**BIOINFORMATICS**

Bioinformatics is the development and application of computational and statistical techniques for solving problems involving complex biological data. This emerging discipline is growing rapidly alongside technological developments for large-scale data generation in the life sciences, such as in genomics, proteomics, functional pathway analysis, health sciences, and biodiversity. Demand is accelerating for new approaches for data storage, retrieval, analysis, and applications. A new generation of professionals is required to meet this demand, having bioinformatics skills and the capacity to create new approaches.

**Administrative Staff**

**Director and Graduate Coordinator**
Sarah Adamowicz (2447 Science Complex, Ext. 53055)
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**Graduate Faculty**

This list may include Regular Graduate Faculty, Associated Graduate Faculty and/or Graduate Faculty from other universities.

- **Sarah J. Adamowicz**  
  B.Sc. Dalhousie, M.Sc. Guelph, PhD Imperial College - Associate Professor  
  Graduate Faculty

- **R. Ayesha Ali**  
  B.Sc. Western Ontario, M.Sc. Toronto, PhD Washington - Associate Professor  
  Graduate Faculty

- **Emma Allen-Vercoe**  
  B.Sc. London (UK), PhD Open (UK) - Professor  
  Graduate Faculty

- **Daniel A. Ashlock**  
  B.Sc. Kansas, PhD CalTech - Professor and Chair  
  Graduate Faculty

- **Christine Baes**  
  B.Sc. Guelph, M.Sc. Hohenheim, PhD Christian-Albrechts - Associate Professor  
  Graduate Faculty

- **Elizabeth G. Boulding**  
  B.Sc. British Columbia, M.Sc. Alberta, PhD Washington - Professor  
  Graduate Faculty

- **Joseph L. Colasanti**  
  B.Sc., PhD Western Ontario - Associate Professor  
  Graduate Faculty

- **Karl A. Cottenie**  
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  Graduate Faculty

- **Angela Cánovas**  
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  Graduate Faculty

- **Lorna Deeth**  
  B.Sc., M.Sc., PhD Guelph - Assistant Professor  
  Graduate Faculty

- **Giannina Descalzi**  
  BA Guelph, M.Sc., PhD Toronto - Assistant Professor  
  Graduate Faculty

- **Jeremy Dettman**  
  B.Sc., M.Sc. British Columbia, PhD California-Berkeley - Research Scientist, Agriculture and Agri-Food Canada  
  Associated Graduate Faculty

- **Hermann J. Eberl**  
  Dipl. Math (M.Sc.), PhD Munich Univ. of Tech. - Professor  
  Graduate Faculty

- **Michael J. Emes**  
  B.Sc., PhD Sheffield - Professor  
  Graduate Faculty

- **Mazyar Fallah**  
  BA John Hopkins, MA, PhD Princeton - Professor and Dean, College of Biological Sciences  
  Associated Graduate Faculty

- **Vahab Farzan**  
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- **Jennifer Geddes-McAlister**  
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- **Steffen P. Graether**  
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- **Thomas Graham**  
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  Graduate Faculty

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Graduate Faculty

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Graduate Faculty

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Graduate Faculty

Jasmin Lalonde
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Graduate Faculty

Jonathan LaMarre
DVM, PhD Guelph - Professor
Graduate Faculty

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DMV, PhD Guelph, DIP. A.C.V.P. - Associate Professor and Chair
Graduate Faculty

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Graduate Faculty

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Graduate Faculty

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Graduate Faculty

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Graduate Faculty

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Graduate Faculty

Scott Ryan
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Graduate Faculty

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BBA, B.Sc., M.Sc. Brazil, PhD Guelph - Professor
Graduate Faculty

M. Alexander Smith
B.Sc., M.Sc. Trent, PhD McGill - Associate Professor
Graduate Faculty

Dirk Steinke
B.Sc., M.Sc. Konstanz, PhD Goethe - Associate Director, Centre for Biodiversity, University of Guelph
Bioinformatics Program

Admission Requirements

Students will be admitted to the Master of Bioinformatics program from a range of undergraduate programs in the life sciences. Students from undergraduate programs in the physical or computational sciences will be considered for admission if they are considered to have sufficient biological background. Students must begin the Master of Bioinformatics program in a fall semester. To be considered for admission, applicants should meet the minimum requirements of a four-year degree from a recognized post-secondary institution with a minimum 75% average over the last two years of full-time equivalent study.

