जम्मू केंद्रीय विश्वविद्यालय

Central University of Jammu

राया–सूचानी; बागला, जिला सांबा–181143 जम्मू; जम्मू एवं कश्मीर
Rahya- Suchani (Bagla), District Samba-181143, Jammu (J&K)

No. CUJ/Acad/II-15/11/2020/111

12th March, 2020

NOTIFICATION No. 22/2020

Sub: Course Scheme and Syllabus for Ph.D. in Life Science (Molecular Biology) offered by Centre for Molecular Biology w.e.f. Academic Session 2019 -20 – Reg.

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It is hereby notified for the information of all concerned that on the recommendation of the Board of Studies of Centre for Molecular Biology and Dean, School of Life Sciences, the Academic Council has approved the following **Course Scheme** and **Syllabus** for **Ph.D. in Life Science (Molecular Biology)** offered by Centre for Molecular Biology w.e.f. Academic Session **2019-20.** The approved course scheme and syllabus are as follows:

Course Code	Course Title	Credit	CIA	MSE	ESE	Max Marks
Core Courses						
PHMOL1C001T	Research Methodology	4	25	25	50	100
PHMOL1C002T	Advances in Molecular Biology	4	25	25	50	100
PHMOL1C003S	Synopsis Preparation and Presentation	4	25	25	50	100
Elective Courses (Any One)						
PHMOL1E001T	Advances in Probiotics and Host Microbiome	4	25	25	50	100
PHMOL1E002T	Molecular Genetics	4	25	25	50	100
PHMOL1E003T	Protein Engineering & Enzyme technology	4	25	25	50	100
PHMOL1E004T	Microbial Pathogenicity	4	25	25	50	100
Total		**16**	-	-	-	**400**

12/3/2020
Deputy Registrar
(Admin – HR)

Encl: Syllabus for Ph.D. in Life Science (Molecular Biology)

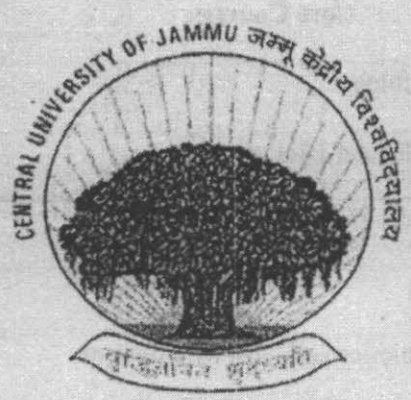
To:
Head, Centre for Molecular Biology

Copy to:
Controller of Examinations

Syllabus

Ph.D. Life Science (Molecular Biology)

(*w.e.f.* 2019-20)



Centre for Molecular Biology

CENTRAL UNIVERSITY OF JAMMU

JAMMU, J&K

PHMOL1E001T

PAPER I: RESEARCH METHODOLOGY

Course Code: Credits 4

Course description: This course emphasizes on research methodology or involves specific techniques that are adopted in research process to collect, assemble and evaluate data. It defines those tools that are used to gather relevant information in a specific research study.

Learning objectives: The students should be able to understand some basic concepts of research and its methodologies, identify appropriate research topics, select and define appropriate research problem and parameters, prepare a project proposal, organize and conduct research in a more appropriate manner and write a research report and thesis.

Unit I: Defining the research problem

1.1. Identification of research areas; Review of literature; Research gap analysis; Methodology for literature review;

1.2. Defining objectives; Research design, Sampling, Expected outcomes

Unit II: Approaches and Methodology

2.1. Experimental design to address the problem; Data collection approach; Tools and techniques required to address the problem;

2.2. Protocol design; Documentation of the experiments and results; Data analysis and interpretation; presentation of the data; Manuscript preparation.

Unit III: Advanced Analytical Techniques

3.1. Basic techniques in Microscopy, Spectroscopy, Spectrometry

3.2. Chromatography, Centrifugation, Electrophoresis, Cell disruption, Analysis and separation of biomolecules.

Unit-IV: Core Techniques of Molecular Biology

4.1. Cloning and expression vectors, molecular cloning methodologies, genomic and cDNA libraries, reverse genetics, site directed mutagenesis;

4.2. Protein expression, blotting techniques, Next Generation Sequencing (NGS) and Protein sequencing methodologies.

Unit V: Bioinformatics and statistics

5.1. Introduction, basic concepts, resources, sequence databases: Nucleic acid and Protein sequence databases, protein structure Databases, Sequence Analysis: Basic concepts of sequence similarity, identity and homology, Sequence alignment and data analysis.

