1. Calendar Entry for the Program Change

DOCTOR OF PHILOSOPHY IN BIOTECHNOLOGY (PHD)

The Ph.D. in Biotechnology Program is a research-based, interdisciplinary program focused on the professional development of scientists in two areas of specialization, environmental biotechnology and molecular biotechnology. Research topics include, but are not limited to:

- Applied microbiology
- Bioinformatics (gaining insight into the behaviour of biological systems from analysis of complex data)
- Biophysical modelling (protein folding, biological membrane formation)
- Bioproducts (transforming biomass from industrial waste streams into useful products)
- Bioremediation and biodegradation (neutralize contaminants and decomposing biological agents)
- Environmental engineering (gaining insight into assessing, managing and designing sustainable environments)
- Human and environmental toxicology (identifying human toxicants and toxins in the environment)
- Laser technology (for detection and treatment of health and industrial problems)
- Nanotechnology (building electronics from single atoms and molecules)
- Mathematical modelling (developing and using algorithms to predict how real biological systems behave)
- Molecular anthropology (analysis of ancient DNA to track the evolution of organisms and disease over time)
- Molecular breeding (understanding plant metabolism and improving valuable traits through genetic engineering)
- Molecular forensics (investigating the chemical and physical properties of molecules)
- Soil nutrient cycling (investigating the source and cycle of nutrients within the soil)
- Systems biology (gaining insight into the metabolism of organisms using genomics, proteomics and metabolomics)
- Water and waste treatment (investigating the cyclic processes of water treatment)

Although the host unit for the program is the Faculty/Office of Graduate and International Studies, the Ph.D. in Biotechnology is an interdisciplinary, value-added program involving the Faculty of Science and Environmental Studies, the Faculty of Forestry and the Forest Environment, the Faculty of Engineering and the Northern Ontario School of Medicine, with adjunct professors also from Genesis Genomics, Inc. (Thunder Bay) Molecular World, Inc. (Thunder Bay), and the Northwestern Ontario Regional Cancer Care at the Thunder Bay Regional Health Sciences Centre (Thunder Bay).
ADMISSION REQUIREMENTS

Admission to the Ph.D. program is governed by the Lakehead University general regulations for graduate programs (see pp. xxx - xxx). Admission, however, will be subject to the availability of an Advisory Committee for the student.

Normally, an applicant to the program would be expected to have completed a Master’s Degree in science, engineering or an allied discipline. Students from other disciplines may take part in a 1 year PhD Qualifying year which will ensure that the applicants complete any additional courses to cover deficiencies as determined by the Supervisory Committee and approved first by the appropriate Faculty Dean(s) and then by the Dean of Graduate and International Studies. The academic program for each Ph.D. candidate will be developed by the Supervisory Committee in consultation with the student and approved by the Dean of Graduate and International Studies.

ACADEMIC REGULATIONS – PHD IN BIOTECHNOLOGY

1. Supervisory Committee
The Supervisory Committee will consist of at least three members, of whom two are core faculty, and one of the core faculty will be the supervisor for the student. The Chair of the Committee will be the student’s supervisor or co-supervisor. Other members of the Committee may include core faculty and non-core faculty who participate in the teaching of graduate courses.

The interdisciplinary nature of the degree program mandates that Lakehead Biotechnology Ph.D. research projects take elements and methodologies from distinct, but complementary scientific fields and integrate them into a research proposal that allows investigation of hypotheses from multiple angles. Similarly, Supervisory Committee members will come from the separate fields chosen to be investigated and synthesized in the student’s work. It is critical that the combined expertise of the Supervisory Committee’s academic members’ provides the necessary conceptual and practical expertise and support for the student.

For assignment of adjunct professors to the Supervisory Committee of particular Biotechnology Ph.D. students working with that adjunct’s company, it will be important to avoid any conflict of interest between project and company goals. If a Ph.D. thesis is to include work done by the student in conjunction with a biotechnology oriented company, it will be imperative to formulate the project so that it allows the student to demonstrate the expertise they have developed. These measurable, externally valuable outcomes for the project should include accomplishments such as papers published in peer reviewed journals and external grants received. This will ensure that the primary Program goals of training students in biotechnology and peer recognition of their work are met.

In consultation with the student, the academic program for each PhD candidate will be developed by the Supervisory Committee. The Supervisory Committee for the student will recommend to
the Biotechnology PhD Program Graduate Studies Committee the academic program for the student for approval.

2. Residency
The residency requirement will be on a full time basis for a minimum of one year (three terms), of which two terms must be consecutive.

4. Comprehensive Examination
The comprehensive examination will assess the student's general preparedness for the Ph.D. degree and specific areas in his or her chosen area of study and research. It will also assess the student's ability to integrate material from divergent areas, to reconcile theoretical, methodological and empirical issues, and to think creatively. The comprehensive examination will be an oral examination conducted by the Comprehensive Examination Committee. The comprehensive examination may include a written component, if recommended by the Supervisory Committee.

The comprehensive examination must be completed at least one year prior to graduation and no later than 12 months after initial registration. Only two attempts at the comprehensive examination will be permitted. Students who fail the second attempt will be required to withdraw from the Ph.D. program.

