

Biol 432 Syllabus

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Course Information

General Course Information

Course: BIOL 432

Course title: Introduction to Computation and Big Data in Biology

Pre-requisites: BIOL 343

Semester and year: Winter/Spring 2025

Number of credits: 3.0

Learning hours: 120 (36 Lecture, 12 Tutorial, 72 Private Study)

Modality (on campus, blended, or online): On campus

Course Description

Application of basic coding and analytical methods to obtain, organize, analyze, visualize, and interpret information from large, complex datasets (i.e. 'Big Data') in biology. Datasets may include climate/weather records, 'omics' data, specimen collections, long-term observational studies, journal articles, and other historical and online sources.

Topics*

Week	Module	Topic
1	Week 01: R-eview	Review R coding and concepts from BIOL 243 and BIOL 343
2	Week 02: ML & PCA	Introduction to machine learning concepts and principal components analysis in R
3	Week 03: LDA, QDA & RDA	Discriminant Analysis in R
4	Week 04: SVMs & DTs	Support Vector Machines and Decision Trees in R
5	Week 05: R-egex	Regular Expressions in R
6	Week 06: Sequence Data	Working with DNA data files and the BLAST search in R
7	Week 07: Alignments & The Dragon Phylogeny	DNA Alignments and phylogenetic trees in R
8	Week 08: Metabarcoding	Species community data and metabarcoding data for microbiome analysis.
9	Week 09: HPC-CAC	Fundamentals of High Performance Computing on remote servers at the Queen's Centre for Advanced Computing
10	Week 10: HTS Genomes	Fundamentals of High Throughput Sequencing and de novo genome assembly
11	Week 11: Transcriptomics	Fundamentals of RNA sequencing and transcriptome analysis
12	Week 12: Presentations	Final project presentations
*NOTE: Module order may differ from year-to-year due to scheduling of guest lectures. Please see OnQ for the correct schedule.		

Course Learning Outcomes

On successful completion of this course, students will be able to:

1. Develop strategies and identify data types appropriate for testing biological hypotheses.
2. Design write code that is **OPEN** and **REPRODUCIBLE** to address biological questions.
3. Write custom scripts to analyze large biological datasets, including the training of machine learning models and the analysis of high-throughput sequencing data.
4. Interpret and create 'big data' file formats in biology (e.g. CSV, FASTA, FASTQ, SAM, BED, BAM) to address biological hypotheses.
5. Combines multiple programming languages into analysis pipelines that can run on remote servers, including those maintained by Queen's Centre for Advanced Computing (CAC).
6. Interpret and write original *regular expressions* to efficiently modify biological data files (e.g., automated error correction, file conversion, and data extraction).
7. Use Git with GitHub and R Studio to collaborate with peers on large coding projects.
8. Reflect on systematic biases in large datasets and computing algorithms, and strategies to detect and account for these biases.

Important University Dates

Please visit the [Faculty of Arts and Sciences Sessional Dates website](#) for all academic deadlines.

Inclusion

Land Acknowledgement

As a descendant of uninvited colonists, I feel tremendously privileged to live, learn, work, and play on these lands. As Queen's University is situated on traditional lands of the Anishinaabe and Haudenosaunee, I invite you all to be mindful with me about the many lessons we learn while on these lands, and how we might apply our newfound skills and knowledge for the benefit of all.

Even as a well-established scientist, I admit I have much to learn from the teachings and traditions of the Anishinaabe and Haudenosaunee, who have lived on these lands since time immemorial. While researching some of this history, I was moved to learn about the Seven Grandfathers in the Anishinaabe tradition, which, as I understand, demonstrate principles for living a "good" life. These include *Dabaadendiziwin* (humility/compassion/patience), *Gwayakwaadiziwin* (bravery to be honest), *Minaadendamowin* (respect for all creation), *Nibwaakaawin* (wisdom/knowledge to help people) and *Zaagi'idiwin* (unconditional love given and received). It is worth reflecting on how well these principles resonate with other cultures and traditions around the world, suggesting a deep truth.

It can be difficult and even overwhelming as a student to struggle through the stresses and demands of a university degree and life more generally. When you feel this way, I encourage you to learn or return to these Indigenous teachings, and/or teachings from your own cultural traditions, to recall what really matters in life, and to let these insights guide you through difficult decisions. *To read more about the history of the land, see the [Queen's Encyclopedia](#) and to learn more about land acknowledgements, see the [Office of Indigenous Initiatives](#).*

Equity, Diversity, and Inclusivity Statement

Equity and diversity are central to our educational mission and the standards of excellence in this course and at Queen's University. It is critical that we work together to dismantle direct, indirect, and systemic discrimination that still exists within our institutional structures, policies and practices -- and in our community. These take many forms and work to differentially advantage and disadvantage persons across social identities defined by race, ethnicity, disability, gender identity, sexual orientation, faith and socioeconomic status, among other factors. As students and educators, we all have important roles to play to identify and address systemic discrimination for the benefit of science and society. As members of these societies, we benefit greatly from diversity of knowledge and perspectives.