Space in the program is limited and prospective students are encouraged to apply as early as possible. Application details are posted on the program website (http://www.bioinf.uoguelph.ca/).

Program Requirements

A total of 4.0 credits are required, which must include:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>BINF*6110</td>
<td>Genomic Methods for Bioinformatics</td>
<td>0.50</td>
</tr>
<tr>
<td>BINF*6210</td>
<td>Software Tools for Biological Data Analysis and Organization</td>
<td>0.50</td>
</tr>
<tr>
<td>BINF*6890</td>
<td>Topics in Bioinformatics</td>
<td>0.50</td>
</tr>
<tr>
<td>BINF*6970</td>
<td>Statistical Bioinformatics</td>
<td>0.50</td>
</tr>
<tr>
<td>BINF*6999</td>
<td>Bioinformatics Masters Project</td>
<td>1.00</td>
</tr>
</tbody>
</table>

The advisory committee and/or the Graduate Program Committee may require additional courses.

Advisory Committee

Students taking the Master of Bioinformatics will have an advisor and a co-advisor. Both the advisor and the co-advisor must be members of the Bioinformatics Graduate Faculty such that one has expertise in the life sciences and the other has expertise in statistics or computing.

Duration of the Program

Students normally take 3 courses per semester for two semesters (3.0 credits) and complete the Bioinformatics Master's Project (1.0 credit) in a third semester. Therefore, the program typically takes 12 months of full-time study. There is, however, the option to continue the Bioinformatics Master's Project into a second fall semester, in which case the program will take 16 months of full-time study.

MSc Program

Admission Requirements

Students may be admitted to the MSc in Bioinformatics program from a range of undergraduate programs in the life, physical, statistical, mathematical, and computational sciences. To be considered for admission, applicants should meet the minimum requirements of a four-year degree from a recognized post-secondary institution with a minimum 75% average over the last two years of full-time equivalent study.

Applicants must indicate their research interests and their agreed advisors. Prospective students should commence discussions with faculty well in advance of applying. Offers of admission will only be issued in cases where a member of Bioinformatics Graduate Faculty has agreed to be the advisor.

Program Requirements

A total of 2.0 credits are required, which must include:

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<tr>
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<tbody>
<tr>
<td>BINF*6110</td>
<td>Genomic Methods for Bioinformatics</td>
<td>0.50</td>
</tr>
<tr>
<td>BINF*6210</td>
<td>Software Tools for Biological Data Analysis and Organization</td>
<td>0.50</td>
</tr>
</tbody>
</table>

The advisory committee and/or the Graduate Program Committee may require additional courses. When the course work is satisfactorily completed, the submission and successful defence of an appropriate thesis on an approved topic completes the requirements for the MSc in Bioinformatics.

Advisory Committee

Students taking the MSc in Bioinformatics will have an advisory committee comprising at least two members of the Bioinformatics
Graduate Faculty. The advisor must be a member of the Bioinformatics Graduate Faculty.

Duration of the Program
The program typically takes 16-24 months of full-time study.

