIONS, AND INTERNATIONAL COOPERATION

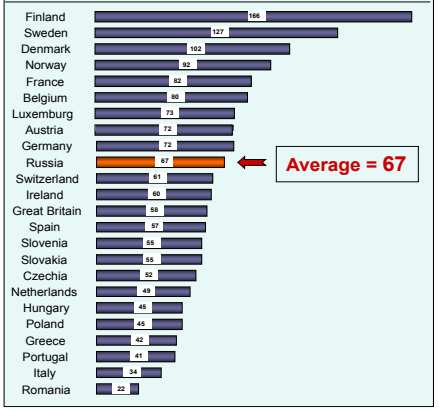
Major problems:

- Significantly lower level of the RAS financing compared to similar organizations in EU;
- Permanent staff reduction;
- Difficulties with innovations because of the industry degradation and minor investments of private companies.

Funding of science and technologies as % of Gross Domestic Product



Number of employees in science and technologies per 10 000 of employees in economics



HEALTH: THE HIGHEST PRIORITY OF SOCIETY

Challenges for world society and science in the XXI century :
*Climate, energy, food, pure water, space flights, terrorism, **human health***

Internationalization and globalization of science :
Cooperation instead of competition – pooling of international facilities

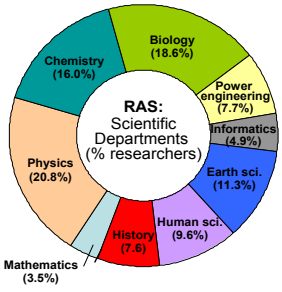
"Today, of course, we face more complex challenges than we have ever faced before: a medical system that holds the promise of unlocking new cures and treatments - attached to a health care system… Scientific innovation offers us a chance to achieve prosperity. It has offered us benefits that have improved our health and our lives…"

B. Obama. Speech to the NAS, April 27, 2009

D. Medvedev has declared that the medicine is among five priority areas as the quality of life and an efficiency of the patient treatment strictly depends on the availability of the advanced technologies, diagnostics, instruments, and medicaments. On the other hand, he emphasized that there is practically no instrument making pharmaceutics industry in Russia .

2010

DEVELOPMENT OF HIGH TECHNOLOGIES FOR MEDICINE IN RAS: INFRASTRUCTURE AND MANAGEMENT



New departments:

- ✓ Nanotechology;
- ✓ Physiology and Basic Medicine.

Infrastructure:

- ➢ Most institutes of eight traditional departments of RAS;
- ➢ New departments of RAS in Nanotechnology and Physiology and fundamental medicine;
- ➢ Technological and scientific platforms.

Financing of targeted programs under competition by:

- ➢ The RAS Presidium ("Basic research for medicine") ;
- ➢ The RAS Departments;
- ➢ The Russian Foundation for Basic Research;
- ➢ The Russian Humanitarian Foundation;
- ➢ "Bortnik's" Foundation (support of small enterprises)
- ➢ The Russian Ministry for Education and Science;
- ➢ The Framework Programs of the European Union.

Management:

- ✓ Presidium of the RAS;
- ✓ Coordinating Committee on the innovative activity and intellectual property
- ✓ Coordinator and council of the program "Basic Research for Medicine" ;
- ✓ Council «Medical Equipment, Technologies, and Pharmaceutics».

"TECHNOPARK OF THE RAS NOVOSIBIRSK ACADEMGORODOK"
(PROTOTYPE OF SKOLKOVO)

The goal: to promote the start up of hi-tech producing companies in microelectronics, communication and computer technologies, biotechnologies, and nanotechnologies.

Investments in the creation of the "Academpark" infrastructure: **$ 113 millions** from 2006 to 2009.

Over **60 companies** are already the residents of "Academpark" having over **$ 150 millions** revenues per year.

DEVELOPMENT OF HIGH TECHNOLOGIES FOR MEDICINE IN RAS: GOAL AND OBJECTIVES

Goal: Development of innovative export-oriented and import-substituting technologies

Objectives

Diagnostics:
- ✓ Preclinical;
- ✓ Non-invasive;
- ✓ Based on information and communication technologies;
- ✓ Diagnosticums

Treatment:
- ✓ Targeted treatment;
- ✓ Nuclear- and laser technologies;
- ✓ Cell technologies;
- ✓ Genetic therapy;
- ✓ Nanotechnology and materials;
- ✓ Instruments.