Building a Classroom Community

University is a place to share, question, and challenge ideas. Each student brings a different set of lived experiences. You can help to create a safer, more respectful classroom community for learners by following these guidelines:

- Make a personal commitment to learn about, understand, and support your peers.
- Assume the best of others and expect the best of them.
- Recognize and value the experiences, abilities, and knowledge each person brings to the course.
- Acknowledge the impact of oppression on other people's lives and make sure your words and tone are respectful and inclusive.
- Encourage others to develop and share their ideas.
- Pay close attention to what your peers say/write before you respond. Think through and re-read what you have written before you post online or send your comments to others.
- Be open to having your ideas challenged and challenge others with the intent of facilitating growth.
- Look for opportunities to agree with one another, building on and intentionally referencing peers' thoughts and ideas; disagree with ideas without making personal attacks, demeaning, or embarrassing others.

Fostering Accessibility

All of us have a shared responsibility for fostering accessibility and promoting meaningful inclusion of those with disabilities. The [Accessibility Hub](#) at Queen's University's Human Rights & Equity Office offer a host of [tutorials](#) that provide us all with practical tips for:

- creating accessible documents, e.g., to submit to your teaching team or share with peers in peer feedback activities/in a presentation,
- emails, e.g., while communicating with group members or your teaching team, and
- meeting practices (e.g., in tutorials/labs/seminars or virtual meetings).

Name/Pronoun

If, for whatever reason, you wish to change how your name appears in onQ and/or on class lists, please follow these steps. You may also use this process to add your pronouns to the appearance of your name.

1. Log into SOLUS.
2. Click on Personal Information tab.
3. Click on the Names tab

4. Click on the Add New Name tab
5. Choose Preferred from the Name Type drop down menu
6. Enter the name you would like to appear in onQ and/or on class lists.
7. Click Save.

Please allow 24 to 48 hours for your name to be registered within the system. If you have further questions or concerns, please contact ITS at Queen's University.

Course Materials & Technologies

NOTE: *You are not required to purchase any textbooks for this class.* All required reading is provided free to students through the course website.

In addition to the required reading listed below, several books are recommended if you are serious about pursuing a career in bioinformatics and/or computational biology. However, note that it is not required or expected that you will have read these.

Required Course Textbooks

NONE

Optional Course Textbooks

Course Textbooks	Edition(s)	Publisher	For Purchase	At Queen's Library?	Price
<i>R Crash Course for Biologists</i>	1st	DP Press	Amazon.ca	No	\$40
<i>R STATS Crash Course for Biologists</i>	1st	DP Press	Amazon.ca	No	\$40
<i>R Machine Learning Crash Course for Biologists</i>	1st	DP Press	Amazon.ca	No	\$40

Other Required Materials

Resource	Resource Type	Access	Further Information
Bioinformatics chapters	Website	OnQ	Provided to the student at no cost

Supplemental Materials

Resource	Resource Type	Access	Further Information
<i>Practical Computing for Biologists</i> by Haddock & Dunn	Other	Bookstore	Oxford University Press
<i>Bioinformatics Data Skills</i> by Vince Buffalo	Other	Bookstore	O'Reilly

<i>R for Data Science</i> by Hadley Wickham	Other	Bookstore	O'Reilly
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Educational Technologies, Help, Privacy, and Accessibility

This course makes use of the following website(s), program(s), and/or application(s) for specific educational use/purposes: OnQ (website), Perusall (website), R & R Studio (software), python & biopython (software), MobaXTerm (Windows software), Git (software), GitHub (website)

Privacy: Be aware that your independent use of the website(s), programs, and/or application(s) used in this course, *beyond what is required*, is subject to their terms of use and privacy policy. You are encouraged to review the applicable privacy statements before using the site.

Accessibility: Queen’s University is committed to developing courses that are accessible.

