



Committee for the Evaluation of Chemistry Study Programs

Weizmann Institute of Science

Feinberg Graduate School

Chemical Sciences

Evaluation Report

March 2012

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Chapter 1- Background

At its meeting on July 14, 2009, the Council for Higher Education (CHE) decided to evaluate the study programs in the field of Chemistry in higher education in Israel.

The initial steps by CHE included the formulation of a self-evaluation study for each participating institution and the appointment of an evaluation committee consisting of:

- Professor Richard Eisenberg, Department of Chemistry, University of Rochester, Rochester, NY
- Professor Allen J. Bard, Department of Chemistry, University of Texas, Austin, TX¹
- Professor Tobin J. Marks, Department of Chemistry, Northwestern University, Evanston, IL
- Professor William L. Jorgensen, Department of Chemistry, Yale University, New Haven, CT
- Professor Joan S. Valentine, Department of Chemistry, University of California - Los Angeles, Los Angeles, CA
- Professor David Milstein, Weizmann Institute of Science, Rehovoth²

Each of the committee members is a research active chemistry faculty member with broad disciplinary experience. Each non-Israeli member is a member of the U.S. National Academy of Sciences and is fully involved in all aspects of chemistry programs at the graduate and undergraduate levels.

The committee was assisted in its efforts by Ms. Alisa Elon, Coordinator of the committee on behalf of the Council for Higher Education.

Within the framework of its activity, the Committee was requested to submit the following documents to CHE:

1. A final report on each of the evaluated departments,
2. A general report on the state of the discipline in the Israeli higher education system, including recommendations to the CHE for standards and potential state-wide changes in the evaluated field of study.

The Committee's letter of appointment is attached as **Appendix 1**.

The process was conducted in accordance with the CHE's Guidelines for Self-Evaluation (of October 2009).

¹ Prof. Prof. Allen J. Bard was not able to participate in the visit to Feinberg Graduate School of the Weizmann Institute of Science for personal reasons.

² In accordance with the CHE's policy, Prof. David Milstein did not participate in the evaluation of chemical sciences studies at the FGS to prevent the appearance of a conflict of interests.

Chapter 2- Committee Procedures

The Committee held its first meetings on June 12, 2011 during which it discussed fundamental issues concerning higher education in Israel, the quality assessment activity, as well as Chemistry study programs.

In June 2011, the Committee held its first round of visits and went to Ben-Gurion University of the Negev, Bar-Ilan University, and the Weizmann Institute of Science. The second round of visits was carried out in December 2011 with site visits to the Hebrew University, the Open University, the Ariel University Center of Samaria, the Technion Israel Institute of Technology, and Tel Aviv University.

This report deals with the evaluation of chemical science studies at the Feinberg Graduate School (FGS).

In the preparation of this report, the Committee met with members of the Faculty of Chemistry at both junior and senior levels, students at the masters and doctoral levels, and administrators of the Feinberg School. The analysis given below reflects the results of those meetings coupled with the information provided by FGS-WIS in its self-evaluation study.

The Committee's visit to the Feinberg Graduate School took place on June 19, 2011. The Committee thanks the management of the Feinberg Graduate School for their self-evaluation report and for their hospitality towards the Committee during its visit at the institution.

The schedule of the visit is attached as **Appendix 2**.

Chapter 3-Executive Summary

The Faculty of Chemistry is one of 6 major subdivisions of the Weizmann Institute of Science. There are 58 members of the faculty, who have primary affiliations with 5 constituent Departments, namely, Chemical Physics, Materials & Interfaces, Structural Biology, Organic Chemistry, and Environmental Sciences & Energy Research. There is also a large Department of Chemical Research Support, which employs 42 people including 26 Ph. D. level scientists. The broad defining arc of chemistry at WIS is a genuine strength and allows the faculty of Chemistry to tackle problems of great societal importance as well as of fundamental interest. These include new materials in a resource-limited world, energy for sustainable development and biological imaging to name just a few. However, the breadth of chemistry's arc at WIS also raises particular challenges that should be addressed in the teaching and mentoring of students at the FGS in the Research School of Chemistry as discussed below.

