Central University of Punjab, Bathinda

Ph.D.
Microbiology
Batch 2026
Department of Microbiology

Graduate Attributes

The students graduating will be skilled in scientific manpower with an understanding of research ethics and vast knowledge of microorganisms. Scholars will be equipped with the knowledge of microbial, molecular and **c**ellular processes and their applications which can be utilized for the betterment of society and careers in industry, agriculture, and applied research.

Course Structure

Sr. No	Course Code	Course Title	L	P	Credits
1	MMIC.701	Research Methodology and Computer Applications	4	0	4
2	MMIC.702	Trends in Microbiology	4	0	4
1	MMIC.751	Research and Publication Ethics	2	0	2
2	MMIC.752	Teaching Assistantship	-	2	1
3	UNI.753	Curriculum, Pedagogy and Evaluation	1	-	1
		Total Credits			12

L: Lectures; P: Practical; Cr: Credits

Evaluation Criteria for Theory Courses

End Semester Examination: Based on Subjective Type Test [100 Marks]

L	P	Credits
4	0	4

Course Code: MMIC.701
Course Title: Research Methodology and Computer Applications
Total Hours: 60

Course Learning Outcomes
Students will be able to:
CLO 1: Critically analyse, interpret, and synthesize existing scientific knowledge based on literature review.
CLO 2: Identify the knowledge gap and formulate a hypothesis and design experimental/theoretical work.
CLO 3: Apply good laboratory practices and biosafety protocols.
CLO 4: Appreciate the crucial issues in research ethics, like responsibility for research, ethical clearance for experimental studies and scientific misconduct.
CLO 5: Perform hypothesis testing on small and large data samples.
CLO 6: Use correlation and linear regression methods to find a relationship and good fit for the given data.
CLO 7: Retrieve various biological data from the appropriate databases for analysis.
CLO 8: Compare protein structures and perform structure-based drug designing.

Course Content

Unit/ Hours	Content	Mapping with CLO
I 15 hours	**General Principles of Research:** Meaning and importance of research, Critical thinking, Formulating hypothesis and development of research plan, Review of literature, Interpretation of results and discussion. Bibliographic index Technical Writing: Scientific writing, writing synopsis, Research paper, Poster preparation, oral presentations and Dissertations. Reference Management using various softwares such as Endnote, reference manager, Refworks, etc. Communication skills: defining communication; type of communication; techniques of communication, etc.	CLO1 & CLO2
II 15 hours	**Introduction and Principles of Good Lab Practices:** Good laboratory practices, Biosafety for human health and environment. Biosafety issues for using cloned genes in medicine, agriculture, industry, and eco-protection, biological containment and physical containment, Biosafety in Clinical laboratories and biohazard management, Physical, Chemical & Biological hazards and their mitigation. Biosafety level/category of pathogens. Biosafety level of laboratories, WHO/CDC/DBT guidelines for biosafety. **Research Ethics:** Ethical theories, Ethical considerations during research, consent. Animal handling/testing, Animal experimental models and animal ethics. Perspectives and methodology & Ethical issues of the human genome project, ICMR guidelines for biomedical and health research. Intellectual property protection (IPP) and intellectual property rights (IPR), WTO (World Trade Organization), WIPO (World Intellectual Property Organization), GATT (General Agreement on Tariff and Trade), TRIPs (Trade Related Intellectual	CLO3& CLO4

	Property Rights), TRIMS (Trade Related Investment Measures) and GATS (General Agreement on Trades in Services). Patents, Technology Development/Transfer Commercialization Related Aspects, Ethics.	
III 15 hours	**Computer Applications and Biostatistics:** Introduction to spreadsheet, presentation tools. Reference Management software. Role of Cloud computing and HPC in life science research. Introduction to Big data in biology and big data analytics. Data types and sources – variables and types. Descriptive statistics of categorical data and continuous data. Estimation of parameters – hypothesis testing: tests of significance, type I and II errors, z test, t test, analysis of variance (ANOVA), chi-square goodness-of-fit test. Regression and correlation. Statistical packages and their applications.	CLO 5& CLO 6
IV 15 hours	**Bioinformatics:** Biological data: sequence, structure, gene expression, pathways and molecular interactions. Primary Sequence and structure databases. GEO, KEGG Database. Introduction to Next generation Sequencing. Proteomics: Resources & repositories. Sequence analysis: Pair-wise sequence comparison, database searching methods- BLAST, FASTA, PHI-BLAST and Multiple sequence alignment. Molecular phylogeny-building phylogenetic trees. Introduction to Protein structure, Structure comparison and visualization, Structure based protein classification: CATH and SCOP. Introduction to structure-based drug designing. Structural genomics initiatives. Deep Learning in protein structure prediction and Biomedical Image analysis.	CLO 7& CLO 8