Notice of Recording

Synchronous (live) classes will be delivered in this course and may be recorded through Zoom and/or Teams, video conferencing platforms supported by the University. Steps have been taken by the University to configure these platforms in a secure manner. Classes will be recorded with video and audio (and, in some cases, transcription) and will be made available to students in the course. The recordings may capture your name, image or voice through the video and audio recordings. By attending these live classes, you are consenting to the collection of this information for the purposes of administering the class and associated coursework. If you are concerned about the collection of your name and other personal information in the class, please contact the course instructor to identify possible alternatives. To learn more about how your personal information is collected, used and disclosed by Queen’s University, please see the [Notice of Collection, Use and Disclosure of Personal Information](#).

Copyright of Course Material

Course materials created by the course instructor, including all slides, presentations, handouts, tests, exams, and other similar course materials, are the intellectual property of the instructor. It is a departure from academic integrity to distribute, publicly post, sell or otherwise disseminate an instructor’s course materials or to provide an instructor’s course materials to anyone else for distribution, posting, sale or other means of dissemination, without the instructor’s express consent. A student who engages in such conduct may be subject to penalty for a departure from academic integrity and may also face adverse legal consequences for infringement of intellectual property rights.

Communication

Questions about the Course and Contacting the Teaching Team

The teaching team will be available for 3+ hours of help every week, including the instructor’s weekly office hours, the weekly tutorial sessions, and part of weekly lectures. Please use this time to ask your questions in person. We will act on emails about the quizzes and assignments only if they report an error or general problem that is time-sensitive (e.g., broken links, erroneous dates).

Queen's Email

The university communicates with students via Queen's email. Please check your email regularly to ensure you do not miss important information related to your course.

Course Feedback

At various points during the course, you may be asked to take part in a variety of feedback activities, such as surveys and questionnaires. This feedback enables the teaching team to improve the course. All surveys are anonymous and are directly related to activities, assessments, and other course material.

Assessments

Weighting and Alignment with Course Learning Outcomes (CLOs)

Assessment	Alignment with CLOs	Weighting
Weekly Quizzes	2,3,4,5,6	10%
Weekly Assignments	1-8	20%
Final Project -- Proposal	1,8	10%
Final Project -- Report	1-8	20%
Final Project -- Code	2-7	20%
Participation & Peer Review	1,8	20%
Total		100%

Descriptions of Learning Activities and Assessments

Weekly Quizzes

- Weekly quizzes are completed before each lecture and are graded on a pass/fail basis.
- You will receive a full grade if you complete the quizzes on time.
- Answers are provided to self-assess understanding of the weekly assigned readings to support learning of the background knowledge needed to complete the weekly assignments.

Weekly Assignments

- Weekly assignments are assigned in each lecture and due by the end of tutorial.
- These assignments reinforce coding knowledge learned in assigned readings and support development of coding skills that are needed for the final project.

Final Group Project

- The final project integrates learning from the entire course, building on BIOL 243, BIOL 343. Working in assigned groups over several weeks, you will identify a large dataset and develop relevant biological questions and hypotheses to address with the data.
- You will work collaboratively on a project proposal, code repository, and a final poster that you will present to the class.

Participation & Peer Review

- Participation includes participation in in-class discussion and comments on Perusall.

- You will also be evaluated by your peers for your contribution to the final group project. This includes your contribution to the design, analysis and writing of the following project, AND your ability to engage in a respectful, helpful and encouraging manner.

Proctored Exams

There is no final exam in this course

Assignment Submission Policy

Weekly quizzes and assignments are designed to reinforce learning of the techniques and concepts covered in the assigned readings. Late submissions receive a grade of zero, but each one is worth only 1% to 2% of your final grade. The tight deadline is necessary for the teaching team to provide you with timely feedback to help you identify knowledge gaps and improve on future assignments. Students with appropriate accommodations or extenuating circumstances may take an additional 24 hours to complete assignments and quizzes, and may drop up to two of each from the final grade calculation.

Please see the Academic Considerations for Students with Extenuating Circumstances and Accommodations for Disabilities sections of the syllabus for more information.

Policy Review of Graded Work

Questions about grading on an assignment should be directed to the TA during the weekly tutorial session, not over email. If you cannot resolve the grading issue with the TA, then you may petition the instructor during weekly lecture or office hours, within two weeks of an assignment due date. Explain the specific aspects of your assignment that you believe were not sufficiently awarded, and why you believe that your assignment meets the criteria for a higher mark, referring to the categories of the rubric. The instructor will then re-grade the entire assignment, which could result in a higher or lower grade.

Policies

Class Attendance

Your presence and participation in class contributes to the knowledge and skills that you will develop throughout this course, reinforced through group assignments. I expect that you attend class regularly, participate in class conversations and learning activities. These types of activities provide active engagement, promote a deeper understanding of the course content, and contribute to your success in this course.

