Approved by BoS (12 August, 2026)

COURSE CONTENTS & SYLLABUS

(Effective from the Academic Year 2026-2027)

UG (7-8 semesters) - MICROBIOLOGY

(Honours and Research)

National Education Policy (NEP) - 2020

DEPARTMENT OF BOTANY AND MICROBIOLOGY
HEMVATI NANDAN BAHUGUNA GARHWAL UNIVERSITY
(A CENTRAL UNIVERSITY)
Srinagar, Garhwal – 246174, Uttarakhand, INDIA

SYLLABUS: UG – MICROBIOLOGY (7-8 semesters) Honours and Research

DEPARTMENT OF MICROBIOLOGY

Hemvati Nandan Bahuguna Garhwal University
(A Central University)
Srinagar, Garhwal – 246174, Uttarakhand, INDIA

U.G (7-8 semesters) – Microbiology (Honours and Research)				
Sem.	**Codes**	**Credits**		**Paper name**
		T	P	
VII	Core Major-I	5	-	Fundamentals of Microbial Life
	Core Major-II	5	-	Biochemistry of Microbial Life
	Research Methodology	5	-	Research Methodology
	Core Major Elective-I	3	1	Molecules of Microbial Life
	Major Practical-1		5	Practical based on Core majors I and II
	Minor-I	3	1	Basic Bioinformatics
	Total credits	**21+7=28**		
VIII	Core Major-III	5	-	Laboratory Methods in Microbiology
	Core Major Elective-II	3	1	Introductory Immunology
	Major Practical-2	-	3	Practical based on Core major III
	Dissertation	-	12	Dissertation
	Minor-II	2	2	Fundamentals of Epidemiology
	Total credits	**10+18=28**		
NHEQF Level- 6		Student on exit after successfully completing four years (i.e., securing minimum required 176 credits along with securing additional 2 credits under SSD course work) will be awarded “Four years Bachelor’s Degree (Honours with Research)”, in related field/discipline		

U.G (VII semesters) – Microbiology (Honours and Research)

Core Major-I: Fundamentals of Microbial Life - (Theory)

Credits: 5 **75 h**

Unit I: History and Classification (15 h)

History and development of microorganisms; Conflicts over spontaneous generation; Golden era of microbiology; Concepts of prokaryotes and eukaryotes; Classification of microorganisms: Haeckel's three kingdom concept, Whittaker's five kingdom concept, Eight kingdom classification, Techniques used in microbial classification (Morphological, chemotaxonomic and genetic methods); Future of microbiology.

Unit II: Microscopy (15 h)

Principle of bright field microscopy, dark field microscopy, fluorescence and electron (transmission and scanning) microscopy and their applications in microbiology, Staining of microorganisms, simple staining, negative staining, Gram staining and endospore staining.

Unit III: Basics of Microbiology (15 h)

Microbial nutrition; Culture media; Culture techniques for isolation of pure culture; Cultivation of aerobic and anaerobic bacteria; Preservation methods; Microbial growth; Generation time, Diauxic growth curve; Effect of environmental conditions (pH, temperature, aeration, etc.) on microbial growth.

Unit IV: General Bacteriology (15 h)

Ultrastructure of bacterial cell: Morphology of bacteria, Structure and properties of cell wall and cell membrane, Cell wall synthesis, Capsule (Types, composition and function), Ultrastructure and functions of flagella, cilia, pili, s-layer, ribosomes and nucleoid; Reserve food materials-PHB, phosphate granules, oil droplets, cyanophycean granules and sulphur inclusions Bacterial reproduction; Characteristic features of Archaea.

Unit V: General Virology (15 h)

Discovery of viruses; Characteristic feature of viruses, viroids, virusoids prions and Satellite viruses; Baltimore scheme of classification; Morphology and ultrastructure: Capsids and their arrangements, Types and composition of envelopes, Viral genome (Types and structures); Isolation and cultivation of viruses using embryonated eggs, Multiplication of viruses; Bacteriophage: Structural organization, Cultivation, Replication, One step growth curve, Eclipse phase, Phage production, Burst size; Application of bacteriophages.

