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)  
sadamowi@uoguelph.ca

**Bioinformatics Program Manager**  
Monica Wong (4451 Science Complex, Ext. 56474)  
moniwong@uoguelph.ca

**Admissions Secretary**  
Karen White (3479 Science Complex, Ext. 52730)  
cbsgrad@uoguelph.ca

**Graduate Program Assistant**  
Sarah Lakhan (2483 Science Complex, Ext. 56097)  
cbsibgrad@uoguelph.ca

### Graduate Faculty

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

<table>
<thead>
<tr>
<th>Name</th>
<th>Degree Details</th>
<th>Institution/Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sarah J. Adamowicz</td>
<td>B.Sc. Dalhousie, M.Sc. Guelph, PhD Imperial College - Associate Professor</td>
<td>Graduate Faculty</td>
</tr>
<tr>
<td>R. Ayesha Ali</td>
<td>B.Sc. Western Ontario, M.Sc. Toronto, PhD Washington - Associate Professor</td>
<td>Graduate Faculty</td>
</tr>
<tr>
<td>Emma Allen-Vercoe</td>
<td>B.Sc. London (UK), PhD Open (UK) - Professor</td>
<td>Graduate Faculty</td>
</tr>
<tr>
<td>Daniel A. Ashlock</td>
<td>B.Sc. Kansas, PhD CalTech - Professor</td>
<td>Graduate Faculty</td>
</tr>
<tr>
<td>Christine Baes</td>
<td>B.Sc. Guelph, M.Sc. Hohenheim, PhD Christian-Albrechts - Associate Professor</td>
<td>Graduate Faculty</td>
</tr>
<tr>
<td>Elizabeth G. Boulding</td>
<td>B.Sc. British Columbia, M.Sc. Alberta, PhD Washington - Professor</td>
<td>Graduate Faculty</td>
</tr>
<tr>
<td>Joseph L. Colasanti</td>
<td>B.Sc., PhD Western Ontario - Associate Professor</td>
<td>Graduate Faculty</td>
</tr>
<tr>
<td>Karl A. Cottenie</td>
<td>M.Sc., MS, PhD K.U. Leuven - Associate Professor</td>
<td>Graduate Faculty</td>
</tr>
<tr>
<td>Angela Cánovas</td>
<td>B.Sc. Lledia, M.Sc. Valencia, PhD Lledia - Associate Professor</td>
<td>Graduate Faculty</td>
</tr>
<tr>
<td>Lorna Deeth</td>
<td>B.Sc., M.Sc., PhD Guelph - Assistant Professor</td>
<td>Graduate Faculty</td>
</tr>
<tr>
<td>Giannina Descalzi</td>
<td>BA Guelph, M.Sc., PhD Toronto - Assistant Professor</td>
<td>Graduate Faculty</td>
</tr>
<tr>
<td>Hermann J. Eber</td>
<td>Dipl. Math (M.Sc.), PhD Munich Univ. of Tech. - Professor</td>
<td>Graduate Faculty</td>
</tr>
<tr>
<td>Michael J. Emes</td>
<td>B.Sc., PhD Sheffield - Professor</td>
<td>Graduate Faculty</td>
</tr>
<tr>
<td>Vahab Farzan</td>
<td>DVM Tehran, M.Sc., PhD Guelph - Research Associate, Population Medicine, University of Guelph</td>
<td>Associated Graduate Faculty</td>
</tr>
<tr>
<td>Zeny Feng</td>
<td>B.Sc. York, MMath., PhD Waterloo - Professor</td>
<td>Graduate Faculty</td>
</tr>
<tr>
<td>Jinzhong Fu</td>
<td>B.Sc. Nankai, M.Sc. Chinese Academy of Sciences, PhD Toronto - Associate Professor</td>
<td>Graduate Faculty</td>
</tr>
<tr>
<td>Jennifer Geddes-McAlister</td>
<td>B.Sc., M.Sc. Lethbridge, PhD British Columbia - Assistant Professor</td>
<td>Graduate Faculty</td>
</tr>
<tr>
<td>Steffen P. Graether</td>
<td>B.Sc., M.Sc., PhD Queen's - Professor</td>
<td>Graduate Faculty</td>
</tr>
<tr>
<td>Thomas Graham</td>
<td>B.Sc., M.Sc., PhD Wageningen - Assistant Professor, Environmental Sciences, University of Guelph</td>
<td>Graduate Faculty</td>
</tr>
<tr>
<td>T. Ryan Gregory</td>
<td>B.Sc. McMaster, PhD Guelph - Professor</td>
<td>Graduate Faculty</td>
</tr>
<tr>
<td>Cortland K. Griswold</td>
<td>B.Sc. Wisconsin, M.Sc. Toronto, PhD British Columbia - Associate Professor</td>
<td>Graduate Faculty</td>
</tr>
<tr>
<td>Mehrdad Hajibabaei</td>
<td>B.Sc. Tehran Azad, PhD Ottawa - Associate Professor</td>
<td>Graduate Faculty</td>
</tr>
<tr>
<td>Andrew Hamilton-Wright</td>
<td>B.Sc., M.Sc. Guelph, PhD Waterloo - Associate Professor</td>
<td>Graduate Faculty</td>
</tr>
</tbody>
</table>
Bioinformatics