Suggested Reading:

1. Gupta, S. (2010). *Research Methodology and Statistical Techniques*. Deep & Deep Publications (P) Limited, New Delhi.
2. Kothari, C.R., Garg, G. (2019). *Research Methodology: Methods and Techniques.*4th Edition, New Age International (p) Limited. New Delhi.
3. Sahay, Vinaya and Pradumna Singh (2009). *Encyclopedia of Research Methodology in Life Sciences.*Anmol Publications. New Delhi.
4. Kauda J. (2012). Research Methodology: A Project Guide for University Students. Samfunds literature Publications.
5. Dharmapalan B. (2012). *Scientific Research Methodology*.Narosa Publishing
6. Norman, G. and Streiner, D. (2014). *Biostatistics:* The Bare Essentials. 4th Edition, PMPH-USA Limited.
7. Rao, P. P., S. Sundar and Richard, J. (2009). *Introduction to Biostatistics and Research Methods.*PHI learning.
8. Christensen, L. (2007). *Experimental Methodology*. Boston: Allyn & Bacon.
9. Fleming, D. O. and Hunt, D.L. (2006). *Biological Safety: Principles and Practices*. American Society for Microbiology, USA.
10. Rockman, H. B. (2004). Intellectual Property Law for Engineers and Scientists.Wiley-IEEE Press, USA.

11. Shannon, T. A. (2009). *An Introduction to Bioethics*. Paulist Press, USA.
12. Vaughn, L. (2012). *Bioethics: Principles, Issues, and Cases.* 2nd Edition, Oxford University Press, UK
13. Lesk, A.M. (2019). Introduction to Bioinformatics.5th Edition, Oxford University Press, UK.
14. Ramsden, J. (2021). Bioinformatics: An Introduction (Series: Computational Biology). 4th Edition, Springer International Publishing.
15. Mount. D.W. (2004) Bioinformatics: Sequence and Genome Analysis. 2nd Ed., CSHL Press, New York.
16.Branden, C. and J. Tooze, (1999) Introduction to Protein Structure, 2nd Ed., Garland Science, USA.

Course Code: MMIC.702
Course Title: Trends in Microbiology

Total Hours: 60

Course Learning Outcomes:
The students will be able to:
CLO 1: Outline the concept of epidemiology and various cellular processes during disease development.
CLO 2: Comprehend the clinical diagnostics and treatment of the different diseases caused by microbes.
CLO 3: Describe virulence determinants – colonization, toxins, enzymes and invasiveness with varied examples from different pathogens.
CLO 4: Categorise 1-IV secretion systems, importance of biofilms and quorum sensing
CLO 5: Propose the concepts of antimicrobial, multidrug efflux pumps, extended spectrum β-lactamases, X-MDR, Mycobacterial tuberculosis, methicillin-resistant *S.aureus* (MRSA)
CLO 6: Categorise different kinds of environmental pollutants and xenobiotics and comprehend various bioremediation approaches towards their treatment.
CLO 7: Develop an understanding of different plant pathogens and resistance mechanisms employed by plants.

