

Mahayogi Gorakhnath University, Gorakhpur

Health and Life Sciences

Department of Microbiology



Ph.D. Course Work
In
Microbiology
2025-26

Shailendra

Name of the Program: PRE PhD-COURSE in Microbiology

Program Objectives:

- Enhancing and imparting skills and knowledge in advance research methodologies of Microbiology.
- Solving the existing scientific problems in area of basic and applied Microbiology.
- Creating a highly skilled professionals with expertise in current trends of research in area of Microbiology.
- Imparting hand on experience to students of different techniques and instrumentations of advance Microbiology, Molecular biology and Immunology.
- Generating independent researchers who are capable of translating the research developed at laboratory scale to translational scale.
- Imparting skills needed to become a successful academician, scientists or inculcating the scientific ethics, temperament to contribute—entrepreneur to field of science and help in nation building.

Program Specific outcomes (PSO)

The students who successfully complete the course will have following skills:

- Solid basic knowledge of research methodologies in area of modern biological sciences specifically applied Microbiology.
- Contributing new methodologies and results in area of the basic and advanced Microbiology for taking the research to next level.
- Innovative Scientific skilled workforce to work in specialized area of Microbiology.
- Independent researchers who can contribute through fulfilling responsibilities of academicians, scientist and entrepreneur.
- Develop as a researcher at different research institute at national and international level where they can initiate their independent research.
- Develop skill so that they can be absorbed by R&D, academic or industrial sector of different Microbiology-based company/university/institute.

Shailendra

Ph. D. Microbiology
Course Work

I Year: I Semester										
S No	Course Code	Course	L	T	P	Evaluation Scheme		Total	Credits	Course Type
						CIE	ESE			
Theory										
1	PBT 701	Research Methodology	4	0	0	30	70	100	4	Core
2	PBT 703	Research and Publication Ethics	2	0	0	30	70	100	2	Core
3		Discipline-Specific Elective	3	0	0	30	70	100	3	Departmental Elective
4		Open Elective Multi Discipline	3	0	0	30	70	100	3	Open Elective
5		Literature Review project	2	0	0			100	2	LRP
TOTAL			14	0	0	150	350	500	14	

Departmental Elective Course (Choose any one)

Course Nature	Course Code	Courses
Discipline-Specific Courses	PMM 704	Tools and Techniques in Microbiology
	PMM 705	Immunology and Medical Microbiology
	PMM 706	Environmental and Applied Microbiology
	PMM 707	Microbial Bio-Synthesis and Molecular Biology

Open Elective Course (Choose any one)

Course Nature	Course Code	Courses
Open Elective	PMM 708	Microbial Metabolism
	Code: PMB722	Human Metabolic Disorders

Shailendra

Multi Discipline	Code: PBT722	Omics Technology (Open Elective)
	PHT 707	Modern Pharmaceutical Analytical Techniques
	PAY 711	Ayurveda Perspectives of Research Methodology

Shailendra

Research Methodology

Code: PBT 701

L	T	P	C
4	0	0	4

Course objectives (CO)

1. To introduce the research methodology and nature of problem to be studied and identifying the related area of knowledge.
2. To analyzing the data appropriate to the problem.
3. To reviewing literature to understand how others have approached or deal with the problem.
4. To know the idea of paper and Scientific/ thesis writing.
5. To introduce the funding agencies, databases and research metrics

Unit I Introduction of Research Methodology and Design

Meaning, objective, types and significance of research, problems encountered by researchers in India, Need and Features of Good Research Design, Types of Research Designs, Basic Principles of Experimental Designs, Design of experiments, and Synopsis design for research topic.

Unit II Quantitative Methods

Tools parametric and non-parametric statistics. Probability, chi square test, t-test, Confidence interval, Errors. Level of significance, Regression and Correlation coefficient, Analysis of variance for one way and two-way classifications, Multiple Comparisons- Least Significant Difference Test, Duncan's new Multiple Range Test, Factorial Analysis, Analysis of Covariance, Use of SPSS.

Unit III Research Problem, Editing, Data Collection and Validation

Definition, necessity and techniques of defining research problem, Formulation of research problem, Objectives of research problem. Primary and secondary data, Methods of collecting primary and secondary data, Importance and methods of editing and data validation.

Unit IV Scientific Writing and Report Generation

Basic concepts of paper and their writing, literature search, review of literature and peer review, Concepts of Bibliography and References, types of citation, graphical abstracts, significance of report writing, steps of report writing, Research proposal and Types of Research reports and Methods of presentation of report.

