

Higher Chemical College of the Russian Academy of Sciences[†]

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Higher Chemical College of the Russian Academy of Sciences (HCC RAS) is an educational institution of university level, operated directly under umbrella of the Russian Academy of Sciences and associated with D. I. Mendeleev University of Chemical Technology of Russia. Founded in 1990, it became one of the most remarkable higher schools of chemical education in Russia because of not only the unique curriculum, wide connections with world renowned scientists, universities and academic research centers but also its friendly atmosphere of creativity and scientific activity.

The HCC RAS has effective collaborations with leading Russian research and educational centers. Principal courses are given by lecturers from M. V. Lomonosov Moscow State University, D. I. Mendeleev University of Chemical Technology, as well as acting researchers of N. D. Zelinsky Institute of Organic Chemistry, A. N. Nesmeyanov Institute of Organoelement Compounds, N. S. Kurnakov Institute of General and Inorganic Chemistry, and others.

One of the key advantages of the education at the College is the early implementation of regular research work that allows students to get extensive practical experience in chemistry and its methods, to develop their own projects.

Admission to the College

Annual admission to the College is usually 30 students. The majority of the enrollees are the best graduates from the Moscow Chemical Lyceum, Tula and Bryansk Lyceums, winners of Regional, All-Russian, and International Chemical Olympiads. The College is also opened to other Russian-speaking applicants provided that they pass the entrance examinations and an interview testing their educational level and creative ability. At present there are over 120 students and 50 staff members at the College. The high ratio of the number of faculty staff to the number of students gives HCC RAS a significant advantage of greater individuality of education.

Duration of the study at the College is 5–5.5 years. After the presentation of a research diploma thesis the graduates are qualified as a ‘chemistry researcher’ (Master’s Degree).

Continuous Education System

The College is a part of a three-stage educational system, consisting of the Moscow Chemical Lyceum (high school), associated with N. D. Zelinsky Institute of Organic Chemistry, RAS, the College (university level) and research institutions of the RAS. Students take advanced level courses at the Lyceum and then continue studies at the College — the same lecturers, the continued chemical courses. Such unique integration enables to provide a continuity of the College and Lyceum programs and to provide leading academic centers with top-quality specialists.

The Moscow Chemical Lyceum was established in 1990 for the most talented and highly motivated pupils interested in chemistry and physics. The Lyceum collects annually 22–25 such young people from Moscow ordinary schools for three-year study. One of the key concepts of the Lyceum is diversity and advanced level of high-school education. Principal chemical courses are similar to those taught in D. I. Mendeleev University of Chemical Technology for 1st and 2nd year students. The Lyceum also has a number of unique chemical programs beyond the scope of classical chemical courses, which are designed to provide students with knowledge about the most interesting progress in advanced science and to develop creativity. As a result, every year Lyceum students win Moscow and All-Russian Chemical Olympiads. Some Lyceum students have also won silver and golden medals in World Chemical Olympiad.

One of the principal advantages of Lyceum education is the early start of research work. In the last year of study the majority of Lyceum students begin to work in leading laboratories of Academy research centers. Some of them get such an opportunity a year earlier, having almost two years of research practice before entering the College. Some of Lyceum students have scientific papers by the time they enter the College. Every year Lyceum students successfully participate in the Intel International Science and Engineering Fair Conference held in the United States and organized by Intel and the American Chemical Society (ACS). For instance, in 2004 Michael Klenov received the Intel Foundation Achievement Award for outstanding work in chemistry, Second Award in Chemistry and ACS Third prize for his synthetic work. Ivan Bushmarinov got Second Award in Chemistry and ACS First Prize for his NMR study. Lyceum students successfully present their works at scientific conferences.

The majority (70–90%) of Lyceum graduates enter the HCC RAS, which provides maximum opportunities to develop skills gained in the Lyceum. Early involvement in real research work, diverse and comprehensive education, advanced training in major fields and atmosphere of sound competition — all these things result in Lyceum graduates becoming enthusiastic and motivated people with deep knowledge, well prepared for successful continuation of their studies at the advanced level of Higher Chemical College.

Thus, the Moscow Chemical Lyceum is an important basis of the Continuous Education System in Chemistry.

Such a precocious involvement of students into scientific research increases their motivation to its further continuation on the graduate and postgraduate levels at the institutes of the RAS, other leading research centers and universities.

The Curriculum

The College basic educational program includes the following courses: chemistry (19%), laboratory work (10%), mathematics (10%), physics (5%), foreign languages (English/French/German) (8%), history/philosophy/economics (4%), computer (4%), special courses (7%) and scientific research (36%). Chemical courses

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cover inorganic chemistry, organic chemistry, physical chemistry, physical methods of analysis, quantum chemistry, materials science, chemistry of macromolecular compounds, environmental chemistry, analytical chemistry, catalysis and chemical technology. Professors W. A. Smit (organic synthesis), V. B. Kazansky (catalysis), D. A. Lemenovskii (theoretical inorganic chemistry, chemistry of organometallic compounds), V. P. Pavlov (theoretical physics), N. A. Platé (chemistry of macromolecular compounds), B. V. Lokshin and M. Yu. Antipin (physical methods), A. A. Pasynskii and A. B. Yaroslavl'tsev (experimental inorganic chemistry) and others are the lecturers at the HCC RAS. Among the faculty there are eight Members of the Russian Academy of Sciences.

The Higher Chemical College education is not limited to natural sciences and mathematical disciplines. Much attention is also paid to sociology, economics, psychology, history, philosophy, ecology and problems of sustainable development, foreign languages (special attention is drawn to English lessons).

