FOOD SCIENCE AND TECHNOLOGY EDUCATION IN CANADA

Present Status and Future Prospects

by D. P. Ormrod

Canada Department of Industry
Food Products Branch

Foreword

Through the years there has been concern expressed by the food industry of the lack of sufficient food scientists and technologists to fulfill the requirements of the industry. The Food Products Branch of the Department of Industry was requested by the Canadian Institute of Food Technology to undertake a study reviewing the present and future trends in food science education in Canada. The Department engaged Dr. D.P. Ormrod of the University of British Columbia to conduct this study.

The views expressed by Dr. Ormrod are his own, based on his assessment of the current situation in food science education.

The report should be of interest to both the food industry and educational institutions concerned with the training of food technologists.

Food Science and Technology Education in Canada

Present Status and Future Prospects

by

Douglas P. Ormrod

A report resulting from a comprehensive survey of
Canadian Universities, Colleges and Institutes
in cooperation with
The Canadian Institute of Food Technology

Sponsored by:

Canada Department of Industry, Ottawa

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Terms of Reference

"A study of the present and future plans for courses and facilities at Canadian universities for the training of Food Technologists.

1. To determine the nature of current and proposed courses in Food Science and Technology at universities in Canada.

2. To determine educational requirements for Food Technologists from a cross-section of food industrialists and to determine the present and future needs for university educated Food Scientists and Technologists.

3. To assess findings developed by studies of a similar nature conducted in the United States.

4. To develop a comprehensive assessment of the situation in Canada.

Specific tasks:

1. Interviews with senior administrators at each university to determine:

(a) Current programs in Food Science and Technology.

(b) Proposed programs in Food Science and Technology.

(c) Facilities presently available and planned.

2. Interviews with a few senior management officials of representative companies in the food industry to determine:

(a) Required educational background of university educated Food Technologists.

(b) Duties to be carried out by Food Technologists in their organizations.

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3. Develop a recommended course of study for Food Technology and Food Science.

4. Prepare a comprehensive report, assessing and commenting on the education at university level for Food Science and Technology in Canada.

5. Present the report to a seminar on Education to be held in the spring of 1968"[1].

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[1] From the request put forward by the Department of Industry, August 23, 1967.

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Summary of Findings

The nature of Food Science and Technology education in Canada was determined by visiting 33 universities, colleges and institutes. Full undergraduate curricula in Food Science are offered at the Universities of Alberta, British Columbia, Guelph and Manitoba, and at Laval University. Closely related undergraduate curricula are offered at the University of Toronto and at Macdonald College of McGill University. Courses in Food Technology leading to a diploma are offered at the British Columbia Institute of Technology, Cambrian College (North Bay, Ontario), Institut de Technologie Agricole de Saint-Hyacinthe, Newfoundland College of Fisheries, Northern Alberta Institute of Technology, and St. Claire College (Windsor, Ontario).

The programs at the University of Guelph, Cambrian College, Northern Alberta Institute of Technology and St. Claire College have been recently established. All others have been established for four or more years. The Nova Scotia Agricultural College is considering the establishment of a diploma program. The University of Waterloo is very interested in establishing a useful program within Applied Chemistry. The University of Saskatchewan has several related programs underway but has no unified Food Science program.

Other institutions appear to be nowhere near the establishment of programs in Food Science and Technology.

Some interest in Food Science and Technology is scattered throughout the educational institutions of Canada. This interest may be manifest simply by verbal indications or by the existence of actual food research and teaching. At institutions with departments

or formal committees of Food Science and Technology, the interest in food processing is centered in these groupings of staff. In institutions without such groupings, the few interested staff members may be located in Departments of Biology, Chemistry, Microbiology, Chemical Engineering and even in Mathematics. In many institutions there is no interest in Food Science and Technology whatsoever with no courses and no research related to Foods and none planned. It is evident that many members of science and engineering departments conducted food research in past years but this is no longer the case. The present-day nature and dimensions of the fundamental research in these disciplines is such that the scope of research does not go as far as a consideration of problems related to foods.

Summary of Recommendations

The primary demand of the food industry has been found to be for professional food scientists and technologists. Therefore, most attention should be directed to the provision of such people. In addition, limited numbers of more specialized graduates in chemistry, microbiology, chemical engineering or bioengineering, and economics or business are required.

Establishment of more Departments of Food Science and Technology should be proceeded with very cautiously. The only area of distinct need is in the Atlantic provinces where no complete university program is presently available. Otherwise it is expected that the University of British Columbia could generally provide the food scientists needed in that province, the Universities of Alberta and Manitoba could provide sufficient graduates for their provinces, the Universities of Guelph and Toronto for Ontario, and Laval University and Macdonald College of McGill University should provide sufficient food scientists for Quebec. A program could be established relatively easily at the University of Saskatchewan to meet the needs of that province. The University of Waterloo with its excellent Co-operative Program could make a useful contribution to the food industry in some special areas such as Food Chemistry and Biochemical Engineering. The need for Food Technicians and Technologists should be almost met by graduates of the Colleges and Institutes at present actually offering courses in Food Technology.

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Institutions with Food Science or Food Technology programs and those contemplating such programs should realize that the provision of programs of professional merit for students requires organization of the faculty and students preferably in a department, with a minimum of perhaps four faculty together with supporting faculty in other departments. Special physical facilities must also be provided for Food Science and Technology including laboratories, library facilities, and particularly a pilot plant or unit operations laboratory.

The curriculum for Food Science and Food Technology must be carefully developed to meet the varied demands placed on the new graduate and provide sufficient fundamental knowledge to allow him to extend his competence in the future. There should be considerable uniformity in curricula among Food Science programs at Universities and among Food Technology programs at Institutes and Colleges. There must be courses in basic sciences, humanities, economics and business together with sufficient courses oriented to food processing to provide a truly professional education including courses in food composition, food analysis, food microbiology, food engineering and food processing. Several of the Canadian educational institutions have devised curricula which appear to meet these requirements. They have generally used the model curriculum developed by the Institute of Food Technologists as a basis for their curriculum development. Institutions interested in improving present curricula or in establishing new curricula should carefully evaluate this use of the model curriculum.

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The future for Food Scientists and Technologists has never been brighter. However, if sufficient numbers of students do not become interested in careers in the food industry, the progress of the industry will be impeded. Food Science and Technology must be given a new exciting image through the joint efforts of educators and industry. Continuing publicity campaigns are recommended together with projects directly aimed at student recruitment such as a national food industry scholarship program.

Terminology

In Educational Institutions

The names used for departments, schools, faculties, curricula, options, course titles, and other related categories vary widely around the world and to some extent in Canada. The general pattern is that university-level studies related to food processing are referred to as Food Science while institute and community college level studies are referred to as Food Technology. Variation from this pattern occurs at two Canadian institutions where earlier programs primarily related to Home Economics have been re-named Food Science.

There seems little hope of achieving complete uniformity in terminology. Names, once established at an institution, are very difficult to change and one can only appeal to institutions contemplating new programs or changes in existing programs to attempt to relate their program naming to the apparent majority view, that is to the general pattern noted above.

In Industry

Many thoughtful members of the food industry are attempting to clearly differentiate between the graduates of two- and three-year Institute and College programs and the graduates of four- or five-year University programs. The strong trend is to refer to the former as Food Technicians with the latter referred to as Food Technologists. While this is a commendable practice which recognizes the time which a graduate has put into his training, it does lead to some confusion

in relation to the institutions from which the various graduates come. It seems likely that graduates of Institutes of Technology and Colleges of Applied Arts and Technology will ultimately be referred to as Food Technologists while university graduates will ultimately be generally referred to as Food Scientists.

In the United States, the words Food Technologist are generally used for the holder of a university bachelors' degree while the Food Scientist is a person with a graduate degree. It should be noted that there are very few Institutes of Technology in the United States compared to the number in Canada, but, even so, most university Departments of Food Technology are being re-named as Departments of Food Science.

In this report Food Science will be used to refer to University programs and Food Technology to College and Institute of Technology programs.

Introduction

Food Science and Technology is now well-established in Canada as a discipline in its own right. Surveys show that the food industry clearly recognizes the need for graduates from our higher education institutions who are Food Science and Technology specialists. In the past, most of the University graduates entering the food industry have been graduates in such disciplines as Chemistry, Biology and Chemical Engineering. There are now, however, many University and other courses available in Food Science and Technology in Canada and around the world. The majority of future food industry technical and scientific personnel will likely be graduates from these courses. In part, this reflects the changing emphasis in general science programs away from attention to problems of interest to the food industry, but most of this change should result from the emergence of strong Departments of Food Science and Food Technology. The curricula and laboratory experience in Food Science and Technology should become so invaluable to the food industry that the industry would not accept any less appropriately and less thoroughly educated graduate.

The food industry is undergoing a continuous revolution as more and more research and development results in information which dramatically improves production practices, processing methods and marketing systems. The food industry, in the next two decades, is likely to be as dynamic and to become as advanced as other industries, such as the chemical and petroleum industries, have become in the last two decades. In order to accomplish this revolution the findings

of research must be transferred quickly to the benefit of industry and this can only be done by knowledgeable, competent and enthusiastic specialists. The education institutions do have a responsibility to provide these specialists and, after a very slow start, it appears that the educational facilities for Food Science and Technology may well develop as rapidly as the industry is expected to develop, and, with some help from the industry itself, be able to keep pace with the need for graduating specialists.

For this objective to be achieved the numbers of students must be increased sharply through creating an awareness among young people of Food Science and Technology as a desirable career, the present curricula must be improved to eliminate the many inadequacies, and proper courses in Food Science and Technology must be offered in sufficient institutions to meet the need for graduates. This will only be accomplished by a concerted effort by educators and the food industry. The food industry is urged to support the development of specific Departments of Food Science and Technology, for these are the very departments which exist for the benefit of the industry. The mutual support should have a highly beneficial effect on both the strength of the industry and on the quality of education.

It is recognized that the needs of particular food industries differ markedly depending on size and commodity interest. Many larger companies will likely continue to hire some specialists in Chemistry, Microbiology, Chemical Engineering and graduates of other "pure" fields but the greatest need has been demonstrated to be for graduates with a strong education in science and with sufficient background in food processing science to be capable of assuming many

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duties in the food industry. The curricula must therefore provide education in courses ranging from unit processing, food chemistry, food physics and food microbiology to business management. Graduates must be vitally interested in the food industry and its future and not merely interested in getting into the laboratory to do research. Canadian institutions are clearly changing and improving their curricula to meet this need for fundamental education together with its application to food and food processing. In most cases, entirely new curricula have been devised based primarily on the model curriculum recommended by the Institute of Food Technologists.

Earlier Studies of Food Science and Technology Education in Canada

The National Education Committees of the Canadian Institute of Food Technology have through the years noted the problem of lack of sufficient graduating specialists and lack of sufficient interest in Food Science and Technology on the part of educational institutions. A most thorough study was undertaken by the Committee in 1961 under the chairmanship of A. Belanger. The issues considered by the Committee at that time are still appropriate today. Thirty-three questions were posed to the Committee by Mr. Belanger. Their appropriateness is indicated by the following sampling:

"Should C.I.F.T. make recommendations regarding a curriculum for food technologists? What in your opinion should be the minimum basic elements that should be part of the curriculum? What has food technology to offer to students? Should C.I.F.T. try to raise the professional level of its members? etc., etc.,".

A survey of Canadian universities, industries and government agencies was proposed to find answers to the following three points:

(1) The scope and location of courses now being offered in Canada for the training of Food Technologists or for Technicians in the food industry.

(2) The type and location of courses that are needed by employees or prospective employees of the food industry.

(3) The direction of future progress in this field.

There were a number of efforts to establish special courses in Food Technology for re-education of industry personnel but the principal problem appeared to be lack of knowledgeable teachers and lack of volunteers to handle the organization of the courses. A wide variety of subjects has been considered by the various Education Committees and the problems related to education have become well known to many members of C.I.F.T.

Canadian Universities, Colleges and Institutes

Introduction

All major Canadian universities and some other colleges and institutes were visited during the period October 1967 to January 1968. Major universities were visited regardless of apparent interest in Food Science, together with colleges and institutes with an interest in Food Technology, totalling 33 institutions. At each institution the most senior administrators available for consultation were interviewed to determine the interest of the institution in education and research in Food Science and Technology. When interest on the part of specific faculty members was determined, they were also visited. The persons interviewed are listed in the Appendix.

The questions to senior education administrators related to whether they offer or plan to offer courses in Food Science and Technology and whether they had any thoughts whatever regarding this field of study. In many cases, an explanation of the nature of Food Science and Technology was requested by the educators. The availability of relevant courses and the presence of physical facilities were noted. An attempt was made to pinpoint the interest at the institution in Food Science and Technology education and research, no matter how small the program might be.

Interviews usually also included a discussion of the general aims of each institution together with a consideration of the problems of financing new programs and the nature of the many demands on educational institutions. The educators were also asked to make suggestions for the improvement of education in Food Science and Technology whether or not they have or plan a program.

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A summary of the interests, aims, and special attributes of each institution is provided in this section together with an indication of existence of specific interest in Food Science and Technology. The suggestions of the educators for improvement of Food Science and Technology in Canada are presented in a later section.

Newfoundland

Memorial University of Newfoundland, St. John's

This is the only university in the province. It primarily provides a general university education for approximately 5,000 students. The principal objective of the university is to serve the province. There are, at present, Faculties of Arts and Science, Education and Applied Science with a Faculty of Medicine in the planning stage. There is a modest graduate study program. The university has grown rapidly in the last five years and is now obviously dynamic. The university offers four-year general and five-year honours courses. There are no fees after first year and all students are paid a stipend.

President Taylor noted that Fisheries Biology is stressed within the Biology Department. The new Faculty of Medicine will include nutrition as a supporting subject. The Faculty of Applied Science will embark on co-operative experience programs in industries in the new town of Harlow, England. At present, no students take courses even remotely related to Food Science and Technology.

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The Department of Biochemistry will offer an intensive course in analytical biochemistry in co-operation with the Department of Chemistry. The primary objective of the Biochemistry Department will be to conduct fundamental research in proteins and steroids. One present faculty member is interested in the oxidation of fatty acids. An agricultural biochemist may be appointed at a later date.

In the future, the Department of Biology will teach introductory and advanced microbiology including applications. The associated Marine Sciences Research Laboratory includes studies of parasites, health hazards and food acceptability.

Mr. Ross Peters, an engineer teaching in the Mathematics Department, has been conducting studies of drying fish for several years. His work is supported by the Newfoundland Department of Fisheries. Dr. E. Bullock of the Chemistry Department is prepared to direct graduate work in collaboration with the Biochemistry Department. There are excellent relations between the Science Departments which is ideal for interdisciplinary teaching and research. In addition, the Federal Department of Fisheries is considering locating the Fisheries Technological Station on the University campus.