Suggested Readings

1. Willey, J., Sandman, K., and Wood, D., (2023) Prescott's Microbiology (12th Edition), McGraw-Hill, New York.
2. Madigan, M.T., Bender, K.S., Buckley, D.S., Sattley, W.M., Stahl, D.A. (2020) Brock Biology of Microorganisms, (16th Edition), Pearson Publisher, USA
3. Pommerville, J.C. Alcamo's fundamentals of microbiology. Jones and Bartlett Learning, Sudbury.
4. Wheelis, M. Principles of modern microbiology. Jones and Bartlett Learning, Sudbury.
5. Stanier, R.Y., Ingraham, J.L., Wheelis, M.L. and Painter, P.R. General microbiology. MacMillan Press, London.
6. Sclegel, H.G. General Microbiology. Cambridge University Press, Cambridge.
7. Pelczar, M.J., Chan, E.C.S. and Kreig, N.R. Microbiology. McGraw-Hill, New York.
8. Dubey, R.C. and Maheshwari, D K, A Textbook of Microbiology, S Chand, New Delhi
9. Hawkes, P.W., Spence, J.C.H. (2019) Springer Handbook of Microscopy, Springer Nature Switzerland
10. Dimmoc, N.J., Easton, A.J. and Leppard, K.N. Introduction to Modern Virology. Wiley-Blackwell, New Jersey.
11. Read related review articles and research papers published recently in reputed journals.

Core Major-II: Biochemistry of Microbial Life (Theory)

Credits: 5 **75 h**

Unit I – Acid–Base Chemistry (12 h)

Bronsted and Lewis concepts; conjugate acid–base pairs; ionization of solutions; pH and pKa; physiological relevance of pH. Biological buffers; Henderson–Hasselbalch equation, buffer capacity, polyprotic acids, amphoteric salts, ionic strength in biological systems, Lab buffers; Phosphate, bicarbonate, histidine-containing peptides, Good's buffers.

Unit II Bioenergetics (12 h)

Energy generation in biological systems: substrate-level phosphorylation, oxidative phosphorylation, photophosphorylation. Electron transport chain: organization in bacteria and mitochondria; artificial electron donors; inhibitors and uncouplers. Chemiosmotic theory of ATP synthesis; experimental evidence and modern perspectives. High-energy phosphate compounds: ATP, GTP, PEP, creatine phosphate. Phosphate group transfer potential; free energy of ATP hydrolysis under physiological conditions.

Unit III – Carbohydrates Metabolism (12 h)

Glycolysis and its regulation. TCA cycle and amphibolic role. Glyoxylate shunt and its significance in microbes. Pentose phosphate pathway: oxidative and non-oxidative phases. Anaplerotic reactions and gluconeogenesis. Fermentation pathways: lactic acid, ethanol, mixed acid, butanediol, propionic acid.

Unit IV –Lipid Metabolism (10 h)

Biosynthesis of fatty acids, triacylglycerols, phospholipids, cholesterol, steroids, isoprenoids. Regulation of cholesterol biosynthesis (HMG-CoA reductase). B-oxidation, α-oxidation, ω-oxidation of fatty acids. Ketogenesis and ketolysis. Integration of lipid metabolism with carbohydrate metabolism.

Unit V –Amino Acids & Nucleotides (15 h)

Biosynthesis of Amino acids and its regulation. Deamination and transamination reactions. Biosynthesis of purines and pyrimidines (de novo and salvage pathways). Regulation of nucleotide biosynthesis. Degradation pathways of purines (uric acid) and pyrimidines. Role of nucleotides in cellular energy and signaling (ATP, GTP, cAMP, cGMP).

