Syllabus

IMED 7280: Medical Computational Biology

(Winter Term 2019)

(Revised on September 12, 2018)

Rady Faculty of Health Sciences

University of Manitoba

TABLE OF CONTENTS

COURSE DETAILS

Course Title & Number:	IMED 7280 – Medical Computational Biology
Number of Credit Hours:	3
Class Times & Days of Week:	Monday: 10am – 11:30am Wednesday: 10am – 11:30am
Location for classes/labs/tutorials:	Room 341, Basic Medical Sciences Building (BMSB) Department of Biochemistry and Medical Genetics 745 Bannatyne Avenue, Winnipeg, MB, R3E 0J9
Pre-Requisites:	All students should have a basic knowledge of biology, statistics and/or computer science, or the consent of the instructor(s). It should be noted that this course is open ONLY to **graduate students**. Auditing of this course or sitting in on the course will only be granted under very special circumstances. Please be informed that auditing student will be charged fees of one-half the associated credit course fees of the course. If you are currently enrolled in a university program, you must receive and submit written permission from the instructor before registering to audit any courses.

Instructor Contact Information

Instructor(s) Name & Preferred Form of Address:	Dr. Pingzhao Hu (Dr. Hu)
Office Location:	Room 308, BMSB
Office Hours or Availability:	Available by appointment only.
Office Phone No.	(204) 789-3229
Email:	**Pingzhao.Hu@umanitoba.ca** (reply within 48 hours) *Note*: All email communication must conform to the Communicating with Students university policy and be professional in appearance.
Contact:	Students can contact the instructor by email, phone or in person.
Instructor (2) Name	Dr. TP (on leave)

Course Description

U of M Course Calendar Description

Medical Computational Biology provides the basic knowledge necessary for students to pursue research in the use of computational methods in biomedical research. The course will focus on concepts

necessary for applying computation to genomics, transcriptomics and proteomics experimental data and their applications to topics relevant to human health. This course is suitable for a broad range of students with interest in large scale biomedical research.

General Course Description

This is a graduate-level course for life sciences students with interests in applying bioinformatics, computational biology, and biostatistics in analyses of omics data sets (e.g. next-generation DNA and RNA sequence, epigenetic, microbiome, and proteomics data) or students with a background in statistics, mathematics or computer science/engineering interested in developing new methods for the analysis of omics data. This course will provide students with state-of-the-art theories and methods in bioinformatics/computational biology and genome science for precision medicine outlined in the course plan included in this syllabus.

Course Goals

Students will be expected to have attained the following goals upon completion of the course:

1. Understand the basic principles of different omics technologies and their applications.
2. Understand the basic analysis pipelines of different omics data sets.
3. Understand how to design omics experiments.

Course Learning Objectives

Students will be expected to have learned the following skills upon completion of the course:

1. Understand how to select suitable bioinformatics methods and their tools to analyze specific omics data types.
2. Perform data preprocessing, simple data modeling, and post-hoc analysis of specific omics data types using R or other available bioinformatics tools and interpret analytical results from different bioinformatics tools.
3. Understand how to select suitable omics technologies for a specific genomic project.

Textbook, Readings, and Course Materials

Given the board introductory nature of this course there is no one textbook that covers all of the course material. Instead, we will provide all materials that should be read at least one week prior to the class. These will mostly be our lecture slides, data sets and assignments. For journal review articles, we will provide weblinks to University of Manitoba library. So please keep in mind the copyright laws outlined in the Using Copyright Materials section below when using them.

Required materials: you will need to bring your own laptop to the tutorial sessions to be able to complete the data analysis steps that will be taught. You will also need to have installed the *free* software outlined in the Course Technology Section below before beginning this course, as all tutorials will make use of them!

Using Copyrighted Material

Please respect copyright. We will use copyrighted content in this course. We have ensured that the content we use is appropriately acknowledged and is copied in accordance with copyright laws and

university guidelines. Copyrighted works, including those created by us, are made available for private study and research and must not be distributed in any format without permission. Do not upload copyrighted works to a learning management system (such as UM Learn), or any website, unless an exception to the *Copyright Act* applies or written permission was obtained. For more information, see the University's Copyright Office website or contact um_copyright@umanitoba.ca.