Newfoundland College of Fisheries, Navigation, Marine Engineering and Electronics - St. John's

The Department of Food Technology offers a three-year diploma course with entrance after grade 11. The emphasis in the curriculum is on Fisheries Technology but other food industries could benefit from employment of graduates because many general courses in Food Technology and related sciences are offered. There are five full-time staff members in Food Technology, with supporting staff located

in other departments. The only limitation in the program is the lack of a unit operations laboratory but as much as possible is done through field trips and exercises in industry plants. There are about 15 students in each year. The program is described in detail later in this report.

Nova Scotia

Dalhousie University, Halifax

Dalhousie is one of several universities in the province of Nova Scotia. It is a general university with Faculties of Arts and Science, Law, Medicine, and Health Professions. The latter consists of a School of Nursing, College of Pharmacy, School of Physical Education and School of Physiotherapy. There are presently about 4,000 students at this University. The Faculty of Medicine facilities dominate the campus and it is presently the only Faculty of Medicine in the Atlantic provinces. The Departments of Biochemistry and Microbiology are in Medicine. The presence of a large National Research Council laboratory on the campus strengthens research programs in Chemistry and Biology. The university offers three-year general and four-year honours degrees.

There is presently no teaching or research in Food Science and Technology in the Departments of Biochemistry, Microbiology, Biology and Chemistry and none is anticipated. Nutritional aspects of Medicine are presently taught in Biochemistry, Physiology and Microbiology. One faculty member in Biochemistry is interested in protein malnutrition in the West Indies. Only one member of the Department of Microbiology might undertake industrial microbiology work.

Nova Scotia Technical College, Halifax

This is a university-level College of Engineering which has an arrangement with all Atlantic universities, except the University of New Brunswick, to take students for the last two years of Engineering. There are Departments of Civil, Electrical, Mechanical, Mineral, Chemical, and Industrial Engineering, and General Studies. There are about 500 students with 50 taking graduate studies.

A co-operative program in Food Technology was organized in the 1950's with Dalhousie University and the Department of Fisheries. The program was not a success and was dropped. There are presently no members of the Department of Chemical Engineering who are interested in Food Science and Technology. There is a course listed in the Calendar but it has not been offered for many years. There is some interest in waste disposal, sanitation and water quality. Mr. A.E. Steeves of the Department of Industrial Engineering has very wide experience in the food industry and has directed graduate work on fats and oils.

An Industrial Research Institute has been established at the College with Dr. O. Cochkanoff, a mechanical engineer, as director. Most current projects are industrial engineering studies but food industry problems would be welcomed.

Acadia University, Wolfville

This is a small general university of about 1,700 students. Most students are in the Faculty of Arts and Science. In addition, there are small schools of Pre-Engineering, Education, Home Economics,

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Music, Secretarial Science and Theology. The proximity of Acadia University to the Kentville Research Station of the Canada Department of Agriculture has special meaning for sciences related to agriculture. About six members of the Research Station staff at present participate in some university activities. General course degrees are three years and honours degrees four years after senior matriculation.

Biochemistry is offered within Chemistry and Nutrition is offered in Home Economics. There is a bacteriologist in Biology. While there are no definite programs in Food Science and Technology, considerable interest was expressed in the establishment of such a program. The proximity to food industries and to the Research Station were noted to be points in favour.

Nova Scotia Agricultural College, Truro

This college specializes in Agricultural Science programs with a pre-degree program of three years' duration after Junior Matriculation. Students then transfer to Macdonald College, University of Guelph, or some other university for completion of degree requirements. A considerable number of students are on terminal technical and vocational programs. A new program in pre-engineering has been started from which students will go on to Nova Scotia Technical College. There are no departments in the college but several course work models are followed.

The technical programs were established as a result of a study by the Atlantic Provinces Economic Council. They are of two years' duration with slightly lower entrance requirements than for degree programs. The present technical programs are Agricultural

Business, Plant Science and Animal Science. These programs provide technicians and have compulsory on-the-job training during the summer. It is proposed to offer one extra year over the technician course for technologist training with heavy emphasis on directed studies during this year.

St. Francis Xavier University, Antigonish

This is a small university with approximately 2,000 students located on the northern coast of Nova Scotia. The emphasis is on a general education for students with little specialization. Mount Saint Bernard College which, includes Home Economics in its curriculum, is located adjacent to the University but is operated independently, although College students take many courses in the University.

Home Economics is strongly oriented to Foods and Nutrition. Biochemistry and Microbiology are slanted toward Home Economics. The University has several extension workers in Fisheries. Their activities consist largely of advising co-operative programs on harvesting and marketing of fish, but there is no processing expert. General science graduates presently go in great numbers to the food industry and related government agencies, especially to the Department of Fisheries.

Other Nova Scotia Universities

There are several small universities and colleges including St. Mary's University with about 900 students, Mount St. Vincent University with about 600 students and the University of King's College with 300 students. All provide a very general education in Arts and Science.

New Brunswick

Mount Allison University, Sackville

This is a small general university of about 1,500 students located in the extreme eastern section of New Brunswick. There is a Faculty of Arts and a Faculty of Science. Home Economics and Pre-Engineering are in the Faculty of Science. There are recent modern facilities for Home Economics and Chemistry. General course Science students take a major and a minor in a four-year program. There are also honours programs available. Microbiology is offered in the Biology Department and Nutrition in Home Economics. The Home Economics Department also offers an Institution Management program.

University of New Brunswick, Fredericton

This is a general provincial university with about 4,000 students. The academic work is divided into Faculties of Arts, Science, Engineering, Forestry, Law and Education and a School of Nursing. One special development is a bioengineering institute in Engineering, with the theme of the interaction of man with modern technology. Institute projects relate to medical functions.

The university attempts to provide a general education for as many students as possible and is reluctant to enter into any new fields. There are only a few applied faculties on the campus and they are serving a wide geographic area. Biology, Chemistry and Physics are highly specialized and there is little opportunity for students to take courses in other departments in their senior years. Dr. O. Page, a microbiologist in the Biology Department, has undertaken occasional research projects in food microbiology.

The New Brunswick Research and Productivity Council is located in Fredericton and has a Food Science section with highly qualified staff but there is little interchange with the University. The Canada Department of Agriculture maintains a Research Station at Fredericton where there are two scientists working on potato quality.

Other Universities in New Brunswick

The Université de Moncton has approximately 1,600 students and is a French-language institution. St. Thomas University has only 400 students while the University of New Brunswick at Saint John has about 500 students.

Quebec

Université Laval, Quebec City

This is a large French-language university of about 18,000 students. There are about 250 undergraduates in Agriculture with many graduate students. One of the departments in Agriculture is Food Science. Home Economics (Dietetics) is also located in the Faculty of Agriculture and emphasizes nutrition. There is a Food Service Management program. All courses in Agriculture are of four years duration.

The Food Science facilities are outstanding in Canada. A quality control laboratory is set up with an ideal microbiological section and chemical section. The unit operations laboratory has two zones, one for solid materials and the other for liquid foods. There are many service islands and 19 controlled-temperature and humidity rooms. There is a separate room for cheese processing.

The curriculum in Food Science and other details are discussed elsewhere.

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Universite de Sherbrooke

This is a French-language university of about 5,000 students with Faculties of Education, Arts, Pure and Applied Sciences, and Administration. A new medical school is associated with a general hospital and both are seven miles from the main campus. The medical school is being built at a cost of thirty million dollars and will give heavy emphasis to research. There are about 500 undergraduates in Science with specialist and general courses available. There is one microbiologist on staff in Biology. Biology includes water pollution studies among its areas of competence. Biochemistry is planned as a joint option between Chemistry and Biology, and Chemical Engineering will be a joint option between Chemistry and Mechanical Engineering. Engineering and Administration have a co-operative program with industry similar to that of the University of Waterloo program. There are presently no faculty members at the University who are particularly interested in Food Science but related courses and research projects may develop in the future.

Universite de Montreal

This is the largest university in Canada, with about 28,000 students, and is French-language. The University has almost all possible faculties, but there is no program specifically oriented to Food Science, although there are strong programs in Chemistry, Biochemistry and Microbiology. The University is responsible for the Veterinary School at St. Hyacinthe where some meat science instruction is given. Food Science could be developed and strengthened in the Institute of Dietetics.

Before any new programs related to Food Science are established, the full potential at Laval University must be exploited. The efforts of Quebec universities will be more co-ordinated in the future with the establishment of a joint university-government grants commission.

McGill University, Montreal

This is the largest English-language university in Montreal with about 13,000 students. There are a large number of options offered at McGill University ranging from Medicine and Dentistry to Commerce and Law. The work in sciences related to Agriculture is offered at Macdonald College, an associated institution located about 25 miles away.

The relationship of Food Science to basic Chemical Engineering is recognized at McGill University but there are presently no projects underway in that department which relate to food. Students do have a choice of options in their final year and these could include biological courses. Several organic chemists are interested in natural products chemistry but none are conducting Food Science Research. The Pulp and Paper Research Institute on the McGill University campus might provide a model for a food-oriented institute.

Macdonald College of McGill University, St. Anne de Bellevue

This is a small separate campus with most of the students in Agricultural Sciences and Education. The School of Household Science has been recently renamed the School of Food Science. The primary interest in this School is in Dietetics and Food Management.

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The School is closely affiliated with Agriculture and now hopes to attract men students and perhaps men faculty. The School is interested in the relationship of production to food problems and encourages team efforts with production departments in Agriculture. This has been done, for example, with irradiation studies of poultry products.

There is also a separate Food Management option designed for students interested in a career in the Food Service Industry. It is built around a sound knowledge of food and food handling procedures from the managerial standpoint. Some graduates of this program have entered the Food Processing Industry, even though the program has the Food Service emphasis. This has led the faculty to introduce more aspects of Food Processing into this option.

Macdonald College has a distinguished record for research related to Food Processing. The major Departments, particularly Agricultural Chemistry and Microbiology, have placed many graduates in the Food Industry. Some of the present research projects in Agricultural Chemistry are studies of proteins in meat, kappa-casein in milk, proteins in legume seeds, and pesticide residues in food. In Animal Science, there are studies of irradiation effects on meats and studies of aging effects of protein. In Horticulture, off-flavours in green beans and cauliflower are being studied. In the School of Food Science there are several projects on the irradiation of poultry and bacteria.

Sir George Williams University, Montreal

This university has about 5,000 students and is housed in two large downtown buildings in Montreal. There are both day and

evening degree programs with the same courses. It is possible for students to get their entire degree through evening study. Science students usually transfer to a full-time day program for their final year. The Chemistry Department is particularly oriented to electronics and instrumentation and has excellent facilities for teaching these subjects. All faculty members are engaged in research to some extent but there are currently no food research problems. Biochemistry is organized as a joint offering of Chemistry and Biology. There are at present no faculty members interested in Microbiology and no specific facilities for this field.

Other Universities in Quebec

The only other university is Bishop's University with about 800 students, mainly in general Arts and Science. Several other religious and military colleges have perhaps an additional 1,000 students at university level.

Institut de Technologie Agricole, Saint Hyacinthe

This is a superbly quartered and equipped institution with about 400 students in about five different agricultural technologies. The course is three years in length. The teaching of Dairy and Food Technology is deliberately oriented to the needs of the food industry with a balance of theory and practice. Most graduates go into industry and some go into inspection work. Many become involved in quality control work while others go into production work. Most students are men. It has been difficult to find appropriate jobs for women graduates of the program. About fifty different food companies are

visited during the course and industry personnel are brought to the Institute. A board of ten industry people advises the department on its program. The professors do some research and, in addition, there are several full-time specialists of the Quebec Department of Agriculture quartered here. The emphasis in research is on the solution of industry problems. The institution is presently under the Quebec Department of Agriculture but may be shifted to the Department of Education.

Ontario

University of Ottawa

This is a bilingual university of about 5,000 students. There are programs in Arts, Pure and Applied Science, Commerce, Home Economics, Law, Medicine and Nursing. There is, at present, no program in Food Science or closely related to Food Science and none is planned for some time unless funds and space are made available. The obvious advantage in establishing such a program in relation to other agencies in Ottawa is recognized within the university. Biochemistry is offered in both Science and Medicine. One professor in Biology is interested in Microbiology. The Faculty of Medicine is endeavouring to establish a Health Science complex which would involve Nutrition and Home Economics and this might later involve Food Science. The Department of Chemical Engineering is considering the establishment of Biochemical Engineering. Water pollution and waste disposal are currently of special interest.

Carleton University, Ottawa

This university has about 4,000 students on a new campus. The emphasis is on Humanities and Sciences. While there are no formal courses related directly to Food Science, there are a number of faculty members who might take an interest in food problems. Dean Nesbitt of the Faculty of Science was formerly involved in stored product insect research. There are two microbiologists in the Department of Biology. A number of organic chemists are interested in the chemistry of natural products. The presence in Ottawa of numerous supporting scientists in Federal Government agencies would be of value to programs at both Carleton University and the University of Ottawa.

McMaster University, Hamilton

McMaster is a general university with about 4,500 students. There are Faculties of Arts, Science and Engineering and a Faculty of Medicine is just becoming established. The emphasis is very heavily on Science. The nuclear reactor facility on the campus appears to be the most elaborate in Canada.

There is presently no Food Science offered or contemplated at McMaster. The new Division of Health Sciences does not anticipate research or teaching in Food Science or Nutrition in its first phase but these might be included in a second phase. Engineering has established a Centre for Industrial Engineering but no Food Science is offered in connection with the engineering programs. There is some research in Biology related to food including projects on yeast preservation and the mass culture of algae.

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University of Windsor

This university has about 3,000 students in general Faculties of Arts, Science and Engineering. The emphasis at Windsor is on the presentation of a general education to all students. Many faculty members express an interest in the needs of the food industry but all agree that no special programs in Food Science will be offered. There is some food microbiology and some related biochemistry but there are presently no faculty members more than casually involved in Food Science. Some graduate students in Biochemistry have conducted thesis research related to food fermentations and have been employed by the food industry.

University of Toronto

The University of Toronto is the largest and most complex university in Ontario with about 15,000 students. Among its various faculties is that of Food Sciences which was created in 1962. It replaced the Faculty of Household Science and includes the instruction in Food Chemistry which was formerly in the Faculty of Arts and Science. The degree B.Sc. (Food Sciences) is awarded upon successful completion of the four year program in any of the four branches: Nutrition-Textiles, Nutrition, Textiles, and Food Chemistry. The curriculum for Food Science facilitates transfer of students from other faculties at the end of first year. Courses of instruction include Food Quality, Analysis of Foods, Basic Nutrition, Food Bacteriology, Study of Colloidal Aspects of Foods, Food Service Administration, Prevention of Deterioration of Food, Chemistry of Vitamins, and Research in Food Chemistry. Apparently no other Faculties or Departments at the University of Toronto have any interest in Food Science teaching or research.