Unit VI – Enzymes: Structure, Function & Regulation (14 h)

Mechanisms of enzyme catalysis: acid–base catalysis, covalent catalysis, metal ion catalysis. Kinetics of single-substrate and multi-substrate reactions (sequential, ping–pong mechanisms). Reversible and irreversible inhibition (competitive, non-competitive, uncompetitive, mixed). Allosteric enzymes: sigmoidal kinetics, cooperative binding, models of allostery (MWC, KNF). Regulation of enzyme activity: covalent modification, feedback inhibition. Determination of active site structure and turnover number. Applications of enzymes in biotechnology and industry.

Suggested Readings

1. Nelson, D. L., Cox, M. M., & Hoskins, A. (2021). Lehninger Principles of Biochemistry. Macmillan. (8th edition)
2. Rodwell, V., Bender, D., Botham, K. M., Weil, P. A., & Kennelly, P. J. (2022). Harper's Illustrated Biochemistry. 28. Citeseer, New York, United States. (32nd edition)
3. Voet, D., Voet, J G., Pratt, C W. (2018). Voets Principles of Biochemistry, 235. John Wiley. (5th edition)
4. Berg, J., Stryer, L. (2023). Biochemistry. 1120. Springer Verlag. (10th edition)

RESEARCH METHODOLOGY

Credits: 5 **75 h**

Unit I: Research Problem and Experimental Planning (15 h)

Literature survey; Identification of research problem; Defining the aim and objectives, Planning of experimental work: Designing of experimental protocol; Principles of experimental designs; Randomized block and Latin square designs; Description of strategies to meet the objectives.

Unit II: Data Collection and Hypothesis Testing (15 h)

Data, types of data: Sampling techniques: Sample size; Recording of data and data summarisation; Measures of dispersion: Range, Quartile deviation, Mean deviation, Standard deviation, Coefficient of variation; Probability: Random experiment, Events, Sample space, Mutually exclusive events, Independent and dependent events, Statement of addition and multiplication theorems of probability; Hypothesis; Hypothesis-Testing Procedure; Sample Size, Tests for Differences between Means: Test for Differences between Proportions;

Unit IV: Analysis of Variance (15 h)

Analysis of Variance; One- way and two-way ANOVA, Inferences about Population Variance; Standard curves: Correlation, Linear regression (fitting of best line through a series of points), MLR, Multiple collinearity, Standard curves and interpolation of unknown Y-values; Chi-Square Test; The Sign Test for Paired Data; Rank Sum Tests: The Mann-Whitney U Test and the Kruskal-Wallis Test; The One-Sample Runs Test; Rank Correlation; The KolmogorovSmirnov Test.

Unit IV: Basics of Bioinformatics (15 h)

Bioinformatics: Introduction to various biological databases (Primary, secondary and composite databases); Introduction to biological information system: SRS, ENTREZ; Sequence comparison and alignment: Sequence similarity searching tools (FASTA and BLAST), Multiple sequence alignment and applications; Introduction of data mining: Classification, Clustering, Data collection, Data warehousing, Data preprocessing, Applications of data mining and genomes mining; Phylogenetic analysis: Phenetic and cladistic approach; Phylogenetic tree construction (Rooted and unrooted method).

Unit V: Scientific Writing (15 h)

Different types of scientific writing: Thesis, Book, Review, Proceedings, Research article, Research proposal; Title, Abstract, Introduction, Aims and objectives, Review of literature, Methodology, Results, Discussion, Summary and Conclusions, Bibliography.

Reference Books

1. Kothari, C. R. (2004). *Research methodology: Methods and techniques*. New Age International.
2. Singh, Y. K. (2006). *Fundamental of research methodology and statistics*. New Age International.
3. Thomas, C. G., & Thomas, C. G. (2021). *Research methodology and scientific writing* (pp. 135-151). Thrissur: Springer.
4. Dawson, C. (2002). *Practical research methods: A user-friendly guide to mastering research*. How to books.
5. Daniel, P. S., & Sam, A. G. (2011). *Research methodology*. Gyan Publishing House.
6. Campbell, R. C. (1989). *Statistics for biologists*. Cambridge University Press.
7. Mount, D. W., & Mount, D. W. (2001). *Bioinformatics: sequence and genome analysis* (Vol. 564). Cold Spring Harbor, NY: Cold spring harbor laboratory press.