5.2. Introduction, basic concepts, data types and applications of biostatistical tools. Frequency distribution, dispersions, Central tendency, Regression and Correlation. Probability distribution, t-test, Chi-square test, statistical analysis software, Analysis of variance (ANOVA), Design of experiments.

Suggested Readings:

1. Wilson K and Walker J. Principles and Techniques of Biochemistry and Molecular Biology. (2018). Cambridge University Press. 8th edition.
2. Bisen PS & Sharma A. Introduction to Instrumentation in Life Sciences. (2012). CRC Press. 1st edition.
3. Freifelder DM. Physical Biochemistry: Applications to Biochemistry and Molecular Biology (1983). W. H. Freeman. 1st edition.
4. David S. Physical Biochemistry: Principles and Applications. (2009). Wiley-Blackwell. 2nd edition.
5. Brown SM, Next-generation DNA Sequencing Informatics. (2015). Cold Spring Harbor Laboratory Press. 2nd edition
6. David WM. Bioinformatics Sequence and genome analysis. (2006). Cold Spring Harbor Laboratory press. 2nd edition.
7. Primrose SB. Principles of Gene Manipulation and Genomics. (2013). 7th edition.
8. Bruce Alberts, J.D. Watson. Molecular Biology of the cell (2008) Garland publishing Inc., N.Y. 5th edition
9. Brown TA. Gene Cloning and DNA Analysis. (2016). John Wiley & Sons Inc. 7th edition.
10. Recent reviews and research articles published on relevant topics like International Review of Cell and Molecular Biology, Nature reviews Molecular Cell Biology, TRENDS journals/ Trends in Cell Biology/ Trends in Biochemistry/Trends in Molecular Medicine/ Trends in Biotechnology/ Trends in Genetics.

PHMOL1C002T

PAPER 2: ADVANCES IN MOLECULAR BIOLOGY

Course Code: **Credits 4**

Course description: Course dealing with the molecular basis of cellular function, with emphasizes upon modern developments, and the foundation for practical applications of this knowledge. The course will involve the conceptual background necessary to appreciate the applications of molecular biology.

Learning objectives: The advances in molecular biology gives in-depth knowledge to students about advances in biological processes at molecular level through the investigation of the underlying mechanisms.

Unit I Genome organization

1.1. Gene structure and organization: Prokaryotic and Eukaryotic genes structural organization -regulatory elements of genes, coding region and terminal region of the genes.

1.2. Genome replication, DNA damage and repair, Transcription and translation.

Unit II Genome and Gene regulation

2.1. Gene regulation Transcriptional and post-transcriptional gene silencing, housekeeping genes and tissue specific gene regulation.

2.2. Regulation of gene expression in eukaryotic: DNA binding proteins; Helix turn Helix proteins, Helix loop helix proteins, Helix turn beta, Zinc finger proteins, leucine zipper proteins and homeodomain proteins.

Unit III Recombinant DNA technology

3.1 Enzymes used in molecular biology and recombinant DNA research, important enzymes such as RNA replicase, reverse transcriptase, ligase, polymerase, ribozyme, restrictions etc., cloning and expression vectors: plasmid, Lamda (λ), Cosmid, M13, phagmid and viral vector for animal cells, synthetic chromosomes BAC, YAC and PAC.

3.2 Transformation and Plasmid isolation; PCR; DNA sequencing methods, Global expression profiling; Whole genome analysis of mRNA and protein expression; Real time PCR, Microarrays and their applications

Unit IV Proteomics

4. .Proteomics: strategies in proteomics, protein-protein interaction, mapping of protein interaction, applications of proteomics. Protein separation quantification and identification:

4.2. Applications of proteomics, Drug discovery, Disease diagnosis, identification and characterization of novel proteins

Unit V Disease diagnosis and gene therapy

5.1. Diseases diagnostics: Methods of DNA analysis, diagnosis of infectious diseases, Identifying genetic diseases. gene therapy: Introduction, vectors in gene therapy, advances in gene therapy, safety assurances,

5.2. Nanobiotechnology: Introduction, Definitions and current practice, Types of nanomaterials and their classifications, Applications of Nano-Materials in Biosystems, Nanomaterials and Diagnostics/Drug Delivery and Therapeutics

