COPY

Ref. No. 5136/209 22 April 1997

Dr. Antony B. Dickinson
International Liaison Officer
Department of Biology
Memorial University of Newfoundland
St. John's Newfoundland
CANADA A1B3X5

Fax: (709) 737-4330

RE: POSSIBLE COLLABORATION BETWEEN SUT AND UNF

I am most greatful for your letter of 4 April regarding the interest of your University in a possible linkage with SUT in the field of Environmental Science (focus on Environmental Bilogy). It is with great interest that I noted your courses in Freshwater-Ecology and Plant Physiogical Ecology. Please let me know how we could have exchange or sharing of course materials, exchange of faculty and students and collaborative research. I do not know if you are aware but we now have collaboration with 4 Canadian Universities in Engineering and Food Science with partial support from CIDA.

Our potential partner in Vietnam in Food Technology project are the Hanoi University of Agriculture and Hanoi University of Technology. Can we discuss possible ways of Third Country cooperation under CIDA or other Canadian Foundations as source of funds? Our interest includes possible involement of any Canadian Food Industry that may want to open a pilot plant in the university-either in Thailand and/ or Vietnam.

I would appreciate highly receiving advice as to how we could actualize our interests and intentions.

Thank you.

Yours sincerely,

(Prof. Dr. Ruben C. Umaly)
Director, Center for International Affairs

Memorial
University of Newfoundland

International Programmes

Dr. Reuben Umaly
Director, International Affairs Centre
Suranaree University of Technology
111 University Avenue
Muang District
Nakhon Ratchasima
Thailand

Fax: 66 44 216 122

April 4, 1997

Dear Dr. Umaly,

We are informed by the Asia Pacific Foundation of Canada that their Canadian Education Centre in Bangkok has been approached by your university for assistance in developing links with Canadian institutions. This letter therefore constitutes an expression of interest on behalf of Memorial University of Newfoundland. The university is situated in Canada's most easterly province, and one which is largely rural in nature with a primary resources-based economy. The university currently has some 18 000 full and part-time students. Further details can be found on the internet (www.mun.ca).

I also note that you are specifically interested in establishing B.Sc/Ph.D programs in Environmental Biology and related areas (environmental science, environmental engineering and environmental auditing. Memorial University offers these or very similar programs, as shown in the abstracts attached to this letter.

I see also that you are interested in further developing your degree program in Food Technology, and obtaining collaboration on an agrofood/agrobusiness proposal with the Hanoi University of Agriculture. Our Department of Biochemistry, and the Food Technology Unit of our Marine Institute has relevant expertise, including the operation of a Food Science Pilot Plant for the development of new materials and processes. Relevant brief information is attached.

Memorial University of Newfoundland also has significant international development assistance experience, and is currently operating a Canadian International Development Agency (CIDA) - funded institutional linkage program in Vietnam focussing on training of primary health care workers, and through its Marine Institute is working on aquaculture and coastal zone mangement projects in Vietnam and Cambodia respectively. We also have some experience in Thailand. In the past we have worked with Srinakharinwirot University, and currently have an academic exchange

agreement with Naresuan University.

If you wish to pursue this expression of interest further, I can be contacted at the phone/fax numbers on this letter, and by email at adickins@morgan.ucs.mun.ca.

Sincerely,

Dr. Anthony B. Dickinson
International Liaison Officer
Associate Professor, Department of Biology.

cc. Dean of Science
Dean of Engineering and Applied Science
Asia Pacific Foundation of Canada

B.Sc. General & Joint B.Sc. General Degree Programs

Applied Mathematics
Behavioral Neuroscience
Biochemistry
Biochemistry and Physics
Biology
Chemistry
Computer Science
Computer Science and Geography (Cartography)
Computer Science and Physics
Computer Science and Pure Mathematics
Computer Science and Statistics
Geography
Geology
Geology and Geophysics
Geophysics
Nutrition
Physics& Physical Oceanography
Psychology
Pure Mathematics
Statistics

Sir Wilfred Grenfell College (Corner Brook):
B.Sc. and B.Sc. Honors specializing in
Environmental Sciences -- Chemistry or Biology

B.Sc. Honors & B.Sc. Joint Honors Programs

Applied Mathematics
Applied Mathematics and Chemistry
Applied Mathematics and Physics
Behavioral Neuroscience
Biochemistry
Biochemistry and Chemistry
Biochemistry and Cell Biology/Microbiology
Biology
Biology and Earth Sciences (Geology)
Biology and Psychology
Biology and Statistics
Cell Biology and Microbiology
Chemistry
Chemistry and Earth Sciences (Geology)
Chemistry and Physics
Computer Science
Computer Science and Geography (Cartography)
Computer Science and Pure Mathematics
Computer Science and Statistics
Dietetics
Ecology and Evolution
Entomology and Parasitology
Geography
Geography and Earth Sciences
Geology
Geology and Geophysics
Geophysics
Marine Biology
Nutrition
Physics & Physical Oceanography
Psychology
Pure Mathematics
Pure Mathematics and Statistics
Statistics

Memorial University
St. John's, NF, Canada A1C 5S7
Phone: (709) 737-8896
Fax: (709) 737-8611
e-mail: sturecru@morgan.ucs.mun.ca
Website: www.mun.ca

Memorial
University of Newfoundland

4

Memorial
University of Newfoundland

SIR WILFRED GRENFELL COLLEGE

DEPARTMENT OF

ENVIRONMENTAL SCIENCE

Studying the Environment...

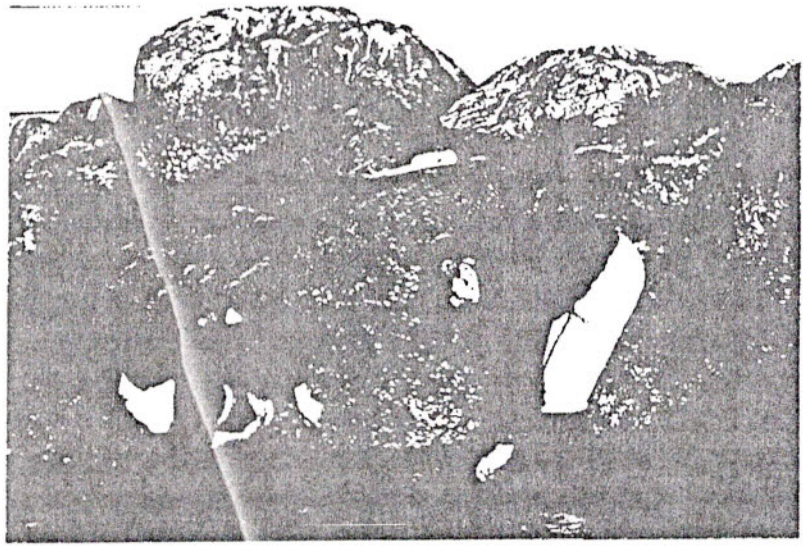
The environment. It's all around us, a headline in every newspaper, but what do we really know about it?

As the 20th century draws to a close, we are all paying more and more attention to the natural world — the air, rivers, forests, oceans and resources we once took so much for granted.

Does industrial progress necessarily mean wholesale environmental destruction, or can the impact of progress on the natural world be lessened? What can be done to restore an ailing habitat?

As scientists attempt to answer these questions the knowledge they acquire is applied to our world in countless ways. As we become more aware of the effects we have on planet Earth, people who can help us understand will be in demand.

Our environmental science degree program is designed to produce biology and chemistry graduates who can work in dozens of different positions to better the country's understanding of, and interaction with, the natural environment.



... on Newfoundland's West Coast

Memorial University's undergraduate environmental science program is offered only at Sir Wilfred Grenfell College in Corner Brook. The city, located on the west coast of the island of Newfoundland, is an ideal place to undertake studies of the environment.

Within an hour's drive of campus, you can observe a range of natural habitats not found anywhere else in the world, including wetlands, boreal forest, the ocean, river systems, and sub-Arctic tundra.

All the book-learning in the world cannot substitute for up-close study of the creatures who inhabit a salmon stream, a peat bog, or a beach.

... at Grenfell College

The inter-disciplinary nature of Grenfell College is a great benefit. Students in environmental science can expect regular interaction with people engaged in related or widely divergent topics. You may share a coffee with someone producing environmental art, or discuss the sociological impact of scientific decisions with someone doing research in that area.

Because knowledge of the environment cannot be gleaned solely through a microscope, our program includes courses in the ethics and political theory of the environment.

Description of Program

The environmental science program is multidisciplinary, combining aspects of the natural sciences, specifically as they contribute to a greater awareness and understanding of the environment. The program provides a broad education in several areas of environmental science to enhance your appreciation of the scientific, social, cultural and political issues that impinge on the environment. It also provides focused in-depth knowledge in a single discipline as it relates to the environment.

With its two streams and potential for the addition of other streams, this degree will be attractive to students who are seeking higher education in a focused environmental science program and who value a special locale that offers a close, friendly atmosphere with relatively small class size and high quality instruction.

General Degree

The general BSc in environmental science requires 40 credits, usually earned over a four-year course of study. Of those 40 credits, between 26 and 29 are compulsory.

All students take basic chemistry, biology, calculus, and statistics courses. Other required courses common to both streams are principles of ecology, and several specially designed environmental science courses such as an environmental seminar, computer-based scientific writing, and a one-semester research project.