Unit V: Funding Agencies, Databases and Research Metrics

Funding agencies ICMR, CSIR, DBT-BIRAC, UGC, DST, SERB, ICAR etc. Indexing databases, Citation dataset, web of science, scopus etc. Impact factors of Journal as per citation report, Research Metrics- SNIP, SJR, IPP etc. Metrics: h-index, g-index, i10 index and altmetrics.

Suggested Readings

1. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.

Shailendra

2. Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International. 418p.
3. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, EssEss Publications. 2 volumes.
4. Trochim, W.M.K., 2005. Research Methods: the concise knowledge base, Atomic Dog Publishing. 270p.
5. Wadehra, B.L. 2000. Law relating to patents, trademarks, copyright designs and geographical indications. Universal Law Publishing.
6. Anthony, M., Graziano, A.M. and Raulin, M.L., 2009. Research Methods: A Process of Inquiry, Allyn and Bacon.
7. Carlos, C.M., 2000. Intellectual property rights, the WTO and developing countries: the TRIPS agreement and policy options. Zed Books, New York.
8. Coley, S.M. and Scheinberg, C. A., 1990, "Proposal Writing", Sage Publications.
9. Day, R.A., 1992. How to Write and Publish a Scientific Paper, Cambridge University Press.
10. Fink, A., 2009. Conducting Research Literature Reviews: From the Internet to Paper. Sage Publications
11. Leedy, P.D. and Ormrod, J.E., 2004 Practical Research: Planning and Design, Prentice Hall.
12. Satarkar, S.V., 2000. Intellectual property rights and copy right. Esses Publications.

Course Learning Outcomes (CLO):

On completion of this course, the students will be able to:

1. Understand the limitations of particular research methods.
2. Develop skills in qualitative and quantitative data analysis and presentation.
3. Develop advanced critical scientific thinking skills.
4. Describe the idea of paper and scientific/ thesis writing.

Shailendra

Research and Publication Ethics

Code: PBT 703

L	T	P	C
2	0	0	2

Course Objectives (CO)

1. To describe philosophy, ethics and scientific conduct.
2. To explain the publication ethics and publication misconduct.
3. To understand open access publication, databases and research metrics

Unit-I Philosophy, Ethics and Scientific Conduct

Introduction to philosophy: definition, nature and scope, concept, branches; Ethics: definition, moral philosophy, nature of moral judgements and reactions, 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, and falsification of images.

Unit-II Publication Ethics

Definition, introduction and importance of publication ethics, best practices/standards setting initiatives and guidelines: COPE, WAME, etc., Conflicts of interest, Publication misconduct: definition, concept, problems that lead to unethical behavior and vice versa, types, Violation of publication ethics, authorship and contributor ship, Identification of publication misconduct, complaints and appeals, Predatory publishers and journals.

Unit-III Open Access Publishing

Open access publications and initiatives, SHERPA/RoMEO online resource to check publisher copyright and self-archiving policies, Software tool to identify predatory publications developed by SPPU, Journal finder/journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggester, etc.

Unit-IV Publication Misconduct

Group discussions on -Subject specific ethical issues, FFP, authorship, Conflicts of interest, Complaints and appeals: examples and fraud from India and abroad, Using Software tools - Anti-plagiarism tools like Turnitin, Urkund and other opensource software tools.

Unit-V Databases and Research Metrics

Databases - Indexing databases, Citation databases: Web of Science, Scopus etc., Research Metrics - Impact factor of journal as per Journal Citation Report, SNIP, SJR, IPP, Cite Score, h-index, g index, i10 index, altmetrics, Citation of bibliography using Mendeley.

Suggested Reading:

Shailendra

1. Research & publication ethics by Wakil kumar Yadav, Jitendranath Gorai, Ms Seema Shukla, Yogendra Kumar, Dr Dinesh Sriwash, Dr Dev Brat Mishra, Dev Kamlesh Paswan, NOTION PRESS, India, Singapore-Malesia, ISBN-13:9781685546717.
2. Research & Publication Ethics, A Complete Guide To Conducting & Publishing Research Ethically, by enago academy.
3. Research and Publication Ethics: A Textbook, March 2022, Edition: First edition, Publisher: Concept Publishing Company Pvt. Ltd., New Delhi, ISBN: 978-93-5439-084-5
4. Elsevier | Ethics in Research & Publication, ethics.elsevier.com.

