



**Committee for the Evaluation of
Biotechnology & Biotechnology Engineering Study Programs**

Technion Israel Institute of Technology

Faculty of Biotechnology and Food Engineering

Evaluation Report

April 2013

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Chapter 1: General Background

At its meeting on July 25, 2010, the Council for Higher Education (CHE) decided to evaluate study programs in the field of Biotechnology and Biotechnology Engineering during the academic year 2012.

Following the decision of the CHE, the Minister of Education, who serves ex officio as Chairperson of the CHE, appointed a Committee consisting of:

- Prof. Moshe Rosenberg, Department of Food Science & Technology, UC Davis, USA, Committee Chair¹
- Prof. Gad Galili, Department of Plant Sciences, Weizmann Institute of Science, Israel
- Prof. Milica Radisic, Institute of Biomaterials and Biomedical Engineering, Department of Chemical Engineering and Applied Chemistry, University of Toronto, Canada²
- Prof. Joseph Shiloach, Biotechnology Core Lab, NIH- National Institutes of Health, USA

- *Ms. Yael Elbocher* - Coordinator of the Committee on behalf of the CHE.

Within the framework of its activity, the Committee was requested to:³

1. Examine the self-evaluation reports, submitted by the institutions that provide study programs in Nutritional Sciences, and to conduct on-site visits at those institutions.
2. Submit to CHE an individual report on each of the evaluated academic units and study programs, including the Committee's findings and recommendations.
3. Submit to the CHE a general report regarding the examined field of study within the Israeli system of higher education including recommendations for standards in the evaluated field of study.

The entire process was conducted in accordance with the CHE's Guidelines for Self-Evaluation (of October 2010).

Chapter 2: Committee Procedures

¹ During the first round of visits Prof. Carl Batt of Cornell University was Committee Chair. During the period between the two rounds of visits Prof. Batt resigned due to incomparable disagreements

² Prof Radisic joined the committee for its second round of visits, thus did not take part in the evaluation of Tel Hai College, ORT Braude College and The Hebrew University of Jerusalem

³ The Committee's letter of appointment is attached as **Appendix 1**.

The Committee held its first meetings on March 14, 2012, during which it discussed fundamental issues concerning higher education in Israel, the quality assessment activity, as well as Biotechnology and Biotechnology Engineering Study programs.

In March 2012, the Committee held its first round of visits of evaluation, and visited Tel Hai College, ORT Braude College and the Hebrew University of Jerusalem. In June 2012 the Committee conducted its second evaluation cycle, and visited Ben-Gurion University of the Negev, Hadassah Academic College Jerusalem, Tel Aviv University and The Technion. During the visits, the Committee met with various stakeholders at the institutions, including management, faculty, staff, and students.

This report deals with the Department of Biotechnology and food engineering of the Technion which took place on June 19 and 20, 2012.

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

The Committee thanks the management of the Technion and the Faculty of Biotechnology and Food Engineering for their self-evaluation report and for their hospitality towards the Committee during its visit at the institution.

Chapter 3: Evaluation of Faculty of Biotechnology and Food Engineering at the Technion

** 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.*

3.1 Executive Summary

The faculty Biotechnology and Food Engineering (BTFE) at the Technion has undergone a major evolution during the recent two decades, from a department that was focused mainly on food engineering and technology to a department with a major focus directed at biotechnology engineering and, to a lesser extent on food engineering. The Faculty awards a single combined B.Sc. degree in Biotechnology and Food Engineering, with specialization in two engineering tracks: food and/or biotechnology. The faculty of BTFE has a well developed graduate study program towards Master and Doctorate degrees. During the evaluated years (2006-2011) the number of undergraduate students enrolled in the program ranged from 217 to 320 and the number of graduate students ranged from 71 to 90. The curriculum of the undergraduate study program is aimed at providing its graduates with the theoretical knowledge and practical skills that are needed in order for them to successfully assume positions in the respective industries, or to pursue studies towards higher degrees. Although, in general, the curriculum is rigorous and its academic level is high, it requires some adjustments. The proportion of engineering courses in the curriculum has to be increased and the extent to which concepts pertaining to food- science, technology and engineering are being addressed by the curriculum has to be enhanced. The academic staff of the Faculty is of very high caliber and its competitiveness and productivity is impressive. In general, the research that is carried out by the faculty members and their students is of high quality, competitive and relevant, however, some adjustments, aimed at attaining a balance between the different constituent research directions are recommended. Specifically, the extent to which the research program addresses food-related issues has to be increased and more research effort has to be directed at addressing engineering and technology aspects of both biotechnology- and food science-related issues. Faculty members have demonstrated a high level of success in securing research funds, both nationally and internationally. Results of research that has been conducted at the Faculty are well published in reputable peer-reviewed journals. Both the undergraduate and graduate study programs attract students with a competitive

