THE FORECAST AND THE STRATEGY OF CHEMISTRY DEVELOPMENT

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Preliminaries

A lasting economy of the state requires continuous progress in technology based on novel scientific achievements. Science and innovation are the basic factors ensuring competitiveness of our industry and agriculture and provide for about 50-85% of economic growth.

Science is the nation's patrimony and it determines the future of the country.

The objectives of Science in Moldova are:

- to get new knowledge about nature and society;
- to create a wide scientific-technologic basis that would ensure:
  (1) innovation activity in the country;
  (2) technology progress;
  (3) world competitiveness of our production.

The first pedagogic institution in our country specialized in chemistry was created in 1939 as a part of the Agronomy Department in Chisinau (a of the University of Jassy). Since 1946 till present graduate and undergraduate university training in chemistry in Moldova took place in the following institutions:

- Department of Chemistry and Technological Chemistry of Moldova State University;
- Department of Chemistry and Biology of Tiraspol State University (headquarter in Chisinau);
- Institute of Chemistry of the Academy of Sciences of Moldova.

At the Department of Chemistry and Technological Chemistry of Moldova State University there are three Divisions: inorganic and physical chemistry, organic and analytical chemistry, technological and ecological chemistry. In addition to these institutions there are Chemistry Departments in other high-educational institutions in Moldova that have university level training in chemistry, namely, "N.Testemitsanu" State University of Medicine and Pharmaceutics, Moldova Technical University and Moldova State Agrarian University.

The departments and divisions of these institutions provide for the country's needs in chemistry teachers, researchers and industry chemists. Biochemists are trained by the corresponding divisions in the Biology Department of Moldova State University and of "N.Testemitsianu" Moldovan State University of Medicine and Pharmaceutics.

At the Chemistry Institute of Moldova Academy of Sciences investigations are carried out in the following laboratories: coordination chemistry, bioinorganic chemistry, quantum and chemical kinetics chemistry, chemistry of terpenoides, organic synthesis, analytical chemistry and ecological chemistry. Since the onset of this institute the following laboratories were active during a limited time period: chemistry of regulators of plant growing, chemistry of mineral resources and water. Presently the Institute of Chemistry Moldova Academy of Sciences has 125 co-workers, 57 of them being scientific researchers (13 habilitatus doctors, 33 Ph doctors). The percentage of scientific researchers with scientific degree is 81%.

The chemical institution "Isomer" is also operative at Moldova Academy of Sciences.

The graduate studies that functions as a part of the mentioned institutions are aimed at training qualified experts in chemistry. During 1961-2005 Moldova Academy of Sciences prepared 181 doctors of philosophy and habilitatus doctors specialized in chemistry and physics. The distribution of the high qualified graduates on their majors is shown in the Table 1.

Table 1

The number of high qualified experts trained at the Chemistry Institute of Moldova Academy of Sciences during 1961-2005.

Specialty	Nr. of high qualified experts trained		Total
	Ph doctors	Habilitatus doctors	
Inorganic Chemistry	46	7	53
Quantum Chemistry	21	4	25
Organic Chemistry	39	6	45
Analytical Chemistry	29	1	30
Physical Chemistry	24	4	28
Ecological Chemistry		2*	2*
Total	159	22	181

*Thesis of habilitatus doctors defended at two specialties.

The research staff of the Institute of Chemistry of Moldova Academy of Sciences published over 2662 scientific works, 120 monographs, 10 handbooks, 240 patents. They took part at 330 national and international exhibitions.

Among the most important achievements of the Institute of Chemistry the following should be mentioned:

1. Perfumes and sauces for tobacco industry;
2. Odorous compounds with amber smell for perfumery and technologies for such compounds preparation;
3. New compositions for plastering;
4. Technology of surface water treatment;
5. Catalysts for epoxyde (rubbers) solidification;
6. Dyes for plastics;
7. ***"Gajazot"*** – product with anti-chlorosis properties for vineyards;
8. ***"Virinil"*** – growth stimulator for grafted vineyards;
9. Stomatologic preparations ***"Fenglicol", "Fencarin"***;
10. ***"Salivit"*** – product for treating the inflammatory diseases or other diseases of locomotor's system;
11. ***"Mobipan"*** – antihypotensive product for treating the cardiovascular diseases.

