PH8001: COMPUTATIONAL BIOLOGY, EXPERIMENTAL DESIGN AND DATA SCIENCE

Effective Term
Summer Term 2025

Part I Course Overview

Course Title
Computational Biology, Experimental Design and Data Science

Subject Code
PH - Infectious Diseases and Public Health
Course Number
8001

Academic Unit
Infectious Diseases and Public Health (PH)

College/School
Jockey Club College of Veterinary Medicine and Life Sciences (VM)

Course Duration
One Semester

Credit Units
3

Level
R8 - Research Degree

Medium of Instruction
English

Medium of Assessment
English

Prerequisites
Nil

Precursors
Nil

Equivalent Courses
Nil

Exclusive Courses
Nil

Part II Course Details

Abstract

This course aims to make the postgraduate students

a) equipped with the fundamental knowledge in computational biology and data science;

b) prepared with practical skills and appropriate logic to analyze molecular or numerical data, including data processing, visualizing, interpreting, and hypothesizing; and

c) capable of designing biomedical/veterinary projects/experiments rationally. Python will be the main programming language used in the practical sessions.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Explain and apply the concepts, logic and algorithms underlying the commonly used bioinformatics tools	10	x	x	
2	Attain the ability of performing data mining for the -omics data using proper tools/parameters under a Linux environment	40	x	x	x
3	Design a biomedical/biological experiment regarding statistical and biological factors	15	x	x	x
4	Perform explanatory data analysis with Python	15	x	x	x
5	Apply supervised machine learning models to biological data for regression or classification	20	x	x	x

A1: Attitude
Develop an attitude of discovery/innovation/creativity, as demonstrated by students possessing a strong sense of curiosity, asking questions actively, challenging assumptions or engaging in inquiry together with teachers.

A2: Ability
Develop the ability/skill needed to discover/innovate/create, as demonstrated by students possessing critical thinking skills to assess ideas, acquiring research skills, synthesizing knowledge across disciplines or applying academic knowledge to real-life problems.

A3: Accomplishments
Demonstrate accomplishment of discovery/innovation/creativity through producing /constructing creative works/new artefacts, effective solutions to real-life problems or new processes.

Learning and Teaching Activities (LTAs)

	LTAs	Brief Description	CILO No.	Hours/week (if applicable)
1	Lectures	Students will engage in interactive lectures to understand the fundamental philosophy/ algorithms and apply appropriate tools for -omics data mining	1, 2, 3, 4, 5	

2	Hands-on practical tasks	Students will perform problem-based practices to 1) strengthen the understanding of the principles, algorithms, or philosophy underlying the models/tools; and 2) apply bioinformatics or data mining tools/ models on biomedical/ veterinary problems and interpret the results	1, 2, 3, 4, 5	
3	Take-home assignments and reports	Students will complete project-based assignments to consolidate the understanding of bioinformatics or data mining tools/models and proficiency in performing the analyses	2, 3, 4, 5	Out of classroom
4	Q&A sessions	Students will participate in Q&A sessions to 1) clarify concepts or correct the misunderstanding of the principles, algorithms or philosophy underlying the models/tools; 2) expand the scope of knowledge in biomedical data mining; 3) apply methods/tools learned to the real-world problems.	1, 2, 3, 4, 5	

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks ("-" for nil entry)	Allow Use of GenAI?
1	Classroom assessment	2, 3	30	Formative assessment will be carried out to evaluate students' comprehension and improve the learning outcomes (aligns with ILOs 1, 2, 3 4 and 5).	Yes

2	Assignments	1, 2, 3, 4, 5	70	These tasks are designed to evaluate the ability of assessing pros and cons of different tools/ models and the ability of applying them to realistic biomedical or veterinary problems (aligns with ILOs 2, 3, 4 and 5).	Yes

Continuous Assessment (%)

100

Assessment Rubrics (AR)

Assessment Task

Classroom assessment (30%) (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

Students will apply their competence in the content of both the theoretical and practical components.

Excellent

(A+, A, A-) High

Good

(B+, B, B-) Significant

Fair

(C+, C, C-) Moderate

Marginal

(D) Basic

Failure

(F) Not reaching basic levels

Assessment Task

Assignments (70%) (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

Students will appraise their competence in the key concepts and algorithms of commonly used bioinformatics tools, construct biological/veterinary experiments based on the principles taught, and utilize the techniques/tools learned to solve specific biological problems.

Excellent

(A+, A, A-) High

Good

(B+, B, B-) Significant

Fair
(C+, C, C-) Moderate

Marginal
(D) Basic

Failure
(F) Not reaching basic levels

Assessment Task
Classroom assessment (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion
The comprehension of the contents in both the theoretical and practical parts

Excellent
(A+, A, A-) High

Good
(B+, B) Significant

Marginal
(B-, C+, C) Basic

Failure
(F) Not even reaching marginal levels

Assessment Task
Assignments (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion
1) The comprehension of the key concepts and algorithms in the commonly used bioinformatics tools; ability to design a biological/ veterinary experiment based on the principles taught in this course;
2) the ability to solve some specific biological problems using the techniques/ tools learned/ recommended in this course.

Excellent
(A+, A, A-) High

Good
(B+, B) Significant

Marginal
(B-, C+, C) Basic

Failure
(F) Not even reaching marginal levels

Part III Other Information

Keyword Syllabus

Bioinformatics, computational biology, sequence analysis, -omics data mining, bioinformatics software, Linux operation, Python programming, experimental design, data visualization, multivariate analysis, supervised machine learning, unsupervised machine learning, exploratory data analysis, predictive modeling, causal inference

Reading List

Compulsory Readings

	Title
1	Biological sequence analysis, R. Durbin, S.Eddy, A. Krogh, G.Mitchison, https://pdfs.semanticscholar.org/2ed5/d6b35f8971fb9d7434a2683922c3bfcc058e.pdf
2	Python Data Science Handbook, Jake VanderPlas, https://github.com/jakevdp/PythonDataScienceHandbook

Additional Readings

	Title
1	Deep Learning, Yoshua Bengio, MIT Press, ISBN10 0262035618
2	The Book of Why: The New Science of Cause and Effect, Judea Pearl and Dana Mackenzie, ISBN-10: 046509760X
3	How to Create a Mind: The Secret of Human Thought Revealed, Ray Kurzweil, Penguin Books; 7/28/13 edition, ISBN-10: 9780143124047