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Some of the present research projects include studies of anthocyanin degradation in cherries, nutritive value of Canadian fish and fish products, effect of browning reactions on nutritive value of foods, isolation of wheat proteins and the use of gas chromatography in the determination of fat rancidity. The faculty library contains an excellent collection of texts and journals.

University of Waterloo

The University of Waterloo is a new university with about 6,000 students. The university specializes in the Sciences and Engineering. An important feature is the existence of a strong co-operative experience program with industry. There are, at present, 3,200 students on this program. This is particularly well-developed in Engineering. One microbiologist in the Biology Department is currently concerned with food microbiology. A graduate in Food Science is a member of faculty in the Chemistry Department. A new Co-operative Applied Chemistry program is now starting. One option may well be Food Chemistry with about 6 to 10 students per year as the minimum number of students. New applied biochemistry courses will be offered but nutrition principles and animal experiments will not be covered.

Many faculty members at Waterloo expressed an interest in Food Science and some have highly appropriate backgrounds. The co-operative program would be a useful adjunct. The disadvantage of the establishment of a Food Science Program is that Waterloo is quite close to Guelph where such a program is already established. The food industry participates in the Co-operative Program and takes students from Chemical Engineering and Applied Chemistry.

University of Guelph

The University of Guelph, which now has about 2,500 students, was created in 1964 by the amalgamation of the Ontario Veterinary College, the Ontario Agricultural College and the Macdonald Institute (Household Science). These units had formerly operated as the Federated Colleges of the Ontario Department of Agriculture and were affiliated with the University of Toronto. Wellington College was established in 1964 at the University of Guelph for the teaching of arts and science.

The three original components of the University of Guelph have had a very distinguished history in teaching and research in the Agricultural Sciences. The Ontario Veterinary College was established in 1862 while the Agricultural College was established in 1874. Macdonald Institute was established in 1903. the university continues to maintain a close association with the Ontario Department of Agriculture and Food.

There are several departments at the University of Guelph, such as Animal Science, Poultry Science, Nutrition, Microbiology and Horticulture, which offer courses and conduct research in areas of interest to the food industry, including meats and meat marketing, poultry products technology and dairy products. A Department of Food Science has just been established and the first students will be enrolled in a Food Science program in September 1968. The University of Guelph is the only university in Ontario definitely planning to offer a fall program in Food Science. Details on this new program and supporting programs at the University of Guelph are provided elsewhere in this report.

Other Universities in Ontario

There are several other universities in Ontario including Brock University in St. Catherines with about 800 students, Lakehead University in Fort William with about 800 students, Laurentian University of Sudbury with about 1,500 students in a bilingual program, Queen's University at Kingston with about 6,000 students, Trent University in Peterborough with about 500 students, Waterloo Lutheran University with about 3,000 students and York University in Toronto with about 2,000 students. With the exception of Queen's University all the other universities are providing a general education in Arts and Science. Queen's has Engineering, Law, Medicine and other more specialized faculties. There is apparently no research or teaching related to Food Science at any of these universities.

Cambrian College of Applied Arts and Technology, North Bay

Cambrian College is one of a series of Colleges of Applied Arts and Technology formed in Ontario in 1965. They are administered by local Boards of Governors so that community needs may best be served. These Colleges took over the operation of Institutes of Technology and Vocational Centers wherever they existed. Cambrian College has thus become established at three centres; North Bay, Sudbury, and Sault Ste. Marie. A two-year program of technician training for the food service industry was established at North Bay. This has now been expanded into a full three-year program (after Ontario Grade 12) in Food Technology leading to a Diploma of Technology, with the first students to be enrolled in September, 1968. Details of this program are presented elsewhere in this report.

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St. Clair College of Applied Arts and Technology, Windsor

This is another new college serving southwest Ontario. In this case, the Western Ontario Institute of Technology has been incorporated into the College. Courses in Business Administration, Chemical Technology, Electrical-Electronic Technology, and Mechanical Technology have been offered. A number of new programs are starting including a full program in Food Technology which will be administered through the Chemical Technology Department, at least for the present. More details about the Food Technology program are presented elsewhere in this report.

Manitoba

University of Manitoba, Winnipeg

This is a large general university with about 9,000 full-time students. The university has recently established a Department of Food Science in the Faculty of Agriculture. A four-year course is offered together with graduate studies leading to the M.Sc. and Ph.D. degrees. There is also some processing work in the Departments of Animal Science and Plant Science. These departments have special laboratories within their own buildings for processing studies on meat products, and cereals and vegetables, respectively. The expansion into full-fledged Food Science was made possible through a total reorganization of the Department of Dairy Science. The detailed curriculum for Food Science is presented elsewhere in this report.

Home Economics is also in the Faculty of Agriculture and is the largest school of its kind in Canada. Some joint approaches to Food

Science problems are contemplated. Home Economics concentrates on nutrition studies while processing is emphasized in Food Science. Home Economics also retains a strong interest in consumer acceptance of foods. There is a laboratory of the Federal Department of Fisheries on the campus, which does research on processing of fish. Several other university departments are involved in interdisciplinary fields such as Food Engineering, Food Toxicology, and Food Microbiology. There is an exceptionally good level of co-operation among departments. Considerable support for Agricultural Science research of all kinds is provided by the Manitoba Department of Agriculture.

Other Universities in Manitoba

United College in the City of Winnipeg, with about 2,000 students, has recently been renamed the University of Winnipeg while Brandon College, with about 1,000 students has been renamed the University of Brandon. Both were closely associated with the University of Manitoba but are now independent. No Food Science is taught at either institution and no Food Science research appears to be conducted.

Saskatchewan

University of Saskatchwan, Saskatoon Campus

The Saskatoon campus, main campus of the University of Saskatchwan, is a large general university with about 9,000 full-time students studying in a large number of programs. There is at present no department of Food Science but work related to Food Science and Technology is conducted in several Departments of the University. A strong group in Cereal Chemistry had been established many years ago in the Chemistry Department and a Food Technology

course was offered but it was not taken by many students. The Prairie Regional Laboratory of the National Research Council is located on the campus and is involved in some research related to Food Science. The College of Veterinary Medicine teaches meat pathology and milk disorders originating in diseased animals, and is interested in irradiation preservation of meat. The College of Home Economics is attempting to move from home-oriented teaching to a closer relationship to industry. The Department of Dairy Science has a small group of undergraduate students with about 12 graduate students. Many of the courses in Dairy Products have recently been changed to a more fundamental nature or consolidated.

The University is considering the establishment of some sort of interdisciplinary organization for Food Science which would bring together the considerable support on the campus among the various departments, colleges, and laboratories. This sort of organization would parallel that for other interdisciplinary subjects such as Genetics and Microbiology.

University of Saskatchwan, Regina Campus

This is a closely associated campus. There is, at present, no Food Science teaching or research at Regina.

There are no other universities in Saskatchwan, although there are a number of very small colleges, mostly with religious affiliation.

Alberta

University of Alberta, Edmonton

The University of Alberta has about 13,000 full-time students. There is a separate Department of Food Science which

has an advisory committee drawn from the Faculties of Agriculture and Science and the School of Household Economics. The Department originated from the Department of Dairying which was re-named in three steps to the present title. The program in Food Science is of four years' duration and is described in detail elsewhere in this report.

The School of Household Economics is housed in a new building and has about 300 students on a three-year program. Included in the program is a Foods and Nutrition option. Institution food service management is of interest and an option is presently being developed. There are many other supporting departments on the campus, including Chemistry, Microbiology and Departments of Engineering.

University of Calgary

The University of Calgary was formerly closely affiliated with the University of Alberta but is now a completely independent institution. There are about 5,000 students studying in several programs. There is no formal program of courses or research specifically in Food Science. A program in Biochemistry has been established in the Department of Chemistry and at least one research project is related to Food Science. There is strong development in some aspects of Engineering, including the special interest of Chemical Engineering in unit processing and in air and water pollution. Bioengineering is being developed co-operatively between Chemical Engineering and Biology. Civil Engineering is interested particularly in the storage of solids and liquids, and Mechanical Engineering is specializing in cryogenics. Several highly specialized items of research equipment are available on the campus.

Other Universities in Alberta

A university has recently been established at Lethbridge with initial emphasis on programs in general Arts and Science. There are a number of small junior colleges and religious colleges providing partial university programs.

British Columbia

University of British Columbia, Vancouver

This is a large general university with virtually every field of study represented by a faculty, school or department on the campus. There are at present about 19,000 students. An interdepartmental program in Food Science and Technology was established in 1947 in the Faculty of Agriculture and a considerable number of bachelor graduates of the program have found places in industry, government and education. A graduate program is also available. The interdepartmental committee responsible for administration of the program now numbers five. Formal submissions have been made to the university administration to have Food Science recognized as a separate department and the related administrative procedures are nearly complete. Details on the academic program in Food Science together with research activities are provided elsewhere in this report.

Other Universities in British Columbia

The University of Victoria has about 4,000 students enrolled in general programs of arts, science and education. Simon Fraser University in Burnaby also has about 4,000 students enrolled

in general programs. Notre Dame University of Nelson has about 800 students. None of these universities offers any courses related to Food Science and no faculty members appear to be directing any research related to Food Science.

British Columbia Institute of Technology, Burnaby

This Institute offers a wide variety of two-year full-time technical and commercial programs in new well-equipped facilities. A number of evening programs are also offered. The Institute, in co-operation with industry through its advisory committees, attempts to satisfy the post-secondary technical training needs of every segment of trade, commerce, and industry.

There is a well-established program in Food Technology at the Institute with separate laboratories and pilot plant and four staff members with about twenty students per year. Details on the program in Food Technology are provided elsewhere in this report.

Food Science and Technology Education in the United States, Great Britain and Europe

United States

Teaching of Food Science and Technology in the United States has been closely related to teaching of agricultural production in the universities. The number of institutions offering some teaching in Food Science and Technology has risen from only four or five universities in 1930 to more than 50 today. There are now about 2 universities with separate Departments of Food Science and/or Technology. In other institutions teaching may be through an inter-departmental committee or food processing may be taught in some other department. Departments are designated as Food Technology, Food Science, Food Science and Technology, Food Industries, or Dairy and Food Industries, but all teach the subject in essentially the same way. Activities related to food processing in the universities have been consolidated in recent years to give students broader commodity acquaintanceships, provide a more fundamental curriculum to better meet industry's needs, to coordinate research and to reduce costs through greater administrative and teaching efficiency and encouragement of larger student enrollments.

The Institute of Food Technologists and the American Dairy Science Association have studied education needs extensively through the years with the result that there has been a movement toward greater uniformity of curricula among the universities. The trend is toward stronger teaching of the fundamentals of physical and biological sciences and less emphasis on teaching of specific

commodities and processes. Both the University staffs and employers of graduates have recognized the desirability of some kind of minimum requirements for the bachelors degree to maintain high professional standards. The Institute of Food Technologists has formulated a model curriculum which has become a guide in organizing or improving curricula and making them more uniform. This model curriculum is shown on the following page.

There has been considerable development of graduate studies and research in Food Science and Technology in U.S. Universities. Graduate students increasingly need to undertake advanced study in organic, bio-, and physical chemistry and microbiology and other sciences. Only about five universities and two technical schools have two-year study programs in Food Technology.

The Institute of Food Technologists Model Curriculum

Subject	Suggested Semester-hours
Chemistry	
Inorganic	5
Qualitative	5
Quantitative	5
Organic	5
Physical	8
Food Chemistry-Analysis	4
Biochemistry and Nutrition	6
Biology	5
Microbiology	5
Food Microbiology and Sanitation	5
Mathematics	
Algebra	3
Analytical Geometry	3
Calculus	8
Physics	10
Food Processing	12
Unit Operations	10
English	6
Speech and Technical Writing	3
Economics	3
Humanities and Social Science	12
Physical Education and Military Training	8
Total	131

The Institute of Food Technologists Undergraduate Curriculum Minimum Standards

The Institute of Food Technologists has also recently (1966) adopted a more general description of minimum standards for undergraduate curricula in Food Science and Technology. The points made in these minimum standards are just as pertinent for other countries including Canada. The primary objective of the educational activities of I.F.T. is to enhance the professional competence of food scientists and technologists. The standards have been developed to evaluate the effectiveness of undergraduate education and, as well, they should be a guide for colleges and universities establishing or evaluating programs, for students in selecting the institutions that offer acceptable educational programs, and for ensuring wider recognition of Food Science and Food Technology as professional disciplines. There is diversity in curriculum requirements among universities, so a rigid pattern cannot be recommended. In addition, experimentation is encouraged in order to make use of changes and developments which are continually occurring. However, major deviations from the curriculum are discouraged.

The minimum standards note that Food Science and/or Technology departments should be organized as independent administrative units with responsibility for an adequate budget. A minimum of four faculty members is recommended, with the actual number commensurate with the diversity of courses offered. The fields of specialization must be carefully distributed over the disciplines fundamental to Food Science and Technology. Faculty members are

encouraged to participate in professional activities and should undertake individual research. Faculty salaries should be on a level sufficient to obtain highly qualified personnel.

Classroom laboratories should have fixtures and equipment to conduct the chemical, engineering and microbiological exercises required in courses in Food Science and Technology. Pilot plant facilities should be available to teach principles of unit operations and processes. Library facilities should be adequate to encourage and stimulate independent study and research.

The curriculum requires not only food-oriented courses but also courses in many other fields. Professional employment opportunities are so diverse that it is desirable to acquire a foundation in each related discipline and at the same time try to obtain some in-depth competence. Courses in Food Science and Technology should stress principles and a rigorous treatment similar to that demanded in other departments. The minimum Food Science and Technology courses required should be equivalent to the following:

Food Chemistry - the basic composition, structure and properties of food and the chemistry of changes occurring during processing and utilization.

Food Analysis - a study of the principles, methods and techniques necessary for quantitative physical and chemical analysis of food and food products.

Food Microbiology - relationship of habitat to occurrence of microorganisms in foods; microbiology of food spoilage and food manufacture; physical, chemical and biological destruction of microorganisms in foods; microbiological examination of foodstuffs; and

public health and sanitation bacteriology.

Food Engineering - engineering concepts and unit operations applied to food processing; engineering principles to include mechanics, transfer and rate processes, and process control instrumentation; unit operations to include fluid flow, heat transfer, evaporation, drying, extraction, distillation, filtration, mixing, and materials handling.

Food Processing - general characteristics of raw food materials; harvesting, assembling and receiving raw materials; methods of food preservation; processing objectives including factors affecting food acceptability and preferences; packaging, and water, waste disposal and sanitation.