Course Technology

Monday classes will be in a lecture format where the lecturer will present the key elements of the topic being covered. Lecture support materials will be provided at least 24 hours before class. You will require the *free* Adobe Acrobat Reader or similar software to view the provided materials.

Wednesday classes will be in a tutorial format where the lecturer will walk you through the application and interpretation of approaches taught in the Monday class to real data. Students will be required to bring their own laptop to all Wednesday classes, which they will use to perform the data analysis steps.

Prior to the first tutorial class, you should install R statistical software (https://cran.r-project.org/) according to the instructions provided by their respective creators. Other free software required for each class on Wednesday can be downloaded by following instructors instructions.

Expectations: I Expect You To

We will treat you with respect and would appreciate the same courtesy in return. See Respectful Work and Learning Environment Policy. That means no tweet'ing, Facebook'ing, WhatsApp'ing, etc., during class, and please put your phone on silent. We will also expect you to follow university policies described below around Class Communication, Academic Integrity, and Recording Class Lectures. Also, if necessary, we expect you to utilize Student Accessibility Services so that you get the most out of taking this course.

Class Communication:
You are required to obtain and use your University of Manitoba email account for all communication between yourself and the university. All communication between us and you as a student must comply with the Electronic Communication with Student Policy; that is, we cannot respond to emails from students that are sent from public email services such as Gmail.

Academic Integrity:
The University Code of Academic Integrity is central to the ideals that under gird this course. Students are expected to be independently familiar with the Code and to recognize that their work in the course is to be their own original work that truthfully represents the time and effort applied. Any test or assignment submitted by you and that bears your name is presumed to be your own original work that has not previously been submitted for credit in another course unless you obtain prior written approval to do so from your instructor. If you are not clear about the expectations for completing an assignment or taking a test be sure to seek clarification from your instructor beforehand. Violations of the Code are most serious and will be handled in a manner that fully represents the extent of the Code and that befits the seriousness of its violation. Visit the Academic Calendar, Student Advocacy, and Academic Integrity web pages for more information.

Please note that an important element of academic integrity is fully and correctly attributing any materials taken from the work of others. In all of your assignments you may use words or ideas written by other individuals in publications, websites, or other sources, but only with proper attribution. "Proper attribution" means that you have fully identified the original source and extent of your use of the words

or ideas of others that you reproduce in your work for this course, usually in the form of a footnote or parenthesis. As a general rule, if you are citing from a published source or from a website and the quotation is short (up to a sentence or two) place it in quotation marks; if you employ a longer passage from a publication or web site, please indent it and use single spacing. Feel free to consult with me before completing assignments if you have concerns about the correct way to reference the work of others. In the unlikely event that any concerns do arise about the originality of a written assignment it will be evaluated with *iThenticate* to determine its originality and will be handled in a manner that fully represents the extent of any plagiarism detected by that software.

Finally, you should keep in mind that as a member of the campus community, you are expected to demonstrate integrity in all of your academic endeavors and will be evaluated on your own merits. So be proud of your academic accomplishments and help to protect and promote academic integrity at the University of Manitoba. The consequences of cheating and academic dishonesty are simply not worth it.

Recording Class Lectures:
No audio or video recording of lectures, presentations, or tutorials is allowed in any format, openly or surreptitiously, in whole or in part. All forms of course materials (both paper and digital) are for your private study and research use only.

Student Accessibility Services:
The University of Manitoba is committed to providing an accessible academic community. Students Accessibility Services (SAS) offers academic accommodation supports and services such as note-taking, interpreting, assistive technology and exam accommodations. Students who have, or think they may have, a disability (e.g. mental illness, learning, medical, hearing, injury-related, visual) are invited to contact SAS to arrange a confidential consultation.