Specific Committee recommendations include:

- Efforts to engage undergraduate and high school students in chemistry at WIS are excellent and should be expanded as capacity and resources permit.
- WIS "primer" courses to bring graduate students with diverse backgrounds up to speed in modern chemical concepts such as in organic chemistry or chemical aspects of quantum mechanics should be offered.
- When possible, students should be encouraged to the "Direct to Ph.D." track to decrease overall time that would be spent in graduate studies.
- Expand international outreach/visiting student programs to recruit outstanding graduate students to the WIS.
- Increase efforts in faculty recruiting to include contact with a wider pool of international applicants.
- Target a possible hire in synthetic organic chemistry including complex-molecule synthesis because of its importance to pharmaceutical companies and its relatively low profile in the faculty as of June 2011.
- Major multi-P.I. research initiatives should build on key institutional strengths such as renewable energy.
- Planning for succession in research areas where WIS faculty members are expected to retire or leave should begin now.

Chapter 4: Evaluation of Chemical Science studies at the Feinberg Graduate School

- *This Report relates to the situation current at the time of the visit to the institution, and does not take account of any subsequent changes. The Report records the conclusions reached by the Evaluation Committee based on the documentation provided by the institution, information gained through interviews, discussion and observation as well as other information available to the Committee.*

Background

The Weizmann Institute of Science (WIS) is unique among the institutions and programs that this committee has been charged with evaluating. The WIS is an internationally known and respected center of basic research in all areas of science. Its primary mission in chemistry is to learn, study and analyze new systems, concepts and phenomena in science that relate broadly to chemistry and molecular science. It embraces the notion that chemistry is "the central science" and has structured its Faculty of Chemistry to reflect this philosophy. It thus goes beyond traditional Chemistry Faculties in the breadth of its academic interests and the organization of its faculty and students into specific departments.

As a research institute, WIS recognizes the close relationship between research and education, particularly at the graduate and advanced levels. As such, the Feinberg Graduate School was founded in 1958 as the educational arm of the Institute to oversee graduate education. In contrast with other programs the Committee has been asked to assess, WIS does not have a specific mission in teaching chemistry to substantial undergraduate populations, although it does recognize the importance of attracting talented young students at the secondary and undergraduate levels to science.

A concern of the Committee in the assessment of the WIS Feinberg School and Faculty of Chemistry was the perceived absence of broad faculty participation in the preparation of the self-assessment. The Committee has found that the process of self-evaluation can be revealing and instructive to all who participate in it. The possible absence of broad-based participation in the self-evaluation has thus limited the benefit that such a process can yield.

Undergraduate Student Activities

WIS has no formal undergraduate degree program in Chemistry, but significant numbers of undergraduates are involved in various programs of the Institute. The programs serve as both recruiting tools for identifying and attracting talented graduate students, and as outreach to scientific and non-scientific communities, both within Israel and beyond. For Israeli undergraduates, there is a "junior scholars" program which attracts talented local students to spend one day per week carrying out research in WIS faculty members' groups, and also a "summer camp" program in which undergraduates live on campus and carry out research. The WIS also has an extensive "visiting student" program in which qualified foreign students can spend periods from one month to one year on campus carrying out research and/or taking courses. The undergraduate component of this program hosts up to 30 foreign undergraduates annually. The Committee views these programs very favorably as a way to strengthen the WIS graduate program in Chemistry as well as to enhance the visibility, stature, and welcoming image of the institution globally.

Recommendations

- **All of the the programs mentioned above are excellent and should be expanded as capacity and resources permit.**

Graduate Program

The graduate program in Chemistry at the WIS is very strong and commensurate in scope with the impressive multi-disciplinarity of the program in that it attracts outstanding students with very diverse backgrounds. Indeed, the Committee was told that approximately 40% of the entering graduate students do not have undergraduate chemistry degrees. Instead, their degrees are in other disciplines that intersect with research activities in the Faculty of Chemistry. The program consists of both: 1) sequential M.Sc. then Ph.D., or 2) direct Ph.D. track options. In both programs, incoming graduate students must spend three 10-week rotations in the groups of three different faculty members. All rotations cannot be in the same department. This program helps orient the new students to the research opportunities and also helps in evaluating the new students. It was rated very highly by the students the Committee met.