Grenfell College is a liberal arts institution, with the philosophy that graduates need to know about more than their area of specialization in order to be able to make their maximum contribution to our society.

The Grenfell College BSc program is an interdisciplinary one, designed to give you a broad base of general knowledge as well as depth in one subject area. In addition to your specialty, we require you to complete a core program.

Core Requirements for the Bachelor of Science

Literacy: You must complete 10 designated writing courses, including a first-year English sequence.

Numeracy: The two courses in mathematics required to fulfil the numeracy requirement are part of your BSc studies. You must also pass the General Mathematical Skills Test, designed to ensure our students can perform basic mathematical functions necessary to live in modern society.

General Education: In order to ensure students have been exposed to a broad range of subjects, six designated general education courses must be completed, from at least four different subject areas.

Writing and General Education courses can be taken as electives; we urge you to consult with your faculty adviser and the university *Calendar* to ensure you are accumulating the appropriate credits. Some of the writing and general education courses overlap with the BSc requirements.

Honors Degree

The honors program comprises 40 credits, and can also be completed in four years. Course requirements are slightly different, and honors students must conduct an original research project over two semesters.

Honors students must also satisfy the basic requirements for a Grenfell degree as described above.

Faculty

Grenfell's Chemistry Department is made up of PhD chemists with national and international reputations in their areas of expertise. These include physical/inorganic and environmental research (migration of pollutants through the geosphere) — externally funded; organic polymer and pesticide research — internally funded; science education; chemical education and curriculum development; history of science and women in science; and textbook writing.

Grenfell's Biology Department includes biologists with research interests and expertise in a variety of botanical, zoological, and ecological areas related to Newfoundland fresh-water and terrestrial habitats.

Like all faculty at Grenfell College, instructors in the Biology and Chemistry departments consider students their first priority. The closeknit atmosphere of the college allows for considerable interaction. It's not at all unusual for science student experiments and groundbreaking faculty research to be conducted at the same time, in the same laboratory.

Chemistry Stream

You will learn about the physical and chemical properties of naturally occurring and anthropogenic (devised by humans) substances, and how they interact with the environment.

The first two years include survey courses in inorganic, physical, environmental and organic chemistry. You will learn about important global topics including the ozone layer, global warming and air pollution before focusing more specifically on areas of chemistry related to the environment.

In-depth courses in the third and fourth years include atmospheric, industrial, environmental analytical, aquatic, and environmental organic chemistry.

Students in the honors program of the chemistry stream will take additional advanced courses in aquatic chemistry and environmental organic chemistry and complete a major two-semester research project.

Because there's more to the environment than science you will also take a philosophy course in environmental ethics and an anthropology course covering how cultural crises affect the environment and vice versa.

Biology Stream

This stream concentrates on the relationships between environmental factors and organisms in terrestrial and freshwater habitats.

In your first two years, you will gain a broad background in general biology through courses emphasizing the structure, function and classification of the various kingdoms of life.

In your third and fourth years, you will use this knowledge to promote an understanding of how environmental factors influence organisms at different levels of biological organization, from single-celled creatures to the largest mammals, from one leaf cell to the interaction of everything that lives in a forest.

Our biology stream emphasizes field studies in the rich range of natural settings found only in western Newfoundland.

The experience you gain will allow you to understand the interrelationships involving the physical, chemical and biotic components of the environment, appreciate the ecological and social implications of environmental modification, and comprehend environmental issues and problems at the local, national and global levels.

Where You'll Go

The economic future of Canada, many experts agree, is based in science and technology. One of the major areas of scientific interest is the environment, in part because our social and economic futures are so dependent on the world around us.

At Grenfell, we expect that future employment opportunities, therefore, will lie in private and public sectors associated with the environment. Graduates of the general bachelor of science (environmental science) might expect to be employed as science technologists in environmental laboratories, or in analytical laboratories supervising technicians. The degree will prepare you to continue studies in professional programs such as environmental law, business administration, library science, or the medical professions, including the growing field of industrial hygiene. Your degree might also lead to a career as an educator or a science journalist, passing on your knowledge and awareness of the issues.

Graduates of the honors program may find employment in government or industrial laboratories leading research and development projects. For those seeking academic positions, pursuit of graduate programs is possible. Several universities in Canada (Queen's, University of Alberta) offer MSc and PhD programs in environmental science and may provide students direct access to graduate school.

Facilities

Students in the biology stream will focus on laboratory and field studies of the richly varied environments on the west coast of Newfoundland.

Access to a university field station and co-operative interaction with provincial and federal parks and forestry departments provides a solid practical background for interpretation of biotic and abiotic features of the boreal forest biome.

The major laboratory courses in environmental analytical chemistry are housed in a new laboratory, equipped with the very latest instrumentation: gas chromatography/mass spectrometry; high-performance liquid chromatography; Fourier transform infrared; atomic absorption; ion chromatography; diode array ultraviolet/visible spectrophotometry; spectrofluorimetry and electrochemical apparatus.

Admission Requirements

For Memorial: Generally speaking, Memorial University requires high school graduation with a 70 per cent average in all courses. Consult the university *Calendar* for specific requirements by province and country.

High school chemistry is pre-requisite to Chemistry 1200 and 1001. Advanced Mathematics and Physics are strongly recommended as well.

There is just one application form for Memorial University. If you wish to attend Grenfell College, specify when you apply.

For the program: Students will normally be admitted into the environmental science program after completing first-year science courses at Grenfell. Students entering Memorial University from high school who wish to pursue a degree in environmental science should consult with the co-ordinator of the Chemistry or Biology departments at Grenfell to determine which first-year courses they should take to complete the degree in four years.

Want more Information?

If you're interested in the BSc with specialization in environmental sciences, contact the Registrar's Office. The adviser on duty will be happy to answer your questions and/or refer you to someone in the department.

Office of the Registrar
Sir Wilfred Grenfell College
University Drive
Corner Brook, NF A2H 6P9
Phone (709) 637-6298
FAX (709) 637-6496
e-mail info@beothuk.swgc.mun.ca
home page http://www.swgc.mun.ca

Published by the Division of University Relations for
Sir Wilfred Grenfell College

Photography by Photographic Services, Division of University Relations, except front cover by Biology Department, Grenfell College

8

Memorial University of Newfoundland

GRADUATE PROGRAMS

THE FACULTY

DEANS AND DIRECTORS

Christopher A. Sharpe, Ph.D., Acting Dean of Graduate Studies.

Arts: T. M. Murphy, Ph.D., Dean.
Business Administration: R. W. Blake, Ph.D., Dean.
Education: T. Piper, Ph.D., Dean.
Engineering and Applied Science: R. Seshadri, Ph.D., Dean.
Medicine: I. Bowmer, M.D., Dean.
Nursing: M. Lamb, M.N., Director.
Pharmacy: G. R. Duncan, D.Phil., Director.
Physical Education and Athletics: W. L. Redden, Ph.D., Director.
Social Work: J. Pennell, Ph.D., Director.
Science: A. Law, Ph.D., Dean.

Interdisciplinary Programs

Aquaculture: S. Goddard, Ph.D., Coordinator.
Biopsychology: W. Montevecchi, Ph.D., Coordinator.
Environmental Engineering and Applied Science: F. Curtis, P.Eng., Chair.
Environmental Science: T. Abrajano, Ph.D., Chair.
Humanities: W. Barker, Ph.D., Chair.
Toxicology: B. B. Virgo, Ph.D., Chair.
Women's Studies: R. Tite, Ph.D., Chair.

