INVERTIS
UNIVERSITY BAREILLY
Established by Govt. of U.P. u/s 2F of UGC Act, 1956 vide U.P. Act 22 of 2010.

# SCHEME OF INSTRUCTION & SYLLABUS

**FOR**

**DOCTOR OF PHILOSOPHY**
**(Ph. D.)**

**IN**

# MICROBIOLOGY

(Academic Session: 2020)

## FACULTY OF BIOSCIENCES & BIOTECHNOLOGY

## INVERTIS UNIVERSITY, NH24, BAREILLY - 243 123

INVERTIS UNIVERSITY BAREILLY
Established by Govt. of U.P. u/s 2F of UGC Act, 1956 vide U.P. Act 22 of 2010.

# DOCTOR OF PHILOSOPHY (Ph.D.)
# IN
# MICROBIOLOGY

## COURSE STRUCTURE

**(EFFECTIVE FROM THE ACADEMIC SESSION: 2020)**

1. Duration of the Pre-Ph.D. course: Six Months
2. Qualifying Marks: 55% (in each paper)

| S. No. | CODE | SUBJECT | MARKS DISTRIBUTION | | | CREDIT |
|---|---|---|---|---|---|---|
| | | | CA | EE | TOTAL | |
| 1. | DRM-101 | RESEARCH METHODOLOGY | 00 | 100 | 100 | 4 |
| 2. | PBM-102 | ANALYTICAL TECHNIQUES | 00 | 100 | 100 | 4 |
| **ELECTIVE PAPER (ANY ONE)** | | | | | | |
| 3. | PBM-103 | MICROBIAL DIVERSITY | 00 | 100 | 100 | 4 |
| 4. | PBM-104 | MOLECULAR & STRUCTURAL BIOLOGY | | | | |
| 5. | PBM-105 | IMMUNOLOGY & VACCINE TECHNOLOGY | | | | |
| 6. | PBM-106 | INDUSTRIAL MICROBIOLOGY | | | | |
| **TOTAL** | | | **00** | **300** | **300** | **12** |

.

INVERTIS UNIVERSITY BAREILLY
Established by Govt. of U.P. u/s 2F of UGC Act, 1956 vide U.P. Act 22 of 2010.

# DRM-101 RESEARCH METHODOLOGY

**UNIT I**

Research Topic: selection of problems, stages in the execution of research, preparation of manuscript and report writing. Search engines: google, pubmed, google scholar, EMBL, etc. Publication of Report in Journals: Standard of research journals, impact factor, citation index, H index, and more. Proof reading, reading journals and review.

**UNIT II**

Introduction of computer science- Database management systems, presentation graphics, management of biological data by office applications: MS-office, MS-Word, MS-Excel, and MS-PowerPoint.

**UNIT III**

Measures of dispersion: sampling methods: random sampling - types of variables: qualitative and quantitative variables - continuous and discontinuous variables - scaling method – mean - standard deviation- standard error - coefficient of variation. Comparison of means: chi square test, students t test and ANOVA.

**UNIT IV**

Spectrophotometer: principle and applications, Ultra violet, Infra Red, Nuclear magnetic resonance (NMR), fundamental and procedure of chromatography: Paper Chromatography, TLC, Gas Chromatography, etc., Generation and evaluation of data.

**UNIT V**

Principle and application of microscopy, Light and electron microscope - scanning electron microscopy, transmission electron microscopy; X-ray diffraction, generation and analysis of data, basic of softwares: Matlab and Labview.

**Text/Reference Books:**


- Statistical methods, Snedecor, G, W. and W.G. Cohran, 1978. Oxford and IBH publishing CO Pvt. Ltd.
- Biometry, Sokal, R.R. and F.J.Rohlf, 1981. W.H. Freeman, NewYork.
- Authoring a PhD, thesis: how to plan, draft, write and finish a doctoral dissertation, Duncary, P. 2003. Macmillan, pp 256.
- Biostatistical analysis, Zar, J.H., 1996. Prentice Hall, Uppar Saddle River, newjersy, USA.
- Scientific courses and presentations, Martha Davis, 2005. Academic press, Tokyo.pp.356

INVERTIS UNIVERSITY BAREILLY
Established by Govt. of U.P. u/s 2F of UGC Act, 1956 vide U.P. Act 22 of 2010.

