

INSTITUTIONAL PROFILE: NOVOSIBIRSK INSTITUTE OF ORGANIC CHEMISTRY (NIOCH SD RAS)

1. GEOGRAPHICAL POSITION

The region combining the North Asia, partly Central Asia and East Europe is huge and covers more than 10 percent of the Earth's surface. Main part of the region is occupied by the Russian Federation including the large area in the Arctic zone. About two third of the territory of the Russian Federation has not been touched by economic operations and preserves undisturbed environment. In a sense, Novosibirsk is located almost on the border of industrial and innocent parts of Russian and the region in whole.

Novosibirsk is the most populous city in Asian Russia (more than 1.5 million people). It is the administrative center of the Siberian Federal District. Novosibirsk International Airport is the largest beyond the Ural Mountains. It has numerous direct flights to cities in Europe and Asia.

Akademgorodok is a part of Novosibirsk located 30 km south of the city center. It is the Siberian educational and scientific center surrounded by a birch and pine forest on the shore of the river Ob. Novosibirsk Institute of Organic Chemistry is one of 40 research institutes located within Akademgorodok.

2. GENERAL AND RELATED INFORMATION

Novosibirsk Institute of Organic Chemistry (NIOCH SD RAS) was founded in 1958 within the framework of the Siberian Branch of the USSR Academy of Sciences. At the present, the Institute employs about 414 people including 184 researchers (33 Professors, 100 researches with PhD degree, 51 Postgraduates). The Institute is the base for the Department of Organic Chemistry of the Faculty of Natural Sciences, Novosibirsk State University.

Research departments and labs

- Laboratory of Investigation of Nucleophilic and Radical Ionic Reactions
- Laboratory of Intermediate Products
- Laboratory of Heterocyclic Compounds
- Terpenoids Laboratory
- Laboratory of Nitrogenous Compounds
- Laboratory of Organic Photosensitive Materials
- Laboratory of Halogen Compounds
- Laboratory of Ecological Research and Chromatography
- Laboratory of Physical Methods of Investigation
- Laboratory of Microanalysis
- Laboratory of Pharmacological Investigations
- Laboratory of Biologically Active Compounds

- Laboratory of Medical Chemistry
- Group of Synthesis of Polymerization Catalysts
- Group for Determining Compositions and Structures of Organic Substances
- Metalocomplex Catalysis Group
- Functional Materials Group
- Organic Electronic Materials Group

The Laboratories of Ecology Research and Chromatographic Analysis, Microanalysis and Physical Methods of Investigation form a core of the Multi-access Analytical Center. The Analytical centre was organized in 1987 as a basement for analytical, ecological and pharmaceutical research.

3. MAIN ACTIVITIES OF THE ANALITICAL CENTER

The Analytical Centre of NIOCH SD RAS is certified by the Federation Agency on Accreditation. It was certified that the Centre is able to carry out analysis and identification of organic substances and materials including the analysis of ‘trace’ and ‘ultra-trace’ analysis of persistent organic pollutants. List of the main activities of the Analytical Centre includes:

- Target and review analysis of environment objects, identification of pollution sources;
- Development of physical-chemical methods for analysis of substances and materials;
- Evaluation of toxicological and pharmacological parameters of substances;
- Independent examination and quality control of the food products, cosmetics, soil, water and air.
- Educational programs for modern analytical methods with “instrumental” practice.

The accreditation scopes cover today around 350 environmental assays: inorganic and organic, microbiological, ecotoxicological, mutagenicity, and vehicular emission testing and sampling procedures. Concerning POPs the next Limits of Quantification Analysis were certified:

- in water: aldrin, chlordane, chlordecone, dichlorodiphenyltrichloroethane (DDT), dieldrin, endosulfan, endrin, heptachlor, hexachlorobenzene (HCB), gamma-hexachlorocyclohexane (γ -HCH, lindane) – 0.00001 mg/l;
- polychlorinated biphenyls (PCBs) and polychlorinated dibenzo-p-dioxins (PCDDs) and dibenzofurans (PCDFs) – 0.5 pg/l;
- in soil and related sources: aldrin, chlordane, chlordecone, DDT, dieldrin, endosulfan, endrin, heptachlor, hexachlorobenzene (HCB), gamma-hexachlorocyclohexane (γ -HCH, lindane) – 0.001 mg/kg;
- polychlorinated biphenyls (PCBs) and polychlorinated dibenzo-p-dioxins (PCDDs) and dibenzofurans (PCDFs) – 1 ng/kg.