FACULTY RESEARCH AREAS

Aquaculture: Mussel and scallop culture, development of new candidate species, fish nutrition, and aspects of charr aquaculture.
Biochemistry: Environmental biochemistry, toxicology, metabolic regulation, nutritional biochemistry, molecular and cell biology, macromolecules, lipids, membranes, glycoproteins, food science, food engineering, and marine biotechnology.
Biology: Biopsychology, marine biology, ecology of aquatic organisms, physiology, microbiology, and population biology.
Biopsychology: Marine mammal and seabird energetics, hormonal aspects of parental behavior; mating systems of fish; spatial dynamics of marine animals, and behavior of larval fish, whales, and birds as bio-indicators in marine and terrestrial ecosystems.
Business Administration: Marketing research, consumer research, market segmentation from both a domestic and international perspective, international topics, small business research, accounting, finance, management information systems, organizational behavior and decision-making and policy research.
Chemistry: Analytical/environmental, electrochemistry, inorganic chemistry, marine chemistry, organic chemistry, physical chemistry, and theoretical computational chemistry.
Classics: Greek and Latin literature, Greek and Roman history and historiography, and ancient thought.
Computer Science: Computational complexity, computational geometry, computer-aided design, computer graphics, computer vision, data analysis and clustering methods, database concurrency control and recovery, dataflow architectures, development of mathematical software, functional and logic programming languages, image processing, knowledge-based systems, modeling and performance evaluation of systems, neural networks, numeric computations, parallel processing, pattern recognition, software engineering, and VLSI design.
Earth Sciences: Marine geoscience; igneous, metamorphic, and sedimentary petrology; marine geology and geophysics; environmental geochemistry; paleontology and palynology; structural geology and tectonics; geochronology; economic geology and mineral deposits; mineralogy and geochemistry; hydrogeology; petroleum geology; crustal geophysics; seismology; magmatism; and regional geology.
Economics: Microeconomics, macroeconomics and econometrics; natural resource economics, public-sector economics.
Education: Educational leadership and change, policy studies, teaching and learning, counseling and school psychology, and postsecondary education.
Engineering and Applied Science: Civil, electrical, mechanical, and ocean engineering and applied mathematics; statistical data analysis, probability and statistics; optimization, remote sensing; environmental studies; transportation; costing and scheduling; structural design and analysis; coastal engineering, environmental hydraulics, environmental geotechnics; radar systems; applied electromagnetics; applied marine acoustics, naval architecture; hydrodynamics; robotics; computer-aided design; fluid dynamics; ice friction; and corrosion fatigue and fracture.
Environmental Science, Engineering, and Applied Science: A joint program providing the conceptual and analytical tools to understand and seek solutions for a wide range of environmental problems. Research subjects range from understanding subtle changes in ecosystem structures and function in marine and terrestrial systems to characterizing and remediating toxic contaminant discharges in geological and biological systems and the integration of various facets of science and related fields to addressing environmental concerns.
Folklore: Folk music, song, and ballad; folk narrative, folk belief, and religion, traditional health systems; custom; drama; national culture and vernacular architecture; folk and popular culture; applied folklore; folklore and gender; and folklore and technology—all areas focus primarily on Newfoundland, Canada, North America, and the British Isles.
Geography: Cultural, historical, economic, urban resource, and physical geography; cartography; geographical information systems remote sensing; climatology; quaternary; and geomorphology.
History: Maritime, Canadian, and Newfoundland history; fishery economics; economic/business history; ethnic, labor, women's, and social history.
Humanities: Interdisciplinary studies in the humanities and social sciences.
Languages, Literatures, and Linguistics: English language and literature; Renaissance, eighteenth-century, Romantic, and modern literature; Anglo-Irish, Canadian, and feminist studies; critical theory, phonology and dialectology; interdisciplinary studies with the departments of folklore and linguistics; studies in Newfoundland literature, language, and culture; French language and literature, and German language and literature.
Mathematics and Statistics: Algebra, analysis and functional analysis; combinatorics and graph theory, geometry, topology, applied mathematics, mathematical statistics, and probability.
Medicine: Community medicine and behavioral sciences, immunology, molecular biology, and neurosciences.
Nursing: Health promotion and education, coping with chronic illness, infant feeding, nursing education, self-care, and women's health.
Pharmacy: Pharmaceutics, medicinal chemistry, physical pharmacy, pharmacokinetics, pharmacology, and toxicology.
Philosophy: History, metaphysics, ethics, epistemology, philosophy of religion, philosophy of science, and aesthetics.
Physics and Physical Oceanography: Condensed-matter physics, atomic and molecular physics, and physical oceanography.
Political Science: Canadian, provincial, international, and comparative politics.
Psychology: Experimental psychology; learning and behavioral pharmacology; behavioral neuroscience; cognition, perception, and motor behavior; developmental psychology; applied social psychology; clinical psychology; and biopsychology.
Religious Studies: Biblical studies and Christian thought and world religions, with emphasis on the study of religion in Newfoundland.
Social Work: Child welfare, family violence, sexual offender rehabilitation, AIDS prevention, aboriginal culture and issues, history of social welfare, and women's issues.
Sociology: Maritime sociology; gender, work, and development; social theory, social inequality; and criminology.
Toxicology: Biochemical effects of toxicants, hormonal and chemical regulation of toxicokinetics, female reproductive toxicology, neonatal/perinatal toxicology, and neurotoxicology.
Women's Studies: Interdisciplinary program of women's studies specialties, particularly feminist theory and methods.

GRADUATE STUDIES ENVIRONMENTAL SCIENCE at MEMORIAL UNIVERSITY OF NEWFOUNDLAND

Master of Science and Master of Environmental Science Degrees

The Faculty of Science and the Faculty of Engineering and Applied Science jointly offer a program in **Environmental Science, Applied Science and Engineering** leading to:

- *Master of Science in Environmental Science* (M.Sc.)
- *Master of Environmental Science* (M.Env.Sc.), and
- *Master of Applied Science in Environmental Engineering and Applied Science* (M.A.Sc.).

The program is available on a full-time or part-time basis for students with science or engineering backgrounds.

Admission for the M.Sc. and M.Env.Sc. degrees is limited and competitive. To be considered, an applicant shall normally hold an honors degree in science or a bachelor's degree in engineering with at least a second-class or equivalent standing from an institution recognized by the Senate, or shall have qualifications and/or environmental experience deemed acceptable by the Dean of Graduate Studies and the Environmental Science Admission/Administration Committee.

Students obtaining an M.Sc. degree are required to successfully complete five courses including two of our integrated courses (*Environmental Science and Technology, Earth and Ocean Systems, Environmental Chemistry and Toxicology, Applied Ecology, Environmental Pollution and Mitigation, Environmental Sampling and Analysis, Environmental Law and Management*), two depth courses in the student's science specialization, and a seminar course. In addition, an interdisciplinary environmental thesis that meets the normal requirements of the School of Graduate Studies is required. Students obtaining an M.Env.Sc. degree are required to successfully complete eight courses including four integrated courses and four depth courses. In addition, an environmental project and a scientific report must be completed.

St. John's and Memorial University

St. John's, the capital city of Newfoundland and one of the oldest cities in North America, is a colorful seaport with a metropolitan population of about 165,000. Its climate is more moderate than that of many other places in Canada, even during the winter months. Excellent recreational opportunities exist for fishing, hiking, windsurfing and cross-country skiing in and around the city.

Memorial University is located near the edge of the city, flanked by wooded hills and ponds, although it is only a couple of minutes by car or a 20-minute walk from the city centre. The university includes faculties of Arts, Science, Education, Medicine, Business Administration and Engineering and Applied Science, and schools of Graduate Studies, Music, Nursing, Pharmacy, Physical Education and Social Work. Total student enrollment is about 20,000, with about 1,200 graduate students. The campus also hosts a sports complex, an arts and culture centre and a hospital complex.

The Faculty of Science

The Faculty of Science is a dynamic faculty with 270 full-time faculty members distributed over the departments of Biochemistry, Biology, Chemistry, Computer Science, Earth Sciences, Mathematics and Statistics, Physics, Psychology, and the Ocean Sciences Centre. There are approximately 300 graduate students in M.Sc. and PhD programs whose research is undertaken on both the national and international scenes.

Environmental Faculty and Research Interests

ABRAJANO, T.A., PhD, Washington 1984
Sources and fate of organic contaminants; biogeochemistry; stable isotope geochemistry

CATTO, N.R., PhD, Alberta 1986
Quaternary geological, paleoenvironmental, and sedimentological research

COLBO, M.H., PhD, Queensland 1975
Freshwater ecology; ecology of Chironomidae and black flies

de YOUNG, B., PhD, British Columbia 1986
Physical oceanography; circulation of the northwest Atlantic

GALE, J.E., PhD, Berkeley 1975
Hydrogeology and geological engineering

GOGAN, N., PhD, Nat. Univ. Ireland 1965
Inorganic chemistry; environmental chemistry

HAEDRICH, R., PhD, Harvard 1966
Biological oceanography; fish ecology

HAY, A.E., PhD, British Columbia, 1981
Physical oceanography, nearshore sediment dynamics, acoustical oceanography

HELLEUR, R.J., PhD, Queens 1984
Analytical chemistry; chromatographic and mass spectrometric techniques

JACOBS, J.D., PhD, Colorado 1973
Climatology and climate change; arctic and subarctic environments

MARTIN, A.M., DChE, Havannah 1977
Biochemical engineering; biological degradation of waste; bioconversion and biodegradation

MONTEVECCHI, W.A., PhD, Rutgers 1975
Biopsychology; birds as environmental indicators

PARRISH, C.C., PhD, Dalhousie 1986
Chemical oceanography; production, transport, fate and effects of marine lipids

PATEL, T.R., PhD, Texas 1974
Environmental and applied microbiology; microbial biotechnology

RAHIMTULA, A.D., PhD, Southampton 1970
Toxicology

WADLEIGH, M.A., PhD, McMaster 1989
Environmental and atmospheric geochemistry; stable isotopes

Facilities

Numerous state-of-the-art facilities and laboratories are available within the Faculty of Science. Modern analytical and field facilities and instrumentations for a wide range of environmental research,

assessment and monitoring including inductively coupled plasma-mass spectrometer (ICP-MS); high-precision thermal ionization and stable isotope mass spectrometers; scanning electron microscope; wave-length and energy dispersive electron microprobe with image analysis facility; X-ray diffractometer; X-ray fluorescence spectrometer; atomic absorption spectrophotometer; gas chromatograph; gas chromatograph/mass spectrometers; trace gas analyzer; sedigraph; geographic information system and workstation; well log database and stratigraphic/seismic modeling software packages; deep-tow seismic profiler; multi-channel acoustic imaging systems, acoustic image processing facilities, acoustic calibration facilities; equipment for coupled stress-flow and transport experiments in fractured rock flow system studies.

Computer facilities are linked to the university Ethernet backbone and include: the CONVEX C1 XL mini supercomputer; SUN workstations; 386- and 486-based workstations. Computer drafting, slide making, word-processing and desk-top publishing are all available. University computer facilities include a VAX 4200-4300-4500 cluster operating under VMS; a VAX 5500 running under UNIX; and access to an AMDAHL 5860.