Course learning outcome (CLO):

Upon completion of the course students will be able to:

1. Describe philosophy, ethics and scientific conduct.
2. Explain the publication ethics and publication misconduct.
3. Understand open access publication, databases and research metrics

Shailendra

Tools and Techniques in Microbiology
(Discipline-Specific Elective)
Code: PMM 704

Course Objectives (CO)

L	T	P	C
3	0	0	3

1. To study about techniques used in microbial research.
2. To learn basics of statistics for qualitative and quantitative analysis and deduce inferences from the observed biological data.
3. To get knowledge about the omics studies and data analysis.
4. To learn about the fermentation technology.

Unit – I: Instrumentation

Microscopy: Principles and applications of phase contrast, differential image control, fluorescence, confocal, scanning and transmission electron microscopes. Spectrophotometry: Principles and applications of UV-Visible, atomic absorption and fluorescence spectrophotometers, inductively coupled plasma emission spectrometer. Chromatography: principle, types and applications, TLC, Gas chromatography, HPLC, FPLC, ion exchange chromatography.

Unit – II: Microbial culturing and characterization

Microbial culturing and preservation, molecular characterization of microorganisms. Bioprospecting of microbes for industrial applications. Identification and characterization of DNA, RNA, plasmids. Agarose gel electrophoresis, ethidium bromide staining. Southern, Northern, Western Blotting, RAPD, RFLP, DGGE, TGGE, PCR. Basic Principle of electrophoresis, Gel electrophoresis, PAGE, SDS PAGE, Agarose gel electrophoresis.

Unit – III: Omics studies and data analysis

Types of Omics data, Principles of Omics studies, Concepts of genomics and transcriptomics; techniques for genomic and transcriptomic data acquisition, Next Generation Sequencing analysis and RNA-Seq bioinformatics workflows, ChIP-seq. Concepts and techniques to study proteomics and metabolomics, their workflows and data analysis.

Unit: IV Fermentation technology

Components of a fermentation process, Kinetics of microbial growth and product formation, Types of bioreactors and their designs. Scale-up of bioprocesses. The recovery and purification of fermentation products. Immobilization of cells and enzymes for industrial applications. Industrial effluent treatment.

Unit: V: Biostatistics and Computer Application

Frequency distribution, mean, mode and median. Standard, normal, binomial and Poisson's distribution, Sampling methods and standard errors. Correlation and regression: Partial and multiple, tests of significance; t, F, chi-square, Duncan's multiple range tests. Design of experiments: Principles of

Shailendra

Randomized block design, completely randomized block design, Latin square design, Split-plot designs. Probit analysis.

Recommended Books

1. Text Book of Microbiology, Pelczar MJ, Chan, ECS & Kreig N.R, Mc Graw- Hill, New York
2. Omics Approaches, Technologies and Applications, Preeti Arivaradarajan and Gauri Misra, Springer, 2018 Edition.
3. Rosner B (2010) Fundamentals of Biostatistics, 7th Edition, Brooks/Cole Cengage Learning Publication
4. Principles of Fermentation Technology (2nd Edition, 2013), P.F. Stanbury, W. Whitaker & S.J. Hall, Elsevier India Pvt. Ltd.

Course learning outcome (CLO)

At the end of the course the student will be able to:

1. Students will learn the techniques of microbial culturing, characterization, identification and preservation.
2. This course will describe the fundamentals of microbial fermentation and bioprocess technology.
3. The students will gain knowledge of basic instruments and techniques required for research in microbiology laboratory.
4. The students will understand the techniques and workflows of Omics.

Shailendra

Immunology and Medical Microbiology
(Discipline-Specific Elective)
Code: PMM 705

L	T	P	C
3	0	0	3

Course Objectives (CO)

1. To compare and contrast humoral versus cell-mediated immune responses.
2. To study different types of immunological disorder.
3. To get knowledge about immunodiagnostic procedures to study the immune response.

Unit – I: Receptors of the immune cells

Detailed structure of B and T cell (TcR) receptors, co-receptors and accessory molecules; Structure of CD4, CD8 receptors and, cellular adhesion molecules viz. ICAM, VCAM, MadCAM and selectins; Structure and distribution of major histocompatibility I and II antigens or molecules, integrins. Markers of suppressor / regulatory cells - CD4⁺ CD25⁺ Foxp3⁺ Treg; Markers of invariant natural killer T cells (iNKT).