PhD Program

Admission Requirements
1. Applicants with a master's degree
   Applicants holding either a Master of Bioinformatics, an MSc in Bioinformatics, or a masters in a related discipline with a GPA above 80 over the last two years equivalent of full time study will be considered for admission.
2. Applicants without a master’s degree (i.e., direct entry)
   Strong applicants (GPA>80) may be admitted without holding a master’s degree provided that their undergraduate major is appropriate. In these cases, the program committee will assign necessary courses to ensure sufficient preparedness for research.
3. General Requirements
   Applicants must indicate an agreed advisor at the time of application. Prospective students should commence discussions with faculty well in advance of applying. Offers of admission will only be issued in cases where a member of Bioinformatics Graduate Faculty has agreed to be the advisor.

Program Requirements
A minimum of 1.0 credit is required, which must include:

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<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>BINF*6500</td>
<td>PhD Research Writing in Bioinformatics</td>
<td>1.00</td>
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</table>

The program committee and the advisory committee may, and usually will, require additional courses. After the prescribed course work is satisfactorily completed, a qualifying examination is taken. Finally, the submission and successful defence of an appropriate thesis on an approved topic completes the requirements for the PhD in Bioinformatics.

Advisory Committee
Students taking the PhD in Bioinformatics will have an advisory committee comprising at least three members of the Graduate Faculty, two of whom should be Bioinformatics Graduate Faculty. The advisor must be a member of the Bioinformatics Graduate Faculty. Usually, if there is a co-advisor, (s)he will also be a member of the Bioinformatics Graduate Faculty; under special circumstances, the Director, after consultation with the Bioinformatics Program Committee, may approve a co-advisor who is not a member of the Bioinformatics Graduate Faculty.

Duration of the Program
The completion period of the program is 12 semesters of full-time study.

Collaborative Specializations

Artificial Intelligence
The MSc in Bioinformatics program participates in the collaborative specialization in Artificial Intelligence. MSc students wishing to undertake thesis research with an emphasis on artificial intelligence are eligible to apply to register concurrently in Bioinformatics and the collaborative specialization. Students should consult the Artificial Intelligence (calendar.uoguelph.ca/graduate-calendar/collaborative-specializations/artificial-intelligence/) listing for more information.

Courses

BINF*6110 Genomic Methods for Bioinformatics  Winter Only  [0.50]
This course provides an introduction to current and emerging methods used to generate genomic data analyzed in bioinformatics. This may include techniques for DNA sequencing as well as transcriptome, proteome and metabolome analysis. The objective is to develop an appreciation for the challenges of producing data.
Restriction(s): Restricted to Bioinformatics students.
Department(s): Dean's Office, College of Biological Science
Location(s): Guelph

BINF*6210 Software Tools for Biological Data Analysis and Organization  Fall Only  [0.50]
This course will familiarize students with tools for the computational acquisition and analysis of molecular biological data. Key software for gene expression analyses, biological sequence analysis, and data acquisition and management will be presented. Laboratory exercises will guide students through application of relevant tools.
Restriction(s): Restricted to Bioinformatics students.
Department(s): Dean's Office, College of Biological Science
Location(s): Guelph

BINF*6410 Bioinformatics Programming  Fall Only  [0.50]
This course will introduce bioinformatics students to programming languages. Languages such as C and Perl will be introduced with a focus on bioinformatics applications. The topics covered will serve to aid students when existing software does not satisfy their needs.
Restriction(s): Restricted to Bioinformatics students.
Department(s): Dean's Office, College of Biological Science
Location(s): Guelph

BINF*6420 Biosequence Pattern Analysis  Winter Only  [0.50]
This course is an overview course on different approaches to analyze biological sequences. Basic concepts are introduced, as well as related algorithms.
Restriction(s): Restricted to Bioinformatics students.
Department(s): Dean's Office, College of Biological Science
Location(s): Guelph

BINF*6500 PhD Research Writing in Bioinformatics  Summer, Fall, and Winter  [1.00]
Background literature pertinent to the student's initial research direction will be studied. Starting with a reading list provided by the advisor and the instructor, the student will build on this list and construct a major literature review over two semesters. As the student begins to generate initial ideas for their own research direction, their ideas are written and explained. The emphasis will be on a sub-field or sub-fields of bioinformatics and the depth of study will be appropriate to the doctoral level.
Restriction(s): Restricted to PhD Bioinformatics students.
Department(s): Dean's Office, College of Biological Science
Location(s): Guelph