Financial Assistance

Financial support for graduate students is available on a competitive basis from various sources. Students with excellent academic records are encouraged to apply to provincial or federal government sources, as well as to the university. The value of these awards range from $6,000 to $14,000 per year, and supplementary financial support is normally available for students through grants of individual faculty members. Students will be informed of their level of financial support as part of the acceptance letter that the university send[redacted] to each individual.

Tuition and Accommodations

program and a three-year PhD program, respectively. On-campus accommodation for single and married students costs around $200 - $535 a month. Accommodation in private homes near campus is also readily available at about $250 - $400 a month. Good bus connections exist within the city limits. The student stipends permit a reasonable standard of living in St. John's.

For More Information

For further information regarding admission, financial support and specific research in progress, please write:

Chair
Board of Study in Environmental Science
School of Graduate Studies
Memorial University of Newfoundland
St. John's, Newfoundland
CANADA A1B 3X5

Tel. (709) 737-8200
Fax (709) 737-4702
abrajano@sparky2.esd.mun.ca

Published by the Division of University Relations

Memoria

University of Newfoundla

ENVIRONMENTAL SCIEN

AT MEMORIAL

97

MARINE INSTITUTE

ADVANCED DIPLOMA - FOOD TECHNOLOGY

This programme was developed through consultation with the food processing industry in order to meet the increasing demand for technologists. It is a graduate - level programme designed to:

- upgrade the knowledge and skills of university graduates from other disciplines.
- equip them with capabilities to meet changes in the food industry.

Credit Earned: Advanced Diploma in Food Technology

1 Year: 2 academic terms and 1 work term

Normal Start: Fall

School of Fisheries

Contact: Admissions Officer

(709) 778-0380

PROGRAMME ENTRY:

Students entering this programme must be university graduates with the following prerequisites: organic chemistry, biology, microbiology, and statistics.

PROGRAMME STRUCTURE:

Term One:
Students study food microbiology and food chemistry as well as food processing and food quality management.

Term Two:
The second term continues the study of food processing and also includes courses in food processing engineering, food chemistry, and food biotechnology. A project course allows for in-depth study of an area of special interest.

Term Three:
The students will be placed in pertinent industries or agencies for practical experience.

PROGRAMME HIGHLIGHTS:

The programme is designed to equip university graduates with the in-depth knowledge and practical skills required to meet the needs of the food processing industry:

- The industrial applications of food technology are emphasized.
- There is only one other Advanced Diploma in Food Technology in the world which is being offered by the Singapore Polytechnic.
- Intensive laboratory training in food microbiology, food chemistry, and food biotechnology will allow graduates to perform related tasks within the food industry.
- Lectures and practical laboratory work in food processing technology, food engineering, and food quality management provide the graduate with a solid background in food production.
- Currently IFT has no guidelines for an Advanced Diploma in Food Technology; however, this programme, built on a university degree with clearly defined prerequisites, comes very close to meeting the requirements for an undergraduate degree in food science/food technology.
- The programme design enables each of the courses to stand alone or to serve as partial fulfillment of the Advanced Diploma in Food Technology requirements.

CAREERS

Graduates of this programme will compete for positions as technologists within various sectors of the food processing industry as well as within various government agencies.

Sample Job Description:

- Responsible for the design and implementation of appropriate food processing techniques.
- Responsible for the design and implementation of effective quality programmes.
- Interpret and apply relevant government regulations, standards and policies.
- Perform laboratory procedures.
- Apply product development procedures.
- Supervise food plant operations.
- Operate and maintain food processing equipment.

PROGRAMME OUTLINE

Term 1

Food Technology 4103 (Food Processing I)

Business & Organizational Management 4100 (Management Principles)

Food Technology 4101 (Food Microbiology)

Communication Skills 4100 (Effective Presentation)

Food Technology 4104 (Food Chemistry A)

Business & Organizational Management 4105 (Food Quality Management)

Term 2

Food Technology 4203 (Food Processing 2)

Food Technology 4204 (Food Chemistry B)

Food Technology 4105 (Food Biotechnology)

Food Technology 4205 (Food Processing 3)

Food Technology 4106 (Food Processing Engineering)

Technical Project 4104 (Technical Project)

Term 3

Work Term 4104

there is only one other Advanced Diploma in Food Technology in the world which is being offered by the Singapore Polytechnic

4317. Elizabethan-Jacobean Drama. A survey of Shakespeare's dramatic rivals and the Elizabethan and Jacobean repertoires. Prerequisites: English 3200 or 3201.
NOTE: Students cannot receive credit for both English 3022 and 4317.

4836-44. Special Topics in Drama. Supervised study in specialized areas of dramatic literature. Course topic, design, and requirements to be determined through consultation by the student with the instructor.
Prerequisites: Permission of the instructor.

CANADIAN LITERATURE

2152. Introduction to Canadian Literature. An introduction to the poetry and prose of selected Canadian writers.

2155. Newfoundland Literature. A study of Newfoundland literature with emphasis on representative writers since 1949.
NOTE: Students cannot receive credit for both English 2155 and 3155.

Canadian Short Stories. A study of Canadian short stories which aims to give the student a heightened appreciation of individual short stories, and some sense of the range of Canadian accomplishment in the genre.

3145. Canadian Prose to 1949. A study of the outstanding works of Canadian prose from the beginnings to 1949.

3146. Canadian Prose after 1949. A study of the outstanding works of Canadian prose from 1949 to the present.

3147. Canadian Poetry to 1949. A study of representative Canadian poetry from the pre-confederation period to 1949.

3148. Canadian Poetry After 1949. A study of Canadian poetry from 1949 to the present, with emphasis on the work of major poets and an examination of the various styles and theories of poetry developed during the period.

4307. Contemporary Canadian Drama. See description in dramatic literature list above.
NOTE: Students cannot receive credit for both English 3156 and 4307.

4825-35. Special Topics in Canadian Literature. A variety of topics are available, to be offered as resources permit.

MODERN LITERATURE

2 American Literature to 1900. A study of the historical origins and development of 19th Century American Literature, concentrating on a selection of works within their political, social and artistic contexts.
NOTE: Students cannot receive credit for both English 2214 and 2215.

2705. Modern World Literature in Translation. A study of modern world literature in English translation, with focus on writers of the 20th Century who have attained international stature.

2805. Women's Writing to 1900. A study of writing by women in the British Isles and North America from the Middle Ages to 1900, including such items as letters and journals as well as fiction, poetry, and drama.
NOTE: Students can receive credit for only one of English 2805, 3810, and 3830.

3215. 20th Century American Literature. A study of American poetry and fiction from 1900 to 1960.
Prerequisites: English 2215 or permission of the instructor.
NOTE: Students can receive credit for only three of English 3215, 4260, 4261, and 4270.

3216. 20th Century British and Irish Literature. A study of British and Anglo-Irish poetry and fiction from 1900 to 1960.

3810. 20th Century Non-Fiction Writing by Women. A study of 20th Century topical writing by women, including writing about social, political, and artistic and literary questions. Non-traditional as well as traditional genres will be studied.
Prerequisites: English 2805 or permission of the instructor.
NOTE: Students can receive credit for only one of English 2805, 3810, and 3830.

3905. Creative Writing. A workshop course for aspiring writers of poetry and/or fiction. Limited enrolment. Applicants will be required to submit a sampling of their previous and current work.
Prerequisite: permission of the instructor.

4245. Contemporary Fiction in English. An in-depth study of a selection of recent short fiction and novels in English. The focus will be on recent developments in American, British, Irish and Commonwealth fiction (excluding Canadian).

4246. Contemporary Poetry in English. An in-depth study of contemporary poetry in English. The focus will be on major poets and developments in the U.S.A., Britain, Ireland and the Commonwealth (excluding Canada) since 1945.

4905. Advanced Creative Writing. A workshop course for creative writers who have demonstrated considerable talent and skill in poetry and/or prose fiction. Limited enrolment.
Prerequisite: Permission of the instructor.

ENVIRONMENTAL SCIENCE COURSES

For existing MUN courses, the numbers remain the same. For new courses in Environmental Science, the following 4-digit scheme is used:

1st digit = Year

2nd digit = Parent Discipline:

- 0 = Multidisciplinary
- 1 = Biology
- 2 = Chemistry
- 3 = Earth Science
- 4 = Physics
- 9 = Project

3rd digit = Subdiscipline:

(Biology)	(Chemistry)	(Multidisciplinary)
1 = Botany	1 = Analytical	5 = Research
2 = Zoology	2 = Inorganic	8 = Science Writing
3 = Ecology	3 = Physical	
	4 = Organic	
	6 = Environmental	

4th digit = Numerical Sequence.
= 9 for 4000 level courses that are requirements of the Honours streams.

Courses specifically designed for the environmental science programme(s) are given the designation "EnSc". Thus, for example, in the Winter semester of the 2nd year, Environmental Chemistry is offered, with a course number = EnSc 2261.

ENVIRONMENTAL BIOLOGY COURSES

3130. Freshwater Ecology. The study of freshwater ecosystems (lakes, rivers, streams, peatlands). Included are abiotic components, community structures, energy flow, biogeochemical cycles, and the evolution of natural and altered aquatic ecosystems. Emphasis will be placed on field and laboratory studies of the ecology of freshwater organisms and systems in western Newfoundland.
Prerequisites: Biology 2010, 2122, 2600; Chemistry 1001.
Lectures: Three hours per week.
Laboratory: Three hours per week.