The Food Science and Technology Department will probably also offer special courses for advanced undergraduates and graduate students. Supporting courses will be in English, Mathematics and Statistics, Physics, Biological Sciences, Humanities and Chemistry.

The I.F.T. program presents a minimum core of courses as a basis for preparation of the bachelor graduate food scientist or technologist. Considerable time for electives is thus available. Election of courses from a wide variety of disciplines is not recommended. Instead, the student should choose a complimentary discipline area and complete prerequisites enabling him to enrol in advanced courses in this discipline. Disciplines suggested for such concentration include Chemistry, Engineering, Microbiology, and Economics or Business Management.

The I.F.T. state that their minimum standards should be considered as an initial approach to be tested in actual use with re-evaluation and revision at frequent intervals.

Great Britain

Students can study at either the University or Technical College level in Great Britain. There are now four Universities offering degree course in Food Science (University of Strathclyde, University of Leeds, University of Nottingham, and University of Reading) and one in Food Technology (National College of Food Technology, Weybridge). In addition the course in Food Science at Borough Polytechnic, London, should shortly lead to a degree.

Courses are also becoming available for the food technologist or technician. The Department of Education and Science has set up a two-year full-time course which will be offered by a number of Colleges throughout the country, some of which will specialize for particular food industries. Diploma courses are also available in closely related fields including Applied Chemistry, specializing in Food Science, and Baking Technology, and Applied Biology, specializing in Food Science.

Europe

University education patterns for Food Science and Technology differ markedly between Europe and North America. In North America the trend for the universities has been towards an education of limited numbers of students in Food Science rather than Food Engineering. In Europe a 4-to-5 year training of a more technological or engineering type is given to a large number of students. For specialists in the various disciplines such as biochemistry, microbiology, and so on, food research establishments and industry rely on the supply of graduates from the appropriate general university departments.

In West Germany, Food Engineering is taught at the University of Karlsruhe. Several universities offer "Diplom-Chemist" engineering degrees in Food Chemistry as a special section of the Chemistry Department. A Food Science Department is contemplated at the University of Giessen.

In Finland, Food Technology is included in the agricultural course. There are facilities for a rather specialized training with Food Technology as the main subject.

In the Netherlands, the Agricultural University in Wageningen offers a four-year course up to a candidate degree and equivalent to a Bachelor of Science degree in Food Science with the possibility of a further 2½ years' specialized study leading to an engineering degree, the equivalent of a Master's degree.

Many food technologists are trained in Poland. Some universities offer full courses in Food Technology, while others are more specialized and give courses, for example, in Meat Technology.

In East Germany, three-year courses in Food Engineering are offered in several engineering schools. Two universities give higher education, with the degree of "Diplom-Engineer". One engineering school educates engineers in Meat Technology.

In the Soviet Union education in Food Technology is given at about six institutions. Training takes 4½ to 5½ years; in most places this includes considerable work in industry. Approximately 2,500 persons, including dairy technologists, graduate annually in this field at day or evening schools, or through correspondence courses.

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Many seem to specialize in refrigeration or mechanical engineering. In addition, there are programs of study specializing in economics and organization, or in food technology at departments of animal husbandry or veterinary science respectively. In addition, some of the veterinary facilities offer special training for veterinarians who are to specialize in food technology; approximately 150 are trained annually. There are also semi-professional schools which train a number of food technicians.

Food Science Education in Canadian Universities

Introduction

Five Canadian universities have established complete programs in Food Science while some others have closely related programs. In order to appreciate the nature of the program one should try to define Food Science. A number of definitions have been used. One good definition is: "Food Science is primarily concerned with the understanding of the nature of food materials, including the chemical, physical and biochemical aspects, the scientific principles of methods of processing and preservation, the causes of spoilage, and improvements in foods to give a quality of product both nutritive and attractive to the consumer"

The Food Scientist must be conversant with the relevant aspects of chemistry, biochemistry, biology, microbiology, physics, mathematics, and engineering. He will frequently also need to study the raw materials of foods and thus be knowledgeable in certain aspects of the agricultural sciences, horticulture, entomology, parasitology, pathology, ecology and toxicology. He must be familiar with the many methods of research, control and analysis which are based on instrumental, physical and chemical techniques.

Food Science is the application of many different branches of science to the study of food and although it is a comparatively young subject, already there has accumulated a considerable store of fundamental knowledge, in particular from a number of government research laboratories, from universities already established, and from the laboratories of industry itself.

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Food Science has, therefore, now been accepted as a subject for study at undergraduate and graduate levels in a large number of universities. Seven universities in Great Britain offer university level programs and have departments, and about 25 U.S. universities have established separate departments. In Canada there are now departments at the University of Alberta, University of Manitoba, University of Guelph, and Laval University. There is a sprinkling of departments in many other countries of the world. In addition, several universities are presently establishing Departments of Food Science. All these universities have recognized that, in order to prosper, Food Science must be established under a separate administrative unit responsible to a single departmental chairman.

Departments of Food Science and interdepartmental curricula in Food Science are most frequently associated with Faculties of Agricultural Sciences. While there are a number of potential hazards in such arrangements, there are also a number of distinct advantages. For example, in considering processing and preservation of foods it is often necessary to relate to production of the foods and thus integrate with the agricultural sciences. A knowledge of the physiological, chemical and structural changes occurring during growth and production, and of post-harvest and post-mortem physiology, enables the food scientist to select the variety or strain or raw material adapted to a particular preservation process and to improve the quality and storage stability of the processed food. Some knowledge of Plant Pathology, Entomology and Parasitology is necessary for the control of insect pests, rodents and parasites on

the raw materials in storage of food. Plant and animal physiology and genetics may be needed to allow the study and breeding of new plant and animal strains suitable for fresh food or processing. The Food Scientist must also have an appreciation of the problems of economics and marketing. There are many other examples of the relationship of Food Science to the agricultural sciences. The presence of specialists in the various agricultural sciences within a Faculty of Agriculture means that the related production and economic factors will be given the appropriate expert attention. Food Science is often considered as one of the Agricultural Sciences because of the many interrelationships with the other production Agricultural Sciences.

At the same time, it must be recognized that the number of traditional Agriculture courses which can be included in a Food Science curriculum must be strictly limited in order to provide the time required to present a full program in fundamental sciences and their application to food and food processing.

It is essential that a strong association also be maintained with Engineering. There are many problems in developing processes and designing commercial plants because of the tendency of foods of plant or animal origin to change in chemical composition, appearance, flavour, or nutritive value as a result of physical treatment, such as heat treatment which is so vital in many processes. The Food Scientist must have some knowledge of the principles of food engineering in order to work with, and perhaps advise, his engineering colleagues. As well, he must know much more of the scientific principles and

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properties of the foodstuffs. He must be able to understand problems of heat and mass transfer of food materials, process flow for batch and continuous processes, and plant and factory design and hygiene. He must also be concerned with improvements in unit operations such as mixing, separation, concentration and evaporation, and should have the ability to recognize unsolved problems in a particular process and with his knowledge, to assist in the solution of these and to modify equipment in the light of economic and mechanical limitations.

University of Alberta

An interdisciplinary program focused on the Department of Food Science has been created to attract more students to the field of Food Science. The program is designed so that students may register in it immediately on entering university or may transfer from the Faculty of Agriculture or Science after their first or possibly second years. The program is administered by a committee consisting of the Deans of the Faculties of Science and Agriculture, the Director and a Faculty member of the School of Household Economics and the Head of the Department of Food Science who is the co-ordinator of the program.

The curriculum for the B.Sc. (Fd. Sc.) program is shown on the following page. The program has many required courses to establish the essentials of Food Science but there are options in each year to permit students to specialize within the program. Each undergraduate student is encouraged to spend at least one summer working in some aspect of the food industry.

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Graduate studies leading to the M.Sc. and Ph.D degrees are offered in the Department of Food Science. A great many applications for graduate studies are received each year but the numbers of graduate students must be limited by the extent of financial support which the department and individual staff members receive and the amount of time which each staff member can devote to graduate students in relation to his other duties.

The teaching staff consists of Dr. Lawrence F.L. Clegg, Head of the Department, whose primary interest is in Microbiology; Professor Frank W. Wood, Food Processing; Dr. J.M. DeMan, Food Chemistry; Dr. H. Jackson, Microbiology; and Dr. J.G. Armstrong, Research Associate in Food Chemistry. There is at present a vacancy for a food engineer.

University of Alberta (1967-68)

Four-year Program Leading to B.Sc. (Fd. Sc.)

Five full courses per year

Year	Subject	Number	Content	Full course or Half course
First	English	210		Full
	Chemistry	230	Inorganic Chemistry	Full
	Chemistry	250	Organic Chemistry	Full
	Mathematics	180	Trigonometry or Calculus)	Full
	or	201	Calculus)	
	Food Science	200	Introductory Food Science	Half
	Biology or option	130		Half
	Physical Education	228		
Second	Microbiology	360	General Microbiology	Full
	Physics	100	General Physics	Full
	or	200		
	Biochemistry	300	General Biochemistry	Full
	Chemical Engineering	224	Engineering Thermodynamics	Half
	Food Science	250	Food Processing	Half
	Option			Full or Two Halves
Third	Chemistry	312	Quantitative Analysis	Full
	Chemistry	370	Physical Chemistry	Full
	Food Science	451	Food Processing	Half
	Food Science	465	Food Microbiology	Half
	Food Science	466	Dairy Microbiology	Half
	Food Science	475	Food Chemistry	Half
	Option			Full or Two Halves
Fourth	Household Economics	458	Nutrition	Full
	Agricultural Engineering	305	Materials Handling and Processing	Half
	Food Science	452	Food Processing	Half
	Food Science	474	Food Analysis and Quality Control	Half
	Food Science	480	Food Engineering	Half
	Food Science	481	Food Engineering	Half
	Food Science	561	Advanced Food Microbiology	Half
	Option			Full or Two Halves

Recommended Options:

Subject	Number	Content	Full course or Half course
Accounting	202	Fundamentals of Accounting	Half
Anthropology	202	Introductory Anthropology	Full
Biometrics	455	Statistics	Full
Business	300	Administrative Principles	Full
Chemistry	350	Organic Chemistry	Full
Food Science	241	Principles of Milk Production	Half
Food Science	353	Processing Dairy Products	Half
Food Science	476	Dairy Chemistry	Half
Food Science	560	Industrial Microbiology	Half
Food Science	562	Industrial Microbiology	Half
Food Science	563	Industrial Microbiology	Half
Food Science	571	Food Rheology	Half
Food Science	572	Sensory Analysis	Half
Economics	200	Principles of Economics	Full
Entomology	200	General Entomology	Half
Geology	203	Historical Geology	Full
Mathematics	240	Calculus	Full
Plant Biochemistry	431		
	432	Plant Biochemistry	Full
Political Science	200	Elements of Political Science	Full
Psychology	202	Introduction to General Psychology	Full
Rural Sociology	300	Introduction to Rural Sociology	Half
Sociology	202	Introductory Sociology	Full
Statistics	205	Introductory Statistics	Half
Statistics	255	Elementary Statistics	Full

Specific details on some of the courses in Food Science are as follows:

Introduction to Food Science - Historical and philosophical aspects of food processing and its relation to man's health and well-being. World's food supply and its use by human populations. Trends in the processing, preservation, handling, and utilization of food.

Elements of Food Processing - An introduction to the scientific and technical principles involved in unit operations and processes applied in the commercial manufacture of food products.

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Industrial Food Processing - A study of the commercial processing of food products with particular emphasis on the unit operations involved in fruits and vegetables. The function of management and quality control; grading and packaging standards. A second course with same title presents freezing, dehydration, freeze drying, concentration and fermentation of commercial foods. New product development and marketing of processed foods.

Food Microbiology - The microbiology of the food and allied industries including sterilization and preservation, food poisoning, food spoilage, the contamination of air and water, the disposal of domestic and industrial wastes.

Industrial microbiology - Three courses concerning techniques of industrial microbiology including studies of the industrial significance of microorganisms.

Food Analysis and Quality Control - The scientific principles underlying the chemical, physical and sensory methods of food analysis. Qualitative estimation of food constitutents and chemical additives. Application of instrumental methods to the analysis of foodstuffs.

Food Chemistry - Chemical and physical properties and composition of food fats, proteins and carbohydrates. Food flavours, additives in foods. Effect of processing on some chemical and physical properties of foods.

University of British Columbia

The teaching of Food Science is administered by an interdepartmental committee within the Faculty of Agriculture but

the formation of a separate Department of Food Science is in its final stages. The interdepartmental committee has included representation from Agricultural Engineering, Animal Science, Plant Science and Poultry Science. The program for the Bachelor degree consists of four years of Science, Humanities, Food Science and supporting courses, modeled closely after the Institute of Food Technologists Model Curriculum. The curriculum is at present undergoing revision and will not be shown in this report. Students taking a general course in the Faculty of Science are encouraged to transfer into the Food Science program after first or second year provided that their performance and courses taken are satisfactory. Graduate studies are offered in Food Science leading to the Masters degree. The Ph.D. degree may be taken in co-operation with one or more of the Agricultural Sciences.

The teaching staff consists of Professor Ernest L. Watson, Chairman of the Committee, whose primary interest is in Food Engineering; Dr. S. Nakai, Dairy Products Processing and Protein Chemistry; Dr. D.P. Ormrod, Plant Products and Food Chemistry; Dr. J.F. Richards, Poultry and Animal Products and Dr. P.M. Townsley, Industrial Microbiology.

University of Guelph

The establishment of a Food Science Department at the University of Guelph has just been approved and a new degree program has been devised which should provide highly satisfactory graduates. The specific facilities and the staffing of the department have not

yet been determined. Strong support for the program of the new department should come from the present Departments of Dairy Science, Nutrition, and other well-established departments of the university.

The new degree program has been planned to prepare graduates for professional work in various food industries in research and product development, as well as in government service and teaching. The new program is strongly based in Science, particularly in Chemistry and Microbiology. The program, which is four years in duration after Ontario Grade 13, allows considerable flexibility and permits students to specialize in one of the following thee areas:

(1) The science aspects of the food industry with additional courses in physics, biochemistry and nutrition.

(2) Food technology and engineering with additional courses in food technology, meat science and food processing.

(3) The business management side of the food industry with emphasis on programs in accounting, business management, finance, and industrial psychology.

The Food Science Curriculum may be summarized as follows:

University of Guelph

Food Science Curriculum Summary

	Credit Hours
Food Science	26.5
Biological Sciences	
Biochemistry	7.0
Nutrition	3.0
Biology	7.0
Microbiology	13.5

	Credit Hours
Physical Sciences	
Chemistry	21.5
Physics	7.0
Mathematics and Statistics	12.5
Agriculture	6.0
Economics	3.0
Engineering	9.0
Humanities	15.0
Electives	16.0
Total credit hours (4 yr. program)	147.0

University of Guelph (Starts 1968)

Four-year Program leading to B.Sc.