Unit II: Genetic organization of the receptor genes

Organization of the genes for B and T cell receptors. Genetic organization of MHC-I and MHC-II complex (both HLA and H-2). Mechanisms responsible for generating diversity of antibody specificities and diversity of T cell receptor specificities.

Unit – III: Mechanisms of Immune response

Peptide loading and expression of MHC-I and MHC-II molecules; Detailed mechanisms of humoral and cell-mediated immune responses; Major cytokines and their role in immune mechanisms: TNF, IFN, IL-1, IL-2, IL-4, IL-6, IL-10, IL-12, IL-17, TGFβ.

Unit – IV: Paradigm shift in immunology

Pattern recognition and innate immunity, Pattern recognition receptors (PRRs) and Toll-like receptors (TLR); Cell signaling through NF-κB; Natural killer- Dendritic cells (NK-DC) interactions. CD-1 restricted T cells. Interaction between specific and innate immune responses.

Unit – V: Bacterial and viral infections leading to immunological disorders

Microbial role in development of autoimmune diseases, deficiencies / defects of T cells, and B cells; Mucosal immunology; Comparative analysis of type I-V hypersensitivities.

Unit VI: Applied immunology

Shailendra

Alloreactive T cells; Managing graft rejection and GVHD; Sequence based HLA-matching; Immunodiagnostics; CRISPR-Cas9 and transgenic animals for xenotransplantation; Immunotherapy of tumors in humans.

Recommended Books

Text Books

1. Pathology, Harsh Mohan, Edition Seventh
2. Immunology, David Male MA PhD, R. Stokes Peebles Jr. MD, Victoria Male.
3. Oxford Handbook of Clinical Immunology and Allergy Gavin Spickett.

Reference Books

1. Kuby Immunology. Thomas J. Kindt, Barbara A. Osborne, Richard Goldsby. W. H. Freeman
2. Fundamental Immunology 7th Edition by Paul, Wolters Kluwer | Lippincott Williams and Wilkins

Course Learning Outcomes (CLO)

At the end of the course, the student should be able to:

1. Compare and contrast the innate versus adaptive immune systems.
2. Compare and contrast humoral versus cell-mediated immune responses.
3. Describe the different types of immunological disorder.
4. Discuss about immunodiagnostic procedures to study the immune response.

Shailendra

Environmental and Applied Microbiology
(Discipline-Specific Elective)
Code: PMM 706

L	T	P	C
3	0	0	3

Course Objectives (CO)

1. To understand microbial ecology and microbial interaction in different ecosystems.
2. To understand the significance of soil microorganisms and their role in maintaining soil fertility and soil health.
3. To study impact of microorganisms on environment.
4. To get knowledge about role of microorganisms in industrial production and fermentation.

Unit – I: Microbial Ecology

Principles of microbial ecology, Microbiology of ecosystems -soil, rhizosphere, rhizoplane, endorhizoaphere, phyllosphere, water: fresh and marine, and air. Microbial interactions - symbiosis, synergism, commensalism, parasitism, amensalism, antagonism and predation, adaptation of microorganisms to various ecosystems. Important groups of prokaryotes; photosynthetic bacteria; chemoautotrophic bacteria, spore forming bacteria, actinomycetes, heterotrophic bacteria, nitrobacteria, nitrogen-fixing bacteria, cyanobacteria, lactic acid bacteria, halophiles, thermophiles, acidophiles and methanogens.

Unit – II: Soil Microbiology

Soil microorganisms: major groups, decomposition of organic matter, soil health. Root exudates (rhizodeposition) and rhizosphere effects. Exploration of rhizosphere microflora for plant productivity. Microbial biomass. Nitrogen cycle: ammonification, nitrification and denitrification. Biological nitrogen fixation-symbiotic, associative and a symbiotic. Biochemistry and genetics of nitrogen fixation. Microbial transformations of phosphorus, potassium, Sulphur and other minor nutrients. Role of biofertilizers in agriculture and forestry, plant growth promoting rhizobacteria and their mode of action; Mycorrhiza and their associations. Formation and composition of soil organic matter: ferulic acid, fulvic acid and humic acid.

Unit – III: Environmental Microbiology

Microbial assay of vitamins, enzymes and antibiotics, Pollution of soil, water and air, Role of microorganisms in pollution, bioremediation/amelioration; sources of pollution and their impact on environment, Phyto-remediation, microbiology of sewage and industrial effluents and their safe disposal, management of solid and liquid organic wastes, composting, biogas, water purification, sewage treatment, waterborne diseases and effluent management.