4130. Plant Physiological Ecology. A study of the physiological responses of plants to changes in the physical/chemical environment. Field studies of native species in stressful environments are emphasized. Topics include: environmental monitoring, photosynthetic gas exchange, water relations, nutrient relations, and stress physiology.
Prerequisites: Biology 2010, 2600, 3610.
Lectures: Three hours per week.
Laboratory: Three hours per week.

ENVIRONMENTAL CHEMISTRY COURSES

2261. Survey of Environmental Chemistry. Introduction to environmental problems, underlying chemistry and approaches to pollution prevention. Stratospheric chemistry and the ozone layer. Ground level air pollution. Global warming and the Greenhouse Effect. Toxic organic chemicals (TOC's), including herbicides, pesticides. Toxicology of PCB's, dioxins and furans. Chemistry of natural waters. Bioaccumulation of heavy metals. Energy production and its impact on the environment, including nuclear energy, fossil fuels, hydrogen.
Prerequisites: Chemistry 1001.
Lectures: Three hours per week.

3210. Environmental Analytical Chemistry I. Treatment of data, error analysis, wet methods of analysis of laboratory and field samples. Volumetric methods for acidity, alkalinity and hardness;

halide ions. Turbidimetric and nephelometric measures of water quality. Spectrophotometric analysis of trace metal ions.
Prerequisites: Chemistry 2300.
Lectures and Laboratory: Not more than seven hours per week.

3211. **Environmental Analytical Chemistry II.** Theory and application of spectroscopic methods of analysis (including error analysis) of environmentally important compounds. Spectrophotometric, FTIR, light scattering, chromatographic (GC, GC/MS, HPLC), fluorescence, phosphorescence, atomic absorption and electroanalytical methods will be studied. Synthetic laboratory samples and field samples will be examined by these techniques.
Prerequisites: Environmental Science 3210 (or equivalent).
Lectures and Laboratory: Not more than six hours per week.

3260. **Industrial Chemistry.** Chemical principles used in the manufacture of inorganic and organic chemical products; electrochemical, petrochemical, polymer, pulp and paper, agricultural, cement, cosmetics, detergent and paint industries. Processes, specific pollutants of current interest: inorganic (e.g. mercury, NO_x and SO_x gases, lead etc.) and organic (e.g. PCB's, chlorinated hydrocarbons, freons, pesticides/herbicides). Industrial sources and analytical methods of detection will be studied.
Prerequisites: Chemistry 2210, 240B, 2261.
Lectures: Three hours per week.

3261. **Atmospheric Chemistry.** Electronic, vibrational and rotational spectroscopy. Rates and mechanisms of gas phase reactions (particularly photochemical). Thermodynamics of the atmosphere. Formation, evolution and structure of the Earth's atmosphere. Chemical and physical properties of the atmospheric gases. Global element cycles. The stratosphere and ozone variability. The ionosphere. Atmospheric pollutants. Problems of the "greenhouse" gases. Aerosol chemistry. Wet and dry deposition.
Prerequisites: Chemistry 2300, 2210.
Lectures: Three hours per week.

3230. **Aquatic Chemistry I.** Thermodynamics and kinetics of model systems. Acids and bases (including buffer intensity and neutralizing capacity), dissolved gases, precipitation and dissolution. Metal ions in aqueous solution. Redox control in natural waters. Pourbaix diagrams. Regulation of chemical composition of natural waters, pollution and water quality.
Prerequisites: Chemistry 2300.
Lectures and Laboratory: Not more than six hours per week.

3239. **Aquatic Chemistry II.** Heterogeneous aspects of aquatic chemistry. Surface chemistry of oxides, hydroxides and oxide minerals. Aggregation of colloids and the role of coagulation in natural waters. The oil-water interface. Inorganic and organic complexes in natural waters and problems of specificity.
Prerequisites. Environmental Science 4230.
Lectures and Laboratory: Not more than six hours per week.

3240. **Organic Chemistry of Biomolecules.** Structure and properties of carbohydrates, proteins, lipids, steroids, DNA and RNA. The chemistry of the cell in relation to its toxicology; effects of reactive agents on cells, organelles, tissues and whole organisms. Natural products including those from the rain forest and marine environments. The role of metal ions in biomolecules. Examples of biosynthesis. Chemistry and mechanisms of mutagenesis and carcinogenesis.
Prerequisites: Chemistry 240B.
Lectures: Three hours per week.

3249. **Environmental Organic Chemistry.** Focus on anthropogenic sources of organic chemicals and pollutants in the environment. Concepts of organic chemistry (synthesis, structure, physical properties, chirality, industrial organic processes), biological chemistry (enzymes, oxidative pathways) and physical chemistry (equilibria, partitioning) extended and applied to mass transport through soil, water and air. Kinetics and mechanisms of chemical, photochemical and biological degradation and conversion of organics. Structure-reactivity relationships for organic chemicals and degradation intermediates in the environment.
Prerequisites. Environmental Science 4240, 3261, 4230.
Lectures: Three hours per week.

OTHER ENVIRONMENTAL SCIENCE COURSES

3270. **Global Environmental Change.** A survey of the Earth as a dynamic system. Discussion of interacting cycles that define the Earth's environment. Material cycles and energy concepts. Evolution of the atmosphere in response to lithospheric, biospheric and hydrospheric changes. Major global environmental changes from Earth's formation to present. Emphasis on self-regulating ability of the Earth system.
Lectures: Three hours per week.
Prerequisite: This course is restricted to students with thirty credit hours or more.

3280. **Oceanography.** Historical review of science of oceanography. Ocean and Earth systems (including plate tectonics). Marine sediments and sedimentary environments. Chemical and physical properties of seawater. The atmosphere and the oceans, ocean circulation. Waves and tides, coastal environments, distribution of organisms. Applied oceanography.
Lectures: Three hours per week.
Prerequisite: This course is restricted to students who have completed thirty credit hours or more.

2430. **Energy and the Environment.** Energy, energy conversion, heat transfer, the laws of thermodynamics, nuclear processes and radiation will be treated. Practical problems such as the energy shortage, human influences on climate, resource extraction, nuclear power etc. will be discussed.
Prerequisites: Mathematics 1081 or 1000; Physics 1201
Lectures: Three hours per week.

2450. **Meteorology.** Meteorology as an application of physics and mathematics to the study of the atmosphere. Atmospheric motion on the global, synoptic, meso- and micro-scales. An introduction to atmospheric radiation and thermodynamics, clouds and precipitation. Vertical soundings and the analysis and interpretation of surface and upper-air weather maps.
Prerequisites: Physics 1201.
Lectures: Three hours per week.

4000. **Environmental Science Seminar.** Current topics in environmental science are reviewed and discussed in a seminar format. Normally, students will research and present two seminars relevant to environmental themes agreed upon by the students and the instructor(s). Seminars will also be presented on current research and environmental issues by faculty and guest speakers from universities, government and industry.
Prerequisite: This course is restricted to students who have completed 90 credit hours or more.

4080. **Computer-Based Scientific Writing.** Scientific English including vocabulary, structure, style and bibliography as used in standard scholarly journals and texts will be taught, with emphasis on the use of microcomputers in scientific word processing. Use will be made of commercial software for the production of scientific documents incorporating chemical structures, mathematical formulae, spectral plots and graphs. Instruction will be given in the manipulation of scanned images and spectral plots as well as spreadsheet usage for data manipulation and graphical display. Databases for information storage and retrieval will also be explored, together with on-line searching strategies, including key-word and citation methodologies.
Lectures and Laboratory: Not more than six hours per week.
Prerequisite: This course is restricted to students who have completed 90 credit hours or more.

4950. **Research Project In Environmental Science I.** With the guidance of a faculty member, students will conduct a scientific study based upon original research or a critical review of extant data in an appropriate area. Students are required to present both a thesis and a seminar on their research.
Prerequisite: Permission of Coordinator.
NOTE: This project fulfils the Core requirement for a fourth-year individual project in the area of specialization.

4959. **Research Project In Environmental Science II.** This is a continuation of Environmental Science 4950 specifically for Honours students. Under the supervision of a faculty member, students will carry out an original research project in environmental science. Students will present both a thesis and seminar on their research. (One dissertation and one seminar satisfies the requirements for both Environmental Science 4950 and 4959).
Prerequisite. Environmental Science 4950.
NOTE: This course is restricted to honours candidates.

FOLKLORE

1000. **Introduction to Folklore.** The role that tradition plays in communication, art and society will be discussed through an examination of folklore materials from Newfoundland and the English-speaking world. Readings and "listenings" will emphasize the use of folklore in context, e.g., the proverb in speech and the folksong in childrearing. Students will be urged to analyze the traditions in their own lives through special assignments.
Lectures: Three hours per week.
NOTE: A student may not receive credit for both Folklore 1000 and 2000.

1050. **Folklore Studies.** An examination of specific folklore studies illustrating important themes and approaches in folkloristics. These will include antiquarian, nationalistic, diffusionist, historic-contextual, functional, structural, and performance analyses as typified in selected readings from the works of leading folklorists.
NOTE: There is no prerequisite for this course. However, students should note that they will need to take Folklore 1000 (or 2000) before they can advance to other courses.

plus eighteen credit hours in elective Biology courses chosen in consultation with the Supervisor or Faculty Advisor. At least twelve of the eighteen credit hours must be chosen from the following list or from the above-listed courses not previously taken:

- Biology 3500, 3540, 3620, 4000, 4012, 4040, 4130, 4245, 4402, 4605, 4822.