The instructional program for WIS graduate students in chemistry is uniquely designed for the very special type of students that are admitted to this outstanding program, and all lectures are given in English. Emphasis is placed on close, individual mentoring of students and helping them acquire the skills needed to teach themselves the knowledge and research tools they need. This approach is very suitable for most of the highly motivated and outstanding students in the program. Although some students expressed a desire for more basic graduate courses to be taught by WIS staff, the Committee believes that it is only relatively small number of basic graduate courses in certain targeted areas is needed to prepare the students for the more advanced graduate courses. One example of a successful course of this kind is the NMR primer course, which could be used as a model.

There is a special challenge in the case of the M.Sc. students admitted to the program who do not have bachelor degrees in chemistry or biochemistry. The Committee feels that these students should not be forced to go outside the Feinberg Graduate School for basic undergraduate courses because it would be an inefficient use of their time and would take them away from their rotation activities, which are an important part of the first-year educational program. These students should instead be provided with highly condensed "primer" courses in chemistry for non-chemists during the first semester of their graduate programs. One "primer" course that should be considered for the first semester would be an intensive mathematics and quantum chemistry refresher to prepare physical chemistry and chemical physics students for advanced courses.

A general recommendation that the Committee deems very important for the entire graduate instructional program is a requirement that the assumed prerequisites for each course be stated in advance, not to act as a barrier to students registering for a particular course but to let students know that they might be well-advised to take one of these primer courses before attempting it, if they do not have the background recommended for the course. The graduate program would also be enhanced with a program in which very distinguished speakers are invited to the WIS on a regular basis to speak to a general chemistry audience about their research and where attendance at these lectures is required of all graduate students in chemistry.

A major concern for the WIS is that the number of qualified M.Sc. candidates in chemistry is decreasing. This is a nationwide trend and also true in Europe. The WIS traditionally has in the past been relatively unaffected by such trends because of its outstanding reputation. However, the combination of the diminishing number of chemistry graduate school candidates nationwide, the lack of its own undergraduate program from which to attract graduate students, and the growing quality of graduate programs at competing universities in Israel, will require the WIS to be much more proactive in advertising its program, both within Israel and abroad. There are several impressive programs to expose high school students and undergraduates at other institutions both in Israel and abroad to the Weizmann educational and research experience. These are no doubt effective in graduate recruiting. More publicity is needed internationally to inform top students in other countries that they can apply to the Weizmann for study and that instruction is in English.

The Committee has advocated in the General Report that graduate students follow the Direct to Ph.D. track rather than the separate M.Sc. program followed by the Ph.D. program to reduce the overall time to the Ph.D. degree from the first degree in chemistry. The same view is recommended for WIS but because of the different backgrounds and preparations of entering graduate students, this may be more difficult. Students with non-chemistry B.Sc. degrees will need to take more foundational courses in chemistry.

Recommendations

- **FGS-WIS “primer” courses to bring graduate students with diverse backgrounds up to speed in modern chemical concepts such as in organic chemistry or chemical aspects of quantum mechanics should be offered.**
- **Distinguished visiting lecturer programs should be implemented.**
- **Expanded international outreach/visiting student programs to recruit outstanding graduate students to the WIS and its FGS should be undertaken.**

Faculty

The Faculty of Chemistry has broader research coverage than traditional Departments of Chemistry with greater representation than normal in structural biology, materials science, and environmental science. Structural biology is often centered in departments of biochemistry or molecular biology, while the latter topics have considerable overlap with activities in schools of engineering.

All members of the faculty are active in research and many are highly productive, distinguished scientists. Classroom teaching is not compulsory; however, the faculty members recognize that it is an essential element of a complete graduate education and they provide many offerings at the graduate-level. About half of the faculty members teach one course in a given year.

