Semester: 8	
Course: Major IV	
Paper Title: Genomics and Proteomics and RDT2 practical	
Paper code: C4BT230842T/ C4BT230842P	**Credits: 4 (3+1)**
Hours/week: 3+ 3	
Category: Core/MDC/SEC/VAC: Core	
Theory / Practical / Composite: Composite	
No of Modules: Theory – 2	

Course Overview:

THEORY: This course provides a comprehensive understanding of the principles and emerging applications of genomics, proteomics, and to introduce students to different techniques of recombinant DNA technology and protein based studies. Students will explore advances in structural, functional, comparative, population, and community genomics, including next-generation sequencing technologies, pangenome analysis, metagenomics, genome-wide association studies, pharmacogenomics, and precision medicine. The course further introduces modern proteomic approaches, protein chemistry, and mass spectrometry-based protein characterization.

COURSE OUTCOME:

THEORY

CO1. Explain the principles of structural, functional, comparative, population, and community genomics, along with emerging sequencing technologies and their biological applications.

CO2. Interpret genomic datasets using concepts of pangenomics, average nucleotide identity (ANI), genome graphs, metagenome-assembled genomes (MAGs), and their applications in medicine, agriculture, and public health

CO3. Evaluate the significance of GWAS, polygenic risk scores, pharmacogenomics, digital twin technology, and paleogenomics in precision medicine and personalized healthcare.

CO4. Describe the physicochemical properties of proteins and explain the principles and applications of modern proteomic techniques, including 2D electrophoresis and mass spectrometry.

CO5. Analyze and integrate genomic and proteomic information to solve biological problems and appreciate their applications in biotechnology, biomedical research, and translational sciences.

CO6. Remember the principles and applications of restriction digestion, DNA ligation, bacterial transformation, recombinant DNA isolation, PCR, and affinity-based protein purification**.** Perform recombinant DNA screening using bacterial transformation followed by restriction digestion for insert release, and PCR amplification; protein purification using Ni-NTA chromatography and protein aggregation studies.

PRACTICAL

Syllabus

Unit/Module	CONTENT	Hours / Number of Classes	Co Mapping	Cognitive Level

Module A Genomics	**UNIT I** Structural, Functional and Comparative Genomics. Next Generation DNA sequencing methods - Long Read and Short Read sequencing platforms and data analyses, The human genome project – historical and recent developments. Insights into single cell genomics and its applications. [With Tutorial]	1.5 classes/week	**CO 1 to CO6**	**K1 to K6**
	Unit II Concept of Pangenome in prokaryotes and eukaryotes – Pangenome analyses – average nucleotide identity (ANI) and metaparalogs, Use of graphs for visualizing genomes. Application of pangenome analyses in genomic medicine and crop improvement		**CO 1 to CO6**	**K1 to K6**
	Unit III Applications of community genomics and metagenomic approaches for studying natural populations; concept of metagenome assembled genomes (MAGs) and implications in public health. [With Tutorial]		**CO 1 to CO6**	**K1 to K6**
	Unit IV Population Genomics – Insights into GWAS, Polygenic risk scores and Biobanks. Pharmacogenomics; Digital Twin technology for precision medicine, Paleogenomic methods for aDNA studies [With Tutorial]		**CO 1 to CO6**	**K1 to K6**
Module B Proteomics	**Unit V** Chemical properties of proteins. Physical interactions that determine the properties of proteins, Short-range interactions, electrostatic forces, van der Waals interactions, hydrogen bonds, Hydrophobic interactions, Importance of ionic strength to obtain monodisperse oligomeric state of proteins.	1.5 classes/week	**CO 1 to CO6**	**K1 to K6**
	Unit VI Introduction to Proteomics, Purpose of Proteomics; Top-down and Bottom-up proteomics. Proteomics Technologies - Conventional techniques (Chromatography based techniques); Advanced techniques: Gel based approaches (SDS-PAGE, 2D-PAGE, 2D-DIGE); Mass spectrometry-based		**CO 1 to CO6**	**K1 to K6**

	approaches (MALDI-TOF, ESI-MS); Quantitative techniques (ICAT, SILAC, iTRAQ) and related applications.			
	Unit VII Correlative Mass spectrometry-based identification: Peptide-mass searching, Hydrogen exchange mass spectrometry; Rationale for phosphorylation analysis: 2D-PP mapping.		**CO 1 to CO6**	**K1 to K6**
Practical [40 marks]	1. λ DNA-Hind III digestion followed by ligation 2. Screening of recombinant/non-recombinant vectors through transformation (Blue white screening) 3. Screening of recombinant vectors through: a) Release of insert by restriction digestion b) PCR confirmation using insert specific primers and purified recombinant vector as template. 4. Protein purification using column chromatography (Ni-NTA, ion-exchange or SEC, SDS PAGE)	3 classes per week	CO1-CO6	K1-K6
Text books:	1. Rodríguez-Ezpeleta, N., Hackenberg, M., & Aransay, A. M. (2011). *Bioinformatics for high throughput sequencing*. Springer. 2. Brown, T. A.*Genomes* (5th ed.). Garland Science. 3. Lesk, A. M. *Introduction to genomics* (3rd ed.). Oxford University Press. 4. Pevsner, J. *Bioinformatics and functional genomics* (4th ed.). Wiley 5. Appasani K, ed. *Genome-Wide Association Studies: From Polymorphism to Personalized Medicine*. Cambridge University Press.			
Web Resources:	1. https://www.genomeweb.com/ 2. https://www.yourgenome.org/ 3. https://humanpangenome.org/			
Evaluation:	**Theory**CIA- 10; Assignment – 02; Attendance – 03; Semester Exam- 45; **Practical:** CA (38 marks) **;**Attendance (2 marks)			

Question Paper Structure:
Paper Structure for Theory Semester Exam
Module A (20 Marks)

- 1 Compulsory Objective Question – (any 5 out of 7; each of 1 mark): **1 × 5 marks = 5 marks**
- Any 3 out of 4 questions; each of 5 marks, with subparts (no subpart will be less than 1 mark): **3 × 5 marks = 15 marks**

Module B (25 Marks)

- 1 Compulsory Objective Question – (any 5 out of 7; each of 1 mark): **1 × 5 marks = 5 marks**
- Any 4 out of 5 Questions; each of 5 Marks with subparts; where no subpart will be less than 1 mark) **4 X 5 =**

20 Marks

COURSE OUTCOMES (COS) AND COGNITIVE LEVEL MAPPING

Course Outcome	Cognitive Level (KO)
CO1 Remember the concepts of genomics and sequencing technologies.	**K1 – K3**
CO2 Interpret genomic datasets and pangenome analyses.	**K1 – K3**
CO3 Evaluate genomic applications in precision medicine and healthcare.	**K4 – K6**
CO4 Explain protein structure, chemistry, and proteomic methodologies.	**K1 – K3**
CO5 Perform recombinant DNA laboratory techniques.	**K1 – K4**
CO6 Analyze and integrate genomic and proteomic data for research applications.	**K4 – K6**