Two separate semesters per year

Year		Subject	Number	Content
First	Semester 1	English	110	Modern American Literature
		Philosophy	100	Logic and Philosophical Methods
		Chemistry	100	Fundamental of Chemistry I
		Biology	100	The Nature of Living Things I
		Physics	100	Fundamental Laws of Physics I
		Mathematics	100	Introductory Calculus I
	Semester 2	English	111	Modern British Literature
		Chemistry	101	Fundamental Chemistry II
		Chemistry	129	Organic Chemistry
		Biology	101	The Nature of Living Things II
		Physics	101	Fundamental Laws of Physics II
Second	Semester 3	Mathematics	101	Introductory Calculus II
		Animal Science	200	Animal Science
		Chemistry	200	Quantitative Analysis
		Chemistry	225	Biochemistry
		Food Science	200	Introductory Food Science
		Option		Humanities or Social Science. (One course)
	Semester 4	English	311	Canadian Literature
		Plant Science	220	Plant Science
		Chemistry	226	Biochemistry
		Microbiology	200	General Microbiology
		Statistics	200	Introductory Statistics
		Economics	110	Introduction to Economics

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Year		Subject	Number	Content
Third	Semester 5	Chemistry	213	Physical Chemistry I
		Food Science	300	Food Science I
		Food Science	301	Analytical Techniques I
		Food Science	302	Food Engineering
		Food Science	305	Plant Sanitation and Waste Disposal
	Semester 6	Chemistry	313	Physical Chemistry II
		Microbiology	303	Food Microbiology
		Food Science	303	Food Science II
		Food Science	304	Analytical Techniques II
		Food Science	306	Food Science Laboratory
		Electives:		
		Physics	201	Modern Physics
		OR		
		Food Science	307	Concentrated and Dehydrated Foods
		OR		
		Agricultural Economics	321	Accounting I
Fourth	Semester 7	Food Science	400	Nutrition I
		Food Science	401	Food Additives, Adulterants and Toxicants
		Food Science	405	Industrial Food Processes
		Food Science	404	Seminar
		Electives:		
		Chemistry	425	Biochemistry
		Biology	200	The Nature of Living Things III
		OR		
		Poultry Science	300	Poultry Products
		Animal Science	321	Meat Science
		OR		
		Food Science	407	Processing of Fats and Oils
		Dairy Science	426	Dairy Processing I
		OR		
		Agricultural Economics	331	Business Production
		Agricultural Economics	332	Business Finance
	Semester 8	Microbiology	306	Industrial Microbiology
		Mathematics	431	Computer Programming
		Food Science	403	Quality Evaluation of Foods
		Food Science	406	Food Research Problem
		Electives:		
		Chemistry	426	Biochemistry
		Food Science	402	Nutrition II
		OR		
		Horticulture	327	Processing of Fruits and Vegetables

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Year	Subject	Number	Content
	Animal Science	429	Principles of Meat Processing
	OR		
	Dairy Science	427	Dairy Processing II
	Physiology	—	Human Physiology
	OR		
	Agricultural Economics	335	Cost Accounting
	Psychology	481	Industrial Psychology

The following are a few details of the new courses which will be offered at the University of Guelph in its new Food Science program.

Introductory Food Science - Introduction to the terminology, scope, theory and practice of Food Science. Food supply, quality, storage, processing and costs. Classes of food, nutritive components, and functions in metabolism.

Food Science I and II - Significance and control of chemical, physical and biochemical changes occurring in foods as related to lipid oxidation, natural pigments and colour, odour, texture, and nutritive value of foods. Principles and fundamental concepts of these changes during ripening, storage, processing and manufacture of foods. Part I: Emphasis on fats and oils, cereal grains. Part II: Fruits and vegetables, meats, poultry, fish eggs, dairy products.

Analytical Techniques in Food Science I and II - Studies of the physical and chemical properties of food constituents employing elementary and advanced techniques of instrumental analysis. The second course emphasizes the principles, methods and techniques of instrumental analysis.

Food Engineering - Principles and application of machines, equipment and systems to the preservation and processing of foods.

Food Plant Sanitation and Waste Disposal - The principles and practices of food plant sanitation, disinfection and waste disposal.

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Concentrated and Dehydrated Foods - Processes for concentration by heat, reduced pressure, crystallization and freezing.

Food Additives, Adulterants and Toxicants - Principles and problems in evaluating the wholesomeness and safety of foods, food components, additives and adulterants as well as evaluating types and sources of toxicants.

Quality Evaluation of Foods - Theory and practice of interpreting and correlating various objective and subjective parameters of food quality. Industrial quality control and grade standards, panel testing.

Seminar - Interpreting data and preparing and presenting oral and written reports on current problems and developments in Food Science.

Industrial Food Processes - Lectures on selected industrial food processes by industry representatives and consultants. Plant tours and reading assignments.

Food Research Problem - A literature review of a minor research problem together with practical laboratory work.

Laval University

The Food Science Department of Laval University was established in 1962 as one of eight departments within the Faculty of Agriculture. The facilities occupy 40,000 square feet and include a general laboratory for 60 undergraduate students, a pilot plant, 25 refrigerated rooms, a laboratory for sanitation and quality control,

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an organoleptic laboratory, an irradiation laboratory, and a research laboratory for 60 graduate students. The equipment available for teaching and research is superb.

The Department offers a 4 year program in Food Science leading to the degree of B.Sc. Agr. (Food) and graduate programs leading to the M.Sc. and D.Sc. The undergraduate program is detailed on the following page. It is modeled closely after the I.F.T. recommended curriculum and includes several credits in industrial management. Candidates for Masters and Doctor's degrees are frequently recruited from various science departments and each program at the graduate level is individually fitted to the student's needs. Among the graduate students there are at present graduates from Chemical Engineering, Chemistry, Mechanical Engineering, Dietetics, Biochemistry, Dairy Industry, Agriculture and Food Science. Assistantships are available for qualified graduate students.

The teaching staff consists of Dr. R.R. Riel, Directeur, Unit Operations and Dairy Products; Dr. M. Boulet, Enzyme Chemistry and general Food Science; Prof. J.P. Julien, Food Chemistry and Dairy Products; Dr. J.R. Moreau, Sanitation, Quality Control and Meat Products; and Prof. G.B. Martin, Fish Products.

Laval University

Four-year Program leading to B.S.A. (Vivres)

Year	Subject	Number	Content	Full course or Half course
First	Agrobiology	310	Mathematics I	Half
	Agrobiology	311	Mathematics II	Half
	Agrobiology	314, 314a	General Chemistry I	Half
	Agrobiology	318, 318a	General Chemistry II	Half
	Agrobiology	312, 312a	Physics I	Half
	Agrobiology	313, 313a	Physics II	Half
	Agrobiology	315, 315a	Animal Anatomy and Histology	Half
	Agrobiology	316, 316a	Vertebrate Zoology	Half
	Agrobiology	317, 317a	Botany I	Half
	Agricultural Economics	411	General Sociology	Half
	Agricultural Economics	422		Half

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Year	Subject	Number	Content	Full course or Half course
Second	Agrobiology	320	Mathematics III (Probability)	Half
	Agrobiology	321, 321a	Organic Chemistry	Full
	Agrobiology	322, 322a	Physical Chemistry	Full
	Chemistry	103, 104	Analytical Chemistry	Half
	Agricultural Economics	420	Introduction to Economics	Half
	Soil Science	720, 720a	Soils	Half
	Agrobiology	330, 330a	Statistics	Half
	Agrobiology	323, 323a	Biochemistry	Half
	Agrobiology	327, 327a	General Microbiology	Half
	Agricultural Economics	443	Rural Geography	Half
Third	Plant Science	630, 630a	Plant Physiology	Half
	Agricultural Economics	430	Agricultural Economics	Half
	Food Science	831, 831a	Food Chemistry	Half
	Agrobiology	331, 331a	Food Bacteriology	Half
	Food Science	832, 832a	Industrial Processes	Half
	Animal Science	932, 932a	Animal Nutrition	Half
	Plant Science	633	Horticulture I	Half
	Animal Science	931	Animal Production I	Half
	Agricultural Engineering	531, 531a	Food Engineering	Half
	Food Science	833, 833a	Food Science II	Half
	Agricultural Economics	412	Communications	Half
Fourth	Agrobiology	340, 340a	Applied Microbiology	Half
	Food Science	840, 840a	Sanitation and Quality Control	Half
	Food Science	841, 841a	Science of Milk Products I	Half
	Food Science	844	Industrial Statistics	Half
	Food Science	845	Food Industry Economics	Half
	Food Science	847		Half
	Food Science	848, 848a	Food Analysis	Half
	Agriculture	140	Seminar	Half
	Agrobiology	342, 342a	Descriptive Bacteriology	Half
	Agricultural Economics	441	Agricultural Products	Half
	Food Science	834, 834a	Meat Science	Half
	Food Science	842, 842a	Science of Milk Products II	Half
	Food Science	846	Linear Programming	Half
	Food Science	849	Projects	Half

University of Manitoba

A new Department of Food Science has been created from the long-established Department of Dairying. Facilities formerly used by Dairying have undergone extensive renovation and a new building presently being used by the Federal Department of Fisheries will ultimately be used by the Department of Food Science. The Departments of Plant and Animal Science also maintain

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some processing facilities in their physical plant but a close degree of co-operation is anticipated in future processing research. Common approaches to food problems will also be taken with the School of Home Economics.

Student numbers are increasing rapidly in Food Science at the University of Manitoba both at the undergraduate and graduate level. The Department attempts to locate interested students in their first year at the University, whether in Science or Agriculture, to ensure that appropriate course patterns are followed. Any qualified student may transfer into the program but he must bring himself up to the level of the students already in the program.

The objective of the Department is to concentrate on helping students obtain a good understanding of the basic principles of their profession, suitably illustrated by practical examples. They are shown how to apply these principles in the food industry. They are also taught where to look for existing knowledge of the type required, how to systematically retrieve, store and use it, how to develop new knowledge through research, and how to effectively communicate knowledge to others.

The teaching staff consists of Dr. R.A. Gallop, Head of the Department, whose primary interest is in food processing; Dr. M.B. McConnell, processing in relation to water and waste; Dr. H.M. Henderson, food enzymes; and Dr. P. Cansfield, food pigments. The Department hopes to appoint a biochemical engineer in the near future.

The curriculum for the four-year course leading to the B.S.A. degree in Food Science is as follows:

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University of Manitoba (1968-69)

Four-year Program Leading to B.S.A.

Five full courses per year

Year	Subject	Number	Content	Full course or Half course
First	Chemistry	2.120 or 2.122	Elementary or Organic	Full
	Mathematics	13.136 or 13.137 or 13.120	Calculus or Algebra	Full
	Biology	71.125	Principles of Biology	Full
	Economics	18.120	Principles of Economics	Full
	Agriculture	65.105	Agriculture I	Full
Second	Genetics			Half
	Soil Science			Half
	Plant Science			Half
	Animal Science			Half
	Statistics	32.221		Full
	Chemistry	2.220	Organic	Full
	Microbiology	60.220	General Microbiology	Full
Third	Food Science	78.312	Food Processing	Full
	Food Science	78.415	Food Microbiology	Half
	Food Science	78.___	Food Chemistry	Full
	Chemistry	2.330	Biochemistry	Full
	Humanity Option (Group A)			Full
	Option (Group A or C)			Half
Fourth	Food Science	78.416	Food Analysis	Half
	Food Science		Food Quality Control	Half
	Food Science	78.412	Food Seminar	Half
	Option (Group A)			Equivalent of 2 Full
	Option (Group B or C)			Equivalent of $1\frac{1}{2}$ Full

Optional Courses

Group A	Philosophy	15.226	Philosophical Perspectives	Full
	Psychology	17.120	Introduction	Full
	Sociology	77.120	Introduction	Full
	Economics	18.338	Transportation	Full
	Business Administration	32.225	Fundamentals of Marketing	Half
	Business Administration	32.227	Corporation Finance	Half
	Business Administration or others with approval	32.228	Administrative	Half

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Year	Subject	Number	Content	Full course or Half course
Group B	Physics	16.121		Full
	Chemistry	2.340	Physical Chemistry	Full
	Computing Science	74.202	Introduction to Computing	Half
	Computing Science	74.303	Computing Methods	Full
	or others with approval			
Group C	Food Science	78.414	Food Problems	Half
		34.414	Refrigeration and Storage	Half
		34.___	Plant Mechanics	Half
	or others with approval			

Description of the contents of several of the undergraduate Food Science courses is as follows:

Food Processing -- Principles and practices in food processing, with emphasis on chemical, physical and microbiological aspects.

Food Problems - Assigned problems related to food products.

Food Microbiology. A study of the relationships of micro-organisms to the processing and spoilage of food.

Food Analysis - A study of practices used in the physico-chemical analysis of food products. The functions and operations of a plant laboratory will also be included.

Food Chemistry - The constituents of food and their properties, with emphasis on carbohydrates, vitamins, proteins, lipids, pigments and flavours.

Quality Control in Foods - The fundamentals of quality control and their application through physical, chemical, microbiological and sensory methods.

A group of graduate courses is also available including Advanced Food Microbiology, Advanced Food Analysis, Water and Wastes in Food Processing, Food Enzymes and Food Additives.

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Food Science Research in Canadian Universities

Introduction

Research in Food Science is centered in the Departments of Food Science where such departments exist. Research is closely related to graduate studies at every institution. In addition, projects closely related to Food Science may be found in many Agricultural Science Departments. There are very limited numbers of Food Science research projects at universities which have no formal educational program in Food Science or Agriculture.

The Food Research Information Office of the Canada Department of Agriculture summarized in 1966 the research underway in Canadian Universities. They used the National Research Council data on graduate student thesis topics to compile their list. The topics were noted to concern food product quality, including the preservation and modification of quality characteristics in the use of food.

University of Alberta

As in other universities research work in Food Science is closely related to graduate studies in the Department of Food Science. Financial support for research and graduate studies comes from research grants to individual members of staff and from University support of Graduate Teaching and Research Assistantships. The number of graduate students working in the department varies from 12 to 20.