Higgins, D., & Taylor, W. (2000). *Bioinformatics: Sequence, Structure and Databanks: A Practical Approach* (Vol. 236). OUP Oxford.

Core Major: Elective – I: Molecules of Microbial Life

Credits: 3 **45 h**

Unit I: Microbial Genome (10 h)

Structure and chemical properties of DNA and RNA; Types of DNA (A-, B-, and Z-DNA) and DNA topology DNA denaturation and renaturation; Special DNA structures (G-quadruplexes); Telomeres and their biological importance

Unit II: DNA Replication and Transcription (10 h)

DNA replication mechanisms in prokaryotes and eukaryotes. Transcription & its mechanisms; Role of transcription factors and regulatory proteins; RNA processing: capping, polyadenylation, and splicing; Different RNA types and their functions.

Unit III: Translation and Gene Expression (10 h)

Protein synthesis (translation) in prokaryotes and eukaryotes; Structure and function of ribosomes; Post-translational modifications of proteins; Regulation of gene expression: Operons; Regulatory RNAs.

Unit IV: Genome Recombination, Mobile Elements, and Mutation (15 h)

DNA recombination: homologous and non-homologous recombination; Major proteins involved in DNA repair and recombination; Transposons and retrotransposons; Types and causes of mutations; Chemical and physical mutagens and their effects on microbial genomes.

Suggested Readings

1. Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Scott, M.P., Bretscher, A., Ploegh, H. and Matsudaira, P. Molecular cell biology. W.H. Freeman and Company, New York.
2. Krebs, J.E., Goldstein, E.S. and Kilpatrick, S.T. Lewin's genes. Jones and Bartlett Learning Publishers, Sudbury.
3. Nelson D. L. and Cox, M.M. Lehninger principles of biochemistry. W.H. Freeman and Company, New York.
4. Snustad, D.P. and Simmons, M.J. Principles of genetics. John Wiley and Sons, New York.
5. Malacinski, G.M. and Friefelder, D. Essentials of molecular biology. Jones and Bartlett Learning, Sudbury.
6. Synder, L.J., Peters, E., Henkins, T.M. and Champness, W. Molecular genetics of bacteria. ASM Press, Washington, D.C.
7. Maloy, S.R., Cronan, J.E. and Freifelder, D.M. Microbial genetics. Jones and Bartlett Learning, Sudbury.
8. Hartwell, L. Genetics: From genes to genome. McGraw-Hill, New York.
9. Weaver, R. Molecular biology. McGraw-Hill, New York.
10. Watson, J.D., Baker, T., Bell, S.P., Gann, A., Levine, M. and Lodwick, R. Molecular biology of the gene. Pearson Education, New Jersey.

Practical based on Core Major Elective - I

Molecules of Microbial Life - (Practical)

Hours: 30 **Credits: 1**

1. Quantitative estimation of DNA by diphenyl amine (DPA) and spectrophotometric method.
2. Determination of quality of DNA by spectrophotometric method.
3. Determination of Tm of given DNA sample.
4. Study of the effect of temperature and pH on the denaturation of DNA.

Suggested Readings

1. Sambrook, J. and Russell, D.W. Molecular cloning: A laboratory manual. Cold Spring Harbor Lab Press, New York.
2. Murray, R.G.F., Wood, W.A. and Krieg, N.B. Methods for general and molecular bacteriology. ASM Press, Washington, D.C.
3. Chaitanya, K.V. Cell and molecular biology: A lab manual. PHI Learning, New Delhi.
4. Celis, J.E. Cell biology: A laboratory handbook. Elsevier, Amsterdam.