academic record and high potential. The graduate study program of the Faculty is highly competitive and rigorous. Research that is conducted by the graduate students is hypothesis-driven and of high quality. The teaching and research infrastructure is modern and provides the faculty with the means that are required to maintain its competitive edge, in both teaching and research.

In conclusion, the committee holds the opinion that the Faculty of Biotechnology and Food Engineering at the Technion has developed study and research programs that are effective in meeting the training and innovative objectives and needs of modern biotechnology and food engineering in Israel.

The committee has identified several curricular, personnel and infrastructural needs and deficiencies that should be addressed, and has provided throughout this report, specific recommendations detailing the way these needs have to be met. Some of the committee's major recommendations are listed below.

Recommendations:

- Establish an effective Industry Advisory Board to the BTFE program.
- Enhance the engineering and technology components of the teaching and research elements of the program as well as better adjust the balance between food engineering and biotechnology engineering. Lower the proportion of electives in the curriculum.
- Make the 4th year undergraduate research project a compulsory requirement in both study tracks.
- Offer an upper division compulsory course where the student's skills to integrate knowledge derived from the exact sciences, engineering/technology and from biological/chemical sciences are challenged.
- Introduce and implement the concept of Learning Outcome Assessment as the main tool for assessing the learning outcomes of all of the courses and learning experiences that are offered by the study programs.

3.2 Background

The cornerstone for the Technion was laid on Mt. Carmel in 1912; it officially opened its doors in 1924 and was recognized by the Council for Higher Education in 1962. The Technion has two campuses: the Neve Sha'anani campus, where most of the academic and administrative departments are located, and the Bat Galim campus, where the Faculty of Medicine is located. The Technion consists of 18 academic units, which are divided into 16 faculties and 2 departments. In the academic year of 2010/2011, 9,009 undergraduate students, 2,906 Master degree students and 934 doctorate students were enrolled in the Technion.

A Division of Food Engineering and Biotechnology was established in 1954, as a unit within the Department of Chemical Engineering; this unit became an independent Department in 1967 and then, in 1992, it became a Faculty. During the last two decades this Faculty has increasingly become more focused on the field of biotechnology; a biotechnology engineering study track has been established and in 2004 the name of the Faculty was changed to the Faculty of Biotechnology and Food Engineering (BTFE), reflecting its major emphasis on biotechnology. The Faculty awards a single combined B.Sc. degree in Biotechnology and Food Engineering, with specialization in two engineering tracks: food and/or biotechnology. The faculty of BTFE has a well developed graduate study program towards Master and Doctorate degrees. During the evaluated years (2006-2011) the number of undergraduate students enrolled in the program ranged from 217 to 320 and the number of graduate students ranged from 71 to 90.

3.3 Mission, Goals and Aims

The Biotechnology and Food Engineering Program (BTfEP) represents a unique integration of two major interdisciplinary fields: food engineering (FE) and biotechnology engineering (BTE). The mission statement of the BTfEP has clear objectives and the program operates according to a 5-year strategic plan. The main focus of the BTfEP has shifted during the recent 2 decades, from Food Engineering to Biotechnology and Biotechnology Engineering. This process was paralleled by the retirement of all the faculty members with research and teaching programs directed at food engineering/technology and the recruitment of faculty

members with research/teaching programs directed more at the biological/chemical sciences. As could have been anticipated, this evolution has introduced a certain imbalance in the extent to which the constituent disciplines are addressed by a program. Specifically, the committee holds the opinion that the balance between Engineering/technology and biological sciences is significantly in favor of the latter and that the balance between food engineering and biotechnology engineering is in favor of the latter. This imbalance is reflected in the program's teaching, research and outreach activities and is of a concern to the committee.

The committee was informed during its visit to the BTFEP that the program had become aware of this challenge and that it is looking forward to recruit a new faculty member with strong interest in food engineering. The committee welcomes this decision yet holds the opinion that more has to be done.