Medications:
- ✓ Generic drugs;
- ✓ Design of new drugs
- ✓ Test systems for drugs

Personalized medicine

NEUROLOGIC AND MENTAL DISEASES: AN EPIDEMY OF THE XXI CENTURY

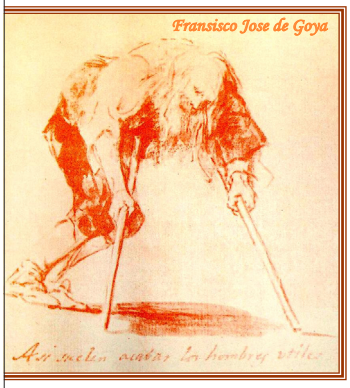
Actual prevalence of socially important diseases:

- ✓ **Cardiovascular**
- ✓ Oncological
- ✓ Neurological and mental

Predicted prevalence of socially important diseases:

- ✓ **Neurological and mental**
- ✓ Cardiovascular
- ✓ Oncological

Disease	2009	2040
Parkinson's disease	16 MM	32 MM
Alzheimer's disease	25 MM	75 MM
Depression		



Every day, millions of American families experience the difficult reality of Alzheimer's disease. The physical and emotional demands of caring for a loved one with Alzheimer's can be overwhelming, but no one should face this disease alone. Doctors are now able to start treatments earlier, slowing the loss of brain cells and the progression of debilitating physical and mental impairments.

Barack OBAMA

La maladie d'Alzheimer qui touche aujourd'hui en France 860 000 personnes est un drame pour notre société, un drame familial. Chaque année ce sont 225 000 nouveaux cas… . Dans les années a venir, les coûts humains et financiers de la maladie, qui sont d'ores et déjà élevés tant pour les familles que pour la société, vont encore s'alourdir ..."

Nicolas SARKOZY

NEURODEGENERATIVE DISORDERS: *PATHOGENESIS, DIAGNOSTICS, TREATMENT*

Pathogenesis and diagnostics

First clinical symptoms appear following the death of major specific neurons (60-80%), 20-30 years after the onset of neurodegeneration

Conventional treatment and results

Agonists of the deficient neurotransmitters
None of the patients has been cured !

Preclinical diagnostics

Experimental modeling

Prophylactic medical examination
(no clinical symptoms)

⇩

Risk group
(selection according to biomarkers)

⇩

Positron emission tomography
(molecular markers of the deficient neurotransmitter systems)

Inst. of Developmental Biology RAS, etc.

Preventive therapy

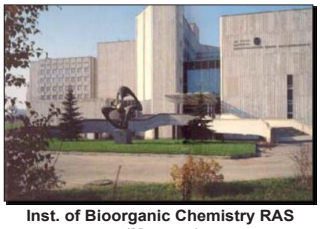
Drug substances
SEMAX *(Met-Glu-His-Phe-Pro-Gly-Pro)*
SELANK *(Thr-Lys-Pro-Arg-Pro-Gly-Pro)*

⇩

Commercial production of drugs in RAS

Inst. of Molecular Genetics RAS

COMMERCIAL PRODUCTION OF THE NUCLEOSIDE-BASED IMPORT-SUBSTITUTING DRUGS



Inst. of Bioorganic Chemistry RAS (Moscow)

Inst. of Bioorganic Chemistry RAS (Pushchino, Moscow Region)

"Pharmsynthesis" (enterprise) (St. Petersburg)

Drug	Prescription *(oncological, infectious, and autoimmune diseases)*
Gemcitabine	Pancreatic cancer, lung cancer, breast cancer, ovary cancer
Clofarabine	Acute myeloid leukaemia, juvenile myelomonocytic leukaemia
Lamivudine	Chronic hepatitis B, human immunodeficiency virus
Fludarabine	Chronic lymphocytic leukemia, non-Hodgkin's lymphoma, acute leukemias
Cladribine	Hairy leukemia (leukemic reticuloendotheliosis), multiple sclerosis
Ribavirin	Anti-viral drug for severe infections (respiratory viruses, hepatitis C, etc.)

Innovative component of new technology:

The use of genetically engineered enzymes (nucleoside phosphorylase) for drug synthesis

Benefit:

- ✓ Import-substitution, **156 MM $**;
- ✓ Export potential, **35 MM $**;

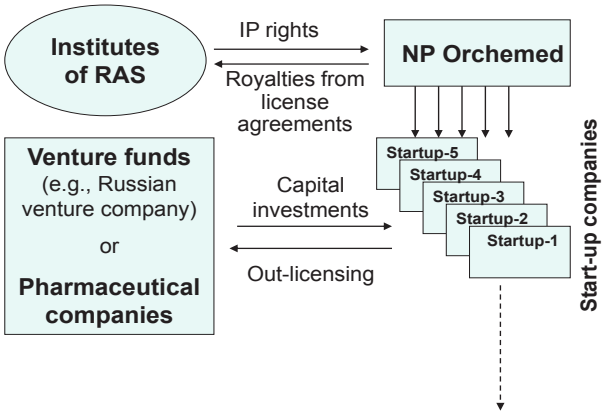
NEW DIAGNOSTICUMS AND DRUGS

Test-kits for high-performance diagnostics of hepatitis B and C viruses by PCR real-time (*Inst. of Chemical Biology and Fundamental Medicine SB RAS and enterprise "Vector-Best"*) .