HONOURS IN ECOLOGY/EVOLUTION

Students in the Honours Programme in Ecology/Evolution must fulfil the general requirements for an Honours Degree in Biology, including the completion of the required core courses and those required in other Departments. In addition, the following programme must be followed:

Required Courses:
- Biology 3295, 4360, 4505, 4605; either 4810 or 4820; 499A/499B

plus fifteen credit hours in elective Biology courses chosen in consultation with the Supervisor or Faculty Advisor.

HONOURS IN ENTOMOLOGY/PARASITOLOGY

Students in the Honours Programme in Entomology/Parasitology must fulfil the general requirements for an Honours degree in Biology, including completion of the required core courses and those required in other Departments. In addition, the following programme must be followed:

Required Courses:
- Biology 3160, 3401, 4150, 4180, 4181, 4605, 499A/B

plus twelve credit hours in biology electives (or fifteen, if Biology 3401 was completed as part of the core programme required of all Biology Majors) chosen in consultation with the supervisor or faculty advisor. The following are especially recommended:

- Biology 3295, 3610, 3750, 4040, 4130, 4200, 4360, 4505, 4600, 4620, 4630, 4822

HONOURS IN MARINE BIOLOGY

Students in the Honours Programme in Marine Biology must fulfil the general requirements for an Honours degree in Biology, including completion of the required core courses and those required in other Departments. In addition, the following programme must be followed:

Required courses:
- Biology 3710, 3711, 4012, 4605, 4810, 499A/499B

plus fifteen credit hours in Biology electives chosen in consultation with the supervisor or Faculty Advisor. The following are especially recommended:

- Biology 3295, 3620, 4360, 4505, 4600, 4601, 4750, 4822

NOTE: In certain circumstances at the discretion of the Head of the Department, students obtaining credit for Biology 4822 may have the requirement for Biology 4810 waived.

COURSE LIST

NOTE: Students may obtain credit for only six 1000-level credit hours in Biology. Normally, these courses will be Biology 1001-1002, which are prerequisite to all higher courses in Biology, except where noted below.

1001-1002. Principles of Biology. An introduction to the science of Biology, including a discussion of the unity, diversity and evolution of living organisms.
Three hours of lecture and a three-hour laboratory per week.
NOTE: Biology 1001 is a prerequisite for Biology 1002.

2010. Biology of Plants. A study of the structure, function and reproductive biology of plants, with emphasis on the vascular plants, and on their relationship to environment and human activities.
Three hours of lecture and a three-hour laboratory per week.
Prerequisites: Biology 1002, Chemistry 1001.

2040. Modern Biology and Human Society I. This course examines the origins and consequences of the environmental crisis of the 20th century. Topics include the population explosion, energy, disease, immunity, human genetics, biorhythms, new diseases, genetic engineering and reproductive engineering.
Three hours of lectures/seminars per week.
NOTE: Biology 2040 is not acceptable as one of the required courses for the Minor, Major or Honours programmes in Biology. There are no prerequisites for this course.

2041. Modern Biology and Human Society II. This course examines the origins and consequences of the environmental crisis of the 20th century. Topics include the population explosion, energy, material cycles, air and water and land pollution, global food supplies, the fisheries, wildlands, renewable and non-renewable resources, environmental ethics.
Three hours of lecture/seminar per week.
NOTE: Biology 2041 is not acceptable as one of the required courses for the Minor, Major or Honours programmes in Biology. There are no prerequisites for this course.

2120. Biology for Students of Earth Sciences. An introduction of the principles of Biology for students in Earth Sciences. Topics will include principles of classification, levels of biological organization, fundamental characteristics of living organisms and basic concepts in ecology.
Three hours of lecture and three hours of laboratory per week.
Prerequisites: Earth Science majors; Earth Sciences 1001 or permission of the Head of Department.
NOTES: 1) Entry to this course is restricted to Earth Sciences majors, or by permission of the Head of Department.
2) This course may not be used for credit by Biology Majors or Minors.
3) Credit may not be obtained for both Biology 2120 and either of Biology 1001 or 1002.

2122. Biology of Invertebrates. A study of the invertebrates with emphasis on structure and function, adaptations and life histories. The laboratories will present a broad survey of the major invertebrate groups.
Three hours of lecture and three hours of laboratory per week.
Prerequisite: Biology 1002.
NOTE: Credit may not be obtained for both Biology 2122 and the former Biology 3122.

2210. Biology of Vertebrates. A study of the vertebrates, with emphasis on structure and function, adaptations and life histories.
Three hours of lecture and three hours of laboratory per week.
Prerequisite: Biology 1002.
NOTE: Credit may not be obtained for both Biology 2210 and the former Biology 3210.

2600. Principles of Ecology. A conceptual course introducing the principles of ecology, including theoretical, functional and empirical approaches.
Three hours of lecture and three hours of laboratory per week.
Prerequisite: Biology 1002.
NOTE: Credit may not be obtained for both Biology 2600 and the former Biology 3600.

3041. Boreal Flora. The identification of the terrestrial plants (vascular plants and bryophytes) of Newfoundland and Labrador. Various aspects of reproduction or floral biology, and the use of dichotomous keys will be covered.
Prerequisite: Biology 2010.
Three hours of lecture and three hours of laboratory per week.

3050. Introduction to Microbiology. A study of the basic principles underlying microbial life. The structure, function, nutrition and growth, control, and bioenergetics of bacteria. An introduction to the biology of fungi and viruses, and to principles of immunology. Aspects of disease and the biotechnological uses of micro-organisms. The laboratory sessions provide training in aseptic techniques and diagnostic experimental manipulations with microorganisms.
Three hours of lecture and three hours of laboratory per week.
Prerequisite: Chemistry 2440 or 2401 or 2420.
Either Chemistry 2401 or 2420 may be used as a corequisite.

3052. Food Microbiology. (Same as Biochemistry 3052) This course is administered by the Department of Biochemistry.
Enrollment priority will be given to students in the Nutrition and Dietetics programmes where this is a required course.
Prerequisite: Biology 3050.
NOTE: Credit may not be obtained for both Biology 3052 and the former Biochemistry 3401.

3060. Principles of Cell Biology. A comprehensive introduction, using modern methodology, to the biology of eukaryotic cells, organelles, and molecules, and their interactions in the functioning of living organisms.
Three hours of lecture and three hours of laboratory per week.
Prerequisites: Physics 1021 or 1054; Biochemistry 2101; and

other arthropod classes will be drawn where appropriate.
Three hours of lecture and three hours of laboratory per week.
Prerequisites: Biology 2122.
NOTE: Credit may not be obtained for both Biology 3160 and the former Biology 3150. It is recommended that students enrolling in Biology 3160 have already completed one of Biology 3401, Biology 3402, Biology 4404, or Biochemistry 3106.

3202. Comparative Vertebrate Anatomy. The phylogenetic development and comparative anatomy of the vertebrates.
Three hours of lecture and four hours of laboratory per week.
Prerequisite: Biology 1002.
NOTE: Credit may not be obtained for this course and either of the former Biology 3200 or the former Biology 3201.

3250. Principles of Genetics. An introduction to Mendelian, population, molecular, and developmental genetics which provides an understanding of the molecular basis of variation in organisms and their populations.
Three hours of lecture and three hours of laboratory per week.
Prerequisites: Two of: 2010, 2122, 2210.
NOTE: Credit may not be obtained for both Biology 3250 and the former Biology 2250.

3295. Population and Evolutionary Ecology. An introduction to the theory and principles of evolutionary ecology and population dynamics.
Three hours of lecture and three hours of laboratory per week.
Prerequisites: Biology 2600; at least one of Biology 2010, 2122 or 2210.
NOTE: Credit may not be obtained for both Biology 3295 and the former Biology 4290.

3401. Comparative Animal Physiology. A comparative study of the basic physiological processes, with special attention paid to those strategies invoked by animals which enable them to adapt to environmental changes.
Three hours of lecture and three hours of laboratory per week.
Prerequisite: Biology 2210.
Prerequisite or Co-requisite: Biochemistry 3106.
NOTE: Credit may not be obtained for both Biology 3401 and the former Biology 4401.

3402. Principles of Plant Physiology. A consideration of the principles of plant physiology, including water relations, nutrition, metabolism, growth and development.
Three hours of lecture and three hours of laboratory per week.
Prerequisite: Biology 2010.
Prerequisite or corequisite: Biochemistry 3106.
NOTE: Credit may not be obtained for both Biology 3402 and the former Biology 4403.

3500. Histology. A study of microstructure and ultrastructure of tissues and organ systems in vertebrates, particularly mammals, with emphasis on correlating structure and function.
Three hours of lecture and three hours of laboratory per week.
Prerequisites: Biology 2210, 3060.

3530. Developmental Biology. A study of developmental systems in protistans, plants and animals with a focus on the underlying principles and molecular mechanisms involved in cellular differentiation, morphogenesis and growth.
Three hours of lecture and three hours of laboratory per week.
Prerequisites: Biology 2122, 2210, 3060.

3540. Histotechnique. Theory and practice of preparatory techniques for microscopical study of tissues and cells. Experimental approach in cytochemical localization of cell components and introduction to electron microscopy.
Three hours of lecture and three hours of laboratory per week.
Prerequisite: Biology 3060.