Because of such broad activities in ecological researches, NIOCH SD RAS is now considered a reference center for a number of environmental actions. NIOCH SD RAS is the one analytical center in Siberia that is able to carry out the quantification analysis of ultra-trace' amount of POPs in water, soils and sediments. NIOCH SD RAS is the one reference institute in Novosibirsk on issues related to water supply and hazardous waste. NIOCH SD RAS currently deals with emergencies in case of disasters, with Police in case of drugs, drugs industry and so on. It also coordinates the network on soil and groundwater contamination prevention, remediation, hazardous waste cleanup in Siberia.

4. EQUIPMENT AND TECHNICAL PARAMETERS

The Analytical Center is equipped with modern analytical precision equipment allowing to carry out research on analysis of food, biological environments, drugs and environmental objects. Equipment of the Center allows to perform research in the field of ecology, biology, chemistry, biochemistry at the highest level corresponding to modern international standards.

As examples, the list of available equipment includes:

- GC-chromatography: MSD, PID, TCD, ECD.
- Chromato-mass-spectrometers: Agilent 6890 with MSD detectors 5973 and 5975
- LC- chromatography: Detectors: MSD, QTOF, DAD.
- High resolution mass-spectrometer: Thermo DFS
- LC Agilent 1200 – Bruker micro-QTOF and others

5. ENVIRONMENTAL QUALITY MONITORING

The NIOCH SD RAS carries out a variety of environmental monitoring programs, including food, medicine, water and soil quality, encompassing the following areas:

Expeditions to hidden places of Siberia, Mongolia and Kazakhstan

Since 1994, NIOCH SD RAS has organized annual expeditions to various off-road regions of Siberia, including Lake Baikal and Buryatia, as well as Mongolia and Kazakhstan. The expeditions were key steps in the implementation of environmental programs including monitoring of persistent organic pollutants: "Environmental safety of Russia," "Protection of the environment and the population from dioxins and dioxin-like toxicants," "Semipalatinsk – Altai" and many others. For further information visit the website <http://web.nioch.nsc.ru/leixa/index.htm> (in Russian).

The expeditions aimed to reveal contamination of the Lake Baikal Basin by persistent organic pollutants coming from Mongolia and other surrounding territories. In surface and groundwater,

bottom sediments and bioindicator organisms (bivalve mollusks *Colletopterum*, roach *Rutilus*, pike *Esox lucius*, catfish *Silurus glanic*) were analysed on the content of selected POP.

Quality Monitoring

In Novosibirsk, NIOCH SD RAS is responsible for the licensing of medicine. In Siberia and Mongolia, NIOCH SD RAS carries out water quality monitoring programs to assess the quality of the aquatic environments for different purposes providing and permanent diagnosis of the water resources. Since 1994, NIOCH SD RAS has monitored the quality of groundwater by collecting samples in more than 35 points in Siberia including the region of the Lake Baikal. POPs substances were revealed and their distribution, possible sources, bioconcentration and bioaccumulation were analyzed. The results of these monitoring were published.

NIOCH SD RAS carries out determination of the chemical sediment quality index, related to the aquatic life protection, based on the national values established for arsenium, heavy metals and organic compounds. NIOCH SD RAS has also focused on soil condition evaluation on a regional scale.

Some selected results: In 2013 NIOCH SD RAS issued a report presenting data on chromatographic profiles, detailed compositions and current levels of POP content in environmental objects of the basin of the River Selenga and the lake Baikal, obtained by the method of chromatography-mass spectrometry. As a result of the analysis of the obtained data, regularities in the intake, distribution and accumulation of POPs were revealed. The effectiveness of using data on the qualitative and quantitative composition of POPs in environmental objects, for regional environmental-geochemical and environmental-hygienic assessments of the state of the natural environment, effective detection of sources and zones of strengthening and weakening of anthropogenic impact on the environment, and the development of bioaccumulative POPs models for water Ecosystems and environmental risk assessment.

In 2015, NIOCH SD RAS published data on the determination of the individual and the group composition for low molecular mass organic substances of natural and anthropogenic origin basing on the analysis of chromatographic profiles and the spectral characteristics. The approach allows to carry out the identification of persistent organic pollutants in the environment of Siberia and Mongolia, as well as of identifying the main sources of pollution.

Chemical Emergencies

Chemical Emergencies are unexpected events that may occur in all those activities where hazardous materials are being handled. These events may cause undesirable consequences to public health, to the natural resources and to public property. Since 1994, NIOCH SD RAS works

in the prevention and response to chemical emergencies, providing technical support and intervening in occurrences involving railroad transport, dangerous substance discard, industries, petrol plants, and so on.