# PBM-102 ANALYTICAL TECHNIQUES

**UNIT I**

Microscopic Techniques: Dark field and bright field microscope; Phase contrast microscopy; Confocal microscope; Brief introduction of EM (TEM, SEM and STEM). Chromatographic Techniques: Affinity, mobile phase and stationary phase. Types of advance chromatography: ion-exchange chromatography, affinity chromatography, gel filteration, HPLC and their MS combination.

**UNIT II**

Centrifugation techniques: Basic principles of sedimentation. Types of centrifuge: refrigerated high-speed preparative centrifuges, analytical ultracentrifuges, density gradient centrifugation etc. Safety aspects of centrifugation.

**UNIT III**

Introduction of Molecular techniques: Polymerase Chain Reaction and its modification. Restriction fragment length polymorphism, RAPD. Electrophoresis: Principal and procedure of agarose Gel electrophoresis. Introduction of genetic engineering: vectors, restriction enzymes, transformation.

**UNIT IV**

Biomolecules: Estimation and separation techniques: Qualitative and quantitative estimation of Protein, carbohydrate and nucleic acids. Sodium dodecyl sulfate polyacrylamide gel electrophoresis (SDS-PAGE), Basics of Isoelectric focusing (IF) and Two-dimensional (2D) electrophoresis.

**UNIT V**

Advanced techniques: Enzyme Linked Immunosorbant Assay (ELISA) and Radioimmuno Assay (RIA), Western blotting. UV and visible spectroscopy, Mass Spectrometry: MALDI-TOF. Mass precision, mass measurement accuracy, mass resolution, ionization energy and appearance energy.

**Text/Reference Books:**


- Principles of Physical Biochemistry, K.E. Van Holde, Prentice Hall.
- Advanced Instrumentation, Data Interprtation, and Control of Biotechnological Processes, J.F. Van Impe,Kluwer Academic
- Modern Spectroscopy, J.M. Hollas, John Wiley and Son Ltd.
- Principles and techniques in biochemistry and molecular biology by Wilson and Walker.
- Introduction to instrumental analysis : Robert. D. Braun (1987). McGraw Hill International Edition, Chemistry Series.
- Principles and techniques of Practical Biochemistry: K.Wilson and J.Walker (1994), Cambridge University Press, Cambridge

INVERTIS UNIVERSITY BAREILLY
Established by Govt. of U.P. u/s 2F of UGC Act, 1956 vide U.P. Act 22 of 2010.

# PBM-103 MICROBIAL DIVERSITY

**UNIT I**

Archaea: Systematics, and occurrence, diversity, characteristic features, significance and potential applications (eg. biochips, methane generation, ultrafiltration membranes, production of PHB and PHA, desulphurization of coal and crude oil, bioleaching of metals, enzymes, compatible solutes and others) of different groups of Archaea (Crenarchaeota, Euarchaeota, Korarchaeota, Nanoarchaeota).

**UNIT II**

Bacteria: Conventional and molecular systematics, and general discussion on the occurrence, diversity, characteristic features, significance and potential applications of various groups of bacteria according to Bergey's Manual of Systematic Bacteriology.

**UNIT III**

Fungal Systematics and diversity: Implications of molecular and biochemical methods including rDNA analysis, RFLP, RAPD and other fingerprinting techniques. Fatty acids, polysaccharides and lipids and role of secondary metabolites. Mycorrhizal fungi: Diversity of endo and ectomycorrhizal fungi. Fungal endophytes and its interaction and functions: Endophytes as latent pathogens and biocontrol agents, colonization and adaptation. Agriculturally important toxigenic fungi: Biodiversity, Chemical and biological characterization of toxic metabolites, toxigenic fungi in sustainable agriculture, Biopesticides.

**UNIT IV**

Biodiversity of yeast: Biodiversity, functional evolution and metabolism. Biotechnological applications of yeasts: Yeasts as producers of bioactive molecules such as pigments, lipids, organic acids and EPS, yeasts as probiotics, yeasts in bioremediation and in alcoholic fermentations.

**UNIT V**

Algal diversity from morphology to molecules: Importance of algae in production of algal pigments, biofuels, hydrogen production, important bioactive molecules, role of algae in sustainable environment.