BINF*6890 Topics in Bioinformatics  Fall Only  [0.50]
Selected topics in bioinformatics will be covered. The course might focus on biological or informatics topics, or upon a mixture of both.
Restriction(s): Restricted to Bioinformatics students.
Department(s): Dean's Office, College of Biological Science
Location(s): Guelph
BINF*6970  Statistical Bioinformatics  Winter Only  [0.50]
This course presents a selection of advanced approaches for the
statistical analysis of data that arise in bioinformatics, especially
genomic data. A central theme to this course is the modelling of complex,
often high-dimensional, data structures.
Restriction(s): Restricted to Bioinformatics students.
Department(s): Dean's Office, College of Biological Science
Location(s): Guelph

BINF*6999  Bioinformatics Masters Project  Summer, Fall, and
Winter  [1.00]
A major research paper is completed and presented by students in the
Master of Bioinformatics program.
Prerequisite(s): BINF*6110, BINF*6210
Restriction(s): Restricted to Master of Bioinformatics students.
Department(s): Dean's Office, College of Biological Science
Location(s): Guelph

Note
Some courses may not be offered every year. Students planning to take
a courses from the above list should consult with the Graduate Program
Assistant for availability and scheduling.

Electives
Biological Sciences

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>ANSC*6240</td>
<td>Topics in Animal Genetics and Genomics</td>
<td>0.50</td>
</tr>
<tr>
<td>ANSC*6330</td>
<td>Topics in Computational Biology and Bioinformatics</td>
<td>0.50</td>
</tr>
<tr>
<td>ANSC*6370</td>
<td>Quantitative Genetics and Animal Models</td>
<td>0.50</td>
</tr>
<tr>
<td>ENVS*6450</td>
<td>Multivariate Environmental Data Analysis</td>
<td>0.50</td>
</tr>
<tr>
<td>HHNS*6440</td>
<td>Nutrition, Gene Expression and Cell Signalling</td>
<td>0.50</td>
</tr>
<tr>
<td>MCB*6370</td>
<td>Protein Structural Biology and Bioinformatics</td>
<td>0.50</td>
</tr>
<tr>
<td>PLNT*6160</td>
<td>Advanced Plant Breeding II</td>
<td>0.50</td>
</tr>
<tr>
<td>PLNT*6500</td>
<td>Applied Bioinformatics</td>
<td>0.50</td>
</tr>
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</table>

Computer Science

<table>
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<tr>
<th>Code</th>
<th>Title</th>
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</thead>
<tbody>
<tr>
<td>CIS*6020</td>
<td>Artificial Intelligence</td>
<td>0.50</td>
</tr>
<tr>
<td>CIS*6080</td>
<td>Genetic Algorithms</td>
<td>0.50</td>
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<tr>
<td>CIS*6120</td>
<td>Uncertainty Reasoning in Knowledge Representation</td>
<td>0.50</td>
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Mathematics and Statistics

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<tr>
<th>Code</th>
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<tbody>
<tr>
<td>STAT*4340</td>
<td>Statistical Inference</td>
<td>0.50</td>
</tr>
<tr>
<td>STAT*6801</td>
<td>Statistical Learning</td>
<td>0.50</td>
</tr>
<tr>
<td>STAT*6802</td>
<td>Generalized Linear Models and Extensions</td>
<td>0.50</td>
</tr>
<tr>
<td>STAT*6950</td>
<td>Statistical Methods for the Life Sciences</td>
<td>0.50</td>
</tr>
</tbody>
</table>

Note
Some courses may not be offered in every semester. Students planning
to take a course from the above list should consult with the department
offering the course to check for availability and scheduling.