Major Practical – 1

(Practical exercises based on Core Majors I & II)

Credits: 5 **150 h**

Fundamentals of Microbial Life (Practicals - Core Major I)

1. Safety rules of working in microbiology lab, disposal of cultures, calibration, validation and maintenance of instruments.
2. Principles and working of instruments used in microbiology lab.
3. Media preparation and its sterilization.
4. Isolation and enumeration of bacteria and fungi from given sample.
5. Isolation and maintenance of pure culture of bacteria and fungi.
6. Staining of bacterial cell (Simple staining, gram staining and negative staining).
7. Measurement of bacterial cell size using micrometer.
8. Staining of endospore and capsule.
9. Staining of fungal cell.

Biochemistry of Microbial Life (Practicals - Core Major II)

1. Preparation of Buffers and Solutions: Molar, normal, and present solutions; pH adjustment and verification.

2. Quantitative Estimation of Biomolecules
A. Proteins: Lowry's method or Bradford assay using BSA standard curve.
B. Reducing Sugars: DNS method using glucose standard curve.

Suggested Readings

1. Cappuccino J., and Welsh C., Microbiology: A Laboratory Manual, 11th Edition, Pearson, USA
2. Dubey, R.C. and Maheshwari, D K, Practical Microbiology, S Chand, New Delhi
3. Practical Biochemistry by Pamela Jha
4. Practical Manual of Biochemistry by G. Sattanathan, S.S. Padmapriya, B. Balamuralikrishnan,
5. Sambrook, J. and Russell, D.W. Molecular cloning: A laboratory manual. Cold Spring Harbor Lab Press, New York.
6. Miller, J.H. Experiments in molecular genetics. Cold Spring Harbor Lab Press, New York.
7. Murray, R.G.F., Wood, W.A. and Krieg, N.B. Methods for general and molecular bacteriology. ASM Press, Washington, D.C.
8. Chaitanya, K.V. Cell and molecular biology: A lab manual. PHI Learning, New Delhi.
9. Celis, J.E. Cell biology: A laboratory handbook. Elsevier, Amsterdam.

Minor – I: Basic Bioinformatics - (Theory)

Credits: 03 **45 h**

Unit I – Bioinformatics and Biological Data Resources (11 hours)

Scope and applications of bioinformatics in microbiology; biological data types; primary, secondary and integrated databases; NCBI, ENA/DDBJ, UniProt, PDB and KEGG; microbial genome/metagenome resources; accession numbers and identifiers; sequence formats; data retrieval, metadata and database searching; data quality, FAIR principles and reproducibility.

Unit II – Sequence Analysis and Phylogenetics (12 hours)

Sequence similarity, identity and homology; global/local alignment and Needleman–Wunsch/Smith–Waterman concepts; BLAST; E-value, bit score, identity and coverage; MSA using Clustal Omega/MUSCLE; conserved regions and functional inference; phylogenetic trees; UPGMA, Neighbor-Joining, Maximum Parsimony and Maximum Likelihood concepts; bootstrap and tree interpretation; microbial taxonomy and evolutionary applications.

Unit III – Microbial Genomics, Proteomics and Metagenomics (11 hours)

NGS concepts; read quality and genome assembly; genome annotation and functional annotation; comparative genomics, orthologs and pangenome concepts; AMR/virulence gene analysis; basic transcriptomics and proteomics concepts; protein structure and structural bioinformatics; metagenomics and microbiome analysis; amplicon versus shotgun approaches; QIIME 2 workflow concepts and diversity analysis.

Unit IV – Statistics, Visualization and Emerging Bioinformatics (11 hours)

Descriptive statistics, correlation, regression and basic hypothesis testing; normalization and transformation; biological data visualization; heatmaps, clustering, ordination and networks; R/Python/command-line awareness; reproducible workflows and metadata; introductory AI/ML applications in biological data analysis; data interpretation, limitations and scientific reporting.