The Dean of the Faculty of Chemistry has considerable latitude in deciding when it is appropriate to add new faculty members. New appointments are normally at the level of non-tenured Senior Scientist. Promotion to tenure needs to occur within 5 years of joining the faculty, though extensions are possible including an automatic extension of 1 year for female faculty members who give birth. Set-up funding for new faculty members is superb with typical levels of \$1-2 M for equipment and an additional \$300K for support of co-workers. There is also much institutional support for graduate students, which allows new faculty members to build rapidly their research groups. Overall, new faculty members are extremely well positioned for success; they also recognize and appreciate their good fortune.

Finally, casting a broader net for faculty recruiting is advisable. Currently, the approach is largely ad hoc and confined to Israeli Ph.D.'s who apply after a postdoctoral experience. Announcement of faculty openings in international journals such as *Science* and *Nature* should be considered along with notification of distinguished scientists in the field, who may have current or former co-workers to recommend. All aspects of the scientific environment at the Weizmann Institute are competitive with those at the most distinguished institutions worldwide. Therefore, efforts to recruit the best faculty available should be done.

Recommendations

- **Increase efforts in faculty recruiting to include contact with a wider pool of international applicants**
- **Target a possible hire in synthetic organic chemistry including complex-molecule synthesis because of its importance to pharmaceutical companies and its relatively low profile in the faculty as of June 2011.**

Research

As noted above, the WIS is an extraordinary research institute that is world-renowned. The Faculty of Chemistry has defined the discipline in especially broad terms that allow its faculty and students to tackle many cutting-edge problems not easily defined or addressed under a more traditional definition of the discipline of chemistry. The research at WIS has strong interdisciplinary character that is viewed as one of its great strengths. Recent research initiatives include appointments and programs in earth and planetary sciences, nanoscience/nanotechnology, and organic materials. Major constraints on the quantity and quality of WIS research possible were identified by the faculty as the small size of government research grants, the quantity of specialized space available to research groups (e.g., cleanrooms), the need for nanofabrication equipment, and the availability of qualified graduate students. The space and nanofabrication issues have been addressed by the WIS, as will be discussed below. One area that is projected to play a more important role in research at the WIS is that of renewable energy.

One of the challenges of the Faculty of Chemistry at the WIS as it moves forward in time is, "How does the Faculty evolve?" What areas are emphasized, what areas are not? It is important for great institutions to work on important or profound problems, and from the perspective of the Feinberg Graduate School, it a great graduate program should expose its students to such research. That is currently being done. However, leadership faculty will retire and scientific evolution of a discipline will take place. One often sees that faculty evolve through the chemistry that new hires choose to conduct. If so, then it is important to recruit world-class faculty with as wide a net as possible as mentioned above. One specific research area of importance is synthetic organic chemistry including complex-molecule synthesis. Another appropriate area is biomolecular modeling, which would complement the strengths in structural biology.

As the interests of the faculty diverge in this evolutionary process, it is also important for the faculty to remember the molecular perspective that is the foundation of chemistry and to reinforce the common connections between increasingly diverse research programs.

Recommendations

- **Major multi-P.I. research initiatives should build on key institutional strengths such as renewable energy.**
- **Planning for succession in research areas where WIS faculty members are expected to retire or leave should begin now.**

Resources and Facilities

The WIS has superb resources in terms of funds for faculty start-up packages, student fellowships, the acquisition, maintenance, and upgrading of instruments, and the maintenance and enhancement of research infrastructure. Equipment and instrumentation for magnetic resonance research, mass spectrometry, x-ray diffraction, electron microscopy, etc. are impressive, and the facilities in which the equipment is housed, are well staffed with highly competent personnel. Short courses are provided to instruct students on the principles and operation of the various instruments. The announcement of the construction of a nanofabrication facility with a clean room will satisfy needs in this area and make the WIS more competitive with other Israeli institutions in the nanoscience/nanotechnology field. This facility will be supervised by a staff scientist. In addition, the new building will house other shared instrumentation and will connect the Kimmelman and Perlman Buildings in an environmentally appealing way.