Faculty members and their research interests are as follows: Dr. Lawrence F.L. Clegg is directing research in chemical disinfection, spores, coliforms and dairy hygiene; Professor Frank W. Wood in physical properties of butter, destabilization of fat, continuous buttermaking, canned butter, caramelization of canned sweet corn, and off flavour removal from milk and cream; Dr. J.M. DeMan in chemistry of fats and oils, including glyceride structure, autoxidation, rheology and crystallization, effect of light on foods, food texture and colour, heat and enzyme stability of milk proteins and cheese flavour; Dr. H. Jackson in temperature effects on microorganisms, with particular reference to psychrophilic and thermophilic bacteria, microbial modification of soybean milk for the production of a soybean cheese of good nutritional value, keeping quality and acceptability, and staphylococcal food poisoning; Dr. J.G. Armstrong who is Officer-in-Charge of the Alberta Dairymen's Association Research Unit. The research in this unit has concerned oxidation deterioration of butter, butter flavour, effects of pro-oxidants on butterfat, storage life of butter, a rapid direct method for the determination of fat in butter, the use of dielectric constant measurements as indicators of moisture content and moisture dispersion in butter, the flavour of pasteurized milk, the storage life of cottage cheese, and the quality of cream for butter making.

Post-doctorate fellows assist staff members with research. Presently three fellows are working in the department, studying new bacteria isolated from milk, chemical disinfectants for dairy purposes, extraneous matter in cream, and food irradiation.

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Other research related to Food Science is conducted in the Department of Animal Science with studies of nutrition and meat science, the Department of Biochemistry with nutrition and enzyme studies, and the Department of Plant Science with studies of plant products.

University of British Columbia

Faculty members and their research interests are as follows: Dr. S. Nakai is directing research in protein chemistry and the technology of milk products including determination of functional amino acid residues of k-casein for stabilizing milk protein systems and milk products, Dr. D.P. Ormrod is directing research in food colour measurements, chemical composition of fruits and vegetables and application of irradiation to preservation of fruit and vegetables; Dr. J.F. Richards is directing research on the emulsifying properties of poultry meat, methodology of egg yolk colour determination, fat content and sensory quality of turkey broilers, and factors influencing egg shell quality; Dr. P.M. Townsley is interested in the utilization of natural materials and industrial wastes for the production of food and other products, together with studies of the fermentation of petroleum, pulp mill wastes, foods and various carbon sources; and Professor E.L. Watson directs research on heat and moisture movement in fruit and vegetables during cooling and storage, physics of freeze-drying, and rheology of fruit purees and of pectin gels.

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Other departments conducting research related to Food Science include Poultry Science and Animal Science with nutrition studies. In addition, the School of Home Economics is conducting human nutrition research.

University of Guelph

There is already considerable research related to Food Science underway at the University of Guelph even though the Food Science Department has been only recently established. It is anticipated that the new department will conduct many research projects of direct interest to the food industry in addition to the contributions of several other departments.

The Dairy Science Department at the University of Guelph has a large number of dairy research projects underway. There is a large staff with well-equipped chemical and bacteriological laboratories and a pilot plant. The research interests of some of the faculty members are as follows: Professor A.M. Pearson, problems with ice cream; Dr. D.R. Arnott, market milk; Professor D.A. Biggs, dairy and physical chemistry; Dr. D.H. Bullock, concentrated dairy and food products and dairy mechanics; Dr. D.M. Irvine, cheese and dairy mechanics; Professor A.G. Leggatt, dairy microbiology, analysis of dairy products, and quality control; and Dr. A.N. Myhr, dairy processing. Recent specific research projects have been concerned with the use of infrared milk analyzers, use of preservatives, microbial studies, processing methods, new products and other subjects.

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The Department of Nutrition has some research programs underway which relate closely to Food Science. Dr. D.C. Hill is working on the separation and utilization of wheat milling functions including an aleurone concentrate. He will be concerned with the utilization of this material in pasta products and biscuit mixes and will be collaborating with the staff of the Macdonald Institute on human diet studies. Dr. B.L. Walker is engaged in isolating and identifying the minor components of rapeseed oil, a number of which interfere with hydrogenation. Two members of the department are presently on loan to the Department of Biochemistry, Nutrition, and Food Science of the University of Ghana.

Other units on the campus with some research related to Food Science include the Macdonald Institute Department of Food and Nutrition which has a number of laboratory items for testing procedures. The Department of Animal Science has a meat research program and their new facilities contain a very detailed and elaborate meat science research section. The Department of Poultry Science has facilities for handling poultry, meat and eggs.

University of Manitoba

Research work in the Department of Food Science is concerned with gaining a better understanding of the materials, processes, microorganisms, and other factors, which are of major concern in Food Science, with a view to the use of this information in helping to solve some of the practical problems of the food industry. Present research projects include (a) the preservation of whitefish, eggs and poultry, by means of gamma irradiation; (b) the possible

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use of high gamma irradiation for controlling the microbial quality of process water during recirculation, and for assisting in the reclamation of this water; (c) the origin and control of Mastitis problems in milk; (d) the occurence and possible methods of control of pathogenic microorganisms, such as Salmonellae, in various foodstuffs; (e) the fixation of flavonoid pigments in plant tissues when processed; and (f) the influence of sprout inhibiting levels of gamma radiation on the composition and quality of potatoes when processed.

The research interests of the faculty members are as follows: Dr. R.A. Gallop, potato chemistry and processing, waste disposal and water utilization; Dr. M.B. McConnell, processing in relation to water and waste, food processing; Dr. H.M. Henderson, food enzymes, particularly phenolases, carbohydrases and myrosinases in rapeseed; and Dr. D.E. Cansfield, flavonoids and other food pigments.

Other Universities

There are several research projects in Food Science at each of Laval University, the University of Toronto and Macdonald College of McGill University as noted elsewhere in this report. Other universities have limited numbers of or no Food Science research projects. The Survey of Food Research in Canadian Universities by the Food Research Office in 1966 indicated that one or more projects related to Food Science were being carried out at several other Canadian universities. Included are Brock University (one

project in Chemistry), Carleton University (two in Biology), McGill University (several projects in Biochemistry, Botany, Chemistry and Zoology), Memorial University (several projects in Biology), Université de Montreal (several projects in Microbiology, Biology, and Dietetics and Nutrition), Mount Allison University (one project in Home Economics), University of Ottawa (one project in Biology), Queen's University (three projects in Pharmacology), University of Saskatchewan (many projects in Animal Science, Chemistry, Crop Science and Dairy Science) and University of Western Ontario (projects in Botany, Medical Research, Pathological Chemistry and Physiology). However, very few of the projects were directly related to food processing and preservation. Instead, the majority were concerned with nutritional problems.

Food Technology in Canadian Colleges and Institutes of Technology

Introduction

The establishment of Institutes of Technology in the provinces of Canada through the Federal-Provincial Vocational Technical education plan has provided a means whereby young people can be technically trained in the area of food processing as well as in a great many other disciplines. A few Institutes have been quick to realize the value of including a course in food processing technology while others have very recently recognized the possibility of offering a course catering to the needs of the food processing industry. Most Institutes have not yet chosen to include food processing in their total program. In Ontario, the Institutes are being amalgamated with the Colleges of Applied Arts and Technology, and two of these colleges are starting to teach Food Technology.

There has been and still is a good deal of confusion as to what constitutes a satisfactory academic program in Food Technology in a two or three-year Institute course. The Canadian Restaurant Association has made a submission to the Colleges of Applied Arts and Technology in Ontario in which it emphasizes the needs of the Food Service Industry. It should be made very clear that the purposes and program of a course for this industry differ considerably from those of the Food Processing Industry. The Restaurant Association recommended that the emphasis in a two-year program be placed on the functions of management, with the knowledge and practice of preparation and service of foods being secondary. They also recommended that their academic program be strongly integrated with on-the-job training and that there be an industry advisory committee for each program. It is interesting to note that this group also called for university degree programs in their area of interest.

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The Ontario Dietetic Association also submitted a brief to the Ontario Department of Education relative to courses of interest to them at the Colleges of Applied Arts and Technology. They called for courses to educate persons for supervisory positions in the food service industry and for the planning of curricula by educators and industry representatives. The Dietetic Association brief takes care to point out that the qualifications for membership in their association include university graduation and that the graduates of food science technician, hotel and institutional management, and hotel and restaurant management courses might best be referred to as food service supervisors. An elaborate classification system for food service supervisors is proposed.

The Food Processing Industry has also, in several locations, supported the establishment of Food Processing Technology courses in the Institutes. Industry personnel have served enthusiastically on advisory committees and have many valuable suggestions on curriculum and on the equipment and physical plant required for effective teaching.

British Columbia Institute of Technology, Burnaby, B.C.

A two-year course in Food Processing Technology has been offered at the B.C. Institute of Technology since the Institute's inception five years ago. There are four full-time faculty members in Food Processing Technology and there is an advisory committee of five persons from industry, government and education. About 20 students are admitted each year to the program.

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The course in Food Processing Technology provides a knowledge of the basic sciences and then proceeds to technical courses in quality control methods, food analysis, food preservation, sanitation, instrumentation, processing machinery, and business management. There is a well-equipped experimental processing laboratory that enables students to become familiar with food processing methods and testing procedures. There are numerous field trips to industrial food plants and laboratories to allow study of the operations performed in commercial food processing.

A Food Production Technology option has recently been added to the Food Processing Technology option and the two together are called Food Technology.

The staff in Food Processing Technology consists of R.B. Hyde, Department Head, Food Processing; S.B.J. Anderson, Food Microbiology; S.L. Hanson, Food Mechanics, Miss J.F. Wylie, Food Chemistry and Analysis.

The curriculum in Food Processing Technology is as follows:

	Subject	Hours per week Lecture	Lab
Year 1, Term 1	Writing and Contemporary Thought	2	1
	Mathematics	3	2
	General Chemistry	3	3
	Introductory Physics	3	3
	Food Microbiology	2	4
	Biology	2	3
	Tutorials	-	4
		15	20

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	Subject	Hours per week Lecture	Lab
Term 2	Writing and Contemporary Thought	2	1
	Mathematics	3	2
	General Chemistry	3	3
	Introductory Physics	3	3
	Food Microbiology	2	3
	Food Processing	3	3
	Tutorials		4
		16	19
Year 2, Term 3	Writing and Contemporary Thought	1	1
	Instrumental Analytical Methods	2	3
	Introductory Food Analysis	2	3
	Mechanics of Machines	2	3
	Instrumentation	-	3
	Business	2	1
	Food Processing	2	3
	Quality Control	1	3
	Tutorials	-	3
		12	23
Term 4	Writing and Contemporary Thought	1	1
	Instrumentation	-	3
	Work Study	-	2
	Food Processing	2	3
	Process Analysis	2	3
	Quality Control	1	3
	Food Analysis	2	3
	Sanitation	2	3
	Tutorials	-	4
		10	25

Specific details on the courses in Food Processing Technology are as follows:

Food Microbiology - An introductory course in food microbiology with emphasis on bacteriological techniques. The use and care of the microscope. The isolation of bacteria for purposes of differentiation and classification by morphological, cultural and biochemical methods. The use of desirable microorganisms in the food industry. Shelf-life studies. Maintaining high bacteriological

standards in fresh and processed foods. Micro-organisms of significance to agriculture. Assessing microbiological test results and report writing to management.

Food Processing - The composition of foods. Nutritional aspects. An introduction to the processes of canning, freezing, pasteurizing, dehydrating, salting, smoking, fermenting, and treating food with ionizing radiations. Experimental lots of food are preserved by these methods during laboratory periods.

Food Processing - Detailed studies of specific food-manufacturing processes, including dairy products manufacture, fruit and vegetable processing, jams and jellies, fish and meat products, edible fats and oils, food emulsions, processed potash products, and many others. Characteristics of packaging materials, including flexible films, and how they meet the package requirements of various foods.

Quality Control - Responsibilities and organization of a quality-control department in the food industry. Equipping a control laboratory. Methods of measuring and controlling quality factors. Principles of statistical quality control. Government standards.

Introductory Food Analysis - Chemistry of the principal components of the major representative classes of foods and feeds. Standard methods of analysis for common constituents.

Mechanics of machines - Basic mechanical principles. Work and energy, power, efficiency. Power transmission, fluid mechanics, steam power and refrigeration. Materials of construction, corrosion, maintenance, and lubrication. Electrical power equipment and its use in food processing.

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Process Analysis - The more important production-engineering aspects of food manufacturing. Basic processes, plant layout and design, flow diagrams, materials handling, and production management techniques.

Food Analysis - Detailed chemistry of the products of the food industry. Vitamins and nutritional supplements. Chemistry of various types of food deterioration and its prevention. Food additives-preservatives, colouring, flavouring, and sweetening agents. Physico-chemical and instrumental methods used in food analysis.

Sanitation - Organization of a sanitation program in the food industry. Cleaning compounds. Methods of disinfection and sterilization. Sanitary aspects of buildings and equipment. Safe water supply. Waste treatment and disposal. Insect and rodent control.

Northern Alberta Institute of Technology, Edmonton, Alberta.

A Food Processing Technology option has been developed within the Chemical Technology Department at the Northern Alberta Institute of Technology. The first group of ten students is now enrolled in the first year of the program. Student numbers are expected to be 20 to 25 per year when the program is fully operative. No additional staff have yet been appointed but one instructor will be appointed to handle the Food Processing Technology courses. Dr. Wesemann, Head of Chemical Technology, is in charge of the program. An advisory committee is actively participating in the planning and operation of the program. There are as yet no separate facilities for Food Processing Technology and the responsible staff members are seeking at least a separate unit operations laboratory for food processing.

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The two year program in Food Processing Technology is designed to provide graduates who have gained competence in handling scientific equipment for chemical, physical and bacteriological tests and also in operating special equipment and in supervising processes within the food plant.

Details of the curriculum are as follows:

	Subject	Total Hours Lecture-Lab
Year 1, Quarter 1	Economics I	48
	Effective Communications I	36
	Basic Mechanics, Fluid Properties	72
	Mathematics Prep. for Physical Chemistry	48
	General Biology	48
	General Inorganic Chemistry	60
	Nutrition	12
		324
Quarter 2	Economics II	48
	Effective Communications II	36
	Electricity, Heat, Light	72
	Elementary Statistics	36
	Microbiology I	70
	Organic Chemistry I	72
		334
Quarter 3	Food Processing I	90
	Microbiology II	48
	Statistics	36
	Effective Communications III	36
	Organic Chemistry II	60
	Instrumental Analysis I	48
		318
Year 2, Quarter 4	Biochemistry	96
	Food Processing II	108
	Instrumental Analysis II	60
	Microbiology III	60
		324

	Subject	Total Hours Lecture-Lab
Quarter 5	Food Analysis	84
	Food Processing III	84
	Industrial Relations I	36
	Instrumental Analysis III	60
	Basic Industrial Instrumentation	60
		324
Quarter 6	Food Processing IV	72
	Industrial Relations II	60
	Production and Marketing	60
	Quality Control	72
	Work Study	60
		324

The courses in Food Processing Technology have not yet been taught but the outlines of the proposed courses are very similar to those in operation at the B.C. Institute of Technology, which were described in detail on the previous pages.