Robert Hanner
B.Sc. Eastern Michigan, PhD Oregon - Associate Professor
Graduate Faculty

George Harauz
BASc, M.Sc., PhD Toronto - Professor Emeritus
Associated Graduate Faculty

Andreas Heyland
B.Sc., M.Sc. Zurich, PhD Florida - Professor
Graduate Faculty

Niel A. Karrow
B.Sc. Guelph, M.Sc., PhD Waterloo - Professor
Graduate Faculty

Jibrán Khokhar
B.Sc. Queen’s, PhD Toronto - Assistant Professor
Graduate Faculty

Peter T. Kim
BA Toronto, MA Southern California, PhD UC San Diego - Professor
Graduate Faculty

Stefan C. Kremer
B.Sc. Guelph, PhD Alberta - Professor
Graduate Faculty

Jasmin Lalonde
BA Ottawa, MA, PhD McGill - Assistant Professor
Graduate Faculty

Jonathan LaMarre
DVM, PhD Guelph - Professor
Graduate Faculty

Brandon N. Lillie
DMV, PhD Guelph, DIP. A.C.V.P. - Associate Professor
Graduate Faculty

Lewis N. Lukens
B.Sc. Carleton College, PhD Minnesota - Associate Professor
Graduate Faculty

John S. Lumsden
B.Sc., DVM, M.Sc., PhD Guelph, Diplomate ACVP - Professor
Graduate Faculty

David W. L. Ma
B.Sc., PhD Alberta - Professor
Graduate Faculty

Elizabeth Mandeville
B.Sc. Yale, PhD Wyoming - Assistant Professor, Integrative Biology
Graduate Faculty

Baozhong Meng
B.Sc., M.Sc. Hebei Agricultural (China) - Associate Professor
Graduate Faculty

A. Rodney Merill
B.Sc. Lethbridge, PhD Ottawa - Professor
Graduate Faculty

David M. Mutch
B.Sc. Queen’s, PhD Lausanne - Associate Professor
Graduate Faculty

Khurram Nadeem
B.Sc., M.Sc. Karachi, PhD Alberta - Assistant Professor
Graduate Faculty

Annette Nassuth
B.Sc., M.Sc. Free (Amsterdam), PhD Leiden - Associate Professor
Graduate Faculty

K. Peter Pauls
B.Sc., M.Sc. PhD Waterlo - Professor
Graduate Faculty

Zvonimir Poljak
DVM Croatia, M.Sc., PhD Guelph - Associate Professor
Graduate Faculty

Ryan Prosser
BEd Wollongong, B.Sc., PhD Guelph - Associate Professor
Graduate Faculty

J. Andrew B. Robinson
B.Sc., M.Sc. Guelph, PhD Cornell - Associate Professor
Graduate Faculty

Scott Ryan
B.Sc. Memorial, PhD Ottawa - Associate Professor
Graduate Faculty

Flavio S. Schenkel
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
Associated Graduate Faculty

Leonardo Susta
DVM Perugia, PhD Georgia, Diplomate ACVP - Assistant Professor
Graduate Faculty

Graham Taylor
B.A.Sc., M.A.Sc. Waterloo, PhD Toronto, PEng - Professor
Graduate Faculty

Dan Tulpan
B.Sc. Burcharest, PhD British Columbia - Assistant Professor
Graduate Faculty

George van der Merwe
B.Sc., M.Sc., PhD Stellenbosch (South Africa) - Associate Professor
Graduate Faculty

Terry Van Raay Van Raay
B.Sc. Windsor, M.Sc. Guelph, PhD Utah - Associate Professor
Graduate Faculty

Geoffrey A. Wood
DVM Guelph, PhD Toronto, D.V.Sc. Guelph - Associate Professor
Graduate Faculty

Krassimir (Joseph) Yankulov
B.Sc. Sophia, PhD ICRF London - Professor
Graduate Faculty

John L. Zettel
BS Waterloo, M.Sc., PhD Toronto - Associate Professor
Graduate Faculty

Wei Zhang
B.Sc. Beijing, MA York, PhD Toronto - Assistant Professor
Graduate Faculty

MBINF 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>
</tr>
</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 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 12 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.

Applications 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:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</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>
</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:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BINF*6500</td>
<td>PhD Research Writing in Bioinformatics</td>
<td>1.00</td>
</tr>
</tbody>
</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/](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 students in Bioinformatics programs.
- **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 students in Bioinformatics programs.
- **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 students in Bioinformatics programs.
- **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 students in Bioinformatics programs.
- **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):** PhD students in Bioinformatics program
- **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 students in Bioinformatics programs.
- **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 students in Bioinformatics programs.
- **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 MBNF students only
- **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>
</tr>
</thead>
<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>
</tbody>
</table>

#### Computer Science

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</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>
</tr>
<tr>
<td>CIS*6120</td>
<td>Uncertainty Reasoning in Knowledge Representation</td>
<td>0.50</td>
</tr>
</tbody>
</table>

#### Mathematics and Statistics

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<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.