Student Accessibility Services
520 University Centre
Phone: (204) 474-7423
Email: Student_accessibility@umanitoba.ca

Expectations: You Can Expect Me To

We will be in class for 5 minutes prior to and after the class time to discuss any questions or comments you may have. You can also contact us by phone or email to arrange a one-to-one meeting to discuss any questions or problems you might have with the material being taught. We will provide meaningful feedback on your performance in course project reports and assignments in written and/or oral forms as well as in an assigned grade, which we will provide within the timeframe set out in the Assignment Feedback section below. We will use both didactic and practical teaching methods to impart the course material to facilitate understanding and ability to implement these approaches in your own research.

CLASS SCHEDULE AND COURSE EVALUATION

This schedule is subject to change at the discretion of the instructor and/or based on the learning needs of the students but such changes are subject to Section 2.8 of ROASS.

Monday lectures are from 10am to 11:30pm, which will focus on basic concepts and principles, while the **Wednesday tutorials are from 10am to 11:30am**, which will focus on practical applications and hands-on data analysis. Students are required to bring their own laptops for the Wednesday tutorials.

Date	Class Titles	Topics	Lecturer
Jan 7	Introduction	Medical computational biology concepts and common themes in analysis of different omics types	Pingzhao Hu
Jan 9	Tutorial (Bioconductor software)		Pingzhao Hu
Jan 14	Principles of Differential Analysis	Principals of differential and gene-set-enrichment analyses	Pingzhao Hu
Jan 16	Tutorial (differential analysis)		Pingzhao Hu
Jan 21	DNA Sequencing I	Technologies, experimental design, quality control, read alignment, and variant calling	Binhua Liang
Jan 23	Tutorial (DNA sequencing I)		Binhua Liang
Jan 28	DNA Sequencing II	Variant filtering, annotation, visualization, and basic tests of phenotype-variant association	Binhua Liang
Jan 30	Tutorial (DNA sequencing II)		Binhua Liang
Feb 4	Proteomics and Systems Biology	Technologies, experimental design, quality control, annotation, variation and network analysis	Adam Burgener
Feb 6	Tutorial (Proteomics)		Pingzhao Hu
Feb 11	RNA Sequencing I	Technologies, experimental design, quality control, read alignment, and quantification	Geoff Hicks
Feb 13	Tutorial (RNA sequencing I)		Pingzhao Hu
Feb 25	RNA Sequencing II	splice junction, isoform discovery, alternative splicing, differential and gene-set enrichment analysis	Geoff Hicks
Feb 27	Tutorial (RNA sequencing II)		Pingzhao Hu
Mar 4	Genetic Epidemiology	Genetic architecture of human diseases/traits, genetic association and linkage methods	Michelle Liu
Mar 6	Tutorial (Genetic epidemiology)		Michelle Liu
Mar 11	Epigenetics	Technologies, experimental design, quality control, quantification for DNA methylation	Michelle Liu
Mar 13	Tutorial (DNA methylation)		Michelle Liu
Mar 18	Metagenomics/Microbiome	Technologies, experimental design, quality control, read alignment, clustering and association analysis	Gary Van Domselaar
Mar 20	Tutorial (Metagenomics)		Gary Van Domselaar
Mar 25	Omics Data Visualization	Biological databases and visualization tools	Meaghan Jones

Mar 27	Tutorial (Visualization)		Meaghan Jones
Apr 1	Omics Data Integration	Quantitative (eQTL, mQTL, pQTL) and meta-analysis approaches	Pingzhao Hu
Apr 3	Tutorial (Omics data integration)		Pingzhao Hu
Apr 15	*Student Project Presentations*	—	All instructors
Apr 17	*Student Project Presentations*	—	All instructors

Lab Expectations

It is expected that these R and Python laboratory sessions will maximize students' understanding of, and capability to use the R statistical software. The labs will also be very helpful for completing students' assignments and project reports. Students are required to bring their own laptops to attend these labs. We expect the same respect that students give us during the regular classes, and in return we will provide students with the same level of service we offer during those classes.