Cambrian College of Applied Arts and Technology, North Bay, Ontario

A three year course in Food Technology (after Ontario Grade 12) will be offered at Cambrian College beginning in September, 1968. There are at present two faculty members in this discipline but three full-time persons are anticipated. There is an existing two-year course training graduates who are referred to as Food Science Technicians. Laboratories and equipment for both courses will be in most cases the same. The College is housed in an old high school building but plans are being made for establishment of new facilities on a spacious new site. In the meantime, arrangements for special facilities for Food Technology and Technician training are being made.

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The course in Food Technology stresses the production, processing and manufacture of food. The course content is clearly differentiated from Food Service courses which are offered in several locations in Ontario and which stress the service handling and distribution of foods. It is expected that graduates from the Food Technology course will be capable of handling a range of scientific instruments and equipment, undertaking routine laboratory procedures, assisting in quality assessment and control and undertaking elementary research and development projects.

The curriculum in Food Technology is as follows:

	Subject	Hours per week Lectures	Lab
Year 1, Semester 1	General Chemistry I	3	4
	Biology	3	4
	Physics I	3	4
	Mathematics I	3	
	Communications	4	
	Psychology	3	—
		19	12
Semester 2	General Chemistry II	3	4
	Physiology	3	4
	Physics II	3	4
	Mathematics II	3	
	Logic	3	
	Sociology	3	—
		18	12
Year 2, Semester 3	Inorganic Chemistry I	3	5
	Microbiology	3	5
	Organic Chemistry	3	5
	Mathematics III	3	
	English Literature	3	—
		15	15

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	Subject	Hours per week Lectures	Lab
Semester 4	Inorganic Chemistry II	3	5
	Physico-Chemical Analyses	3	5
	Organic Chemistry II	3	5
	Mathematics IV	3	
	Contemporary Social Issues	4	
		16	15
Year 3, Semester 5	Biochemistry	3	5
	Introduction to Statistics	3	
	Food Technology I	5	3
	Food Analysis	3	5
	Production and Marketing	2	
	Work Study	2	
		18	13
Semester 6	Food Chemistry	3	5
	Statistical Analysis	3	
	Food Technology II	5	3
	Food Quality Assessment	3	3
	Quality Control	3	
	Industrial Relations	2	
		19	11

Specific details on the courses in Food Technology are as follows:

Food Technology I - The functions of food technology; classification of foods; food as a raw material; food spoilage and its prevention; refrigeration in food processing; frozen foods; drying; smoking of foods; canning; curing; delicatessen and related food products.

Food Analysis - Fundamental concepts of food analysis; proximate analysis; the determination of moisture; salts and ash; carhohydrate analysis; fats and oils; protein determination; acids and bases; determination of pollution.

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Food Chemistry - The biochemistry of muscle; meat and meat products; post-mortem changes in meat; structural aspects of fruit and vegetables; the composition of milk and milk products; cereals; the use of food additives; flavour and aroma in foods.

Food Technology II - Mechanical handling; plant and line layout; compliance with laws and regulations; norms for materials and energy; location; transportation; quality standards; processing procedures; hygiene and sanitation; markets and market requirements; storage and shipping; Federal and Provincial regulations.

Food Quality Assessment - The importance of quality; subjective methods of quality assessment; the training of panels; organoleptic standards; objective methods; chemical and other methods of quality assessment; interpretation of results; correlating subjective and objective methods.

Quality Control - Responsibilities and organization of quality control department; principles of quality control; methods of quality determination; government and trade standards of quality; recording and reporting; control charts; evolutionary operations; inventory and production control; budgeting.

St. Clair College of Applied Arts and Technology, Windsor, Ontario

A three-year course in Food Processing Technology has been developed at St. Clair College with students starting at the first and second years in September 1968. Entrance to first year is after Ontario Grade 12 and students may enter second year from Grade 13. Mr. D. Grolman, Chairman of Chemical Technology at the College has been the prime mover in the establishment of this new program.

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An ad hoc committee representing the food, beverage, distilling, brewing, meat and dairy industries, assisted with the development of the program. The objective of the program is to educate people for factory supervisory positions, with adequate background in scientific as well as processing aspects of the food industry. Graduates will have a broad background without specialization in any one aspect of the industry, and will have a good knowledge of human and labour relations.

The first year is general with other technologies. The entire program will be closely integrated with and administrated by Chemical Technology using their facilities with the addition of a unit operations laboratory with small scale processing equipment, and microbiology apparatus. Instructors will be drawn from the present Chemical Technology staff together with new staff members drawn from the food industry. Part-time instructors will be drawn from industry.

The curriculum for Food Processing Technology is as follows:

	Subject	First Term Hours per week	Second Term Hours per week
Year 1	Liberal Studies	4	4
	Mathematics	5	5
	Chemistry	5	9
	Physics	4	4
	Electricity	5	3
	Applied Mechanics	5	3
	Physical Education	2	2
		30	30

		Lecture	Lab.	Lecture	Lab.
Year 2	Liberal Studies	4	-	4	-
	Mathematics	4	-	4	-
	Analytical Chemistry I	3	3	3	3
	Organic Chemistry I	3	3	3	3
	Unit Operations I	3	4	1	3
	Quality Control Principles	3	-	2	-
	Microbiology	-	-	2	2
		20	10	19	11
Year 3	Industrial Psychology	4	-	4	-
	Mathematics	3	-	3	-
	Biochemistry	3	3	3	3
	Microbiology	3	3	3	3
	Food Analysis	2	3	2	3
	Unit Operations II	1	4	1	4
	Technical Report	1	-	1	-
		17	13	17	13

Unit operations denotes the processing equipment and principles as well as small scale instrumentation, and factory studies. The industrial psychology course will include reporting, recording, human relations, leadership, union relations, and so on. In general, this is a course to benefit potential supervisors. Emphasis in the third year mathematics course will be placed on statistics and statistical quality control, and such business subjects as costing, profit and loss statements, time study, and so on, from a production point of view.

Food Chemistry will be emphasized in the Biochemistry course. The third year Microbiology course will have heavy emphasis on sanitation. The food analysis course will be primarily quality

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control, wet (chemical) methods during the first term; instrumental methods during the second term. Unit Operations II will include factory studies, all types of processing, preservation, dehydration, condensation, pasteurization, emulsification, conveying equipment and related controls. Short courses covering such topics as pesticides, waste disposal, organoleptic analysis and others will be included in the curriculum.

Institut de Technologie Agricole, Saint-Hyacinthe, Quebec.

The Agricultural Institute of Technology is housed in a superb building complex which includes elaborate facilities for five departments including the Department of Food Technology which has programs in Dairy and Food Technology. The staff in Food Technology number approximately twenty.

The programs in Dairy and Food Technology have been offered since the Institute opened in 1962. The curriculum is spread over three academic years. The students must spend the two summer periods in a food plant to provide the desired industry experience. The objectives of the curriculum are: First, to provide a sound general education based on the study of languages, sociology, economics, bookkeeping, mathematics and general agriculture, that is, soils, plant-biology and animal husbandry; secondly, to provide a wide scientific knowledge including the study of many branches of science including physics, biology, genetics, botany, microbiology, chemistry, biochemistry, human and animal nutrition, anatomy, physiology and hygiene; and finally, to provide an elaborate training in the field of food technology which is adapted to today's needs.

Students in dairy technology are given theoretical and practical training in butter-making, ice cream manufacturing, cheese making, the manufacturing of concentrated milk and milk products, market milk, quality control, dairy bacteriology, hygiene, dairy mechanics, marketing, legislation, administration, selling and advertising. Students in food technology must take courses in fruit and vegetables, chemistry, food microbiology and hygiene, applied mechanics, food preservation, canning, freezing, drying, industrial fermentations, technology of vegetables and meat products, quality control, marketing, legislation, management, selling and advertising. There are more than fifty industrial visits and many presentations by visiting food specialists. The graduates are prepared broadly for work in almost all branches of food technology.

A new option in Food Sanitation has recently been added in the Department. The main purpose is to train students in the field of food inspection for food plants, Federal or Provincial Governments, and city sanitary inspection services. Students take courses in their third year which are directed toward sanitation including food quality control, animal hygiene, parasitology and entomology, general pathology, food plant sanitation, epidemiology, immunology and food toxicants, food inspection, and organization of inspection services. Four months of practical work in food inspection are required.

The staff of the Department of Food Technology includes Mr. Edouard Brochu, Head of the Department; Mr. Paul-Emile Belley,

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Head of the Food Hygiene Section; Mr. Lionel D'Amours, Head of the Dairy Products Section; Mr. Leo Emand, Head of the Livestock Products Section; Mr. Jean-Paul LaHaye, Head of the Plant Products Section; and Mr. Laurent Ouellet, Head of the Laboratory Technique Section.

College of Fisheries, Navigation, Marine Engineering and Electronics, St. John's, Newfoundland.

The College occupies extensively renovated buildings formerly occupied by the Memorial University. The Department of Food Technology offers a three-year diploma course with some practical training in industry. The Department is primarily responsible for the technical training necessary in the utilization of raw materials of marine origin but the subject matter covered is of general application in food processing. The scope of the training extends from simple plant operations, such as handling and cutting, to highly specialized operations such as plant design engineering. Entrance requirement for the program is essentially completion of Newfoundland Grade 11.

The curriculum in the first year consists of courses in English, Physics, Mathematics, Engineering Drawing, Inorganic and Organic Chemistry, Biology and Physical Education. In the second year the courses are English, Physics, Mathematics, Mechanical Engineering, Electrotechnology, Biology and Bacteriology, Organic Chemistry, Food Chemistry, Food Analysis, Processing Technology and Physical Education. In the third year students take Mechanical Engineering, Food Engineering, Food Analysis, Processing Technology, Fishing Methods, Plant Management, Technical Projects, Food Laws, Physical Education and optional subjects.

A measure of specialization is permitted in the third year of study. Courses are offered in management and sales, in recognition of the role of Food Technologists in production and manufacuring. Opportunity is also given to specialize in such subjects as Fisheries Law, Inspection Methods, Collection of Statistics, and so on.

The Department of Food Technology also offers a number of vocational courses varying in duration from a few weeks to six months.

There are five staff members in Food Technology with Mr. K. Sepic as Senior Lecturer. Supporting staff are located in other departments.

Some details on course content are as follows:

Food Chemistry (First course) - General Biochemistry including carbohydrates, lipids, proteins, vitamins, enzymes and their importance in food technology.

Food Chemistry (Second course) - General chemistry of foods including meat and meat products, fruit and vegetables, milk and milk products, cereals and their uses, food additives, the flavour and aroma of foods, and measurement of flavour.

Food Chemistry (Third course) - Chemistry of fish including general composition, nitrogenous constituents, elemental composition, vitamins in fish, rigor mortis, and the effects of composition on quality.

Food Analysis (First course) - Methodology including gravimetric, volumetric and instrumental analysis.

Food Analysis (Second course) - The analysis of foods including moisture, salt and ash, carbohydrates, oil, protein, acids and bases, water, pollution analysis, and analysis of fish products.

Food Technology (First, second, third, fourth and fifth courses) - Fish processing including fish as food, spoilage of fish and its prevention, classification of fish, refrigeration in fisheries, fishing methods and characteristics of fish. Salting, drying, smoking, canning and fish by-products. Fish oil and meal processing. Plant sanitation.

Food Analysis (Third course) - Quality assessment including quality definitions, subjective methods, objective methods, interpretation of results, and grading.

Food Engineering (First course) - Unit operations including material and energy balance, fluid flow, heat transfer, methods for thermal process evaluation, dehydration, freeze drying, extraction, filtration, and strength of materials.

Food Engineering (Second course) - Refrigeration including characteristics of products, refrigeration equipment, insulation, instrumentation, maintenance and construction of storages.

Food Engineering (Third course) - Processing engineering for marine products. Equipment for fresh, frozen, salted, dried, smoked fish processing and for fish meat and oil plants.

Food Laws - Fishery products inspection service and legislation, grading, requirements and regulations, standards, processing and sanitation.

Technical Projects - Planning and designing, application of processing methods, capacity and assortment of products, location of plants, equipment, power and water requirements, waste, water and air pollution.

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Recommendations for Food Science and Technology from Canadian Educators

Most educators were genuinely interested in the need for adequate numbers of Food Science and Technology graduates and offered many helpful suggestions and comments relative to their education, even though, in most cases, they would not be participating themselves. These thoughts have been placed in general categories and summarized.

Food Science and Technology Curriculum Suggestions

The need for familiarization with the real problems in industry was frequently mentioned. There must be a balance of academic and practical training and the graduate must be familiar with industry problems. At the same time there must be an appropriate balance of number of students in vocational schools, institutes and in the universities. Practical training was considered to be essential and many thought it should be compulsory. Students should also becom enthused about food industry problems in their formal course work. Field trips and extended tours of industries would also be desirable. The employer should realize, however, that even with industry experience, the new graduate may not have done much applied work and must be brought along by industry and gain practical experience on the job. Industrial relations courses might be included in the curriculum because many graduates will ultimately fit into administrative roles in the food industry. Some economics and business management should be present in all curricula.

A great deal of effort should be put into development of suitable curricula. The enthusiasm of students can be killed if the academic program is inappropriate; for example, if too much non-food material is included, such as medical biochemistry and microbiology. Food Science and Technology curricula should not include courses which are only remotely relevant. In fact, courses have failed in the past primarily because of this. At the same time the availability of good supporting courses in science departments was noted as essential, particularly in Chemistry, Physics and Mathematics.

Some educators were concerned that the graduate of an I.F.T. model curriculum may lack depth and the graduate may not be sufficiently expert in any area to function professionally. It was noted that a great deal depends on the individual graduate and the primary requirement is for people who are able to think and handle food problems. Food Science and Technology curricula should be forward looking. They should be leading the food industry and not following.

The environmental health aspects of Food Science and Technology should not be overlooked in the teaching and research program of an up-to-date department. This should include air and water pollution, water supplies, waste disposal, sanitation, pesticides and pesticide residues in foods. Many people noted that unit operations laboratories must be made available in institutes, colleges, and universities as an absolutely essential part of Food Science and Technology.

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Strengthening Present Food Science and Technology Programs

Many educators noted that Food Science and Technology Programs would benefit greatly if the staff members became more familiar with industry problems. Many considered that in many cases there is a gulf between the educational institutions and industry which is largely the result of a breakdown in communications. Other industries were noted to be much more advanced in their relationship to the educational institutions than are the food industries. The aggressiveness of the petroleum, chemical, pulp and paper industries and others is shown by the scholarships and research grants awarded to educational institutions and also by the much higher proportion of scientific research going on in the industry.