SUMMARY concerning NIOCH SD RAS as a new perspective Regional Centre

- Geographical position (new territories including hidden places of the North Asia)
- Experience (25 years) in ecological researches
- Trained staff including young scientists
- Available analytical equipment and infrastructure
- Close to high-ranked Novosibirsk State University with Department of Environmental Chemistry
- Experience in research of Halogen Compounds
- Pilot plant to develop of chemical technology
- Relationships with other ecological Labs (from Moscow to Vladivostok)
- Close location (30 km) to Novosibirsk and International Airport

Organigram of the institution

(Departments and people highlighted with yellow are those which will be responsible for undertaking technical assistance program in the capacity of the regional centre)

The main areas of fundamental and applied research

The Novosibirsk Institute of Organic Chemistry conducts fundamental and applied research in the following areas:

- studying the mechanisms of reactions of organic compounds and molecular rearrangements; the structure and properties of compounds and active intermediate species, including the methods for quantum chemical calculations of the structure and properties of compounds;
- methods for synthesizing aromatic, fluoroorganic, heterocyclic and heteroatomic (containing nitrogen, sulfur, etc. atoms) compounds, including stable radicals, polymers, and monomers;
- elaboration of analytical and instrumental procedures for identifying the structure and configuration of organic compounds and environmental monitoring;
- Contribute to solution of environmental problems – identification of environmental contamination; risk assessment and assistance/consultancy in remediation, decontamination of contaminated sites/environmental hotspots.
- synthesis, investigation of properties, and formation of organic, hybrid, and polymeric materials; development of the foundations of the technologies for producing the compounds and agents of practical importance;
- extraction methods and procedures, chemical nature, reactivity, and biological activity of plant metabolites. Targeted synthetic transformations, investigation of pharmacological properties and the mechanism of action of biologically active agents.

The Institute today

The Novosibirsk Institute of Organic Chemistry employs 420 people, including 151 researchers (33 Doctors of Science, 96 Candidates of Science (PhD), and 20 employees without a higher academic degree).

Twenty-two PhD students and 8 PhD students from other research and educational institutions are currently enrolled in the Institute's PhD program

The Novosibirsk Institute of Organic Chemistry carries out collaborative research with chemistry (the Institute of Organic Chemistry, RAS; the Institute of Organoelement Compounds, RAS; the Ufa Scientific Center, RAS; the Institute of Catalysis, SB RAS; the International Tomography Center, SB RAS; the Institute of Inorganic Chemistry, SB RAS; the Institute of Biological Chemistry and Fundamental Medicine, SB RAS; the Irkutsk Institute of Chemistry, SB RAS; and the Institute of Solid State Chemistry and Mechanochemistry, SB RAS), physics (the Institute of Automation and Electrometry, SB RAS), and biology (the Institute of Cytology and Genetics, SB RAS and the State Research Center of Virology and Biotechnology VECTOR) institutes, as well as medical research institutes (the Acad. E.N. Meshalkin Novosibirsk Research Institute of Circulation Pathology and the Research Institute of Influenza of the Ministry of Healthcare of the Russian Federation) and state universities (Novosibirsk State University, Novosibirsk State Technical University, Tomsk State University, Krasnoyarsk State Pedagogical University, Bashkir State University, Kazan Federal University, and Moscow State University), as well as the universities and research laboratories in Belgium, Germany, Japan, Great Britain, USA, France, Mongolia, Mexico, Estonia, Spain, the Republics of Kazakhstan and Belarus under bi- and multilateral projects and grants.

Individual departments of the Institute are engaged in active collaboration with the leading companies in the USA, Japan, Belgium, Finland, Germany, the Netherlands, Turkey, France, China, South Korea, the Czech Republic, the Republics of Kazakhstan and Belarus on a commercial basis.

Researchers of the Institute annually

- participate in implementation of 70–80 projects that are supported by the budget or on a competitive basis, including 7 budget-supported projects, 30–35 Russian Foundation for Basic Research (RFBR) grants, 3–5 Russian Science Foundation grants, 5–6 international projects, grants of President of Russian federation, grants from the Administration of the Novosibirsk Region, Novosibirsk City Administration, and the UMNIK program grants.
- publish 150–180 articles and reviews in international and Russian research journals (some of these studies being carried out under international collaboration with foreign scientists), 2–5 textbooks, 2–3 monographs or chapters in multi-authored monographs;
- organize or co-organize 2–4 large research conferences (including schools-conferences for young scientists), hold 5–10 scientific and educational workshops and presentations;
- deliver over 300 presentations at youth, All-Russia, and international conferences;

The developments conducted at the Novosibirsk Institute of Organic Chemistry have been awarded the Lenin Prize; the State Awards of the USSR, RSFSR, and the Russian Federation; the USSR Council of Ministers Award, the State Prizes of the Russian Federation for young scientists, and a number of diplomas and medals at Russian and international fairs and exhibitions.

The Institute offers the PhD program for the following specializations: Chemistry (organic and physical chemistry), Fundamental Medicine (pharmacology and clinical pharmacology). The department for training scientific and pedagogical personnel and the Dissertation Committee awarding the academic degrees have been organized. Five to ten Candidate (PhD) and 1–2 Doctoral theses in the field of chemistry are defended each year.