Recommended Books and Current Online Resources

1. Lesk, A.M. Introduction to Bioinformatics. Oxford University Press.
2. Raghava, G.P.S., & Raghava, S. (2010). Bioinformatics for Beginners. Alpha Science International.
2. Pevsner, J. Bioinformatics and Functional Genomics. Wiley-Blackwell.
3. Zvelebil, M. & Baum, J.O. Understanding Bioinformatics. Garland Science.
4. Mount, D.W. Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbor Laboratory Press.
5. NCBI/BLAST official documentation and NCBI Handbook.
6. UniProt Knowledgebase and current analysis tools.
7. EMBL-EBI/ENA resources; PDB; KEGG.
8. QIIME 2 current amplicon/microbiome documentation.
9. Current official database/software documentation should supersede older interface-specific instructions.

Minor – I: Basic Bioinformatics - (Practicals)

Credit: 01 **30 h**

1. **Introduction to Biological Databases & Data Retrieval**
   - Navigating NCBI, EMBL, DDBJ, and UniProt databases.
   - Downloading nucleotide and protein sequences in FASTA and GenBank formats.
   - Searching microbial-specific databases (MG-RAST, IMG, KEGG).

2. **Sequence Alignment**
   - Pairwise sequence alignment using BLAST (nucleotide and protein).
   - Interpreting BLAST results (E-value, score, identity).
   - Performing Multiple Sequence Alignment (MSA) using Clustal Omega/MUSCLE.

3. **Phylogenetic Analysis**
   - Construction of phylogenetic trees using MEGA or PhyML.
   - Bootstrap analysis for tree reliability.
   - Application of phylogenetics in microbial taxonomy case study.

4. **Statistical Data Handling & Visualization**
   - Creating bar charts, scatter plots, heatmaps from microbiological datasets using statistical softwares.
   - Simple correlation and regression analysis on microbial growth or gene expression data.

5. **Project-based Mini Assignment**
   - Retrieve sequences of a microbial gene/protein of interest.
   - Perform alignment, build a phylogenetic tree, and interpret evolutionary relationships.

U.G (VIII semesters) – Microbiology (Honours and Research)

Core Major-III (Theory)
Laboratory Methods in Microbiology

Credits: 5 **75 h**

Unit I: Advanced Microscopy and Biosensors (15 h)

Microscopy: *Light microscopy*: Phase contrast microscopy, Fluorescence microscopy, Total Internal Reflection Fluorescence (TIRF) microscopy, and confocal microscopy; Scanning and transmission electron microscopy; Atomic Force Microscopy (AFM). Biosensors: Introduction to Biosensors and their evolution; Cell-based biosensors; DNA-based biosensors.

Unit II: Centrifugation Technologies (15 h)

Basic Principles: Centrifugal force, sedimentation rate, sedimentation coefficient. Types and Applications: Clinical, micro, high-speed, ultracentrifuges, industrial centrifuges; Fixed-angle, swinging bucket, zonal, and continuous flow rotors. Density gradient ultracentrifugation.

Unit III: Modern Chromatography Techniques (15 h)

Basic Principles: Adsorption, partitioning, and separation efficiency. Techniques: Adsorption, ion-exchange, affinity, size exclusion, thin-layer, gas chromatography (GC), High-performance liquid chromatography (HPLC) and Ultra High-Performance Liquid Chromatography (UHPLC).

Unit IV: Electrophoretic Techniques (15 h)

Core Concepts: Charge-based separation and gel systems. Types: Paper, moving boundary, isoelectric focusing, SDS-PAGE, native PAGE, reducing PAGE, Disc electrophoresis, Pulse Field Gel Electrophoresis (PFGE).

Unit V: Spectroscopy, Mass Spectrometry, and Radiotracer Technology (15 h)

Core Techniques: UV-Vis, IR, Fluorescence spectroscopy. Principle and applications of NMR; Mass Spectrometry; Radiotracers and radioactivity detection: GM counter & scintillation counters.