The program has developed strong relationships with its target cliental in the Israeli Industry, however, it does not have an Industry Advisory Board (IAB). The committee believes that the program can benefit immensely from establishing and interacting on a regular basis, with an effective and committed IAB. A dedicated IAB can provide the BTFEP with comprehensive feedback about the program's adequacy and can partner with the program in shaping its scope, relevance and growth. The IAB can also assist the program in assessing and enhancing its success in meeting current and future needs of the Food and Biotechnology Industries in Israel. The equal representation of both target industries in the IAB is critically important and it could be helpful to interact with this board on two levels:

- A combined IAB, consisting of equal representation of the food and biotechnology industries.
- Two "sub-boards", each consisting of the IBA members of one of the constituent industries.

It has to be noted that such boards are common at similar programs in Northern America and have been proven to be a powerful and effective means that allow establishing meaningful dialogues with stakeholders.

Recommendations:

Intermediate (full implementation within 2-4 years)

- Establish an effective Industry Advisory Board to the BTFE program.
- Establish a fine balance between the constituent disciplines by enhancing the engineering and technology components of the teaching and research elements of the program; better adjust the balance between food engineering and biotechnology engineering. This effort has to become a top priority objective and an action item of the program's strategic plan.

3.4 The Study Program

3.4.1 The B.Sc. program

During recent years, the study program has undergone major modifications that reflect the increased emphasis on biotechnology, as well as the decision to develop a single study program where both Food Engineering and Biotechnology Engineering are properly addressed.

The 4-year B.Sc. program is designed to educate and train its students to successfully assume professional positions in the food and biotechnology industries and to also prepare its graduate to pursue studies towards graduate degrees. The BTFE B.Sc. study program has thus to provide its graduates with the theoretical background, applicable knowledge and practical skills that are needed in order for them to pursue either directions. Successful graduation of the program requires completion of 160.5 credit points (CP).

In general, the curriculum is rigorous, its academic level is competitive and it is aimed at educating and training the students to succeed either in the industry or in pursuing graduate studies. The curriculum includes sufficient study elements where critical thinking skills of students are being developed and the committee commends the program for addressing this critical aspect of the learning process.

The current curriculum of the undergraduate study program reflects the aforementioned evolution that the faculty of BTFE has gone through during the last 2 decades. This evolution has had its inherent "pendulum effect" that has resulted in some imbalances and challenges in the curriculum. More specifically, the extent to which engineering concepts (both general and discipline-specific) and topics related to food technology are addressed in the curriculum falls short of what is required in a well balanced curriculum. The undergradu-

ate study program offers two tracks, Food Engineering (FE) and Biotechnology Engineering (BTE), however all of the core courses (Math., Chem., etc) and the majority of the compulsory courses that are offered by the BTFEP are common to both study tracks. The structure of the curriculum and its specific course paths requirements lead to a degree that can almost be considered a double major.

The committee is pleased with the current effort that is made by the Faculty to re-design and enhance the way engineering and technological concepts that are relevant to both BT and FE are instructed. The introduction of a 3-course series addressing fluid mechanics, mass transport and heat transfer and the intended course in Food Technology are likely to strengthen the program, however, additional courses addressing topics in food technology are needed. The extent to which the curriculum introduces engineering and technology-related aspects of both biotechnology and food science has to be enhanced.

Both the structure and content of the curriculum have to be addressed while taking into account two important facts: 1) 44% of those graduating the B.Sc. program pursue careers in the food and biotechnology industries. 2) Almost 60% of this group of graduates find jobs as food engineers, while only 7% become employed by the biotechnology industry and 12% find positions in the Pharma industry. About 45% of the graduates pursue higher degrees in biotechnology and life sciences. This, in addition to information conveyed to the committee during its visit to the BTFEP, indicate that: a) the food industry in Israel has a need for highly trained food engineers, and b) employment opportunities in the biotechnology and related industries require, in most cases, a graduate degree (M.Sc. and more likely, Ph.D.). The curriculum of the program has to be adjusted to better reflect these facts, in a well balanced manner. Effort has to be made to ensure that the curriculum addresses in a well balanced manner the array of constituent disciplines and concepts pertinent to Biotechnology Engineering and Food Engineering.