Over 40 employees and PhD students of the Institute are involved in educational activity at schools, colleges (Novosibirsk College of Chemical Technology and etc.) universities (Novosibirsk State University, Novosibirsk State Pedagogical University, Novosibirsk State Technical University, Novosibirsk State University of Architecture and Civil Engineering); 30–35 employees are academic supervisors of students writing the term papers and diploma thesis papers. At least 30 students undergo an internship at the Institute; ~ 10 of those defend their theses

and are awarded the bachelor, specialist, or master degree in chemistry, physics, or biology. The Novosibirsk Institute of Organic Chemistry, SB RAS is the basis institute for the Division of Organic Chemistry (Natural Sciences Department, Novosibirsk State University) and the Division of Chemistry (Department of Natural and Socioeconomic Sciences, Novosibirsk State Pedagogical University).

Tours of the laboratories, the pilot plant, and the museum are organized upon requests from schools. The total number of people taking part in these tours annually is more than 300.

Researchers working at the Institute deliver popular scientific lectures during the academic year or as a part of the Federal or City Days of Science, Science Festivals, or summer science programs (20–30 lectures per year); work as judging panel members at regional, city, and international school student conferences, organizing committees of the Olympiads of different levels and subjects for school students (the All-Siberian Olympiad, “Future of Siberia”, and the All-Russian School Student Olympiad).

Directorate



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Multi-access centers

The Testing Center certified by the Federal Accreditation Service for technical competence and independence has been established and is now successfully operating basing on the Laboratory of Microanalysis, the Laboratory of Physical Methods of Investigation, and the Laboratory of Ecological Research and Chromatographic Analysis.

The Center is equipped with modern high-precision analytical facilities that allow one to analyze food and industrial products, biological media, pharmaceuticals, and environmental objects. The Novosibirsk Institute of Organic Chemistry is the basis organization for the Multi-access Chemical Service Center (CSC) uniting the unique and expensive equipment and setups available at chemistry institutes of the Novosibirsk Research Center. Seven subdivisions have been established as a part of the Center: Departments of Radiospectroscopy, Optical Spectroscopy, Chromatography–Mass Spectrometry, X-ray Diffraction Analysis and X-ray Spectroscopy, Microanalysis, Toxicological and Pharmacological Analysis, and Research Equipment Maintenance. The equipment available in the Center enables high-level research in the areas of ecology, biology, chemistry, biochemistry, and medicine that complies with the modern international standards. The Testing Center is a part of the integrated systems multi-access centers of the Russian Foundation for Basic Research (RFBR) and the fundamental laboratories of environmental analytical control in the Novosibirsk Region.

The Toxicological and Pharmacological Department of the SUC performs biological testing of chemical substances, pharmaceutical and biologically active food additives to determine the pharmacological (anti-inflammatory, antiulcer, wound healing, antioxidant, antiarrhythmic, psychotropic, myorelaxant, etc.) activity and toxicity (acute, subchronic, chronic, cumulation and the allergizing effect).

Laboratory of Ecological Research and Chromatographic Analysis (LERCA)

Research areas:

- Development of the methods for analyzing natural, anthropogenic, and synthetic low-molecular-weight organic compounds, materials, reactions and processes occurring in the living systems and environmental objects.
- Investigation of the chemodynamics and development of bioaccumulation models of persistent organic pollutants for the aquatic ecosystems in the Baikal Natural Area.
- Molecular design, synthesis and studying the properties of spin-labeled natural biologically active compounds.

Laboratory of Microanalysis (LMA)

Research areas:

- Determining the elemental composition of synthetic and natural compounds and materials of various composition and structure by organic elemental analysis and atomic emission spectroscopy; designing and upgrading the analytical procedures.
- Determining the molecular weight of organic compounds and osmolality of solutions by vapor phase osmometry.
- Analysis of waste water and workplace air to detect toxic elements and compounds.

Center of Spectral Research (CSR)

Research areas:

- Analysis and identification of organic, metal-organic, and inorganic compounds and materials, including nanomaterials with targeted (polymeric, optical, ferromagnetic, biologically active) properties by molecular spectroscopy for scientific, technological, and medical applications.
- Development of physicochemical methods for analyzing substances and materials.
- Creation of databases on chromatography-mass spectrometry and molecular spectroscopy.
- Conducting collaborative fundamental and applied research.

Laboratory of Pharmacological Research (LPR)

Research areas:

- Toxicological and pharmacological examination of plant metabolites and their synthetic derivatives to design original medications.
- Studying the pharmacological properties and the mechanism of action of novel natural and synthetic medicinal products, as well as those manufactured by clathration with glycosides and polysaccharides.
- Pharmacological screening of novel biologically active natural and synthetic compounds.