Lab Schedule

There are four two-hour R and one two-hour Python/Shell scripting laboratory sessions to review software tools for performing the assignments in the course. The R sessions (free) will be offered by Data Science Platform of The George & Fay Yee Centre for Healthcare Innovation. The Python session (free) will be offered by a graduate student in Department of Computer Science, University of Manitoba.

Date	Lab Title	Topics that will be covered	Lecturer
Jan 8 3pm –5pm	R Lab 1	Basic syntax, input and output	Robert Balshaw, Kristine Kroeker
Jan 15 3pm –5pm	R Lab 2	Data structures (Vector, factor, matrix, data frame, list, ect)	Robert Balshaw, Kristine Kroeker
Jan 22 3pm –5pm	R Lab 3	Loop, apply and customized functions	Robert Balshaw, Kristine Kroeker
Jan 29 3pm –5pm	R Lab 4	Statistical tests, correlation analysis, simple regression models	Robert Balshaw, Kristine Kroeker
Feb 5 3pm –5pm	Lab 5	Shell scripting and Python basic	Rayhan Shikder

Grading

Letter Grade	Percentage (out of 100)	Grade Point Range	Final Grade Point
A+	90-100	4.25-4.5	4.5
A	80-89	3.75-4.24	4.0
B+	75-79	3.25-3.74	3.5
B	70-74	2.75-3.24	3.0

C+	65-69	2.25-2.74	2.5
C	60-64	2.0-2.24	2.0
D	50-59	Less than 2.0	1.0
F	Less than 50		0

A minimum grade of C+ is required to pass this course.

Voluntary Withdrawal

As stated on the Registrar's Office website, the voluntary withdrawal deadline for this class is March 20. The feedback and grades of the first two of the five assignments and the first of the three parts of the course project will be provided to students before the voluntary withdrawal date.

ASSIGNMENT DESCRIPTIONS

The assignments and course project are all *individual*-based. Suspected collusion among students will be dealt in accordance with the University of Manitoba Academic Integrity policies outlined above.

Assignments

There are five assignments, each taking the form of a short report; a maximum of four pages (including figures and tables), single-spaced, Times New Roman font (12 pt), and 1-inch margins. Each assignment will count 12% toward your final grade. The major content of the assignments will be discussed in Wednesday tutorial classes. For each topic, you will be required to analyze a small assigned data set based on the lecture and tutorial materials. The report should graphically present your findings and provide an explanation/discussion of what you find. **A hard copy of your assignments should be submitted to the course mailbox in BMG Room 336.**

Assignment	Topic	Contribution to final grade (%)	Due date	To be handed in to
1	Gene set analysis	12	Jan 30	Pingzhao Hu (pingzhao.hu@umanitoba.ca)
2	DNA Sequencing	12	Feb 15	Binhua Liang (Binhua.Liang@umanitoba.ca)
3	RNA Sequencing	12	Mar 4	Pingzhao Hu (pingzhao.hu@umanitoba.ca)
4	Genetic epidemiology	12	Mar 20	Michelle Liu (GE) (liu@umanitoba.ca)
5	Microbiome	12	April 3	Gary Van Domselaar (Gary.VanDomselaar@phac-aspc.gc.ca)

Course Project

TITLE of PART 1: Course Project Description 10%

GOAL: This includes brief background introduction, project objectives, brief description of the potential data sources for the project, and the relevance of the project to the lecture topics. Students can select their own omics data sets or use publicly available omics data sets. **Each project should cover at least two lecture topics listed in Class Syllabus**.

PROCEDURE: The written report detailing the project description should be a maximum of 10 pages (including figures and tables) typed in the Times New Roman (12 point), double spaced, with 1-inch margins; references do not count toward the page limit and should be formatted in a style consistent with that described above.

SUBMISSION GUIDELINES: **A hard copy of the report should be submitted to the course mailbox in BMG Room 336 at or before the February 15 .**

EVALUATION CRITERIA: Students will be evaluated on the organization, content, overall presentation of the underlined items in **Goal** Section.