Elaborations that can be applied in the national economy:

1. Preparation of active charcoal by chemical activation (the respective technology is implemented at "Isomer" Chemical institution);
2. Antidepressant ***"Chetizal"***;
3. Anticancer product ***"Setremed"*** ;
4. ***"Trifeden"*** – growth stimulator for corn crops;
5. ***"Difecoden"*** – growth and productivity regulator;
6. ***"Codiclogu"*** – product with anticoccide properties;
7. ***"Codimez"*** – food intoxication antidote for bovine, particularly with pesticide;
8. ***(Funghicide) products*** – for cucumber flouring control, brown blight and wheat flouring control.

Table 2

Annual output of chemical products in Moldova

Chemical Industry				
Item	2001	2002	2003	2004
Number of companies	14	12	14	
Production volume, mln lei	78,0	81,3	99,6	
Annual average number of personnel, thous. pers.	1,1	1,1	1,1	
Cement, lime and plaster production				
Number of companies	5	5	3	
Production volume, mln lei	149,3	268,8	132,9	
Annual average number of personnel, thous. pers.	1,1	0,9	0,6	
Soap, detergents, maintenance products, perfumery and cosmetics products				
Number of companies	3	25	2	
Production volume, mln lei	27,2	20,4	24,6	
Annual average number of personnel, thous. pers.	0,4	0,4	0,4	
Glass and glass articles production				
Number of companies	4	4	4	
Production volume, mln lei	425,4	498,0	502,8	
Annual average number of personnel, thous. pers.	2,0	2,0	2,0	

The main research achievements of the "Industrial and Ecological Chemistry" Division at the Moldova State University involve the following:

- theory of oxidation chemical auto-purification of water and seasonal dynamics of redox condition specific to natural water;

- theory of fluid reactors, transformation of nitrogen compounds with micro-organisms immobilized on support;
- theory of environmental reduction-oxidation condition;
- methods of physical-chemical and biochemical treatment of solid wastes and waste waters;
- methods of inhibiting the formation process of N-nitrosamines using reductons;
- mechanisms of catalytic and photochemical oxidation of organic substances with oxygen, hydrogen peroxide and free radicals.

There is a modest output of chemical industry in Modova. However, according to statistical data, there exists certain chemical production in Moldova.

Chemistry as a science and as a branch of national economy will be developing in the following important areas:

- development of fundamental and applied science, development of applicative research oriented towards the production needs, in line with world's tendencies;
- exports, including high qualified ones;
- modernization of available chemical technologies, elaboration and implementation of new technologies for the obtaining of building materials;
- elaboration of efficient means for plants protection and increase in cultivated plant productivity;
- development of food products chemistry;
- elaboration of new multifunctional technologic materials;
- production of new pharmaceutical substances;
- elaboration of advanced technologies for the needs of cosmetics and tobacco industries;
- development of chemistry of oil and oil products;
- elaboration of advanced technologies for adsorbents production, waste and natural water treatment, soil and air protection, and also offals use in different areas of the country's economy.

The main objectives of chemistry development in the Republic of Moldova are:

- to maintain the high development level of fundamental chemical science;
- to create the efficient research and training system for chemistry development;
- to elaborate the advanced technologies for obtaining the adsorbents, using the available local raw material;
- to provide the scientific and technical control of cement, glass, ceramics materials, concrete production;
- to create the centre for physical methods application in chemistry;
to - create a screening and testing centre of active biologic substances synthesized and obtained by extraction;
- to create institutions for chemical substances production, necessary for national economy (agriculture, medicine, industry);
- to elaborate the efficient non-polluting technologies, and to elaborate the technologies for the treatment of contaminated environmental comportments;
- to create the suitable departments and corporations for offals use;
- to create the suitable departments and corporations for obtaining of competitive oil products;
- to create the institutions to produce the labor-saving devices using the local raw materials.