Note that the College curriculum also includes computer courses with the use of state-of-art software for quantum-chemistry calculations. Jointly with the general course of quantum chemistry, the practical study of using the latest Gaussian, Gamess, Mopac/Ampack and Molden software is given. Students also have an opportunity to attend advanced courses on the UNIX operating system and computer visualizations in science, which are becoming vital for present-day researchers in the swiftly growing world of scientific data.

It is remarkable that nowadays six College graduates give courses in the College: special organic synthesis, molecular structure, computer science, eco-nomics, and OS UNIX.

The total amount of basic and optional courses is 30 and 25, respectively. The educational schedule of the HCC RAS is quite flexible and allows achieving an effective balance between study courses and research work. College students are free to build up their special courses schedule, so that they can start attending them from the first year and are obliged to take at least six during the period of education.

Research Work

One of the main concepts and exceptional advantages of the College is to let students begin their original research activities as early as possible. Special days for work in scientific laboratories are provided by the schedule from the very beginning of the study at the College, this work being a required subject. Every student can find a laboratory where he or she individually wants to work depending on areas of interest. This means that the students become trained researchers by the time of graduation, and this is particularly important for their further doctoral studies.

Many laboratories are eager to engage College students in their work. An effective online informational system has been developed for the College web site to give information on job opportunities. Many College students work under the direction of leading Russian scientists, such as Professors Mikhail Yu. Antipin, Yuri N. Belokon, Sema L. Ioffe, Vladimir B. Kazansky, Larissa A. Leites, Nina N. Makhova, Oleg M. Nefedov, Nikolay E. Nifantiev, William A. Smit, Vladimir A. Tartakovsky, Aslan Yu. Tsivadze, Sergei D. Varfolomeev and others.

Experimental work and regular laboratory research allow students after graduation from the HCC RAS to do original research using modern methods of experimental and theoretical chemistry and prepare results for international conferences and publication in leading chemical journals.

College Administration

The HCC RAS is governed by the Scientific Council and The Board of Trustees. The educational policy of the College is determined

by the Scientific Council, which consists of all the Faculty, the Dean, the Vice-Chairmen and is headed by the Chairman of the College. The Council meets several times a year and discusses principal aspects of College academic life. Furthermore, representatives of each group of students form a part of the Scientific Council. The Council takes into account students' opinions on various problems and this results in a more harmonized control and optimized balance of the educational process.

The Board of Trustees consists of the Chairman and the leading scientists of the Russian Academy of Sciences. Professor Roald Hoffmann (Cornell University, USA) and the Moscow Major Yuri M. Luzhkov have been honorary members of the Board of Trustees since the foundation of the College.

From the date of establishment, Higher Chemical College has been headed by Professor Oleg M. Nefedov, who contributed much to its foundation. The Vice-Chair persons are Professor Natalia P. Tarasova and Dr. Igor V. Svitanko, one of the founders of the College. Professor Dmitry A. Lemenovskii is the Vice-Chairman of the Scientific Council.

Life outside the College

For the majority of College students research work is the most vital part of life, but most of them do not forget about being socially active and do not put out of their minds other activities such as singing, writing lyrics, drawing, playing musical instruments, acting in drama clubs *etc.* Many College students are involved in extensive creative activities of the Moscow Chemical Lyceum, such as Vocals Studio, Drama Club and Orchestra. Several rock bands have been created by the College students; some of them give concerts in rock clubs.

Thus, students are not totally immersed in their scientific work but keep their minds wide open and this helps them to develop creativity and non-standard ways of thinking.

The Road Ahead

The unique experience of Higher Chemical College has appeared to be a success. Started as a bold experiment, it has become a prospering educational institution. Its statistics are impressive. Students of the HCC RAS get Soros' and Chembridge Corp. scholarships as well as Russian President, Russian Government and Moscow Major scholarships every year. A significant number of the winners of the All-Russian Mendeleev Conference of Student Research are College students. The average number of students' publications in the leading journals is over 70 annually, which is the highest ratio of the number of publications to the number of students among national educational institutions.

The great majority of the College graduates continue working in fundamental science in Russia, Europe and the USA. The overall number of graduates of the College, counting from the first graduation in 1996, is 270, and less than 3% of them are not continuing their scientific career. Over 130 graduates have already received Ph. D. degrees. For example, only at N. D. Zelinsky Institute of Organic Chemistry 26 College graduates have successfully obtained their Ph. D. degrees during the last seven years. At least 400 papers are published annually by those who study at the College or have already graduated (approximate data from Chemical Titles), many of these publications being highly (100–300) cited. Four golden medals of the Russian Academy of Sciences were awarded to HCC students and graduates.

Summer internships in European and American institutions are a common practice for College students, which allow them to be included in the international scientific activity. The Higher Chemical College students and graduates have had appointments

not only at home, but also in such prestigious universities and research centers as Oxford, Harvard, MIT, Stanford, Cornell, University of California-Berkeley, Scripps Research Institute and others, working under the leadership of Professors R. Hoffmann, R. Schrock, K. C. Nicolaou, H. Kagan, A. Bell, F. M. Menger, M. Frechet, G. Whitesides, M. Makosza and other famous scientists. A number of early College graduates already have their own

groups and are directing independent research being Assistant Professors at the institutes of the Russian Academy of Sciences and foreign Universities.

All these achievements give students unique opportunities to pursue their educational and research goals. Papers published in this issue represent some scientific areas of their current investigations.

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