The committee holds the opinion that the curriculum of the undergraduate study program has to be focused on the main objective of the program, namely, educating and training engineers. The engineering-related courses included in the curriculum account for about 20 CP, which is significantly less than what is commonly included in similar programs at leading universities worldwide. The committee believes that, especially in the case of Biotechnology

Engineering, students can be encouraged to enroll in specific courses that are being offered by other faculties, such as the faculty of Chemical Engineering. If needed, the latter has the potential to assist the faculty in addressing some of the recommended curricular adjustments.

Elective courses account for 39 CP or almost 25% of the total CP of the curriculum. Providing students with opportunities to explore new horizons, through elective courses, is important, however, the proportion of CP allocated to electives has to be carefully assessed in light of curricular needs, and in relation to the total number of CP that has to be allocated to core and compulsory courses. The committee has identified an excessive degree of content redundancy among the elective courses (that are listed in the catalogue) and it seems that many of these courses are not offered regularly.

Both FE and BTE are interdisciplinary in nature and developing a study program that integrates both disciplines is thus very challenging. Among the critical skills that students in such a program need to acquire, is the ability to effectively and creatively integrate knowledge. An advanced course addressing this need is not included in the curriculum.

Communication skills of students in both writing and oral presentation have to be developed. The committee is satisfied with the extent to which students are trained in preparing and delivering oral presentations, however, a course aimed at developing the technical writing skills, in both Hebrew and English, is missing from the curriculum.

Ethical issues are of critical importance to the field of biotechnology, yet they are not addressed by the curriculum. The committee has identified the latter as a deficiency.

The FE study track offers a research or a design project and the committee perceives this element of the curriculum as strength. Reviewing a selection of recent final research reports (mini-theses) has indicated that in all cases a very well defined and planned research was carried out and that the experimental results are discussed in depth. The quality of both the research and the reports is very high and clearly indicates the high caliber of the students and their mentors. The committee congratulates the program for having such highly motivated and well trained students. The committee holds the opinion that the final research (or design) project should become a compulsory requirement in both study tracks.

The committee recognizes that its recommendation about the research/design project may present an “extra instruction load” placed on faculty members and thus would like to recommend that:

1) Along with projects that are intended to be carried out by one student, projects that can be conducted effectively by groups of two or three students, without compromising the individual learning and skills-building experience, will be considered.

2) Ph.D. students, in their last two years of research, can mentor and supervise (under the guidance of faculty members) undergraduate students engaged in the Research/Design project. The latter will provide Ph.D. students with an extremely valuable opportunity to be trained as mentors/instructors while offering the Faculty a means to better manage the mentoring load associated with the Research/Design Project.

Current and former students of the program highlighted the importance of having a summer internship in the industry and the committee supports this notion.

The undergraduate study program of the faculty of BTFE offers students of its 4-year engineering program an additional B.Sc. (a three year program) in either Biology or Chemistry. This combination represents a potential strength, especially for the Biotechnology Engineering study track, however, over the recent 5 years enrollment to the Chemistry track was very marginal (1-2 students per year) and there was no enrollment to the Biology study track. Although not a top priority, the program may want to re-evaluate the importance and merits of offering these opportunities.

Recommendations:

Intermediate (full implementation within 2-4 years)

- Develop more opportunities for students to have a summer internship (for credit) in the industry.
- Eliminate content redundancy among courses and list only those elective courses that are offered at least every other year.

- Increase the proportion of engineering-related courses in the curriculum.
- Lower the proportion of CP allocated to elective courses to accommodate needs for additional compulsory and laboratory courses.
- Include a research or design project as a compulsory requirement in both study tracks.
- Instruct a course in “Ethics in Biotechnology”.
- Instruct, during the first year of studies, a compulsory course in technical writing in both English and Hebrew.
- Develop and introduce (to both study tracks) an upper division compulsory course where the student’s skills to integrate knowledge derived from the exact sciences, engineering/technology and from biological/chemical sciences are challenged.

3.4.2 The Graduate studies program – M.Sc., M.E and Ph.D.

The graduate study program is very well developed and attracts excellent students. The number of graduate students in the program ranged, during the evaluated years (2007-2011), from 62 to 78 and the ratio of M.Sc.-to-Ph.D. students was about 1:1, reflecting the Technion’s policy in promoting recruitment of direct Ph.D. over M.Sc. students. Both admission and graduation rates from the program are adequate and the ratio of FTE to graduate students (about 1:5) is acceptable and appropriate.