Inorganic and coordination chemistry

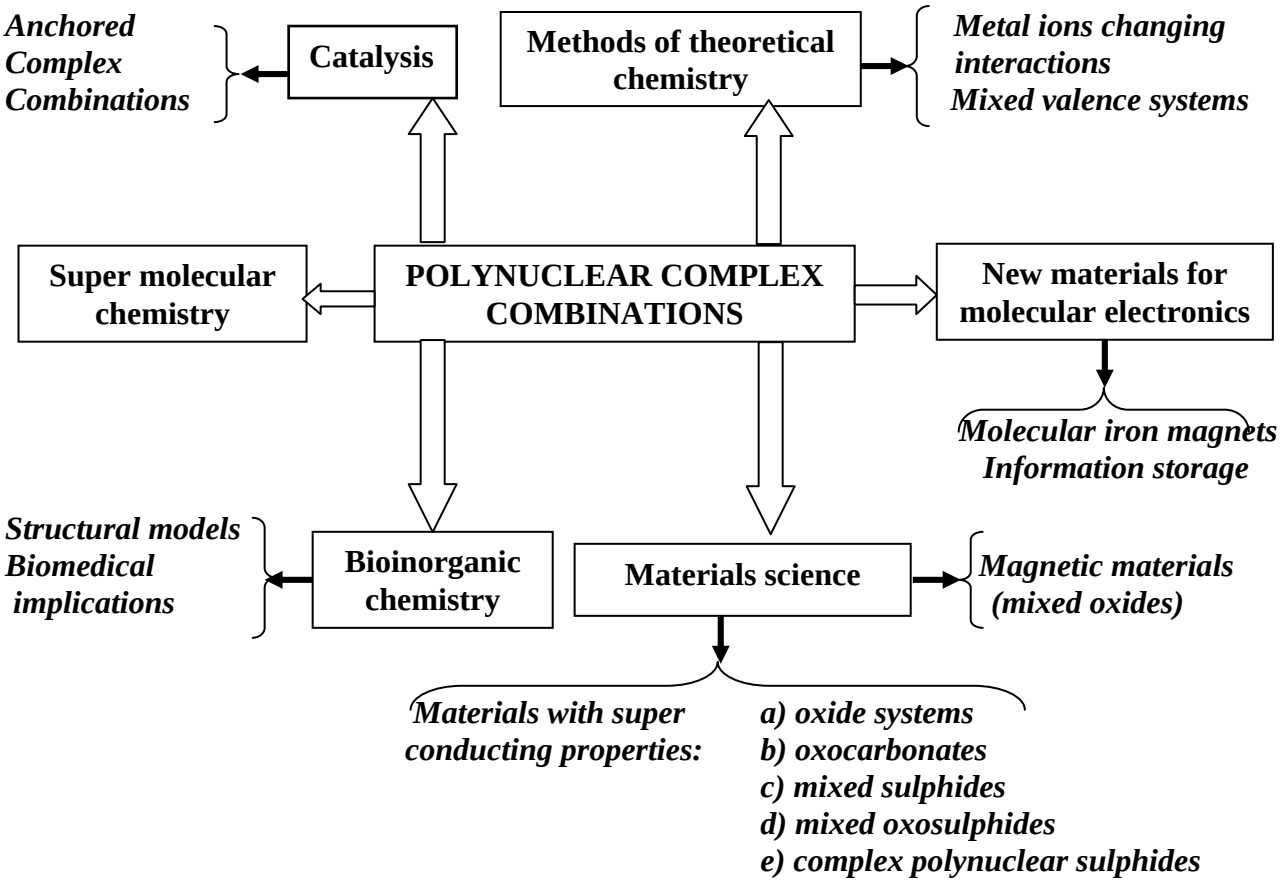
Being considered initially as a part of inorganic chemistry, and regarded as a special discipline nowadays, coordination chemistry is among the most important and actual areas of chemistry, an area that attracted and continues to attract the researchers from all around the world and from all chemistry's areas (inorganic chemistry, physical chemistry, organic chemistry, analytical chemistry, biological chemistry, etc.). This area have found rapid development within a short time period.