Course Content

L	P	Credits
4	0	4

Unit/ Hours	Content	Mapping with CLO
Unit-I 16 hours	**Advanced Approaches in Host-pathogen interactions:** Molecular basis of immune memory, Cancer immunology and immunotherapy, Antiviral immunity (SARS-CoV-2), Immune response during pregnancy, Transplantation immunology, Vaccines. Genomics, bioinformatics, proteomics and systems biology approaches to study host pathogen interactions. Recent advances in the development of antibiotics and vaccines. Microbial metabolites, Human Microbiome and their role in therapeutics. Host directed therapies. Screening and development approaches for new microbial products, High-content screening methods, antimicrobial *in-vitro* and *in-vivo* screening assays and metagenomics.	CLO1 CLO2 CLO3 CLO4
Unit-II 15 hours	**Pathogenesis of Selected Organisms:** Prevalence, Incidence, epidemic, endemic, pandemic, chronic, acute, DALY, YLL, HALE, Mortality, Morbidity of Spirochetes such as *Treponema pallidum*, *Borrelia burgdorferi*, *Borrelia hermsii*. Intracellular pathogens. Gram negative bacteria: *Salmonella* and *Helicobacter pylori*. Gram-positive bacteria: *Staphylococcus aureus*, L*isteria monocyctis*. Myxobacteria: *Mycobacterium tuberculosis*. Swine/Avian virus, MERS-CoV, Ebola, Flaviviruses and SARS-CoV-2. Microbial colonization and adherence strategies, Microbial invasion strategies, Protein and DNA secreting systems and Pathogenicity Island. Antigenic variation, Biofilms and quorum sensing, modulation of apoptotic processes and microbial toxins. Molecular approaches in clinical microbiology. Disease outbreaks, integrated disease surveillance program by National Centre for disease control. Diverse approaches for tackling outbreaks. WHO Emergencies preparedness and response mechanisms.	CLO 6

Unit-III 17 hours	**Applied Microbiology:** Major Foodborne diseases, Biological, chemical, and physical hazards of food, Microbiological testing of food, Hazard analysis and critical control points (HACCP), Food legislation and standards, ISO 22000, Food and Drug Administration (FDA), Food Safety and Standards Authority of India (FSSAI), genetically modified foods. Probiotic *strains - Lactic acid bacteria (LAB): Lactobacillus, Leuconostoc, Pediococcus*, *Lactococcus* and *Streptococcus - Bifidobacteria - Saccharomyces - Escherichia coli - Bacillus - Enterococcus* - Commercial probiotic strains - Genetically modified probiotics (GMP) Probiotic recipes: Fermented and unfermented milk - Yogurt - Cheese - Sauerkraut - Garlic - Miso - Tempeh - Soy beverages. Microbial processing and product recovery); Fermentation process and recovery; Production of Malt beverages, Citric Acid, Lactic acid-fermentation. Microbes in Sustainable farming (Biofertilizer, Biopesticides, Bioinsecticides, Bioherbicides).	CLO 5 CLO6
Unit-IV 12 hours	**Techniques in Microbiology:** **Techniques in Molecular Biology:** Cloning and overexpression of recombinant proteins, Protein extraction and purification by different techniques, Protein precipitation, Analysis of protein-DNA and protein-protein interactions: Electrophoretic mobility shift assay (EMSA), DNA-RNA isolations methods, DNA footprinting by DNase I, Yeast two hybrids, system, Co-immunoprecipitations, pull-downs assay. Plasmids, Agarose gel electrophoresis, ethidium bromide staining. Blotting techniques: Southern, Northern, Western Blotting. Ultracentrifugation, Polymerase Chain Reaction (PCR) and Reverse Transcriptase PCR, Real time PCR. Proteomics, Genomics and Next- Generation Sequencing (NGS) for the diagnosis and monitoring of infectious diseases. Application of multi-omics in health and diseases, High-Throughput Sequencing (HTS): 16S/18S/ITS Amplicon Sequencing and Shotgun Metagenomics. Identification techniques for infectious diseases, Advanced microbial identification techniques (MALDI-TOF-MS, Vitek etc).	CLO 2 and CLO3

Suggested Reading:

Michael F. Cole, (2019) Unifying Microbial Mechanisms: shared Strategies of Pathogenesis by Garland Science,USA

Michael Madigan,KellyBender,Daniel Buckley, W. Sattley , David Stahl (2018) Brock Biology of Microorganisms, 15th Global Edition Pearson Education, USA

Denise G. Anderson, Sarah Salm, Deborah Allen (2015) Nester's Microbiology: A Human Perspective 8th edition McGraw-Hill Education, USA

Reba Kanungo (Editor) (2020) Ananthanarayan and Paniker's Textbook of Microbiology, Eleventh Edition Universities Press (India) Pvt. Ltd.

Tortora, G.J., Funke, B.R. and Case, C.L. (2016). *Microbiology: An Introduction. 12th Edition*

Pearson Education, USA.