TITLE of PART 2: Course Project Data Analysis Report 25%

GOAL: Students are expected to attend the tutorial session offered on Wednesdays. Students are required to use R and other public bioinformatics tools to analyze their own data sets described in their Project Description. The Report should include: Background introduction and the relevance of the project to the lecture topics, Project objectives, Detailed description of data sources, Detailed description of data analysis methods, Detailed description of analysis results, discuss/explain analysis results, conclusions and references.

PROCEDURE: The written report detailing the project description and data analysis findings should be a maximum of 25 pages (including figures and tables) typed in the Times New Roman font (12 point) and double spaced; references do not count toward the page limit and should be formatted in a style consistent with that described above.

SUBMISSION GUIDELINES: **A hard copy of the report should be submitted to the course mailbox in BMG Room 336 at or before the April 25 .**

EVALUATION CRITERIA: Students will be evaluated on the organization, content, overall presentation of the underlined items in **Goal** Section.

TITLE of PART 3: Course Project Presentation 5%

GOAL: Students are expected to present the content outlined in their Project Description and Data Analysis Reports.

PROCEDURE: The presentation should be prepared in Microsoft Powerpoint or a similar application and be not more than 15 minutes in length. The presentation should adequately present the background and findings of the project, as well as interpret the finding of its component analyses. There will be the opportunity for other students and the course lecturers to ask questions afterwards.

SUBMISSION GUIDELINES: The presentation will be made on either **April 15 or 17**. Each student's exact date depends on class size, and will be decided on April 3.

EVALUATION CRITERIA: Students will be evaluated on the organization, visual presentation, content approaches to interpreting the results of their course project, and answers to questions asked by both students and lectures. Each non-presenting student and lecturer will be expected to complete an evaluation form for each presentation, which will be counted as part of the 5 marks. Students will have the opportunity to discuss the evaluation form feedback with the course instructors afterwards.

Referencing Style

Assignments and reports should use the Chicago/Turabian reference style as outlined in – Chicago: The Chicago Manual of Style, 16th edition.

Assignment Feedback

Students will be provided with formative (i.e., comments) and summative (i.e., grade) feedback on all assignments and all aspects of their course project assessment (description, data analysis report, and presentation). We will aim to return graded assignments to you within two weeks of their due dates.

Assignment Extension and Late Submission Policy

Late assignments and reports will not be accepted or graded. If you require more time due to illness or bereavement, please contact Dr. Pingzhao Hu (pingzhao.hu@umanitoba.ca) at your earliest convenience and provide either a doctor's certificate (for illness) or death certificate (for bereavement) when you hand in your late assignments or report.

UNIVERSITY SUPPORT OFFICES & POLICIES

Schedule "A": Academic support available to students

Writing and Learning Support

The Academic Learning Centre (ALC) offers services that may be helpful to you throughout your academic program. Through the ALC, you can meet with a learning specialist to discuss concerns such as time management, learning strategies, and test-taking strategies. The ALC also offers peer supported study groups called Supplemental Instruction (SI) for certain courses that students have typically found difficult. In these study groups, students have opportunities to ask questions, compare notes, discuss content, solve practice problems, and develop new study strategies in a group-learning format.

You can also meet one-to-one with a writing tutor who can give you feedback at any stage of the writing process, whether you are just beginning to work on a written assignment or already have a draft. If you are interested in meeting with a writing tutor, reserve your appointment two to three days in advance of the time you would like to meet. Also, plan to meet with a writing tutor a few days before your paper is due so that you have time to work with the tutor's feedback.

These Academic Learning Centre services are free for U of M students. For more information, please visit the Academic Learning Centre website.

You can also contact the Academic Learning Centre by calling 204-480-1481 or by visiting 205 Tier

Building.

University of Manitoba Libraries (UML)
As the primary contact for all research needs, your liaison librarian can play a vital role when completing academic papers and assignments. Liaisons can answer questions about managing citations, or locating appropriate resources, and will address any other concerns you may have, regarding the research process. Liaisons can be contacted by email or phone, and are also available to meet with you in-person. A complete list of liaison librarians can be found by subject or name. In addition, general library assistance is provided in person at 19 University Libraries, located on both the Fort Garry and Bannatyne campuses, as well as in many Winnipeg hospitals. For a listing of all libraries, please consult the University of Manitoba Libraries. When working remotely, students can also receive help online, via the Ask-a-Librarian chat found on the Libraries' homepage.