There is a world-recognized coordination chemistry school in Moldova, with old and solid traditions. The founder of this school was Academician Antonie Ablov.

The importance of this area consists in the following:

- coordination chemistry is a boundary discipline, that attracts inorganic chemists and other experts in theoretical and experimental areas;
- coordinative compounds, especially polynuclear ones, found broad applications in various fields;
- coordinative compounds are present in numerous natural and technological systems and living organisms (chlorophyll, hemul, vitamin B_{12}, hemocyanine, nitrogenase, etc.).

We should also add that coordination chemistry ensures chemistry progress, from both experimental and theoretic standpoint. The main development trends of coordination chemistry are specified in the chart below.



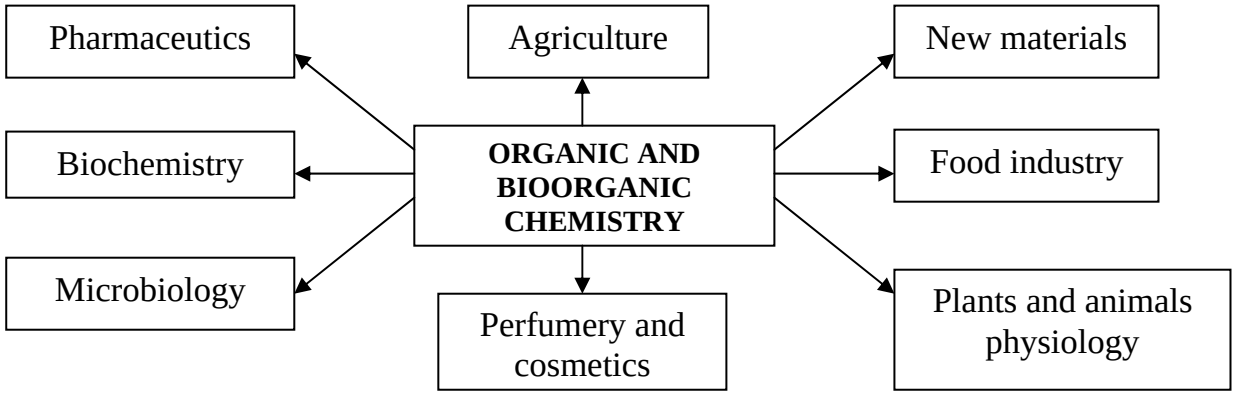
Organic and bioorganic chemistry

Organic and bioorganic chemistry is the most important and large area of the modern chemistry. Organic compounds have are widespread in natural environment, practically providing the regulation of all vital processes specific to land flora and fauna.

Academician Gh. V. Lazurievschii was the founder of organic and bioorganic chemistry school in the Republic of Moldova. The works carried out under his leadership had significant impact on the study of such natural compounds as alkaloids, terpenoides, triterpenic and steroidal glycosides, cannabinoides and carbon hydrates. At the same time, thin organic synthesis found its development. Objects of these studies were natural compounds isolated from spontaneous local flora and some offals accumulated in agricultural and food industry.

The importance of this area of chemistry is evidenced by:

- revealing of the mechanisms of chemical reactions and developing the notions of stereochemistry;
- elaborating synthesis methods and technologies for producing a number of active biologic compounds, used on a large scale in medicine as pharmaceutical products and in agriculture to realize the regulation of processes of plant development and their protection against different diseases and damages;
- existence of renewable autochthonous sources for obtaining organic compounds, which can serve as raw materials for different industry branches;
- application in botany (chemotaxonomy), microbiology (establishing the structure of microorganisms metabolites), physiology (studying organic compounds which realize the regulation of different vital processes specific to living organisms);



- large-tonnage production of plastics and fuel, inclusively of biofuel.