Practical based on Core major III
Laboratory Methods in Microbiology (Practical)
Major Practical - II

Credits: 3 **90 h**

1. Separation and identification of amino acids by ascending and descending paper chromatography.
2. Separation and identification of sugars by paper chromatography.
3. Separation and identification of sugars by thin-layer chromatography.
4. Verification of Lambert-Beer's law.
5. Separation and determination of molecular weight of proteins by SDS-PAGE.
6. Interpretation of UV spectra.
7. Interpretation of IR spectra.
8. Interpretation of NMR spectra.
9. Interpretation of Mass spectra.

Suggested Readings

1. Wilson, K. and Walker, J. Principles and techniques of biochemistry and molecular biology. Cambridge University Press, Cambridge.
2. Robyt, J.F. and White, B.J. Biochemical techniques: Theory and practice. Waveland Press, Long Grove.
3. Chatwal, G. and Anand, S. Instrumental methods of chemical analysis. Himalaya Publishing House, Mumbai.
4. Hamilton, R.J. and Sewell, P.A. Introduction to high performance liquid chromatography. Chapman and Hall Limited, London.
5. Sharma, V.K. Techniques in microscopy and cell biology. Tata McGraw-Hill, New Delhi.
6. Hames, B.D. Gel electrophoresis of proteins: A practical approach. Oxford University Press, Oxford.
7. Wilson, Keith, Andreas Hofmann, John M. Walker, and Samuel Clokie, eds. *Wilson and Walker's principles and techniques of biochemistry and molecular biology*. Cambridge university press, 2018.Keeler, J. Understanding NMR spectroscopy. John Wiley and Sons, New York.
8. Davies, A.M.C. and Creaser, C.S. Analytical applications of spectroscopy. Royal Society of Chemistry, California.
9. Wang, C.H. and Willis, D.L. Radiotracer methodology in biological science. Prentice Hall, New Jersey.
10. Sambrook, J. and Russell, D.W. Molecular cloning: A laboratory manual. Cold Spring Harbor Lab Press, New York.

Core Major Elective - II (Theory) - Introductory Immunology

Credits: 3 **45 h**

Unit I: Immune System and Immunity (15 h)

History of immunology; Innate and acquired immunity; Determinants of innate immunity; Hematopoiesis; Cells and organs of immune system: B lymphocyte, T lymphocyte, NK cells, Monocyte/Macrophages, Dendritic cells, Eosinophils, Basophils, Neutrophils, Mast cells, Organization and structure of lymphoid organs and their role in immunity; Humoral and cell-mediated immunity.

Unit II: Antigens and Antibodies (10 h)

Antigens: Structure and properties; Haptens; Adjuvants; Immunogenicity; Immunoglobulin: Structures, Heterogeneity, Types and subtypes, Properties (Physiochemical and biological), Antibody effector mechanism, Antibody receptors, Antibody diversity, Theories of antibody production, Effect of somatic mutations on the antibody diversity, Recombinant antibodies, Hybridoma technology.

Unit III: Complement system and Cytokines (10 h)

Complement System: Structure, properties and functions of different components, Complement activation pathways (Classical, alternate and lectin pathways), Biological consequences of complement activation, Complement assay; Structure and function of various cytokines; Cytokine receptors.

Unit IV: Immunopathology and Transplantations (10 h)

Immunopathology: Rh- blood groupings, Hypersensitivity reactions (Antibody mediated type I, anaphylaxis, type II- antibody dependent cell cytotoxicity, type III-immune complex mediated reactions and type IV-delayed hypersensitivity reactions); Transplantation: Graft vs. host reaction and rejection.

Core Major Elective - II (Practicals) - Introductory Immunology

Credits: 1 **30 h**

1. Separation and preservation of serum and plasma.
2. Determination of blood group and Rh factor.
3. Quantitative estimation of antigen by radial immunodiffusion.
4. Determination of concentration of antigen by sandwich ELISA/Dot-ELISA method.