5. Dissertation and Defence
The dissertation research must be original and independent work that will significantly advance knowledge in biotechnology. The dissertation may be of traditional thesis format, or a compilation of peer reviewed published articles of the research by the student. Review of the dissertation will be by the student’s Supervisory Committee and by an examiner from outside Lakehead University with expertise in the student’s area of research.

The student must successfully defend the dissertation in a public oral presentation and examination. The Examination Committee at the defence normally consists of the student’s Supervisory Committee and the External Examiner, who may be represented by the Supervisor.

6. Expected Progress through the Program
Full-Time students will be expected to complete their course requirements, comprehensive exam and dissertation within a maximum of 4 years from entry into the Ph.D. program. Part-Time students will be expected to complete their course requirements, comprehensive exam and dissertation within a predetermined time period, arranged by the student and the student’s advisory committee, and approved by the Dean of Graduate Studies.
PROGRAM

To fulfill the degree requirements, students must complete a total of eight (8) full course equivalents (FCE) at the graduate level consisting of the following components:

The normal course load for a Ph.D. in Biotechnology consists of the PhD seminar course (Biotech 6xxx, worth 0.5 FCE), the comprehensive examination (Biotech 6xxx, worth 0.5 FCE), and the dissertation work with defense (Biotech 6xxx, worth 6 FCE). Students will normally be required to successfully complete two additional one-semester courses at the graduate level as part of their program. These may be drawn from 5000-level and/or 6000-level courses offered within the any Faculty of Lakehead University. All graduate courses are open to students enrolled in the Ph.D. program in Biotechnology.

The Supervisory Committee for the student will recommend to the Biotechnology PhD Program Graduate Studies Committee the academic program for the student for approval. A minimum grade of 70% is required for every course undertaken as part of the program and a passing grade is required in the comprehensive examination.

GRADUATE COURSES

For 5000-level courses offered see course descriptions of Graduate Programs offered within the Faculty of Science and Environmental Studies, the Faculty of Engineering, and the Faculty of Forestry and the Forest Environment. All graduate courses are open to students enrolled in the Ph.D. program in Biotechnology.

**Biotechnology 6xxx**

**Special Topics I**
A half-course offering opportunities for in-depth analysis of special topics in biotechnology.

**Biotechnology 6xxx**

**Special Topics II**
A full-course offering opportunities for in-depth analysis of special topics in biotechnology.

**Biotechnology 6xxx**

**Ph.D. seminar course**
A half-course that combines external speakers with student-led discussions on recent advances in biotechnology.

**Biotechnology 6xxx**

**Comprehensive Examination**
The comprehensive examination will assess the student's general preparedness for the Ph.D. degree and specific areas in his or her chosen area of study and research. It will also assess the student's ability to integrate material from divergent areas, to reconcile theoretical,
methodological and empirical issues, and to think creatively. The comprehensive examination may include a written component if recommended by the Supervisory Committee.

*Biotechnology 6xxx*

*Ph.D. Dissertation*

### 2. Description of the Proposed Changes, Purpose and Anticipated Effects

The PhD in Biotechnology is a new program. It is proposed by 21 tenured or tenure-track faculty members from Lakehead University and the Northern Ontario School of Medicine. In addition, 8 PhD-level research scientists from Thunder Bay are involved in the proposed program.

Within the past five years, the focus of biological research at Lakehead University has diversified, and biotechnology research has become a focus of many faculty. Consequently, there has been substantial recent investment in infrastructure to support biotechnology research at Lakehead University, at the Thunder Bay Regional Health Sciences Centre, and by biotechnology companies in Thunder Bay such as Genesis Genomics and Molecular World. New equipment includes quantitative reverse transcription-polymerase chain reaction and laser capture microscopy instrumentation, a gas chromatograph/quadrupole mass spectrometer, and a new microarray facility for high-throughput transcript profiling. The acquisition of this instrumentation, coupled with the high publicity of the Paleo-DNA Laboratory and the Biotechnology initiatives of the City of Thunder Bay, have resulted in increasing numbers of students entering Lakehead University with the goal to study in a field associated with Biotechnology, such as the Applied Bio-Molecular Science program. We now aim to provide a strong graduate program in Biotechnology.

The new PhD Program in Biotechnology will enhance and strengthen interdisciplinary collaborations and build research capacity. This will particularly benefit the increasing student numbers of the BSc Programs in Applied Bio-Molecular Science, and Water Resource Science, and the MSc Program in Environmental Engineering. These existing programs are already interdisciplinary in nature and they have the potential to become critical components for training and qualification of biotechnology-oriented students to enter the proposed PhD program in Biotechnology.