Objectives of organic and bioorganic chemistry are as follows:

- to isolate, identify and synthesize natural compounds representing an interest for different branches of national economy;
- to elaborate the directed synthesis methods of new organic compounds and their testing.

The scheme above shows the areas in which the results of scientific investigations are applied.

Analytical chemistry

The trends of analytical chemistry development in Moldova were justified by the scientific interests of the research school created by academician Yu. Lealikov. The research was focused on electrochemical methods elaboration to detect different elements (metals or non-metals) in non-ferrous metallurgy products, food products, electro-techniques (semiconductors), extra pure metals industry, and also in pesticides. Special attention was paid to preparation and testing of such materials.

Currently, the research in analytical chemistry is developing in two main areas which correlate with the research tendencies specific to the world science:

- elaboration the methods of trace amounts detection of toxic substances, biologically active substances, and their metabolites;
- elaboration of rapid ("express") analysis methods, including the field analysis techniques, which make it possible to provide the analytical control and large-scale monitoring of products quality.

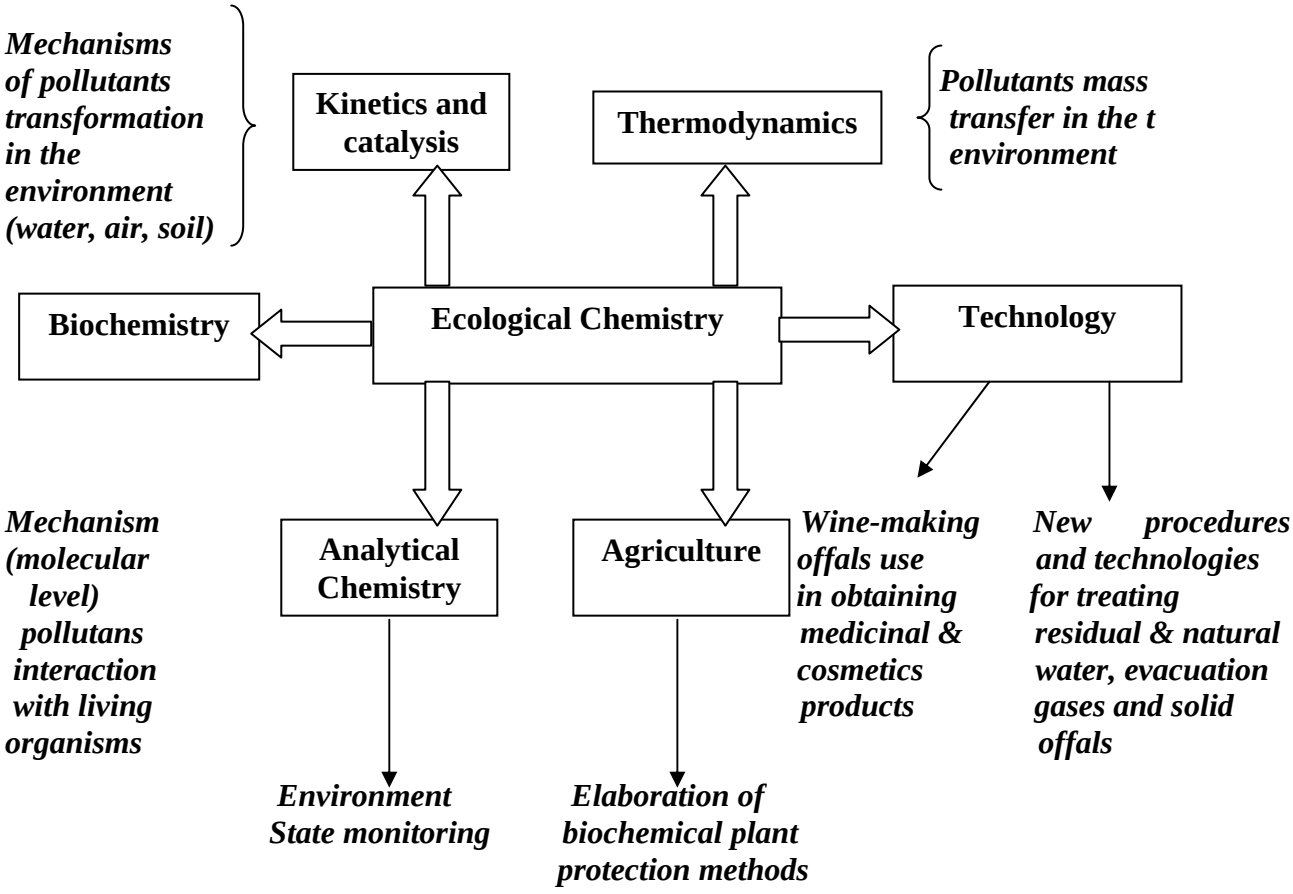
To reach these objectives, the electrochemical methods using the electrochemical or sorption accumulation processes and potentiometric, amperometric, optical, biologic sensors, will be applied.