3610. Boreal Ecology. A study of the principal features of terrestrial ecosystems, with emphasis on the boreal region.
Three hours of lecture and three hours of laboratory per week.
Prerequisites: Biology 2010 and 2600. Statistics 2550 or equivalent.

3620. Aquatic Microbial Ecology. A study of the nature, distribution and activities of microorganisms in the freshwater and marine environments. Field and laboratory work illustrate some of the investigative techniques used in this area of study.
Three hours of lecture and three hours of laboratory per week.
Prerequisites: Biology 2600, 3050.
NOTE: Credit may not be obtained for both Biology 3620 and the former Biology 3603.

3709. Field Course in Marine Principles and Techniques. The course begins with a three-week field school immediately prior to the beginning of the Fall Semester. In the Fall Semester there are follow-up lectures, readings and submission of reports. The course is designed to introduce the principal marine environments, organisms and techniques. May be taken only with the permission of the Head of Department.
Prerequisites: Biology 2010, 2122, 2210, 2600; Statistics 2550.

3710. The Aquatic Environment. The abiotic properties of marine and freshwater systems, including basin formation, chemical properties, circulation and dynamics, sampling techniques and the special characteristics of estuarine systems. Emphasis will be on large bodies of water, but stream hydrology will also be discussed.
Three hours of lecture and three hours of laboratory per week.
Prerequisites: Physics 1021 or 1054; Chemistry 1001; Biology 2600 as prerequisite or corequisite.
NOTE: Credit may not be obtained for both Biology 3710 and the former Biology 3700.

3711. The Ecology of Open Waters. A comparative survey of the major biological groups in open water aquatic habitats, both freshwater and marine, with community structure, trophic interactions and energy flow as central themes. Strategies for measuring population levels and production and for constructing both conceptual and quantitative models of ecosystems and their components are emphasized.
Three hours of lecture and three hours of laboratory per week.
Prerequisites: Biology 2010, 2122, 3710.
NOTE: Credit may not be obtained for both Biology 3711 and the former Biology 3701.

3712. Benthic Biology. The biology of the aquatic benthos (bottom-dwelling organisms); their origins, adaptations, life histories and ecological roles.
Three hours of lecture and three hours of laboratory per week.
Prerequisites: Biology 2010, 2122, 3710.
NOTE: Credit may not be obtained for both Biology 3712 and the former Biology 3630.

3750. Animal Behaviour I. (Same as Psychology 3750). An introduction to the mechanisms and development of the behaviour of animals. Topics include: the history of ethology and comparative psychology, methods of animal behaviour study, behaviour of animals in relation to physiology, sensory function, learning, communication, orientation, and other areas in biology and psychology.
Three hours of lecture and three hours of laboratory per week.
Prerequisites: Statistics 2550 or equivalent, Biology 1002.
NOTE: Credit may be obtained for only one of Biology 3750, Psychology 3750, the former Biology 4700, or the former Psychology 4700.

3811. Paleontology (W). (Same as Earth Sciences 3811) This course is taught and administered by the Department of Earth Sciences.
Prerequisites: EITHER Earth Sciences 1001 and Biology 2120 (or Biology 1001 and 1002), OR Biology 2122 and 2210.
NOTE: Credit may be obtained for only one of Biology 3811, the former Biology 3800, and the former Earth Sciences 3801.

3900. Principles of Evolution. A course analysing the processes and patterns of evolution. Topics include the development of evolutionary theory, the genetic basis of evolution, mechanisms of evolutionary change and the origin and interpretation of phylogeny.
Three hours of lecture and three hours of laboratory per week.
Prerequisites: Biology 2600, 2210, either 2122 or 2010, 3250; and Statistics 2550.

4000. Bacterial Systematics. A study of bacterial classification, nomenclature and identification. Subjects include classical and numerical taxonomy, aerobic and anaerobic culture techniques, phage typing, serotyping and the significance of genetic relatedness. The laboratory work presents the techniques of determinative bacteriology.
Three hours of lecture and three hours of laboratory per week.
Prerequisites: Biology 3050, 3250.

4012. Phycology. A consideration of the biology of algae, including ecology, morphology, life histories, and laboratory culture.
Three hours of lecture and three hours of laboratory per week.
Prerequisites: Biology 2010, 2600.

4040. Mycology. A study of the physiology, morphogenesis, nature of plant and animal parasitism, ecology and taxonomy of terrestrial and freshwater fungi.
Three hours of lecture and three hours of laboratory per week.
Prerequisites: Biology 3050; at least two of Biology 2010, 2122, 2210.
NOTE: Credit may not be obtained for both Biology 4040 and the former Biology 3020.

4130. Protozoology. A study of the systematics, functional morphology, morphogenesis, and ecology of protozoa.
Three hours of lecture and three hours of laboratory per week.
Prerequisites: Biology 2122, 2600.

4150. Insect Systematics and Ecology. A study of the classification, ecology and behaviour of insects with special emphasis on the boreal fauna.
Three hours of lecture and three hours of laboratory per week.
Prerequisites: Biology 2122, 2600.
NOTE: Credit may not be obtained for both Biology 4150 and the former Biology 4140.

4180. General Parasitology. An examination of parasitism as a way of life, with emphasis on classification, structural adaptation, life cycles and ecology.
Three hours of lecture and three hours of laboratory per week.
Prerequisites: Biology 2122, 2210, 2600.

4181. Experimental Parasitology. Consideration of physiological and behavioural aspects of host-parasite associations.
Three hours of lecture and three hours of laboratory per week.
Prerequisites: Biology 2122, 2210, 2600.
Prerequisite or co-requisite: at least one of Biology 3401, 3402, 4404 or Biochemistry 3106.

4182. Fisheries and Wildlife Parasitology. A study of the important parasites of fish and other wildlife and their impact on both individuals and populations.
Three hours of lecture and three hours of laboratory per week.
Prerequisites: Biology 2122, 2210, 2600 and 4180.

4200. Immunology. A study of vertebrate and invertebrate immune systems including antigens and antibodies and their reactions.
Three hours of lecture and three hours of laboratory per week.
Prerequisites: Biology 2122, 2210, 3050.

[illegible]0. Remote Sensing. (Same as Engineering 8623). This course is taught and administered by the Faculty of Engineering and Applied Science.

4241. Molecular Genetics. The molecular basis of genetic information: its organization, replication, expression, regulation, mutation and exchange in eukaryotes, prokaryotes and viruses; recombinant DNA technology and genetic engineering.
Three hours of lecture and three hours of laboratory per week.
Prerequisites: Biology 3050, 3250, 4404; Biochemistry 2101.

4245. Biophysics. An examination of the physical properties involved in defining diffusion, membrane properties, electrochemical potentials and the processes of bioenergetics within cells and organelles. Selected topics in biomechanics and the functioning of whole organisms with respect to size, shape, support, orientation, transport and motility.
Three hours of lecture and three hours of laboratory per week.
Prerequisites: Biology 3060; Biochemistry 2101.

4250. Evolutionary Genetics. An integration of theoretical, empirical and experimental approaches to studying genetic variation at the population level.
Three hours of lecture and three hours of laboratory per week.
Prerequisites: Biology 3250, 3900.

4270. History of Biology. Consideration of the development of biological concepts as interactions between observations, philosophy systems and cultural environment.
[illegible]e hours of lecture plus one afternoon seminar per week.
Prerequisites: Biology 2010, 2122, 2210, 2600, plus at least six credit hours in Biology courses at the 3000 level.

4306. Applied Biology. An examination of how biological and other sciences are applied to the problems of management and utilization of organisms at both the individual and systems level to meet human needs.
Prerequisites: Any twenty-four credit hours in Biology courses (including first year) (excluding 2040, 2041).
NOTE: Credit may not be obtained for Biology 4306 and either of the former Biology 4303 or the former Biology 4304.

4360. Community and Ecosystem Ecology. A study of the basic principles, patterns and processes of ecological communities and ecosystems.
Three hours of lecture plus a seminar/discussion group each week.
Prerequisite: Biology 2600.
Recommended: Biology 3295.

4402. Electron Microscopy in Life Sciences. Principles and methodology of electron microscopy: use of transmission and scanning electron microscopes; preparation of thin films; whole mounts of micro-organisms, viruses, and macromolecules (enzymes), preparation techniques for scanning electron microscopy, related photographic techniques, and interpretation of electron micrographs. This is an intensive course that will be offered for the first three weeks of Spring Semester from 9:00 a.m. to 5:00 p.m.
Admission by permission of the Head of the Department and the Instructor.
Enrolment in this course is strictly limited and priority will be given to Honours students recommended by their supervisor, other Honours students and then other Biology majors.

4404. Microbial Physiology. A study of the structure and growth of microorganisms. Subjects include metabolic diversity and functions of components and organelles. The physiology of microbes interacting with their environment is emphasized. Quantitative

4505. Systematics and Biogeography. A study of the geographi distributions of plants and animals with particular reference temporal and spatial variability and to theories advanced to expl historical and recent distribution patterns.
Three hours of lecture and three hours of laboratory per week.
Prerequisites: Biology 2010, 2122, 2210, 2600, 3250.
Recommended: Biology 3900.
NOTE: Credit may not be obtained for both Biology 4505 a Geography 4170.