Unit – IV: Microbial Biotechnology

Industrial production of metabolites -organic acids, alcohols, antibiotics. Fermenter designs and types. Control of fermentation process -batch, fed batch and continuous. Downstream processing in

Shailendra

fermentation industry. Production of single cell proteins and probiotics, hormones, biofertilizers, biopesticides..

Unit – V Food Microbiology

Microbiology of raw and processed foods. Fermented food - vinegar, wine, sauerkraut, pickles, cheese, yogurt. Food preservation, contamination and spoilage, food-borne illness and intoxication. Food as substrate for micro-organism, microflora of meat, fish, egg, fruits, vegetables, juices, flour, canned foods; bio-degrading microbes, single cell protein for use as food and feed, bioactive food / probiotics.

Recommended Books

1. Prescott, Harley and Klein's Microbiology, Seventh Edition, McGraw Hill publications.
2. Brock Biology of Microorganisms, Michael T. Madigan, John M. Martinko, Kelly S. Bender, Daniel H. Buckley, David A. Stahl, 14th Edition, Pearson Publications.
3. Soil Microbiology (Fourth Edition of Soil Microorganisms and Plant Growth), N. S. Subbarao, Oxford and IBH Publishing Co. Pvt. Ltd.

Course Learning Outcomes (CLO)

At the end of the course, the student should be able to:

1. Describe about role of microorganisms in environment and fermentation industry.
2. Describe the different types of biological processes carried out by microorganisms in ecosystem.
3. Discuss about the importance of microorganisms in soil environment, waste treatment, industrial production and food processing.

Shailendra

Microbial Genetics and Molecular Biology
(Discipline-Specific Elective)
Code: PMM 707

L	T	P	C
3	0	0	3

Course Objectives (CO)

1. To study about prokaryotes, eukaryotes, archaeobacteria and viruses.
2. To understand the regulation process in microbial growth.
3. To understand the regulation of biosynthesis during stress conditions in bacteria.
4. To get knowledge about microbial genetics.

Unit – I Introduction to Microbial world

Origin and evolution of microbial life. Theory of spontaneous generation. Prokaryotes, archaeobacteria and eukaryotes. Structure and classification of viruses, bacteriophages/cyanophages/mycophages; growth of viruses, lytic and lysogenic cycles; plant viruses, viroids, prions and mycoplasma. Differentiation in bacteria, slime molds, yeasts.

Unit – II: Molecular Microbiology

Gene expression, Replication, Transcription and translation in prokaryotes; Regulation of gene expression; Operon model and other regulatory mechanisms. Molecular biology of bioluminescence, bacterial virulence, Heat shock response, Extracellular protein secretion in bacteria.

Unit – III Regulation of Gene Expression

Regulation of initiation, termination and anti-termination of transcription. Global regulation and differentiation by sigma factor. Regulatory controls in bacteria - inducible and biosynthetic pathways. Ribosomal RNA and protein regulation under stress condition. Specific regulatory systems; SOS regulatory control; Antisense RNA regulation of gene expression. Oxidative stress control.

Unit – IV Microbial Bio-Synthesis and Regulation

Biosynthesis of cell wall, protein, macromolecules (DNA/RNA) in microbes. Fermentative and respiratory regulatory pathways. Regulation of cell cycle- Lytic and lysogenic cascade, Global nitrogen control and regulation of nitrogen fixation. Diauxic and Synchronous growth in bacteria.

Unit – V: Microbial Genetics

Genetic mechanisms in microorganisms, including bacteria, archaea, and viruses; principles of genetic variation, and genetic engineering techniques used in microbiology; Basic concepts of genetics: DNA, RNA, and proteins; Types of genetic mutations, Mechanisms of genetic variation, Methods of

Shailendra

detecting and analyzing mutations; Horizontal Gene Transfer; Bacteriophages and Genetic Exchange; Plasmids and Mobile Genetic Elements.

Recommended Books

1. Prescott, Harley and Klein's Microbiology, Seventh Edition, McGraw Hill publications.
2. Molecular Genetics of Bacteria, 4th Edition, Larry Snyder, Joseph E. Peters, Tina M. Henkin, and Wendy Champness, American Society for Microbiology.

Course Learning Outcomes (CLO)

At the end of the course, the student should be able to:

1. Understand the regulatory mechanisms for microbial growth and biosynthesis.
2. Describe the regulatory controls in bacteria during stress response.
3. Discuss about the microbial genetics, gene expression and its regulation in microbes.