The academic level of the students in the program is high and reflects the competitiveness of the program. In addition to offering M.Sc. degree the program also offers training towards a M.E degree, a Master without thesis. In both M.Sc. and Ph.D. the emphasis is placed on the research part of the training while the course requirements are aimed (especially in the M.Sc. program) at closing specific knowledge gaps. The M.E program consists only of coursework and no research element is included in the curriculum.

The quality of both M.Sc. and P.h.D. theses is high and the research addresses current and relevant topics and knowledge challenges. Reflecting the research interest of the faculty members, the graduate studies research has been mainly focused on biotechnology-related topics such as: microbiology, enzymology/biocatalysis, drugs and nutrient encapsulation & delivery systems, and on some aspects of food safety. In most cases, research has been

directed more at the biological/chemical sciences than at the engineering/technology concepts. The committee holds the opinion that the research theses are of high quality and represent the competitive edge and great success of the program, however, the committee is concerned that engineering and technology topics related to Food engineering and Biotechnology engineering are addressed only to a very limited extent.

Recommendation:

Intermediate (full implementation within 3-4 years)

- Expand and develop the research program to include true cutting edge engineering and technology-related research directions.

3.5 Teaching & Learning Outcomes

In general, the quality of teaching in courses offered by the BTFE program is high and a consistent effort is being made to maintain both breadth and depth of teaching. The satisfaction of students with the quality of instruction is assessed and monitored regularly and, in most cases, students are satisfied with both course content and instructors. The committee congratulates the program on having very capable and dedicated academic staff. During its visit, the committee has become aware of some challenges related to the quality of teaching in some Chemistry courses, instructed by faculty members of the faculty of chemistry. The committee urges the leadership of the BTFEP to address these difficulties.

The extent to which information and teaching technology tools are utilized by the program is adequate and clearly enhances the quality of teaching and training. The committee applauds the program for integrating into many of its courses learning modules that are aimed at developing and enhancing not only the knowledge level of its students but also their critical thinking, team work, interdisciplinary interactions and creativity. The committee recognizes this aspect of the program as a unique strength.

Currently, the learning outcomes at the BTFEP are being assessed based on student's grade. In recent years it has been recognized that grades alone cannot serve as effective tools in assessing learning outcomes. Institutions of higher education in the Northern America and

Europe have recognized that a full commitment to teaching and learning must be based on assessing and documenting what and how much students are learning and on using this information to improve the educational experiences. A detailed concept of Learning Outcome Assessment has been developed and implemented in numerous academic programs. This concept allows defining desired learning outcomes (for each course) and quantifying the success with which these outcomes have been acquired by students. This approach has not been yet introduced to the BTFEP.

Recommendation:

Intermediate (full implementation within 3-4 years)

- Introduce and implement the concept of Learning Outcome Assessment, as the main tool for assessing the learning outcomes of all of the courses and learning experiences that are offered by the study programs.

3.6 Human Resources

3.6.1 Faculty members

The Faculty of the Biotechnology and Food Engineering has currently 14 full time faculty members consisting of 3 full professors, 6 associate professors, and 5 senior lecturers (assistant professors). Most of the faculty members are young and only two were recruited before 1984. The program also has 6 adjunct senior academic staff (Ph.D.) and 2 adjunct junior academic staff (M.Sc.) who teach several elective courses. The committee would like to encourage employing only instructors holding a Ph.D. degree in a discipline relevant to their teaching assignment.

During the evaluated years, the average undergraduate students-to-FTE ratio of the program was 1:18; the average graduate students-to-FTE ratio was 1:5 and the overall average students-to-FTE ratio was 1:23. These ratios are satisfactory and common in similar programs at public research universities in Northern America. The committee is impressed with the academic level of the faculty members, with their dedication and passion to teaching and research, their high competitiveness- both nationally and internationally, and with their

continuous effort aimed at meeting the needs of students and ensuring their success. The committee would like to congratulate the program and the Technion for successfully recruiting and retaining such high caliber faculty members.

The academic promotion process is rigorous and designed to maintain a very high competitive nature of both the BTFE program and the Technion. The promotion procedure is clear and adequate and faculty members are well informed about the process. In general, both senior and junior faculty members of the program are satisfied with the process. It seems that junior faculty members would benefit from having a senior faculty member serving as their mentor, during early stages of their academic career.

