

Central University of Punjab



Ph.D. Program in Biochemistry

Batch - 2026

Department of Biochemistry

Graduate Attributes

Students graduating from the program will contribute to the teaching and research needs in biochemistry and life sciences in academia, industry and research institutions at local, regional, national and international levels. They will be part of the scientific workforce that will transform health and agriculture sectors employing higher order thinking skills and capabilities.

Ph.D. Program in Biochemistry Course Structure of the Program

Course Code	Course Title	L	P	Cr
BCH.701	Research Methodology and Computer Applications	4	-	4
BCH.702	Trends in Biochemistry	4	-	4
BCH.751	Research and Publication Ethics	2	-	2
BCH.752	Teaching Assistantship	0	2	1
UNI.753	Curriculum, Pedagogy and Evaluation	1	0	1
	Total Credits			12

L: Lectures; P: Practical; Cr: Credits

L	T	P	Credits
4	0	0	4

Course Code: BCH.701

Course Title: Research Methodology and Computer Applications

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 goodness of 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.

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.	CLO 1 & CLO 2
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 Property Rights), TRIMS (Trade Related Investment Measures) and GATS (General Agreement on Trades in Services). Patents, Technology Development/Transfer Commercialization Related Aspects, Ethics.	CLO3 & CLO4
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: Sequence, structure, gene expression, pathway databases. Introduction to Next generation Sequencing. Pair-wise, local and global sequence analysis, BLAST, PHI-BLAST and Multiple sequence alignment. Molecular phylogeny - building phylogenetic trees. Applications of Artificial Intelligence and Machine Learning in genomics, transcriptomics, proteomics and Biomedical Image analysis. Introduction to Protein structure, Structure comparison and visualization, Structure classification of protein: CATH and SCOP. Introduction to molecular modeling and structure-based drug designing. AI-driven approaches for protein structure prediction, biomolecular interaction prediction, functional annotation, and precision medicine.	CLO 7 & CLO 8
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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: BCH.702
Course Title: Trends in Biochemistry

L	T	P	Credits
4	-	-	4

Learning Outcomes

Students will be able to:

CLO-1 Understand and explain the biochemical and molecular mechanisms underlying beneficial plant-microbe interactions, and their applications in rhizoremediation, stress tolerance, and crop productivity.

CLO-2 Apply advanced methodologies of metabolomics, transcriptomics, and bioinformatics to investigate plant responses to environmental stressors and analyze gene expression data and metabolite profiling.

CLO-3 Investigate molecular and cellular hallmarks of cancer, including signaling pathways, tumor microenvironment, metastasis, and drug resistance

CLO-4 Investigate cancer biology and the role of non-coding RNAs, and utilize experimental and computational tools to study their function and therapeutic potential.

CLO-5 Analyze vascular biology and thrombotic mechanisms and assess nanobiomaterials-based therapeutic and diagnostic platforms for cardiovascular diseases.

CLO-6 Interpret immune responses in health and disease, and apply immunological techniques in biomedical research.

CLO-7 Interpret mechanisms of microbial growth and drug resistance, and understand fungal pathogenesis and host immune evasion strategies relevant to human health.

CLO-8 Critically assess drug resistance, microbial pathogenesis, and emerging biotechnological applications with an emphasis on translational research and ethical practices.

Unit/ Hours	Contents	Mapping with CLO
I 15 Hours	Plant Biochemistry Plant-microbe interactions: rhizoremediation, crop productivity, abiotic stress tolerance, Molecular mechanisms of plant-microbe signaling, Rhizosphere biology: microplastics, heavy metals, fluoride, metagenomics, Metabolomics & transcriptomics: metabolite profiling, RNA-seq, gene regulatory networks, Functional genomics and bioinformatics analysis	CLO1, CLO2