Chromatography and molecular spectroscopy will be developed too, using new organic analytical chemicals. Elaboration and application on a large scale of new devices will be a good dam for the production of counterfeited, spoiled, with deviation from standards products.

Industrial and ecological chemistry

The environment is affected by the continuous anthropogenic loads. The concentration of toxic gases responsible for the greenhouse effect, leading to the destruction of ozone layer or generating the acid rains, is permanently increasing in the atmosphere.

The quality of fresh water is degrading; pollutants concentration (heavy metals, oil products, nitrogen compounds, surfactants, etc.) is increasing. The soil is also subjected to pollution (domestic, industrial discharges, pesticides) and its fertility decreases.



The population health, which is affected by environmental pollution, is an important factor for economy development. Different pollutants may be modified yielding even more toxic metabolites in the environment.

Proceeding from the above considerations, we came to the conclusion that ecological chemistry and environment protection have a paramount significance. In the Republic of Moldova the scientific area of "Ecological chemistry" was founded and directed by academician Gh. Duca.

Fundamental and applied scientific research in this area are carried out at the Industrial and Ecological Chemistry Division at Moldova State University, Research Center on Applied and Ecological Chemistry, National Institute of Ecology and Institute of Chemistry of Moldova Academy of Sciences. The main achievements in ecological chemistry as fundamental science are presented above.

The main results achieved in chemical technology and environment protection research, are as follows:

- elaboration of electrochemical activation technology and conditioning of underground waters which contain fluorine and sulphury hydrogen;
- synthesis of adsorbents with modified surface for removing oil products, for wine demetallisation, etc;
- technology of anaerobic waste water treatment and hydrolytic destruction of persistent organic compounds using suspended and fixed microflora, and biogas obtaining;
- catalytic methods of gas emissions treatment from industry and auto transport;