Shailendra

Microbial Metabolism

(Open Elective)

Code: PMM 708

L	T	P	C
3	0	0	3

Course Objectives (CO)

1. To study the microorganism types based on nutrition and transport.
2. To study the growth of microorganisms and effect of environmental factor on growth.
3. To study about phototrophic metabolism in microorganisms.
4. To promote research in advanced areas of Microbial gap.

UNIT-I

Microbial growth and growth kinetics: Bacterial growth curve, generation time, measurement of microbial growth, growth kinetics, synchronous culture, continuous and batch culture, chemo static and turbidostatic, environmental factors affecting growth, nutritional diversity in bacteria. Solute transport: Active and passive transport, Primary and secondary transport, Transport kinetics, ABC transporter, PEP-PTS system, catabolite repression, inducer expulsion.

UNIT-II

Diversity and regulation of glucose metabolism in microbes: Embden-Meyerhof-Parnas pathway - Variations of EMP pathway in different groups of bacteria; Overall balance sheet; Regulation; Modes of NAD regeneration; alcoholic and lactic acid fermentation, Pentose phosphate pathway – HMP pathway and its link with glycolysis, Fermentative mode of glucose oxidation - Entner-Doudoroff pathway; variations of ED pathway in different groups of microbes and its implications, Fate of pyruvate, Citric acid pathway – Stoichiometry and energy gain; Regulation; Alternate forms of TCA; Reductive TCA; Branched TCA; Glyoxylate cycle.

UNIT-III

Nitrogen metabolism: Nitrogen assimilation, GS-GOGAT pathway and its regulation, Utilization of other modes of nitrogen, nitrate and nitrite utilization, amino acid biosynthetic pathways and their regulation, amino acid utilization – reduction amination and deamination; decarboxylation; Stickland reaction; amino acid oxidases, polyamine biosynthesis and utilization.

UNIT-IV

Shailendra

Lipid metabolism: Biochemistry of lipids, lipid distribution in different groups of microbes, fatty acid biosynthesis, synthesis of different types of lipids – neutral lipids; phospholipids and glycolipids, biosynthesis of archaeal lipids, synthesis of storage lipids, lipid utilization, beta-oxidation pathway – regulation and energy calculation, Lipid accumulation pathway, biochemical and molecular distinction between oleaginous and non-oleaginous microbes.

UNIT-V

Programming metabolism in relation to overproduction of selected metabolites: Introduction to primary and secondary metabolism, classification of secondary metabolites, introduction to metabolic engineering – strain development and pathway engineering, Case studies on primary metabolites viz. citric acid, succinic acid, lactic acid, ethanol fermentation, amino acid pathways (glutamate, lysine, shikimic acid), Case studies on secondary metabolites viz. polyhydroxyalkanoates, polyketides and antibiotics

Recommended Books

1. “Physiology and Biochemistry of Prokaryotes” by David White, published by Oxford University Press, 4th edition, 2011
2. “Microbial Biochemistry” by G. N. Cohen published by Springer Netherlands, 3rd edition, 2014
3. “Microbial Physiology” by Albert G. Moat, John W. Foster, Michael P. Spector, published by John Wiley & Sons, 4th edition, 2002
4. “Biochemistry” by Geoffrey Zubay, published by William C Brown, 4th edition, 2002
5. “The Metabolic Pathway Engineering Handbook” by Christina Smolke, published by CRC Press, 2009

Course learning outcome

After completing the course, the students will be able to:

1. Classify the micro-organisms types based on nutrition and transport.
2. Study the growth of microorganisms and effect of environmental factor on growth.
3. Study about phototrophic metabolism in microorganisms.
4. Study the mechanism and types of microbes.

Shailendra

Human Metabolic Disorders
(Open Elective)
Code: PMB722

L	T	P	C
3	0	0	3

Course Objectives (CO)

1. To demonstrate advanced understanding of key aspects of biochemistry and molecular biology at the individual organ and system level and the integration between body systems.
2. To demonstrate understanding of how alterations to normal body biochemistry can contribute to disease.
3. To demonstrate understanding of key biochemical, molecular biology, genetic and analytical techniques, including state of the art technologies used in understanding the biochemistry of human disease.

Unit I Introduction

Basic Enzymology, Overview of Carbohydrate Metabolism / Glycogen Storage Disorders, Disorders of Fructose Metabolism, Galactose Metabolism, Diabetes and Hypoglycemia.

Unit II Amino Acid Metabolism

Overview of Amino Acid Metabolism, Disorders of Amino Acid Metabolism, disorders of Urea cycle and inborn errors.