On average, promotion from a senior lecturer to associated professor takes 6-7 years; a slightly slower rate than that in similar programs in Northern America (5-6 years). Faculty members of the program publish in peer reviewed journals related to the main disciplines represented in the program: Food Science/engineering, Biotechnology/Biotechnology Engineering and Biological Sciences. The impact factor of top peer reviewed journal related to Food Science/Engineering is significantly lower (2-3) than that of journal of the other relevant disciplines. The latter has the potential to adversely impact promotion of faculty members of the program, unless a clear statement and explanations about this issue are included in the promotion dossier. The committee would like to alert the leadership of both of the program and the Technion about this issue.

The committee was impressed with the level of team work and the dedication of faculty members involved in curriculum and other committees and is satisfied with the way the BTFEP's leadership addresses the needs of its faculty.

Recommendations:

Immediate (full implementation within one year)

- In order to assist junior faculty members in successfully meeting expectation for promotion, assign to each of them a senior faculty member who will serve as his/her mentor.
- Include a document highlighting the among-disciplines differences in impact factors in promotion dossiers of the program's faculty members.

3.6.2 Students

The BTFEP at the Technion enjoys having excellent incoming students. The threshold weighted average grade ("Sechem") for admission to the B.Sc. program is set between 82 to 86, which falls in the middle of the thresholds for admission set by the Technion for the different engineering programs. In the past 5 years the scores of Psychometric test of the incoming students ranged from 670 to 695 and their Matriculation test score was higher than 90. The rate of admission to the program ranged, during the evaluated years, from 45% to 55% and the proportion of admitted candidates that became enrolled in the program ranged from 55% to 78%. The program enjoys a very low attrition rate of less than 10% and the average final grade of its graduates is high (~85). The academic level of students admitted to the graduate studies program is excellent and their average final grade ranged, during the evaluated years, from 88 to 91%. The committee congratulates the program for having such capable students and for successfully maintaining high student retention rate.

The committee was impressed by the enthusiasm of the students with whom it met, and by the way they praised the program and its faculty members. Students of the program feel that they are "at home" and that they have a voice at the Faculty. In general, students are satisfied with the quality of teaching, except for the less than satisfactory experience they have had with instructors of the Technion Core Chemistry courses (service courses of the faculty of chemistry).

Students of the program feel that faculty members of the BTFEP are attentive to their needs and do all that they can in order to ensure their success. The level of financial aid that is

provided to undergraduate students is appropriate and the financial support to graduate students is appropriate and acceptable.

The majority of the students completed (during the evaluated years) the B.Sc. program with the average final grade between 80 and 89%, which is appropriate. Up to 25% of students graduated Cum Laude or Summa Cum Laude in the recent 3 years.

About 45% of the program's graduates continue their academic training towards higher degrees and about 55% of the graduates find employment in the industry. More than 60% of the latter (25% of graduates) join the food industry while 7% and 12% of the graduates find positions in the biotechnology and pharmaceutical industries, respectively. The committee met with current undergraduate and graduate students as well as with alumni that hold positions in the industry. Information that was conveyed to the committee during these meeting indicated satisfaction with the way the BTFEP prepares its graduates to become successful and competitive in both the industry and graduate studies. Of a concern to students is the very limited job opportunities presented by the biotechnology industry in Israel to graduates with a B.Sc. degree.

3.7 Research

The research program at the BTFEP is impressive and reflects the highly competitive and relevant nature of its faculty members. The BTFEP has an inherent multidisciplinary nature that is expected to be reflected in its research program. The research direction of the program is mainly focused on:

- Biopolymers and Nano-Biotechnology ; Food Nanoscience, Nanostructured Molecular Assemblies, nanomaterials, Cancer Drug Delivery & Tissue Engineering, nano- and microencapsulation of bio-active compounds and ingredients in food systems

- Functional Foods, Nutraceuticals, Chemistry of foods and bioactive ingredients
- Biosensors technology, Polymers science and engineering
- Molecular Nutrition
- Molecular Biology of Pathogens, Applied Genomics & Food Microbiology, gene regulation in microorganisms, food safety
- Applied enzymology, enzyme structure function, Molecular and Applied Biocatalysis
- Host Defense Peptides
- Mammalian Cell Technology
- Synthetic Biology & Single Molecule Imaging

The research program has strength when the bio-sciences- and biotechnology-related aspects of the program are considered. The program has also established strength in the field of materials and vehicles for drugs and nutrients delivery. The research represents a fine balance between basic and applied aspects and, in many cases, has also been directed at addressing specific challenges of client industries. Reviewing the array of topics that are addressed by research programs of the faculty members suggests that the proportion of research directed at biotechnology-related topics is significantly higher than that directed at food-related topics. The committee applauds the quality of research that is conducted at the Faculty yet holds the opinion that some adjustments to its focus area are required.