Suggested Readings (Theory and Practical)

1. Punt, P., Stranford, S., Jones, P., Owen, J.A. Kuby Immunology. W.H. Freeman and Company, New York.
2. Male, D.K. Immunology: An illustrated outline. Elsevier Health Sciences, Philadelphia.
3. Spec, A., Escota, G., Davies, B, O'Halloran, J., (2025), Comprehensive Review of Infectious Diseases, 2nd Edition. Elsevier
4. Abbas, A.K., Lichtman, A.H.H. and Pillai, S. Cellular and molecular immunology. Saunders, Philadelphia.
5. Delves, P.J., Martin, S.J., Burton, D.R. and Roitt, I.M. Roitt's essential immunology. Wiley-Blackwell, New Jersey.
6. Tizard, I.R. Immunology: An introduction. Saunders, Philadelphia.
7. Playfair, J.H.L. Immunology at a glance. Blackwell Scientific Publications, Oxford.
8. Abbas, A.K. and Lichtman, A.H.H. Basic immunology: Functions and disorders of the immune system. Saunders, Philadelphia.
9. Chapel, H., Haeney, M., Misbah, S. and Snowden, N. Essentials of clinical immunology. Wiley, New Jersey.
10. Coico, R. and Sunshine, G. Immunology: A short course. Wiley- Blackwell, New Jersey.
11. Gerald B. Pier, Jeffrey B. Lyczak, Lee M. Wetzler, Immunology, Infection, and Immunity, ASM Press
12. Frank C. Hay, Olwyn M. R. Westwood, Practical Immunology, Wiley-Blackwell
13. Miller, L. E., Christine, D. S. (2021) Clinical Immunology and Serology: A Laboratory, F A Davis Co
14. Read review articles and research papers related to this syllabus published recently in reputed journals.

Minor-II-Fundamentals of Epidemiology (Theory)

Credits: 2 **30 h**

Unit I – Introduction to Epidemiology (15 h)

- Definition, scope, and history of epidemiology.
- Basic concepts: incidence, prevalence, morbidity, mortality, case fatality rate.
- Types of epidemiological studies: descriptive, analytical, and experimental.
- Epidemiological triad (agent–host–environment).
- Emerging and re-emerging infectious diseases – global perspective.

Unit II – Disease Transmission & Dynamics (15 h)

- Modes of transmission: direct, indirect, airborne, vector-borne, zoonotic.
- Chain of infection and breaking the chain.
- Reservoirs of infection in humans, animals, and the environment.
- Dynamics of disease occurrence: endemic, epidemic, pandemic, sporadic.
- Mathematical models in epidemiology (basic reproduction number R_0, herd immunity concept).

Suggested Readings

1. Nelson, K.E., & Williams, C.M. (2014). *Infectious Disease Epidemiology: Theory and Practice*. Jones & Bartlett Learning.
2. Ryan, K., & Ahmad, N. (2018). *Sherris Medical Microbiology*. McGraw-Hill.
3. Park, K. (2021). *Preventive and Social Medicine*. Banarsidas Bhanot Publishers.
4. Jawetz, E., Melnick, J.L., & Adelberg, E.A. (2022). *Medical Microbiology*. McGraw-Hill.

Minor-II-Fundamentals of Epidemiology (Practicals)

Hours: 30 **Credits: 2**

1. **Epidemiological Data Analysis**
   - Calculation of incidence, prevalence, morbidity, and mortality rates using sample datasets.
   - Epidemic curve plotting and interpretation.
2. **Food Microbiology for Public Health**
   - Isolation of foodborne pathogens (e.g., *E. coli*, *Salmonella*) from food samples.
   - Detection of contamination by standard microbiological methods.
3. **Bioinformatics in Epidemiology**
   - Using online databases for disease tracking (e.g., WHO, CDC).
   - Data visualization using spreadsheet tools.

Suggested Readings

1. Alan J. Silman, Gary J. Macfarlane (2002). *Epidemiological Studies: A Practical Guide: A Practical Guide* . Cambridge University Press.