Schedule "B": Mental health support available to students

For 24/7 mental health support, contact the Mobile Crisis Service at 204-940-1781.

Student Counselling Centre : 474 University Centre or S207 Medical Services: (204) 474-8592
Contact the Student Counselling Centre if you are concerned about any aspect of your mental health, including anxiety, stress, or depression, or for help with relationships or other life concerns. Crisis services as well as individual, couple, and group counselling are available.

Student Support Case Management : 520 University Centre: (204) 474-7423
Contact the Student Support Case Management team if you are concerned about yourself or another student and don't know where to turn. SSCM helps connect students with on and off campus resources, provides safety planning, and offers other supports, including consultation, educational workshops, and referral to the STATIS threat assessment team.

University Health Service : 104 University Centre: (204) 474-8411
Contact UHS for any medical concerns, including mental health problems. UHS offers a full range of medical services to students, including psychiatric consultation.

Health and Wellness : 469 University Centre : (204) 295-9032
Contact our Health and Wellness Educator if you are interested in information on a broad range of health topics, including physical and mental health concerns, alcohol and substance use harms, and sexual assault.

Live Well @ UofM
For comprehensive information about the full range of health and wellness resources available on campus, visit the Live Well @ UofM site:

Schedule "C": A notice with respect to copyright

All students are required to respect copyright as per Canada's *Copyright Act*. Staff and students play a key role in the University's copyright compliance as we balance user rights for educational purposes with the rights of content creators from around the world. The Copyright Office provides copyright resources and support for all members of the University of Manitoba community. Visit http://umanitoba.ca/copyright for more information.

Schedule "D": University and Unit policies, procedures, and supplemental information

Your rights and responsibilities
As a student of the University of Manitoba you have rights and responsibilities. It is important for

you to know what you can expect from the University as a student and to understand what the University expects from you. Become familiar with the policies and procedures of the University and the regulations that are specific to your faculty, college or school.

The Academic Calendar is an important source of information. You should be familiar with sections *University Policies and Procedures* and *General Academic Regulations*.

While all of the information contained in these two sections is important, the following information is highlighted.

- If you have questions about your grades, talk to your instructor. There is a process for term work and final **grade appeals**. Note that you have the right to access your final examination scripts. See the Registrar's Office website for more information including appeal deadline dates and the appeal form.
- You are expected to view the General Academic Regulation section within the Academic Calendar and specifically read the **Academic Integrity** regulation. Consult the course syllabus or ask your instructor for additional information about demonstrating academic integrity in your academic work. Visit the Academic Integrity website for tools and support regarding the **Student Academic Misconduct** procedure for more information.
- The University is committed to a respectful work and learning environment. You have the right to be treated with respect and you are expected conduct yourself in an appropriate respectful manner. Policies governing behavior include the:

You should be familiar with the University of Manitoba's governing materials pertaining to Respectful Work and Learning Environment, Student Discipline and Violent or Threatening Behaviour.

- If you experience **Sexual Assault** or know a member of the University community who has, it is important to know there is a policy that provides information about the supports available to those who disclose and outlines a process for reporting. The **Sexual Assault** policy may be found on the Administration website and more information and resources can be found on Student Sexual Assault website.
- For information about rights and responsibilities regarding **Intellectual Property** policy visit the Administration website.

For information on regulations that are specific to your academic program, read the section in the Academic Calendar, and on the College of Medicine and Department of Biochemistry and Medical Genetics websites.

Contact an **Academic Advisor** with questions about your academic program and regulations.

Student Advocacy : 520 University Centre : (204) 474-7423

Contact Student Advocacy if you want to know more about your rights and responsibilities as a student, have questions about policies and procedures, and/or want support in dealing with academic or discipline concerns.