Unit III Nucleic Acid Metabolism

Overview of Nucleic Acid Metabolism, Disorders of Purine Metabolism, Disorders of Pyrimidine Metabolism and Porphyrrias.

Unit IV Energy Metabolism

Overview of Energy Metabolism / Pyruvate Metabolism and the TCA Cycle, Disorders of Beta Oxidation and Electron Transport Chain.

Unit V Lipid Metabolism

Overview of Lipid and Lipoprotein Metabolism, Dyslipidemias, Disorders of Cholesterol and Bile Acid Synthesis and Storage, Glycolipids and Complex Carbohydrates, Lysosomal Storage Disorders, Organelle Function Disorder.

Suggested Readings:

1. Lehninger Principles of Biochemistry, Eighth Edition| ©2021.
2. Biochemistry, 4th Edition, Donald Voet, Judith G. Voet

Course Learning Outcome (CLO)

Shailendra

At the end of the course, the student should be able to:

1. Explain advanced understanding of key aspects of biochemistry and molecular biology at the individual organ and system level and the integration between body systems.
2. Explain how alterations to normal body biochemistry can contribute to disease.
3. Discuss key biochemical, molecular biology, genetic and analytical techniques, including state of the art technologies used in understanding the biochemistry of human disease.

Shailendra

Omics Technology
(Open Elective)
Code: PBT722

L	T	P	C
3	0	0	3

Course Objectives (CO)

1. To introduce basics of Omics terminologies and scope.
2. To introduce genomics, transcriptomics and metabolomics
3. To introduce mechanisms underlying the complex architecture of many phenotypic traits of agricultural relevance.
4. To introduce biochemical and molecular markers

Unit I Omics terminologies and scope

Omics and its relevance in agriculture; Definitions, terminologies and scope in crop improvement.

Unit II Biochemical and Molecular markers

Morphological, biochemical and DNA-based markers (RFLP, RAPD, AFLP, SSR, SNPs, ESTs etc.), mapping populations (F₂s, back crosses, RILs, NILs and DH). Molecular mapping and tagging of agronomically important traits. Statistical tools in marker analysis, Robotics; Marker-assisted selection for qualitative and quantitative traits; QTLs analysis in crop plants, Gene pyramiding.

Unit III Marker assisted selection

molecular breeding; Genomics and genoinformatics for crop improvement; Integrating functional genomics information on agronomically/economically important traits in plant breeding; Marker-assisted backcross breeding for rapid introgression, Generation of EDVs.

Unit IV rDNA Technology

Recombinant DNA technology, transgenes, method of transformation, selectable markers and clean transformation techniques, vector-mediated gene transfer, physical methods of gene transfer.

Unit V Transgenic Production

Production of transgenic plants in various field crops: cotton, wheat, maize, rice, soybean, oilseeds, sugarcane etc. Commercial releases, molecular farming.

Suggested Readings:

1. Genomes by T.A. Brown, John Wiley & Sons Ltd, New York
2. Genome analysis (Volume I, II, III and IV) a Laboratory Manual by Bruce Birren, Eric D. Green, Sue Klapholz, Richard M. Myers and Jane Roskams, Cold Spring Harbor Laboratory Press.
3. Discovery Genomics, Proteomics and Bioinformatics, Campbell AM & Heyer L, 2004

Course Learning Outcomes (CLO):

Shailendra

On completion of this course, the students will be able to:

1. To describe the combination of genomics, transcriptomics and metabolomics
2. Understanding of the mechanisms underlying the complex architecture of many phenotypic traits of agricultural relevance.
3. To understand the basic knowledge of Omics terminologies and scope.
4. To understand the uses of biochemical and molecular markers

Shailendra

Modern Pharmaceutical Analytical Techniques
(Open Elective)
Code: PHT 707

L	T	P	C
3	0	0	3

Course Objectives (CO)

1. To promote research in advanced areas of science and technology.
2. To provide advanced instrument knowledge to research scholars.
3. To enhance the skill of scholar for use/operation/applications of sophisticated instruments.

Course Contents

Unit I Nuclear Magnetic Resonance spectroscopy

Principles of H-NMR and C-NMR, chemical shift, factors affecting chemical shift, coupling constant, Spin-spin coupling, instrumentation and applications.

Unit II Mass Spectrometry

Principles, Fragmentation, Ionization techniques electron impact, chemical ionization, and Quadrupole, instrumentation, applications.