Proximity to industry is an important source of strength in a Food Science or Technology department. Institutions would be wise to determine the nature of the food industry in their area or province. A survey of industry problems and research needs would be a very valuable project. The areas in which research is needed should then be summarized in as specific terms as possible. The educational institutions must get specific details on industry problems if these are to be used effectively in teaching and research. It was suggested that Food Science or Technology departments should have an advisory board of industry people to advise on education and research programs.

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Because the strength of an academic program, particularly at the University level, is closely related to the calibre and appropriateness of concurrent research activity, the food industry was called on to support university research, particularly if government incentives could be taken advantage of by the industry. It might be possible to establish a central general organization of the food industry or form organizations of commodity groups. Industry-supported chairs in Food Science and Technology were suggested as a means of strengthening educational work. The federal and provincial governments were also urged to lend more direct support to Food Science and Technology Departments.

The establishment of Industrial Research Institutes in close association with educational units was suggested to provide the needed acquaintance with industry problems and to provide research projects suitable for students. It was noted that some institutions might not be able to establish an Institute for various reasons. It was noted that communication between industry and education would be bound to improve if more scientists were employed in the food industry who would feel free to contact and communicate with educational scientists.

Food Science and Technology Departments were urged to establish evening programs and short courses for the upgrading of the technical and scientific base of the food industry. The food industries might also consider supporting their staff members for full-time studies.

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The educational institutions were noted to have a responsibility to the community. The institutions should respond to community needs. They should explore and draw the maps for progress. At the same time, the institutions must avoid making commitments before the map is charted.

Suggestions for Improvement of Numbers of Students

There were many suggestions on the recruitment of sufficient students in Food Science and Technology programs. If more students are to be encouraged to take Food Science and Technology, guidance officers in schools, institutes, colleges and universities must be influenced. At present, students are frequently not well-advised and only after graduation do they realize what they should have taken. There must be advertising of opportunities and courses and prerequisite requirements. The guidance officers must know where students are needed. There is at present no pattern; one or a few individual faculty members develop a vigourous program and it goes ahead.

Food Science and Technology staff members can speak to high school audiences either in Biology courses or in general assemblies but this was noted to be very time-consuming. Other groups could be addressed, including parents and early-year university students in other programs. Other methods which could be used include filmstrips, placards, and portable showcases.

Students should be encouraged to transfer into Food Science and Technology from other more general programs. Students should

also be encouraged to transfer from institutions without Food Science and Technology because many students do not decide what to do until they are well into their higher education. They often first embark on a general program and procrastinate on the selection of a specialty. Many general science students in the universities are on pre-medical and pre-dental programs and subsequently do not enter Medical or Dental School for a variety of reasons. Some of these students should be encouraged to enter Food Science and Technology. Several educators suggested that students should be permitted to transfer from the Colleges and Institutes of Technology to University with appropriate credit allowed for courses taken. One problem was noted to be that of course evaluation.

Many students graduating from general science programs could become graduate students in Food Science. It was noted that such graduates can get into American Universities much more easily than Canadian. Three-year pass degrees in Science as offered in many institutions might be followed by a final fourth year of Food Science and Technology although some noted that this would hardly be sufficient time to provide a satisfactory professional graduate.

Scholarships were noted to be a very useful method of interesting students in the Food Science and Technology field and a system of scholarships should be established. At the same time some suggested that scholarships should not be binding on students staying in the field. Government agencies should be encouraged to start scholarship programs related to Food Science and Technology much like those started for Meteorology and Librarianship.

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Industries could provide "summer scholarships" for students in Food Science and Technology to provide industry experience without specific wage arrangements. These would permit students to become familiar with industry as scholars rather than labourers. It was suggested that industry could provide summer jobs for Science students to encourage them to take Food Science and Technology. Science undergraduates would prefer to spend a summer in work related to their ultimate profession if they can find a suitable summer position. Caution was expressed that special effort should be put into determining whether prospective students are genuinely interested and not just looking for a way to earn money. Some noted that summer student programs will require a re-education of industry. All too often present summer students are merely "joe-boys" filling in as seasonal help. Industry must take students into meaningful situations and realize that they are potential staff members. Work reports should be required.

A fundamental problem in recuiting students was noted to be their feeling about acceptance of work in the food industry on graduation. Students must be taught to appreciate the depth to which they might become involved in the food industry. The glamour of Food Science and Technology must be increased.

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Education and Research in Related Disciplines

Applied Microbiology

The training required for a modern, successful, applied microbiologist is of concern to many prominent microbiologists. It has been difficult to obtain general agreement on the subject. Surveys of prospective employers show that laboratories wish to have a man trained to their special needs and full of enthusiasm for routine work. As well he must be perceptive enough to solve the problems facing the laboratory. Departments of Microbiology in universities, however, recognize that they cannot really train a person for a specific position or organizational niche. This can be approached only in technical institutes devoted to a particular specific program. Instead, the universities provide a graduate with enough knowledge to permit a variety of alternatives on graduation. Any program for his education must permit him to move and work in fields for which he is not specifically trained.

In modern applied microbiology a man with training to the bachelor level may be a technician doing laboratory work under the direction of someone with more experience, but in a smaller organization he may be the microbiologist with an enormous range of responsibility. The laboratory man may advance through attainment of more technical training or through entering areas such as administration, production and sales, where experience and ability to deal with people becomes more important than technical knowledge.

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Various ideal university curricula have been proposed, with emphasis on basic sciences and microbiology. The microbiologists are acutely aware that very few students enter university to take applied microbiology. Instead, the student discovers this area in his early years at university.

Chemical Engineering

Chemical Engineering is established as a distinct branch of engineering with emphasis on processing operations such as fluid flow, mass transfer, and heat transfer, in the various chemical industries. Biochemical Engineering has developed as a sub-discipline of Chemical Engineering as a result of identification of transport and kinetic phenomena which are common to industries dealing with the processing of biological and biochemical materials and systems. The application of chemical engineering principles has been extended beyond work with the heavy chemicals and petroleum industries. The interest of the biochemical engineer may extend to food processing, beverage manufacture, pharmaceutical supplies, bacterial testing, and waste treatment.

Several world professional organizations have established new divisions in biochemical engineering and related areas, and Universities have been setting up new programs, notably in Great Britain, the United States, and Japan.

Departments of Chemical Engineering in Canada are becoming increasingly interested in this field of study. Dr. M.M. Young recently studied the Canadian situation. He sent questionnaires to

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74 industrial firms and government agencies. He also examined the curricula of all the 15 Canadian Universities with Chemical Engineering faculties. Views from prospective employers on the relative merits of undergraduate and postgraduate University training were also sought.

The Department of Chemical Engineering at the University of Waterloo has provided a course option in its undergraduate curriculum and has provided research opportunities in its post-graduate programs. Queen's University has also set a program and other Universities are considering setting up programs.

The present and future needs for biochemical engineers appear to exceed the present rate of supply. At the same time it was concluded that some measure of control on the present possible proliferation of University programs in Biochemical Engineering would be desirable.

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Appendix A

Educators Interviewed

Memorial University of Newfoundland, St. John's.

The Lord Taylor, President

Dr. L.A.W. Feltham, Head, Department of Biochemistry

Dr. M. Laird, Head, Department of Biology

Mr. Ross Peters, Department of Mathematics

Dr. E. Bullock, Head, Department of Chemistry

Newfoundland College of Fisheries, Navigation, Marine Engineering and Electronics, St. John's.

Mr. K. Sepic, Senior Lecturer in Food Technology

Dalhousie University, Halifax.

Dr. Henry D. Hicks, President

Dr. C.B. Stewart, Dean, Faculty of Medicine

Dr. C.E. van Rooyen, Head, Department of Microbiology

Dr. C.W. Helleiner, Head, Department of Biochemistry

Dr. K.E. von Maltzahn, Head, Department of Biology

Dr. W.J. Chute, Head, Department of Chemistry

Mr. E.B. Mercer, Assistant to the President

Nova Scotia Technical College, Halifax.

Dr. M.R. Foran, Dean of Graduate Studies and Head, Department of Chemical Engineering

Mr. A.E. Steeves, Head, Department of Industrial Engineering

Dr. O. Cochkanoff, Director, Industrial Research Institute

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Acadia University, Wolfville, Nova Scotia.

Dr. J.M.R. Beveridge, President

Dr. E.C. Smith, Vice-President, Academic

Dean E. MacMillan, School of Home Economics

Dr. E.P. Linton, Head, Department of Chemistry

Dr. Brian P. Robinson, Department of Biology

Dr. Joseph Basaraba, Department of Biology

Nova Scotia Agricultural College, Truro, Nova Scotia.

Dr. W.A. Jenkins, Principal

Mr. A.D. Ells, Dean, Vocational and Technical Training

St. Francis Xavier University, Antigonish, Nova Scotia.

Dr. John J. MacDonald, Dean of Science

Sister Catherine MacNeil, Dean of Home Economics

Sister Margaret Delorey, Home Economics

Sister Helen T. Abound, Home Economics

Mount Allison University, Sackville, New Brunswick.

Dr. Laurence H. Cragg, President

Mr. John W.T. Judson, Executive Assistant to the President

Dr. Wilson B. Stallworthy, Head, Department of Biology

Dr. Lawrence R.C. Barclay, Head, Department of Chemistry

Miss Marjorie Kennish, Head, Department of Chemistry

University of New Brunswick, Fredericton.

Dr. C. William Argue, Dean of Science

Dr. Orville T. Page, Department of Biology

Dr. John W. Ker, Dean of Forestry

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Université Laval, Quebec.

Dr. R.C. Lachance, Dean of Agriculture

Dr. R.R. Riel, Head, Department of Food Science

Sister M. Ouellet, Head, Department of Dietetics

Université de Sherbrooke

Dr. Louis-Paul Dugal, Vice President, Administration

Dr. Jean-Marc Lalancette, Dean of Sciences

Dr. Robert Saucier, Head, Department of Biology

Dr. Gerard E. Pelletier, Head, Department of Chemistry

Université de Montreal

Dr. M. Roger Gaudry, President

Miss Rachel Beaudoin, Director, Institute of Dietetics and Nutrition

Dr. M. deGuise Vaillancourt, Assistant Dean, Faculty of Medicine

McGill University, Montreal.

Dr. G.A. Ratcliff, Chairman, Department of Chemical Engineering

Dr. O.M. Fuller, Department of Chemistry

Macdonald College of McGill University, Ste. Anne de Bellevue, Quebec.

Dr. Jean David, Department of Horticulture and Chairman, Food Management Option

Dr. R.H. Common, Chairman, Department of Agricultural Chemistry

Dr. H.F. MacRae, Chairman, Department of Animal Science

Dr. A.C. Blackwood, Chairman, Department of Microbiology

Prof. Helen R. Neilson, Director, School of Food Science

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Sir George Williams University, Montreal

Prof. D.B. Clarke, Vice-Principal, Academic

Dr. J.R. Ufford, Chairman, Department of Chemistry

Dr. C.F. MacLeod, Chairman, Department of Biology

Institut de Technologie Agricole, Saint-Hyacinthe

Mr. Robert Dumais, Director

Mr. Edouard Brochu, Head, Department of Dairy and Food Technology

University of Ottawa

Dr. Roger Guindon, Rector

Dr. Leo Marion, Dean of Pure and Applied Science

Dr. Andre DesMarais, Chairman, Department of Biology

Dr. Benjamin C.Y. Lu, Chairman, Department of Chemical Engineering

Dr. Bernard Belleau, Department of Chemistry

Dr. Antoine D'Iorio, Chairman, Department of Biochemistry, Faculty of Medicine

Carleton University, Ottawa

Dr. H.H.J. Nesbitt, Dean of Science

Dr. W.I. Illman, Department of Biology

Dr. G. Setterfield, Chairman, Department of Biology

Dr. P.M. Laughton, Department of Chemistry

St. Clair College of Applied Arts and Technology, Windsor.

Mr. D. Grolman, Course Director, Chemical Technology.

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Mr. C.M. Jackson, Vice-President

Mr. Francis J. Sheeham, Vice-Principal, Institute of Technology.

Cambrian College of Applied Arts and Technology, North Bay.

Mr. John Jaffray, Teaching Master, Food Technology.

Mr. Ian Macdonald, Instructor, Food Technology.

McMaster University, Hamilton

Mr. Manuel Zack, Assistant to the President

Dr. A.N. Bourns, Vice-President, Science

Dr. D.R. McCalla, Dean, Faculty of Science

Dr. H.F. Stich, Chairman, Department of Biology

Dr. N.W. Radforth, Chairman, Organic and Associated Terrain Research Unit

Dr. R.H. Tomlinson, Chairman, Department of Chemistry

University of Windsor

Dr. F.A. DeMarco, Vice-President

Dr. Maurice Adelman, Head, Department of Chemical Engineering

Dr. R.J. Doyle, Head, Department of Biology

Dr. R.J. Thibert, Department of Chemistry

University of Waterloo

Dr. H.E. Petch, Vice-President, Academic

Dr. D.B.N. Hynes, Chairman, Department of Biology

Dr. A.G. Kempton, Department of Biology

Dr. T. Viswanantha, Department of Chemistry

Mr. A.S. Barber, Director, Co-ordination and Placement

Dr. M.M. Young, Department of Chemical Engineering

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University of Guelph

Dr. W.C. Winegard, President

Dr. B.C. Matthews, Vice-President, Academic

Dean N.R. Richards, Dean, Ontario Agricultural College

Mr. E.W. Franklin, Department of Horticulture

Dr. S.J. Slinger, Chairman, Department of Nutrition

Dr. J.C. Alexander, Department of Nutrition

University of Manitoba, Winnipeg

Dr. Hugh H. Saunderson, President

Dean L.H. Shebeski, Dean, Faculty of Agriculture and Home Economics

Dr. L.A. Lloyd, Director, School of Home Economics

Dr. R.A. Gallop, Head, Department of Food Science

Dr. H. Lees, Chairman, Division of Biological Sciences and Head, Department of Microbiology

Dr. R.H. Betts, Head, Department of Chemistry

University of Saskatchewan

Dr. J.W.T. Spinks, President

Dr. R.W. Begg, Vice-President and Principal, Saskatoon Campus

Dr. D.L.T. Smith, Dean, College of Veterinary Medicine

Dr. J.R. Saunders, Department of Veterinary Microbiology

Dr. N.R. Nielsen, Department of Veterinary Pathology

Dr. Edith C. Rowles Simpson, Dean, College of Home Economics

Dr. D.F. Moore, Dean, College of Medicine

Dr. J.A. Trew, Acting Head, Department of Biochemistry

Dr. W.C. Gibson, Head, Department of Dairy Science

Dr. J.M. Bell, Head, Department of Animal Science

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University of Alberta, Edmonton

Dr. W.H. Johns, President

Dr. Wyman, Academic Vice-President

Dr. Brown, Associate Dean of Graduate Studies

Dr. L.F.L. Clegg, Head, Department of Food Science

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