TRIAZAVIRIN, antiviral drug (influenza viruses H1N1and H5N1, tick-borne encephalitis, etc.) (*Inst. of Organic Synthesis Ural B RAS; clinical trials*)

PERCHLOROZONE, antituberculosis drug (*Irkutsk Institute of Chemistry SB RAS; clinical trials*)

COMMERCIALIZATION



Shares in start-up:

Scientists-developers – **75%**

NP Orchemed – **25%**

Nonprofit partnership Orchemed (*Org*anic *Chem*istry for *Med*icine)

- 11 RAS institutes of chemical or biological specialization
- Transfer of innovative drug technologies to market
- Full technological cycle of preclinical drug discovery
- Recognized academic expert group in Russia
- Wide portfolio of projects (50+), up to advanced preclinical candidates
- Strategic partnership with Russian pharmaceutical companies
- Initiator of strategic national projects, e.g., National bioscreening network

Orchemed

www.orchemed.com

NUCLEAR RESEARCH CENTERS OF THE RUSSIAN ACADEMY OF SCIENCES: CONTRIBUTION TO ADVANCED MEDICINE

- The radiological center was created on the basis of the linear proton accelerator and experimental complex of the Institute for Nuclear Research (INR)
- Patients with cancer are treated using conformal methods of conventional radiotherapy, the proton therapy facility is tested
- The linear proton accelerator serves to produce radioisotopes (Sr-82, Na-22, Cd-109, Ac-225, etc.) for innovative technologies in medicine, e.g. PET-scan
- The new Sr/Rb generator for the PET diagnostics in cardiology was developed.
- Proton treatment system developed in INR is technologically advantageous and less expensive compared to foreign systems. Potential market: 1000 stations with a cost 0.5 billion USD per station.

Project: "Targeted radiotherapy of brain tumors using modular recombinant transporters labeled with auger electron emitting radionuclides." (*Inst. of Gene Biology RAS, Moscow State University, US partners; NIH/NINDS grant #PS-NS020023*)

RUSSIAN ACADEMY OF SCIENCES: BIOMEDICAL ENGINEERING

Physical fields and radiations of humans:

- Infrared (10 mW/cm^2)
- Microwave (10^{-12} W/cm^{2}GHz)
- Magnetic field (10^{-10}-10^{-12} TL at L=10 cm)
- Electric field
- Bioluminescence (visible 10^{-17} W/cm^2)
- Acoustics (10^{-11} W/cm^{2}MHz)
- Microatmosphere (CO_2 , H_2O, etc)

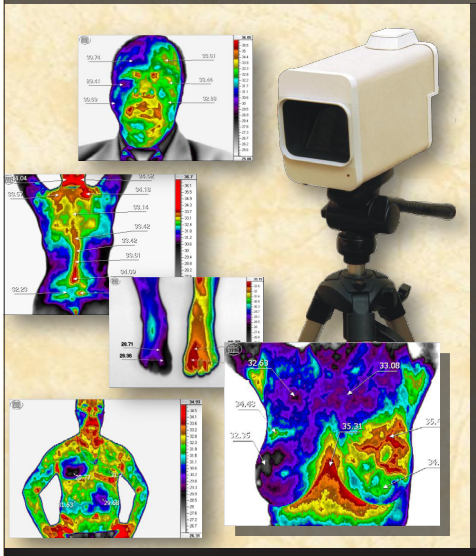
Real devices:

- Scanning infrared thermal imaging system
- Magnetocardiographic system
- Radiothermograph
- Multi-channel acoustothermograph
- Electroimpedance computer thermograph and mammograph

Inst. of Radioengineering and Electronics RAS and associated Companies producing biomedical devices:

- ✓ IRTIS Co. Ltd., Moscow
- ✓ CRYOTON Co. Ltd., Troitsk, Moscow Region
- ✓ CONSTEL Ltd., Moscow
- ✓ Impedance medical technologies Co. Ltd., Yaroslavl

SCANNING INFRARED THERMAL IMAGING DEVICE FOR EVALUATION OF THERMAL FIELDS*



Advantages of thermography developed in RAS:

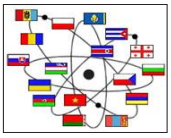
- ✓ Computer-based non-contact infrared thermography is a harmless noninvasive method of functional diagnostics basing on variations in surface temperature of human body;
- ✓ Minimum detecting pattern size – 0.25 mm^2;
- ✓ Sensitivity – 0.02 degree Centigrade;
- ✓ Measuring temperature range: – 20ºC to +120ºC;
- ✓ High resolution: 640 x 480;
- ✓ High thermo data uniformity and stability in time

Thermography is helpful in the diagnostics of:

breast cancer, nervous system disorders, metabolic disorders, pain syndromes, arthritis, vascular disorders, soft tissue injuries, urology, dentistry, dermatology, gynecology, etc.

•Inst. of Radio-Engineering and Electronics RAS &IRTIS Co.Ltd, Moscow, Russia

INTERNATIONAL TECHNICAL CENTERS "PLATFORMS"



Operations:

- ✓ Execution of joint international projects;
- ✓ Training of invited researchers;
- ✓ Organization of international scientific meetings

International laboratory of Strong Magnetic Fields and Low Temperatures, Wroclaw, Poland (1968)

Joint Institute for Nuclear Research Dubna, Russia (1956)