II 15 Hours	Cancer Biology & Non-coding RNAs Molecular cancer biology: carcinogenesis, signaling pathways, tumor microenvironment, Metastasis, angiogenesis, drug resistance, cancer stem cells, Non-coding RNAs: classification, biogenesis, functional roles, ncRNAs in diagnostics, therapeutics, and liquid biopsy, Experimental techniques: cell culture, transfection, assays (MTT, ROS, luciferase), Emerging oncology approaches: precision medicine, High-Throughput Screening (HTS), Nanotechnology and "Smart" Drug Delivery	CLO3, CLO4
III 15 Hours	Vascular Biology, Thrombosis & Cardiovascular Therapeutics Vascular biology: endothelial function, NO signaling, inflammation, Thrombosis: coagulation cascade, platelet activation, biomarkers, Immunovascular interactions: cytokines (TNF-α, IL-6), leukocyte-endothelium interactions, Cardiovascular diseases: atherosclerosis, ischemia, hypertension, stroke, Nanomedicine & theranostics: targeted delivery, smart materials, Experimental techniques: platelet assays, ELISA, nanoparticle synthesis, electrochemical POCD	CLO5, CLO6
IV 15 Hours	Immunology & Microbial/Fungal Drug Resistance Immune system: innate vs adaptive immunity, tolerance, autoimmunity, Immune responses in diseases: infections, immunodeficiency, tumor immunology, Immunological techniques: ELISA, flow cytometry, hybridoma, immunoblotting, Microbial growth & drug resistance analysis (MIC, CFU), fungal genome databases, Host-pathogen interactions & immune evasion, drug-drug interactions, Omics technology, CRISPR/Cas9	CLO7, CLO8

Suggested readings-

- Lugtenberg, B., & Kamilova, F. (2009). Plant-Growth-Promoting Rhizobacteria. *Annual Review of Microbiology*, 63, 541–556.
- Conesa, A., et al. (2016). A survey of best practices for RNA-seq data analysis. *Genome Biology*.
- Lämmerhofer, M., & Weckwerth, W. (Eds.) (2013). *Metabolomics in Practice: Successful Strategies to Generate and Analyze Metabolic Data*. Wiley-VCH.
- Weinberg, R. A. (2013). *The Biology of Cancer* (2nd ed.). Garland Science.
- Kohn, K. (2024/2025) *Drugs Against Cancer: Stories of Discovery and the Quest for a Cure*. NIH/National Cancer Institute
- Gouru, Guna. (2025) *Precision oncology: Computational methods for multi-omics data integration to improve drug response prediction*. Cambridge prisms.
- Weinberg, R. A. (2023). *The Biology of Cancer* (3rd ed.). W.W. Norton & Company.
- Esteller, M. (2011). Non-coding RNAs in human disease. *Nature Reviews Genetics*, 12, 861–874.
- Márton É, Varga A, Domoszlai D, et al. (2025) Non-Coding RNAs in Cancer: Structure, Function, and Clinical Application. *Cancers (Basel)*, 17(4):579.
- Chhabra, R. (2021). The journey of noncoding RNA from bench to clinic. In *Translational Biotechnology* (pp. 165–201).
- Freshney, R. I. (2021). *Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications* (8th ed.). Wiley-Blackwell.
- Margarethe Geiger (Ed.) (2024), *Fundamentals of Vascular Biology*, Publisher: Springer Cham, ISBN: 978-3-031-64591-4
- Michelson, A. D. (2019). *Platelets* (4th ed.). Academic Press.
- Jackson, S. P. (2022). Arterial thrombosis—insights into platelet activation and thrombus formation. *Nature Reviews Cardiology*, 19(6), 351–368. <https://doi.org/10.1038/s41569-021-00635-8>
- Abbas, A. K., Lichtman, A. H., & Pillai, S. (2022). *Basic Immunology: Functions and Disorders of the Immune System* (6th ed.). Elsevier.
- Delves, P. J., Martin, S. J., Burton, D. R., & Roitt, I. M. (2021). *Roitt's Essential Immunology* (14th ed.). Wiley-Blackwell.
- Goffeau, A., & Wong, G. (2002). Functional genomics of yeast: from genes to networks. *Nature Reviews Genetics*, 3, 829–839.
- Pacesa, M., Pelea, O., & Jinek, M. (2024). Past, present, and future of CRISPR genome editing technologies. *Cell*, 187(5), 1076-1100.
- Kumari, N., Maharaj, S., Chattopadhyay, R., Singh, S. K., & Bari, V. K. (2025). Molecular Insights Into the Interplay Between Host Platelets and Fungal Pathogens. *Current Clinical Microbiology Reports*, 12(1), 1-21.
- Published articles from Labs.

BCH.751: Research and Publication Ethics

L	T	P	Credits
2	0	0	2

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.

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
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Course Title: Teaching Assistantship

Course Code: BCH.752

L	T	P	Credit
0	0	2	1

Learning Outcomes: Total Hours: 30

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 the 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).

Course Title: Curriculum, Pedagogy and Evaluation

Course Code: UNI.753

Total Hours: 18

L	T	P	Credit
1	0	0	1

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. <i>Activity: Develop curriculum for a course/programme related to the research scholar's discipline.</i>	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.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>