The competitiveness and high-quality of research at the program is reflected in both the magnitude of research grants that have been awarded to the program during the evaluated years and in the quality and number of publications that have resulted from this research. The faculty members of the BTFEP have demonstrated during the evaluated period of time a high success rate in competing on research grants. The total research grants that were awarded to the program's researchers during the evaluated 5 years was about \$ 12.2 million and the total number of peer reviewed publications produced by these researchers was 187. On average, the total annual research budget (from competitive grants) of the department was \$2.44 million; the annual research grants awarded to individual faculty members during the evaluated years ranged from \$518,000 to \$2,540,000, with an annual average of about \$220,000 per researcher.

The annual average number of peer reviewed publications produced by the researchers of the BTFEP was about 37 with an annual average per researcher of about 4 publications. The number of peer reviewed publications produced by individual researchers ranged during the evaluated years between 4 and 37. The average investment (in \$ research only), per published peer-reviewed research paper, ranged from \$38,200 to \$197,350. The level of funding and total number of publications is adequate and the committee congratulates the program for its success.

In all cases, research of faculty members and their graduate students was published in highly reputable peer-reviewed journals in the relevant fields, thus reflecting the high caliber and competitiveness of research conducted by the faculty members and their students.

The research program reflects the afore-described recent evolution and changes in the BTFEP that have shifted the focus from food engineering to biotechnology, in general, and to biological sciences-related aspect of biotechnology in particular. The committee recommends that the extent to which food-related issues are being addressed by the research program will be enhanced. The committee also holds the opinion that the extent to which research questions and challenges related to engineering and technology aspects of both food sciences and biotechnology has to be enhanced. Among such directions are: advances in food process-engineering, advanced concepts in food technology, processes in biotechnology, bio-reactors, physico-chemical and rheological properties of food products, advanced technologies and processes in biotechnology, downstream operations in biotechnology, advanced separation methods, etc.

The committee believes that implementing the afore-stated recommendations will enhance the relevance and competitiveness of the collective research program of the faculty and will also have a positive impact on the curriculum, when its engineering- and technology-related elements are considered. The committee holds the opinion that implementing its recommendations will allow the faculty to attain a balanced approach to its research scope and depth. The leadership of the BTFEP informed the committee during its visit to the program about future recruitment of faculty members that will be aimed at addressing needs to enhance the instruction of engineering concepts in the BTFEP.

Recommendation:

Long term (full implementation within 4-5)

- Develop and introduce research directions aimed at enhancing the extent to which engineering and technology aspects are addressed by the research program.
- Enhance the extent to which topics related to modern food engineering and technology are addressed by the research program.

3.8 Infrastructure

The committee visited some of the teaching and research facilities of the BTFE program and was impressed with the quality of this infrastructure. The Faculty has recently completed a major renovation and expansion process that resulted in a significant enhancement and updating of its research and teaching laboratories. The teaching and research laboratories of the Faculty meet the needs of both the teaching and research programs and are properly equipped to allow developing high quality research programs and effectively training undergraduate and graduate students.

The committee is satisfied with the extent to which computers and information technology are being used in the program, with the quality and scope of library services to both faculty members and students and with the availability of space dedicated to allow students to interact with each other in both studying and social situations.

The BTFEP has a critical need to upgrade and update its pilot plant facility. The committee was informed by the program's leaderships that this need is currently being addressed in a dedicated campaign. The committee is satisfied with the current effort directed at establishing a state-of-the-art fermentation laboratory for the BTFEP.

Overall, the committee has found the infrastructure of the BTFEP at the Technion to be of impressive quality and adequacy.

3.9 Quality assessment

The Faculty of Biotechnology and Food Engineering at the Technion has a well-established quality-oriented culture and has introduced and maintained an effective and comprehensive self evaluation process, addressing its different activities and objectives. The

BTfEP underwent an internal review by an expert panel in 2011 that had been ordered by the Technion's leadership. The committee was informed by the program's leadership that recommendations that had been made by this panel are currently being implemented.