A significant number of graduate courses suitable for students in the Biotechnology Program are currently offered. Please see table below. Many of these courses are offered only periodically or with a very low student enrolment. The new PhD in Biotechnology will have a positive effect on these courses, and all graduate students in these fields, by allowing more frequent offerings and better learning through the greater exchange among students during class.
Existing Graduate Courses suitable for students in the Biotechnology PhD Program

Biology 5650 - Advanced Issues in Biotechnology
Biology 5770 - Advanced Food Microbiology
Biology 5131 - Aquatic Toxicology
Chemistry 5251 - Advanced Research Methodology
Forestry 5510 - Research Methods I: Philosophy and General Methods of Science
Forestry 5480 - Advanced Geographic Information Systems Applications
Forestry 5815 - Environmental Assessment
Forestry 5850 - Fibre Morphology
Engineering 0334 – Bioprocess Engineering
Engineering 6151 - Geoenvironmental Engineering
Engineering 6251 - Environmental Chemistry
Engineering 6351 - Experimental Design and Analysis for Environmental Engineers
Engineering 6451 - Physicochemical Treatment Processes
Engineering 6551 - Biological Treatment Processes
Math 5213 - Partial Differential Equations in Biology, Physics and Engineering
Math 5351 - Advanced Numerical Analysis I
Math 5371 - Advanced Numerical Analysis II
Math 5331 - Advanced Topics in Statistics
Math 5333 - Advanced Topics in Probability
Public Health 5030 - Research Methods, Design and Analysis
Public Health 5070 - Epidemiology I
OCGS classifies university faculty participating in graduate program teaching into five categories. Three of these categories apply to researchers participating in the Lakehead Ph.D. in Biotechnology Program:

- **Category 3**: tenured or tenure-track core faculty members who are involved in teaching and/or supervision in other graduate program(s) in addition to being a core member of the graduate program under review, and
- **Category 5**: other core faculty: this category may include emeritus professors with supervisory privileges and persons appointed from government laboratories or industry as adjunct professors.

There are twenty-one (21) Category 3 faculty and eight (8) Category 5 faculty participating in the Biotechnology Ph.D. Program. Please see the following table for details.

As described in the calendar entry, the members of a student’s Supervisory Committee will come from the separate fields chosen to be investigated and synthesized in the student’s work. It is critical that the combined expertise of the Supervisory Committee’s academic members’ provides the necessary conceptual and practical expertise and support for the student. Therefore, a Supervisory Committee will always include at least two members with experience in Graduate Supervision.
### Faculty participating in the Biotechnology PhD Program

<table>
<thead>
<tr>
<th>OCGS faculty class</th>
<th>Name of faculty</th>
<th>Faculty or institution</th>
<th>Department</th>
<th>Area of expertise*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Category 3</strong></td>
<td>Dr. L. Catalan</td>
<td>Engineering</td>
<td>Chemical Engineering</td>
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<td></td>
<td>Dr. A. Chen</td>
<td>Science and Environmental Studies</td>
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<td></td>
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<td></td>
<td>Dr. G. Das</td>
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<td>Physics</td>
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<tr>
<td></td>
<td>Dr. W. Gao</td>
<td>Engineering</td>
<td>Civil Engineering</td>
<td>ENV</td>
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<tr>
<td></td>
<td>Dr. B. Kjartanson</td>
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<td>Dr. D. Law</td>
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<td>Dr. P. Lee</td>
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<td>Dr. K. Leung</td>
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<tr>
<td></td>
<td>Dr. B. Liao</td>
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<tr>
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<td>Dr. L. Liu</td>
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<td>Mathematical Sciences</td>
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<td>Dr. N. Luckai</td>
<td>Forestry and the Forest Environment</td>
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<td>Dr. L. Malek</td>
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<td><strong>Category 5</strong></td>
<td>Dr. A. Chahal</td>
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<td></td>
<td>Dr. G. Dakubo</td>
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<td>Dr. R. Thayer</td>
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<td>Dr. I. Zehbe</td>
<td>Northwestern Ontario Cancer Care</td>
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<td>MOL</td>
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</tbody>
</table>

*Areas of expertise* are ENV, environmental biotechnology; MOL, molecular biotechnology.
3. Budgetary Implications

The Ph.D. in Biotechnology Program is new and does not replace any existing graduate programs.

No additional faculty members are required with the introduction of the Program. However, it is expected that the course loads of participating faculty will be reevaluated to emphasize the considerable time and effort required for effective graduate program development and teaching. This will require interaction between Faculty, Academic and Research Deans.

Most funding of the Ph.D. students will be through external scholarships, such as Ontario Graduate Scholarships and NSERC Canada, Industrial or Postgraduate Scholarships. Students will also be funded through external research grants, such as NSERC Discovery and Strategic Project Grants, Collaborative Health Research Projects, Research Partnership Agreements, or Special Research Opportunity projects. Students enrolled in the program would be eligible for one GA per year for up to three years. It would be expected that the GA allocation for Ph.D Biotechnology students would be in addition to current GA allocations to Science, Forestry and Engineering, since the students would represent new growth in graduate education.

No additional library resources are required initially, since books and journals needed for the program are currently available. They have been acquired by the Departments and Faculties of the participating faculty. It is anticipated that purchase of new, additional books and journals would be covered through cancellation of less important resources.

Application for approval of the Program by the Ontario Council of Graduate Schools (OCGS) is expected to cost approximately $10,000. This will be covered by the Office of Graduate and International Studies.