**Texts / References Books:**


1. The Prokaryotes. A handbook on the biology of bacteria: ecophysiology, isolation, identification, applications. Volumes I-IV by Balows, A., Trüper, H. G., Dworkin, K. H. Springer-Verlag, New York;1992
2. Microbiology : An Introduction by Gerard J Tortora, Berdell R Funke. Benjamin-Cummings Publishing Company ; 2008.
3. Principles of Microbiology by R.M. Atlas , Mosby publishers, St. Louis; 1995
4. The Yeast Handbook: Biodiversity and Ecophysiology of yeasts by Carlos A. Rosa and Gabor Peter. Springer- Verlag Berlin Heidelberg; 2006
5. Algae: Anatomy, Biochemistry and Biotechnology by Laura Barsanti and Paolo Gualtieri. Taylor and Francis Group, LLC; 2006.
6. Fundamentals of the fungi by Elizabeth Moore, Fourth edition, Benjamin Cummings; Landecker; 1996.
7. Algae: Anatomy, Biochemistry and Biotechnology by Laura Barsanti and Paolo Gualtieri. Taylor and Francis Group, LLC; 2006.

INVERTIS UNIVERSITY BAREILLY
Established by Govt. of U.P. u/s 2F of UGC Act, 1956 vide U.P. Act 22 of 2010.

## PBM-104 MOLECULAR AND STRUCTURAL BIOLOGY

**UNIT I**

Molecular Basis of Gene, Biological Repair Mechanisms, Repair Defects and Diseases, DNA Replication: Replication Machinery in Prokaryotes and Eukaryotes. Transcription in prokaryotes: Initiation, elongation and termination. Attenuation and anti termination

**UNIT II**

Regulation of gene expression in prokaryotes: Operon concept (lac, ara & trp), induction and repression. Initiation of transcription, Transcription factors, repressor, activator and enhancer.

**UNIT III**

DNA structure and types, base pairing, hydrogen bonding, DNA melting and annealing, difference between AT and GC pairing, Watson Crick model; Crystal structure of B-DNA, major and minor groves, telomeric sequences and structure

**UNIT IV**

Amino acids and peptides: Side chain structure and function in protein folding and functionality: Secondary structure of proteins -helices, sheets, loops and turns; Structural and functional proteins. Tertiary structure of proteins, homo and hetero-dimers, trimers and tetramers

**UNIT V**

Interaction of biomolecules: Protein-protein, Protein-DNA and Protein-ligand, drug-DNA interactions. Databases of sequences and structure for protein and DNA, public domain softwares for visualizing and modeling biomolecules.

**Text/Reference Books:**


- Biochemistry, R.H. Abeles, P.A. Frey and W.A. Jencks, Jones and Bartlett.
- Essentials of Molecular Biology, D. Freifelder, Jones and Bartlett Publications.
- Genes VII, B. Lewin, Oxford University Press.
- Introduction to Protein Structure, C. Branden and J Tooze, Garland Publishing Company.
- Proteins (Structures and Molecular Properties), T.E. Creighton, W.H. Freeman and Company.
- Database Annotation in Molecular Biology, Arthur M. Lesk.
- Genes & Genomes, M.S. Paul Berg.
- Structure and Machanism in Protein Science, Alan Fersht.

INVERTIS UNIVERSITY BAREILLY
Established by Govt. of U.P. u/s 2F of UGC Act, 1956 vide U.P. Act 22 of 2010.

# PBM-105 IMMUNOLOGY AND VACCINE TECHNOLOGY

**UNIT I**

Immune response: Innate and adaptive immune system, Antigen presenting cells, Antigens, Antigenic specificity, Diversity, Immunologic memory, Self / nonself recognition, Antigens and epitopes: immunogenicity, antigenicity and haptens; factors affecting immunogenicity. adjuvants, epitopes, properties of b-cell epitopes and t-cell epitopes.

**UNIT II**

Antigen-Antibody Interactions: Cross-Reactivity, Precipitation Reactions, Agglutination Reactions, Radioimmunoassay, Enzyme-Linked Immunosorbent Assay, Western, Blotting, Immunoprecipitation. Production and application of monoclonal antibody: hybridoma technology.

**UNIT III**

Major histocompatibility complex: Structure of MHC I and II molecule, Association of MHC with disease. Recognition of antigens by T and B Cells: Antigen processing, role of MHC molecules in antigen presentation. T-cell receptor complex, B-cell receptor complex.