Abbas, A., Lichtman, A., Pillai S. (2022). *Cellular and Molecular immunology*. Elsevier

Murphy, K., Weaver, C. (2016) *Janeway'sImmunobiology*. Garland science.
Pelczar, M. J., Chan, E.C.S. and Krieg, N.R. (2020). *Microbiology: Concepts and Applications*. McGraw-Hill Inc. USA.
Joanne Willey, Kathleen Sandman and Dorothy Wood (2019) *Prescott's Microbiology.* 11th Edition, McGraw-Hill Science, USA.
Tortora, G.J., Funke, B.R. and Case, C.L. (2016). *Microbiology: An Introduction.* Benjamin Cummings, USA.
Hal Kin (2015) Food Safety Management: Implementing a Food Safety Program in a Food Retail Business, Springer
Charalampopoulos, Dimitris, Rastall and Robert (2009). Prebiotics and Probiotics Science and Technology, Springer Publication.
Christon J. Hurst (2001). *A Manual of Environmental Microbiology*. 2nd Edition. ASM Publications.
Ian Pepper, Charles Gerba, Terry Gentry (2014) *Environmental Microbiology* 3rd Edition; Academic Press.
Research papers and reviews published in international journals from American Society of Microbiology press; Cell Host and Microbe, Cellular Microbiology, Immunity, Molecular Microbiology, Nature Reviews Microbiology, FEMS Microbiology Reviews, Trends in Microbiology, Microbiome etc.

L	P	Credit
2	0	2

Course Title: Research and Publication Ethics
Course Code: MMIC.751
Total Hours: 30
Course Learning Outcomes: Students will be able to:
CLO1: Familiarize with the ethics of research.
CLO2: Illustrate the good practices to be followed in research and publication.
CLO3: Judge the misconduct, fraud and plagiarism in research.
CLO4: Utilize various online resources and software to analyze their research output.
Course Content

Unit/ Hours	Content	Mapping with CLO
I 3 hours	Philosophy and Ethics Introduction to Philosophy: definition, nature and scope, content, branches Ethics: definition, moral philosophy, nature of moral judgements and reactions	CLO1
II 5 hours	Scientific Conduct Ethics with respect to science and research Intellectual honesty and research integrity Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP), Redundant publications: duplicate and overlapping publications, salami slicing, Selective reporting and misrepresentation of data	CLO1 & CLO2
III 7 hours	Publication Ethics Publication ethics: definition, introduction and importance Best practices/ standards setting initiatives and guidelines: COPE, WAME, etc. Conflicts of interest, Publication misconduct: definition, concept, problems that lead to unethical behaviour and vice versa, types Violation of publication ethics, authorship and contributor ship Identification of publication misconduct, complaints and appeals Predatory publishers and journals	CLO2 & CLO3
IV 4 hours	Open Access publishing Open access publications and initiatives SHERPA/RoMEO online resource to check publisher copyright & self-archiving policies Software tool to identify predatory publication developed by SPPU Journal finder/journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer, Journal Suggester etc.	CLO2
V 4 hours	Publication Misconduct Group Discussions: Subject-specific ethical issues, FFP, authorship; conflicts of interest; complaints and appeals: examples and fraud from India and abroad Software tools: Use of plagiarism software like Turnitin, Urkund and other open-source software tools	CLO2 & CLO3
VI 7 hours	Databases and Research Metrics Databases: Indexing databases; Citation database: Web of Science, Scopus etc. Research Metrics: Impact Factor of journal as per Journal Citation Report, SNIP, SJR, IPP, Cite Score; Metrics: h-index, g-index, i10 index, Almetrics	CLO4

L	P	Credit
0	2	1

Course Title: Teaching Assistantship
Course Code: MMIC.752
Total Hours: 30
Course Learning Outcomes:
At the end of this skill development course, the scholars shall be able to
CLO1: familiarize themselves with the pedagogical practices of effective classroom delivery and knowledge evaluation system
CLO2: manage large and small classes using appropriate pedagogical techniques for different types of content

Activities and Evaluation:
The scholars shall attend Master degree classes of his/her supervisor to observe the various transaction modes that the supervisor follows in the classroom delivery or transaction process one period per week.
The scholars shall be assigned one period per week under the direct supervision of his/her supervisor to teach the Master degree students adopting appropriate teaching strategy(s).
The scholars shall be involved in examination and evaluation system of the Master degree students such as preparation of questions, conduct of examination and preparation of results under the direction of the supervisor.
At the end of the semester, the supervisor shall conduct an examination of teaching skills learned by the scholar as per the following evaluation criteria:
The scholars shall be given a topic relevant to the Master degree course of the current semester as his/her specialization to prepare lessons and deliver in the classroom before the master degree students for one hour (45 minutes teaching + 15 minutes interaction). The scholars shall be evaluated for a total of 50 marks comprising *content knowledge* (10 marks), *explanation and demonstration skills* (10 marks), *communication skills* (10 marks), *teaching techniques employed* (10 marks), and classroom interactions (10).