Academic Support

All undergraduate students face new learning and writing challenges as they progress through university: essays and reports become more complex; effectively incorporating research into writing becomes more important; the types of assignments become more diverse; managing your time and developing the skills you need to read and think critically gets more challenging. I encourage students to contact Student Academic Success Services (SASS). SASS offers many different ways to receive support:

- Free online or in-person [appointments](#) to get personalized support on writing and academic skills from expert staff and trained peers.
- [Workshops](#) and [drop-in programs](#). SASS' [Events Calendar lists events coming soon](#).

- [Online resources](#) that provide strategies for academic skills and writing development at university.
- If English is not your first language, SASS has specific resources for [English as Additional Language students](#), including weekly programs and EAL academic skills appointments. You can meet on an ongoing basis with an EAL consultant to work on your academic writing, speaking, listening, and reading skills.

Accommodations for Disabilities

Queen's University is committed to working with students with disabilities to remove barriers to their academic goals. Queen's Student Accessibility Services (QSAS), students with disabilities, instructors, and faculty staff work together to provide and implement academic accommodations designed to allow students with disabilities equitable access to all course material (including in-class as well as exams). If you are a student currently experiencing barriers to your academics due to disability related reasons, and you would like to understand whether academic accommodations could support the removal of those barriers, please visit the [QSAS website](#) to learn more about academic accommodations or start the registration process with QSAS by clicking **Access Ventus** button at [Ventus | Accessibility Services | Queen's \(queensu.ca\)](#)

VENTUS is an online portal that connects students, instructors, Queen's Student Accessibility Services, the Exam's Office and other support services in the process to request, assess, and implement academic accommodations.

To learn more go to: <https://www.queensu.ca/ventus-support/students/visual-guide-ventus-students>

Academic Consideration for Students in Extenuating Circumstances

Academic Consideration is a process for the University community to provide a compassionate response to assist students experiencing unforeseen, short-term extenuating circumstances that may impact or impede a student's ability to complete their academics. This may include but is not limited to,

- Short term Physical or Mental Illness or Injury (stomach flu, anxiety/depression, mononucleosis, concussion, broken bones, surgery, medical treatments, etc.)
- Traumatic Event/Confidential (Bereavement, serious injury, illness or required treatment for a significant other/family member or a traumatic event such as divorce, sexual assault, social injustice, etc.)
- Requirements by Law or Public Health Authorities (court dates, jury duty, requirements to isolate, etc.)
- Significant Event (varsity athletic event, distinguished event, serving in the Reserve Forces, etc.)

Queen's University is committed to providing academic consideration to students experiencing extenuating circumstances. For more information, please see the [Senate Policy on Academic Consideration for Students in Extenuating Circumstances](#).

Each Faculty has developed a protocol to provide a consistent and equitable approach in dealing with requests for academic consideration for students facing extenuating circumstances. For more information, undergraduate students in the Faculty of Arts and Sciences should consult the Faculty's

webpage on [Academic Consideration in Extenuating Circumstances](#) and submit a request via the [Academic Consideration Request Portal](#). Students in other Faculties and Schools who are enrolled in this course should refer to the protocol for their home Faculty.

Students are encouraged to submit requests as soon as the need becomes apparent and to contact their instructor and/or course coordinator as soon as possible once academic consideration has been granted. Any delay in contact may limit the options available for academic consideration.

For more information on the Academic Consideration process, what is and is not an extenuating circumstance, and to submit an Academic Consideration request, please see the Faculty of Arts and Science's [Academic Consideration website](#). ASO courses include links to information on **Academic Consideration** on your **Course Homepage** in onQ.

Please see the Teaching Team page for contact information for your instructor and TA(s), where relevant.

Queen's Policy Statement on Academic Integrity

Queen's University is dedicated to creating a scholarly community free to explore a range of ideas, to build and advance knowledge, and to share the ideas and knowledge that emerge from a range of intellectual pursuits. Queen's students, faculty, administrators and staff therefore all have responsibilities for supporting and upholding the fundamental values of academic integrity. Academic integrity is constituted by the five core fundamental values of honesty, trust, fairness, respect and responsibility and by the quality of courage. These values and qualities are central to the building, nurturing and sustaining of an academic community in which all members of the community will thrive. Adherence to the values expressed through academic integrity forms a foundation for the "freedom of inquiry and exchange of ideas" essential to the intellectual life of the University.