**UNIT IV**

Introduction to vaccines, fundamental concepts in vaccination, types of vaccines, traditional methods of vaccine production, production of DPT and Rabies vaccine, Production of Modern Vaccines - production of Hepatitis vaccine; DNA vaccine.

**UNIT V**

B-cell epitope and T-cell epitope prediction methods, reverse vaccinology and immunoinformatics Databases. Production of peptide based vaccine in detail

**Text/Reference Books:**


- Kuby Immunology 4e by Richard A. Goldsby, Thomas J. Kindt and Barbara A. Osborne
- Immunoinformatics: Predicting Immunogenicity in Silico By Darren R Flower Publisher: Humana Press
- Immunoinformatics (Immunomics Reviews:) By Shoba Ranganathan ,Vladimir Brusic, Christian Schonbach. Publisher: Springer

INVERTIS UNIVERSITY BAREILLY
Established by Govt. of U.P. u/s 2F of UGC Act, 1956 vide U.P. Act 22 of 2010.

# PBM-106 INDUSTRIAL MICROBIOLOGY

**Unit I**

***Microbial Diversity & Systematics*** Classical and modern methods and concepts; Domain and Kingdom concepts in classification of microorganisms; Criteria for classification; Classification of Bacteria according to Bergey's manual; Molecular methods such as Denaturing Gradient Gel Electrophoresis (DGGE), Temperature Gradient Gel Electrophoresis (TGGE), Amplified rDNA Restriction Analysis and Terminal Restriction Fragment Length Polymorphism (T-RFLP) in assessing microbial diversity; 16S rDNA sequencing and Ribosomal Database Project.

**Unit II**

***Microbial Growth & Physiology*** Ultrastructure of Archaea; Eubacteria; Yeast and viruses (Bacterial, Plant, Animal and Tumor viruses); Microbial growth: Batch, fed-batch, continuous kinetics, synchronous growth, yield constants, methods of growth estimation, stringent response, death of a bacterial cell. Microbial physiology: Physiological adoption and life style of Prokaryotes; Unicellular Eukaryotes and the Extremophiles (with example from each group)

**Unit III**

***Microbial Interactions and Infection*** Host–Pathogen interactions; Microbes infecting humans, veterinary animals and plants; Pathogenicity islands and their role in bacterial virulence.

**Unit IV**

***Microbes and Environment*** Role of microorganisms in natural system and artificial system; Influence of Microbes on the Earth's Environment and Inhabitants; Ecological impacts of microbes; Symbiosis (Nitrogen fixation and ruminant symbiosis); Microbes and Nutrient cycles; Microbial communication system; Quorum sensing; Microbial fuel cells; Prebiotics and Probiotics; Vaccines

**Unit V**

***Industrial Applications*** Basic principles in bioprocess technology; Media Formulation; Sterilization; Thermal death kinetics; Batch and continuous sterilization systems; Primary and secondary metabolites; Extracellular enzymes; Biotechnologically important intracellular products; exopolymers; Bioprocess control and monitoring variables such as temperature, agitation, pressure, pH Microbial processes-production, optimization, screening, strain improvement, factors affecting down stream processing and recovery; Representative examples of ethanol, organic acids, antibiotics etc. Enzyme Technology-production, recovery, stability and formulation of bacterial and fungal enzymes-amylase, protease, penicillin acylase, glucose isomerase; Immobilised Enzyme and Cell based bio-transformations steroids, antibiotics, alkaloids, enzyme/cell electrodes

**Texts/References**

1. Pelczar MJ Jr., Chan ECS and Kreig NR., Microbiology, 5th Edition, Tata McGraw Hill, 1993.
2. Maloy SR, Cronan JE Jr., and Freifelder D, Microbial Genetics, Jones Bartlett Publishers, Sudbury, Massachusetts, 2006.
3. Crueger and A Crueger, (English Ed., TDW Brock); Biotechnology: A textbook of Industrial Microbiology, Sinaeur Associates, 1990.
4. G Reed, Prescott and Dunn's, Industrial Microbiology, 4th Edition, CBS Publishers, 1987.
5. M.T. Madigan and J.M. Martinko, Biology of Microorganisms, 11th Edition, Pearson Prentice Hall, USA, 2006.