L	T	P	Credit
1	0	0	1

Course Title: Curriculum, Pedagogy and Evaluation
Course Code: UNI.753

Total Hours: 15
Course Learning outcomes:
After completion of the course, scholars shall be able to:
CLO1: analyze the principles and bases of curriculum design and development
CLO2: examine the processes involved in curriculum development
CLO3: develop the skills of adopting innovative pedagogies and conducting students' assessment
CLO4: develop curriculum of a specific course/programme

Unit/ Hours	Content	Mapping with CLO
I 4 hours	Bases and Principles of Curriculum 1. Curriculum: Concept and Principles of curriculum development, Foundations of Curriculum Development. 2. Types of Curriculum Designs- Subject centered, learner centered, experience centered and core curriculum. Designing local, national, regional and global specific curriculum. Choice Based Credit System and its implementation.	CLO1
II 4 hours	Curriculum Development 1. Process of Curriculum Development: Formulation of graduate attributes, course/learning outcomes, content selection, organization of content and learning experiences, transaction process. 2. Comparison among Interdisciplinary, multidisciplinary and trans-disciplinary approaches to curriculum.	CLO2
III 3 hours	Curriculum and Pedagogy 1. Conceptual understanding of Pedagogy. 2. Pedagogies: Peeragogy, Cybergogy and Heutagogy with special emphasis on Blended learning, Flipped learning, Dialogue, cooperative and collaborative learning. 3. Three e- techniques: Moodle, Edmodo, Google classroom.	CLO3
IV 4 hours	Learners' Assessment 1. Assessment Preparation: Concept, purpose, and principles of preparing objective and subjective questions. 2. Conducting Assessment: Modes of conducting assessment – offline and online; use of ICT in conducting assessments. 3. Evaluation: Formative and Summative assessments, Outcome based assessment, and scoring criteria. Activity: Develop curriculum for a course/programme related to the research scholar's discipline.	CLO3 &CLO4

Transaction Mode
Lecture, dialogue, peer group discussion, workshop
Evaluation criteria
There shall be an end-term evaluation of the course for 50 marks for duration of 2 hours. The course coordinator shall conduct the evaluation.

Suggested Readings
Allyn, B., Beane, J. A., Conrad, E. P., & Samuel J. A., (1986). *Curriculum Planning and Development*. Boston: Allyn & Bacon.
Brady, L. (1995). *Curriculum Development*. Prentice Hall: Delhi. National Council of Educational Research and Training.
Deng, Z. (2007). Knowing the subject matter of science curriculum, *Journal of Curriculum Studies*, 39(5), 503-535.https://doi.org/10.1080/00220270701305362
Gronlund, N. E. & Linn, R. L. (2003). *Measurement and Assessment in teaching*. Singapore: Pearson Education

McNeil, J. D. (1990). *Curriculum: A Comprehensive Introduction*, London: Scott, Foreman/Little
Nehru, R. S. S. (2015). *Principles of Curriculum*. New Delhi: APH Publishing Corporation.
Oliva, P. F. (2001). *Developing the curriculum* (Fifth Ed.). New York, NY: Longman
Stein, J. and Graham, C. (2014). *Essentials for Blended Learning: A Standards-Based Guide*. New York, NY: Routledge.

Web Resources
https://www.westernsydney.edu.au/__data/assets/pdf_file/0004/467095/Fundamentals_of_Blended_Learning.pdf
https://www.uhd.edu/academics/university-college/centers-offices/teaching-learning-excellence/Pages/Principles-of-a-Flipped-Classroom.aspx
http://leerwegdialoog.nl/wp-content/uploads/2018/06/180621-Article-The-Basic-Principles-of-Dialogue-by-Renate-van-der-Veen-and-Olga-Plokhooij.pdf