Signed by:



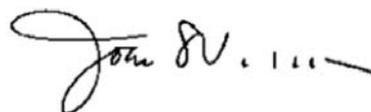
Prof. Richard Eisenberg
Committee Chair



Prof. Tobin J. Marks



Prof. William L. Jorgensen



Prof. Joan S. Valentine

Appendices

Appendix 1- Copy of Letter of Appointment

March, 2011

Prof. Rich Eisenberg
 Department of Chemistry
 University of Rochester
 USA

שר החינוך
Minister of Education
 وزير التربية والتعليم

Dear Professor Eisenberg,

The State of Israel undertook an ambitious project when the Israeli Council for Higher Education (CHE) established a quality assessment and assurance system for Israeli higher education. Its stated goals are: to enhance and ensure the quality of academic studies; to provide the public with information regarding the quality of study programs in institutions of higher education throughout Israel; and to ensure the continued integration of the Israeli system of higher education in the international academic arena. Involvement of world-renowned academicians in this process is essential.

This most important initiative reaches out to scientists in the international arena in a national effort to meet the critical challenges that confront the Israeli higher educational system today. The formulation of international evaluation committees represents an opportunity to express our common sense of concern and to assess the current and future status of education in the 21st century and beyond. It also establishes a structure for an ongoing consultative process among scientists around the globe on common academic dilemmas and prospects.

I therefore deeply appreciate your willingness to join us in this crucial endeavor.

It is with great pleasure that I hereby appoint you to serve as the chair of the Council for Higher Education's Committee for the Evaluation of Chemistry Studies.

The composition of the Committee will be as follows: Prof. Rich Eisenberg (Chair), Prof. Allen Bard, Prof. William Jorgensen, Prof. Tobin Marks, Prof. David Milstein and Prof. Joan Valentine.

Ms. Alisa Elon will coordinate the Committee's activities.

In your capacity as the chair of the Evaluation Committee, you will be requested to function in accordance with the enclosed appendix.

I wish you much success in your role as chair of this most important committee.

Sincerely,


 Gideon Sa'ar
 Minister of Education,
 Chairperson, The Council for Higher Education

Enclosures: Appendix to the Appointment Letter of Evaluation Committees

cc: Ms. Michal Neumann, The Quality Assessment Division
 Ms. Alisa Elon, Committee Coordinator

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כתובת אתר ממשל זמין: <http://gov.il>

כתובת אתר המשרד: <http://www.education.gov.il>

Appendix 2- Site Visit Schedule

09:00-09:30	Dean of the Feinberg Graduate School and the Director of the Feinberg Graduate School	Prof. Lia Addadi Dr. Ami Shalit
09:30-10:00	Dean of the Chemistry Faculty	Prof. Yehiam Prior
10:00-10:30	Chair of the Board of Studies in Chemistry	Prof. Nir Gov
10:30-11:30	Meeting with senior academic faculty	Prof. Debbie Fass Prof. Daniella Goldfarb Prof. Ernesto Joselevich Prof. Abraham Minsky Prof. Samuel Safran Prof. Milko Van Der Boom Dr. Ilan Koren Dr. Didi Margulis Dr. Boris Rybtchinski Dr. Oren Tal
11:30-12:00	Meeting with adjuncts	Prof. Yitzhak Mastai Prof. Abraham Nudelman Dr. Warren Wiscombe
12:00-12:45	Meeting with M.Sc. students (first and second year)	
12:45-13:30	Lunch with alumni	
13:30-15:00	Tour of the Chemistry Faculty	
15:00-15:45	Meeting with PhD students	
15:45-16:30	Closed-door working meeting of the evaluation committee	
16:30-17:15	Summation meeting with the Dean of the Feinberg Graduate School, Director of the Feinberg Graduate School, Dean of the Chemistry Faculty and Chair of the Board of Studies in Chemistry	Prof. Lia Addadi Prof. Yehiam Prior Prof. Nir Gov Dr. Ami Shalit