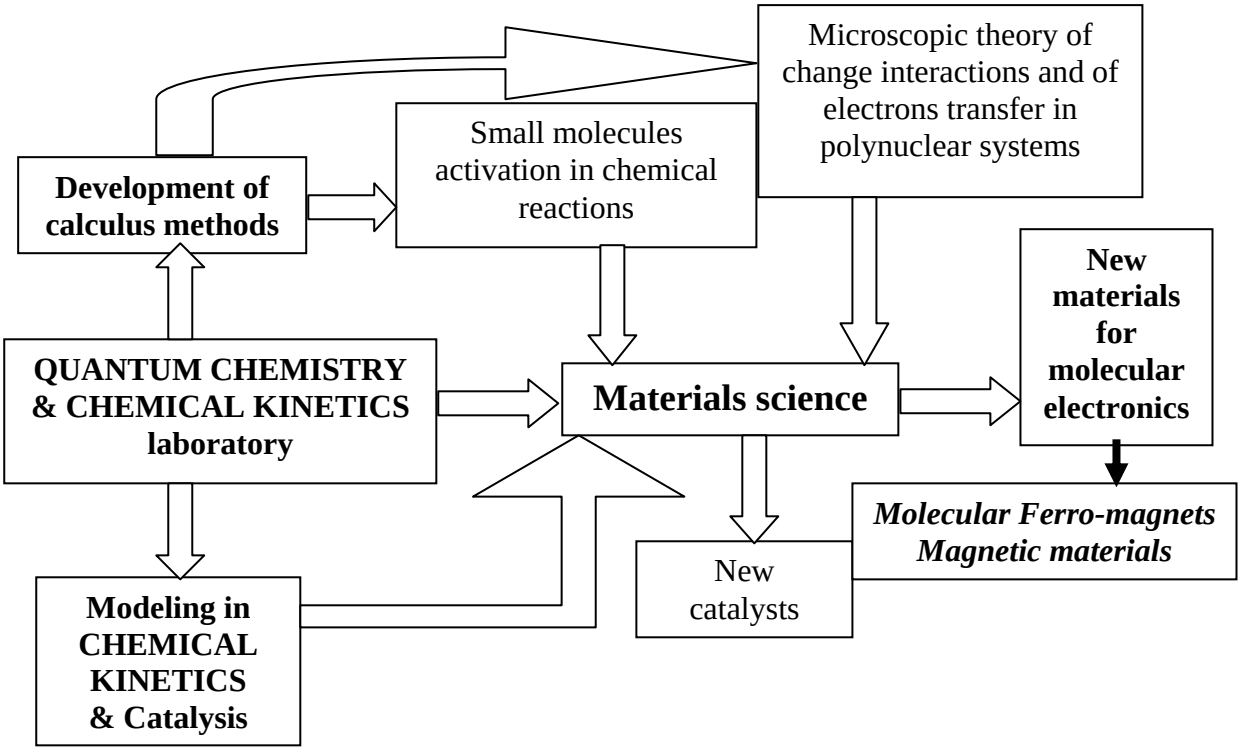
In the above scheme the interrelated areas of ecological chemistry are given, which are the main research trends.

The main tendencies in industrial chemistry research are linked with the requirements of ecological chemistry and are determined by the national economy. They include:

- elaboration of new coagulant types and modified sorbents from secondary products for the water treatment containing oil products, dyes, for selective wine demetallisation;
- utilization and processing of secondary wine-making products by obtaining precious compounds for national economy;
- modernization of electrochemical technologies of water treatment and conditioning at rural zone;
- monitoring of surface and underground water quality in the Republic of Moldova and study of the reduction-oxidation state dynamics in natural waters;
- elaboration of kinetic methods for estimation of natural water quality and their correlation with the results of classical hydro-chemical investigations;
- intensification of catalytic combustion processes specific to fuel and emission gases treatment;
- elaboration of methods for N-nitrozo compounds formation inhibition in order to diminish the chemical risk of cancer occurrence;
- biogas obtaining, as alternative energy source, from industrial organic wastes and elaboration of individual systems for biogas production at the farms.

Quantum chemistry

Being a part of physical chemistry, quantum chemistry currently forms completely the theoretical base of modern chemistry. Various quantum-chemical aspects are discussed in the majority of chemistry papers published in the last decades.



At the beginning of the year 1960 in the Republic of Moldova a specialized quantum chemistry school was established (the founder is academician I.Bersuker). The research on vibronic effects, chemical reactivity, electronography and spectroscopy, magnetic interactions of changing and transferring electrons into polynuclear clusters resulted in outstanding successes highly appreciated by the world scientific community. The following scheme shows the contribution of this research investigations to other areas.

Future research in this area will be focused on the following problems:

- activation of small molecules (oxygen, nitrogen, carbon oxide etc), which participate in different catalytic processes;
- study of molecular magnets;
- development of "structure – activity" scheme at different substances.

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