Unit III Theory, principles, instrumentation and pharmaceutical applications of following: -

Instrumental methods: UV Spectroscopy including derivative UV, Fluorescence spectroscopy. IR spectroscopy including Theory, Modes of Molecular vibrations, Sample handling, Instrumentation of Dispersive and Fourier - Transform IR Spectrometer, Factors affecting vibrational frequencies and Applications of IR spectroscopy.

Unit IV Spectrofluorimetry including Theory of Fluorescence, Factors affecting fluorescence, Quenchers, Instrumentation and Applications of fluorescence spectrophotometer. Chromatography including Theory, methods, instrumentation and pharmaceutical applications of absorption, partition chromatography, HPLC and GLC.

Unit V Radio immune assay

Importance, various components, Principle, different methods, Limitation and Applications of Radio immuno assay. Basic principles, instrumentation and pharmaceutical applications of Paper and Gel Electrophoresis,

Suggested Readings:

1. Instrumental Methods of Analysis: Willard, N., CBS Publishers, New Delhi.
2. Douglas A. Skoog, Principles of Instrumental Analysis, 6th Edition, 2007.
3. Indian Pharmacopoeia 1996, Volume I and Volume II, Controller of Publications, Delhi.

Course Learning Outcome (CLO)

At the end of the course, the student should be able to:

1. Discuss the advanced areas of science and technology.

Shailendra

2. Describe advanced instrument utility for the research scholars.
3. Aware of Use/operate/apply sophisticated instruments in the research.

Shailendra

Ayurveda Perspectives of Research Methodology

(Open Elective Course)

Subject Code: PAY 711

L	T	P	C
3	0	0	3

Course Objectives (CO)

1. To promote research ideas in various fields of Ayurveda Science.
2. To develop integrated research approaches for advanced studies in the field of Ayurvedic science.
3. To create awareness of integrated research in fundamental, drug and clinical studies.

Unit I: Ayurvedic Research Methodology

- Empirical Researches according to Acharya Charak
- Evidence based research as found in later Samhita
- Shastra Lakshan (ideal texts), Tantra Yukti
- Research based literature terminology as found in Samhita
- AYUSH Research Portal, UGC Care list of journals

Unit II: Literary and Fundamental Research in Ayurveda

- Ancient manuscripts/ rare books, collection and compilation related to drugs and diseases
- Popular commentaries and translation on Brihatryi and need of further addition
- Traditional Knowledge and Digital Library (TKDL)
- Contemporary literature and publications related to Ayurveda

Unit III: Drug Research in Ayurveda

- Aushadhi lakshan (ideal drug), Quality control & Standardization techniques
- Good Manufacturing Practices (related to ASU drugs)
- Recent publications and finding in ayurvedic drug research
- The Ayurvedic Formulary of India, The Ayurvedic Pharmacopeia of India, NMPB
- Drug Discovery & Development process in Ayurveda, Preclinical pharmacology
- Network Pharmacology

Unit IV Clinical Research in Ayurveda

- Principles and applied aspects of diagnostic & therapeutic techniques in ayurveda
- Method of patient examination (Rogi Pariksha)
- Concept of Prakriti- Vikriti
- Clinical research designing and Standard questionnaires as per ayurvedic perspectives
- Good Clinical Practices, Pharmacovigilance
- Recent publications related to clinical research in ayurveda

Suggested Readings;

1. P. V. Sharma, "Charak Samhita," Chaukhambha Orientalia, Varanasi, 1983.

Shailendra

2. Anonymous, Research Publications in Ayurvedic Sciences, Catalogue of Research information on Ayurveda and Related Sciences, Central Council of Research in Ayurveda Sciences, Ministry of Ayush, GoI, New Delhi 2015; <http://ccras.nic.in/>
3. Ranjit Kumar (2011). Research Methodology, a Step-by-Step Guide for Beginners (3rd ed.). New Delhi: SAGE Publishers Ltd.
4. Kothari, C.R. (2019) Research Methodology: Methods and Techniques. 4th Edition, New Age International Publishers, New Delhi.

Course Learning Outcome (CLO)

At the end of the course, the scholar should be able to:

1. Discuss the advanced areas of research in Ayurveda by knowing the basic principles of ayurveda.
2. Describe the integrated research areas by utilizing the advanced instrument for the drugs research.
4. Aware of applied aspects of diagnostic instruments in the Ayurvedic clinical research.
5. Know the advances in ayurvedic research and promote the integrated research in ayurveda.

Shailendra