The committee is satisfied with the depth and scope of the current Self Evaluation process and with the high quality of the comprehensive Self Evaluation Report produced by the program. The committee commends the curriculum committee of the program for its continuous effort to enhance and update the quality and relevance of instruction in the program.

Signed by:



Prof., Moshe Rosenberg,
Chair



Prof. Gad Galili



Prof. Joseph Shiloach



Prof. Milica Radisic

Appendix 1: Copy of Letter of Appointment



May, 2012

שר החינוך
Minister of Education
وزير التربية والتعليم

Prof. Moshe Rosenberg
Department of Food Science & Technology
University of California, Davis
USA

Dear Professor Rosenberg,

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 Chair of the Council for Higher Education's Committee for the Evaluation of Biotechnology and Biotechnology Engineering Studies.

The composition of the Committee will be as follows: Prof. Moshe Rosenberg (Chair), Prof. Gad Galili, Prof. Milica Radisic, Prof. Joseph Shiloach.

Ms. Yael Elbocher will coordinate the Committee's activities.

In your capacity as 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. Yael Elbocher, Committee Coordinator

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Appendix 2: Site Visit Schedule

Biotechnology and Biotechnology Engineering –Schedule of site visit- Technion

Tuesday, June 19, 2012

Time	Subject	Participants
9:30 – 10:00	Opening session with the heads of the institution and the senior staff member appointed to deal with quality assessment	Senior Executive VP -Prof. Paul Feigin Dean of Graduate School- Prof. Hillel Pratt Dean of Undergraduate Studies - Prof. Daoud Bashouty Deputy Senior VP - Prof. Daniel Rittel
10:00 – 10:30	Meeting with the Dean and Vice Dean of the Faculty of Biotechnology and Food Engineering	Prof. Ben-Zion Levi Assoc. Prof. Marcelle Machluf (with tenure)
10:30-11:30	Undergraduate committee	Assoc. Prof. Sima Yaron (with tenure) Assoc. Prof. Ayelet Fishman (with tenure) Assoc. Prof. Dganit Danino (with tenure) Mrs. Gila Gvirtz
11:30-12:00	Graduate committee	Prof. Amram Mor Assoc. Prof. Yechezkel Kashi (with tenure) Mrs. Anat Eshel-Gur
12:00-12:45	Lunch – closed meeting	In the same room
12:45-13:30	Tour of campus (classes, library, offices of faculty members, computer labs etc.)	Accompanied by the Dean, Prof. Yuval Shoham and Dr. Uri Lesmes (Senior Lecturer)
13:30-14:30	Meeting with Junior Faculty*	Dr. Yoav Livney (Senior Lecturer), Dr. Esther Meyron-Holtz (Senior Lecturer) , Dr. Ester Segal (Senior Lecturer), Dr. Uri Lesmes (Senior Lecturer) , Dr. Roe Amit (Senior Lecturer)
14:30-15:15	Closed Door Committee Meeting	

Wednesday, June 20, 2012

Time	Subject	Participants
09:00-09:45	Meeting with Alumni* ***	Mr. Eyal Briller - Uniliver Mr. Asaf Ovadia - Shemen Mr. Barak Zohar - Pluristem Dr. (Mrs.) Moran Brouk - Protalix Dr. (Mrs.) Tzafra Cohen - Enzymotec Dr. (Mr.) Tomer Bronshtein – Technion/Singapore
09:45-10:30	Meeting with Bachelor Students* ***	Up to 8 students
10:30-11:15	Meeting with MSc Students* ***	Up to 8 students
11:15-12:00	Meeting with PhD Students* ***	Up to 8 students
12:00-13:00	Lunch and Closed-door working meeting of the committee	
13:00-13:30	Summation meeting with Dean and Vice Dean of the department	Prof. Ben-Zion Levi and Prof. Marcelle Machluf
13:30-14:00	Summation meeting with heads of the institution, department & Faculty*	Senior Executive VP -Prof. Paul Feigin Dean of Graduate School- Prof. Hillel Pratt Dean of Undergraduate Studies - Prof. Daoud Bashouty Deputy Senior VP - Prof. Daniel Rittel

* The heads of the institution and academic unit or their representatives will not attend these meetings.

*** The visit will be conducted in English with the exception of students who may speak in Hebrew and anyone else who feels unable to converse in English.