4510. Distribution Patterns in the Sea. An ecological approach the description and understanding of biogeographic patterns in sea. Lectures and discussions will focus on what the main patter are and how they are determined, aspects of the ocean environme that contribute to pattern, how lifestyles are adapted to ocea conditions, diversity and dispersal, analytical techniques, practical geographic problems concerning the exploitation management of marine resources. It is recommended (but required) that students take Biology 3710, 3711 and 4505 befo hand.
Three hours of lecture/seminar and a three hour laboratory/d cussion session each week.
Prerequisite or corequisite: Biology 4605.

4600. Ichthyology. The study of fishes: taxonomy, life histori evolution, behaviour and zoogeography.
Three hours of lecture and three hours of laboratory per week.
Prerequisites: Biology 2210, 2600.
(Not offered in 1993/94)

4601. Functional Biology of Fish. An introduction to the anato cal, physiological and histological aspects of selected processes the life cycle of fishes.
Three hours of lecture and three hours of laboratory per week.
Prerequisites: Biology 2210, 3060 and one of Biology 3401, 34 4404; Biochemistry 3106.

4605. Quantitative Methods in Biology. (Same as Statistics 45 and the former Statistics 4605). Quantitative reasoning using verb graphical and statistical models of scaled quantities (units dimensions). Exploratory and confirmatory analysis of field a laboratory data. Hypothesis testing, including randomization test Topics include the general linear model (t-tests, ancova etc correlation, autocorrelation, geographic statistics, estimates population size and multivariate methods.
Three hours of lecture and three hours of laboratory per week.
Prerequisite: Statistics 2550.

4620. Ornithology. Structure, classification, evolution, ecology a behaviour of birds, with particular reference to those of econom importance. Identification of the birds of Eastern Canada.
Three hours of lecture and three hours of laboratory per week.
Prerequisites: Biology 2210, 2600.

4630. Mammalogy. Evolution, systematics, life histories an distribution of mammals, with particular emphasis on eastern Nort American forms.
Three hours of lecture and three hours of laboratory per week.
Prerequisites: Biology 2210, 2600.

4701. Animal Behaviour II. (Same as Psychology 4701). A examination of the behaviour of animals with particular emphasis o evolution and ecology. Topics include behavioural genetics an evolution, reproductive strategies, social behaviour, habitat sele tion, territoriality, foraging behaviour, and other topics in biology an psychology.
Three hours of lecture and three hours of laboratory per week.
Prerequisites: Biology/Psychology 3750(formerly Biology 4700).

4750. Fisheries Ecology. The application of ecological principles the problem of managing exploited fish populations. Laborator exercises will be based on a simulation approach to fisheri problems using computer and animal models.
Three hours of lecture and three hours of laboratory per week.
Prerequisites: Biology 3295 and permission of the Instructor.

4800. Advanced Palaeontology. (Same as Earth Sciences 4800 This course is taught and administered by the Department of Ear Sciences.
Prerequisites: Earth Science/Biology 3811, and one of Statist 2510, Statistics 2550 or Mathematics 2000

4810. Field Course in Marine Biology. The course will consist of intensive three-week field school designed to acquaint students w marine organisms and environments. Emphasis will be placed survey work and individual projects. Projects must be designed an approved prior to the commencement of the course, and will involv a written report. May be taken only with the permission of the Hea of the Department. At the discretion of the Head of the Department another recognized field course may be substituted for Biology 481 Prerequisites: Biology 2010, 2210, 2122, 3710.

the Fall Semester. It is designed to acquaint students with terrestrial organisms and environments, and emphasis will be placed on survey and sampling techniques. In the Fall Semester the material and data collected in the field will be used in lecture and laboratory periods dealing with identification, analytical methods, and report compilation.
Prerequisites: Biology 2010, 2122, 2210, 2600 and permission of the Head.
Recommended: Biology 4605.

4622. Internship in Biology. The course is an external applied laboratory where a student works with professionals on a problem or problems in biological research. Co-operating agencies may include Environment Canada, Fisheries and Oceans Canada, Agriculture Canada, the Provincial Departments of Fisheries and Forestry, and others. The student will have a supervisor within the Department and one in the co-operating agency, and will be expected to write a scientific account detailing the particulars of the work experience. The arrangements for the position must be agreed upon, and a project proposal approved, by the Head of the Department or delegate prior to registration for the course. Enrolment will be dependent upon the availability of suitable positions, and will be limited to students in the Honours Programme. This course can be done in any semester, and carries three credit hours.

499A/499B. Honours Dissertation. This course is available only to students in the Honours Programme. Requirements for the Dissertation are outlined under the heading "HONOURS DEGREES".

CHEMISTRY

PROGRAMMES IN CHEMISTRY

The following undergraduate programmes are available in the Department:

Major* or Honours* in Chemistry
Joint Honours in Chemistry and Earth Sciences*
Joint Honours in Chemistry and Applied Mathematics*
Joint Honours in Chemistry and Biochemistry*
Joint Honours in Chemistry and Physics*
Minor in Chemistry

*These programmes are accredited by the Canadian Society for Chemistry.

Details of joint programmes are given after the Honours B.Sc. Regulations.

UNDERGRADUATE HANDBOOK

Additional information about the undergraduate programme, individual courses and suggested timetables can be found in the Department of Chemistry Undergraduate Handbook which is available from the General Office, Department of Chemistry.

FACULTY ADVISORS

Each student majoring in Chemistry will be assigned a Faculty Advisor who should be consulted on all academic matters. Individual programmes must be drawn up in consultation with the advisor.

NOTE: Students who have obtained a grade of 3 or better on the Advanced Placement courses in Chemistry will normally be eligible for direct entry into Chemistry 1001. Such students must consult the department before registration.

MINOR IN CHEMISTRY

Candidates who take a minor in Chemistry will complete Chemistry 1000, 1001, 2400, 2401, 2210, 2300 and six credit hours in courses chosen from 3100, 3211, 3300, 3301, 3400, 3401 and 3500.

GENERAL DEGREE-MAJOR IN CHEMISTRY

The courses required for a Major in Chemistry are:

Chemistry 1000 and 1001 (or their equivalents), 2300, 2210, 2400, 2401, 3100, 3211, 3300, 3301, 3400, 3401, 3500 and 4100 or 4101.
Physics 1050 (or 1020 and 1021), 1054, 2054 and 2056.
Mathematics 1000 (or 1080 and 1081), 1001, 2000 and Applied Mathematics/Pure Mathematics 3260.
Computer Science 2602 or 2700.

To be admitted as a Chemistry Major, students must have completed thirty credit hours in courses at the first year level, including Chemistry 1000, 1001, Physics 1050, 1054 (or 1020 and 1021), Mathematics 1000, 1001 (or 1080, 1081) English 1080, 1110 (or equivalent) and six credit hours in elective courses. In addition, students must obtain a grade of 65% or better in each of Chemistry 1000, 1001 (or a combined average of 65% in Chemistry 1000 and 1001 and the permission of the head of the Department) and a minimum average of 60% in eight of the ten first year courses.

NOTE: Students must consult with the Head of the Department before registering in courses with an initial digit of 3 or greater.

HONOURS DEGREE IN CHEMISTRY

Students wishing to take Honours should consult those sections of the Calendar dealing with 'Regulations for the Honours Degree of Bachelor of Science'. The Honours programme in Chemistry consists of at least 66 credit hours in Chemistry courses. It is recommended that candidates also take groups of eighteen or more credit hours in each of two other science subjects, normally Biochemistry, Biology, Earth Sciences, Physics, or Mathematics.

Required Courses

a) Chemistry 1000 and 1001 (or their equivalents), 2300, 2210, 2400, 2401, 3100, 3211, 3300, 3301, 3400, 3401, 3500, 4100 or 4101, 4300, 4301, 490A/B, six credit hours selected from 4200-4204, and a selection from the remaining 4000-level courses.
b) Physics 1050 (or 1020, 1021), 1054, 2054 and 2056.
c) Mathematics 1000 (or 1080 and 1081), 1001, 2000 and Applied Mathematics/Pure Mathematics 3260.
d) Computer Science 2602 or 2700.

Mathematics 2050 and Applied Mathematics 2130 are highly recommended.

A thesis based on a selected research topic carried out under the supervision of a member of the department is to be submitted in the final year.

Chemistry 490A/B will normally require the equivalent of 9 hours/week for 2 semesters. Registration in Chemistry 490A/B is restricted to those students who have honours standing. Evaluation of the dissertation will be pass/fail, assessed by a committee comprised of the supervisor and two other faculty members.

With approval of the Heads of the Chemistry and Biochemistry Departments prior to registration, a number of courses in Biochemistry may be substituted for a like number of Chemistry courses.

Six credit hours in one language are recommended: French, German or Russian should be selected in consultation with the Department Head.

Prospective Honours students in Chemistry in their first year should take

a) Six credit hours in English
b) Chemistry 1000 and 1001 (or their equivalents)
c) Physics 1050 and 1054 or 1020 and 1021.
d) Mathematics 1000 and 1001 or 1080 and 1081
e) Six credit hours in other courses.

Given appropriate circumstances the Honours Chemistry programme may be completed in four years. Students should consult the Undergraduate Student Handbook for timetabling details.

NOTE: Chemistry 1800, Physics 1020, Mathematics 1080 may not be included as electives towards the 120 credit hours Honours programme. Students who include these courses in their first year programme will need the corresponding number of extra credits to obtain an Honours degree.

Arrangements for subsequent years will depend on the other science subjects being studied and should be made in consultation with the Head of the Department.

NOTE: Certain advanced courses may only be offered in alternate years. Candidates therefore should consult the