The following statements from "The Fundamental Values of Academic Integrity" (2nd edition), developed by the International Center for Academic Integrity (ICAI), contextualize these values and qualities:

1. **Honesty** Academic communities of integrity advance the quest for truth and knowledge through intellectual and personal honesty in learning, teaching, research, and service.
2. **Trust** Academic communities of integrity both foster and rely upon climates of mutual trust. Climates of trust encourage and support the free exchange of ideas which in turn allows scholarly inquiry to reach its fullest potential.
3. **Fairness** Academic communities of integrity establish clear and transparent expectations, standards, and practices to support fairness in the interactions of students, faculty, and administrators.
4. **Respect** Academic communities of integrity value the interactive, cooperative, participatory nature of learning. They honor, value, and consider diverse opinions and ideas.
5. **Responsibility** Academic communities of integrity rest upon foundations of personal accountability coupled with the willingness of individuals and groups to lead by example, uphold mutually agreed-upon standards, and take action when they encounter wrongdoing.
6. **Courage** To develop and sustain communities of integrity, it takes more than simply believing in the fundamental values. Translating the values from talking points into action -- standing up for them in the face of pressure and adversity — requires determination, commitment, and courage.

Students are responsible for familiarizing themselves with and adhering to the Senate [regulations](#) concerning academic integrity, along with [Faculty or School](#) specific information. Departures from academic integrity include, but are not limited to, plagiarism, use of unauthorized materials, facilitation, forgery and falsification. Actions which contravene the regulation on academic integrity carry sanctions that can range from a warning, to loss of grades on an assignment, to failure of a course, to requirement to withdraw from the university.

Syllabus statements for Generative Artificial Intelligence (AI)

As discussed in the introduction of the R Crash Course for Biologists, it is very likely that professional biologists who code will benefit from using Large Language Models (LLMs) and other forms of generative AI on a regular basis. Therefore, it's worth learning how to use LLMs now, as a student, to write effective code. LLMs can save you a lot of time and effort but they can also compromise your learning. Here are some tips to ensure that your use of LLMs in this course does not violate Queen's Academic Integrity guidelines nor interfere with your ability to do well on the final exam.

- DO be skeptical of everything AI tells you, even if it seems right at first.
- DO try to figure it out yourself, ask AI for help only when you get stuck.
- DO ask AI for help interpreting warning or error messages in your code.
- DO read the R help yourself. It's difficult at first, but it gets easier. Ask AI for help with terms or concepts that you don't understand in the R help.
- DO ask AI for feedback on your code, but don't use code that you don't understand, and read the code carefully.
- DO ask AI to explain code to you, as you would ask a tutor.
- DON'T ask AI which packages or functions you should use. Unless you like to spend lots of time memorizing functions and package names, the best way to learn them is by forcing yourself to think about what you know and how you can apply it for a given problem.
- DON'T ask AI to write code for you. Not only will it limit your ability to learn to write effective code through repetition and practice, it might produce something that is completely wrong!

Queen's [Student Academic Success Services](#) (SASS) offers a self-directed, online academic integrity module which we encourage all students to take which will help with:

- Understanding the nature of the academic integrity departure
- Understanding the expectations of and role of sources in scholarly writing
- Integrating sources into your writing (paraphrasing, quoting, summarizing)
- Understanding when and how to cite your sources
- Managing your time effectively to avoid the need for shortcuts
- Taking effective notes to ensure accuracy of source material and correct attribution

Turnitin Statement

This course makes use of Turnitin, a third-party application that helps maintain standards of excellence in academic integrity. Normally, students will be required to submit their course assignments through onQ to Turnitin. In doing so, students' work will be included as source documents in the Turnitin reference database, where they will be used solely for the purpose of detecting plagiarized text in this

course. Data from submissions is also collected and analyzed by Turnitin for detecting Artificial Intelligence [\(AI\)-generated text](#). These results are not reported to your instructor at this time but could be in the future.

Turnitin is a suite of tools that provide instructors with information about the authenticity of submitted work and facilitates the process of grading. The similarity report generated after an assignment file is submitted produces a similarity score for each assignment. A similarity score is the percentage of writing that is similar to content found on the internet or the Turnitin extensive database of content. Turnitin does not determine if an instance of plagiarism has occurred. Instead, it gives instructors the information they need to determine the authenticity of work as a part of a larger process.

Please read Turnitin's [Privacy Policy](#), [Acceptable Use Policy](#) and [End-User License Agreement](#), which govern users' relationship with Turnitin. Also, please note that Turnitin uses cookies and other tracking technologies; however, in its service contract with Queen's Turnitin has agreed that neither Turnitin nor its third-party partners will use data collected through cookies or other tracking technologies for marketing or advertising purposes.

For further information about how you can exercise control over cookies, see [Turnitin's Privacy Policy](#).

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