Suggested reading

1. Cooper and Hausman; The Cell: A molecular approach; Sinauer Associates Press; 8th edition
2. Behlke MA, Berghof-Jäger K, Brown T, et al.; Polymerase Chain Reaction: Theory and Technology, 2019; Caister Academic Press.
3. Karp G, Iwasa J, and Marshall W; Karp's Cell Biology, 2018; Wiley-Blackwell Press
4. Krebs JE, Goldstein ES, Kilpatrick ST; Lewin's Genes XII, 2017. Jones & Bartlett Learning.
5. *Lodish H, Berk A, et al.; Molecular Cell Biology; WH Freeman Press; 8th edition.*
6. T. A. Brown; Genome 3, 2007; Garland Science Press; 3rd Edition.
7. Wilson and Walker; Principles and techniques of biochemistry and molecular biology; Cambridge University Press; 8th edition.
8. Campbell MA; Discovering genomics, proteomics and bioinformatics, 2006; Pearson Education Limited. 2nd Edition.
9. Green MR, Sambrook J; Molecular Cloning: A Laboratory Manual, 2012; Cold Spring Harbor Laboratory Press.
10. Primrose SB; Principles of gene manipulation and genomics, 2006;" Oxford Press; 7th Edition.

PHMOL1E001T

ELECTIVE 1: ADVANCES IN PROBIOTICS AND HOST MICROBIOME

Course Code: **Credits 4**

Courses description: The course provides a comprehensive overview of gut microbiota and metabolomics research from molecular analysis to population-based global health considerations.
Learning objectives: To familiarize the students with the various aspects of probiotics and host microbiome for the betterment of human life.

Unit I: Probiotics

1.1. Introduction and history of Probiotics, Probiotic microorganisms, safety of probiotic microorganisms, legal status of probiotics, identification of probiotics by molecular method, characteristics of probiotics for selection and maintenance of probiotic microorganisms.

1.2. Role of probiotics in health and disease: prevention and treatment of gastrointestinal bacterial infection, constipations, urinary tract infection, antihypertensive and cholesterol level.

Unit II: Mechanism of probiotics

2.1. Mechanism of probiotics: enhancement of the epithelial barrier, increase adhesion to intestinal mucosa, and concomitant inhibition of pathogen adhesion, complete exclusion, production of antimicrobial substances.

2.2. Modulation of immune system, Interaction of probiotics with the gut-associated immune system, TLR and probiotics, modification of intestinal bacterial metabolite action, alteration of microecology of healthy and dysbiosis human's gut.

Unit III: Prebiotics and health benefits

3.1. Prebiotics: concept, definition, criteria, types and sources of prebiotics, prebiotics and gut microflora.

3.2. Prebiotics and health benefits: mineral absorption, immune response, cancer prevention, IBD, elderly health and infant health, prebiotics in foods.

Unit IV: Human microbiome

4.1. Microbiome: An introduction of human microbiome, human gut, oral and skin microbiota, human gut microbiota diversity and its consequence on the human health.

4.2. Gut microbiota profiling, current research methods of microbiome analysis, human gut microbiota and immunity, role of microbiome in therapeutic and diagnostic.

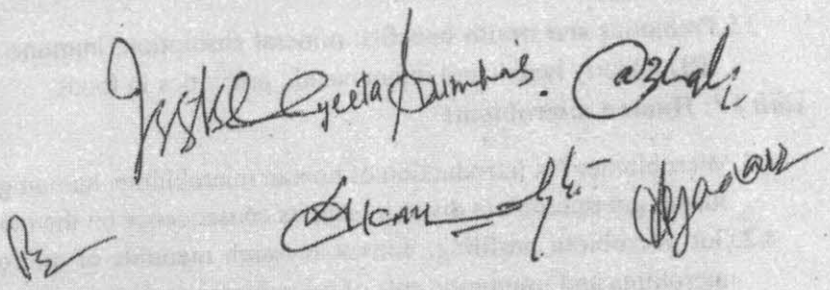
Unit V Metabolomics

5.1 Introduction to metabolomics and its application, integrated microbiome and metabolome analysis, metabolomics-based approach to identify compounds affecting human health.

5.2 Metabolomics resources and analysis; metabolites identification and characterization, metabolomics in practice and case study from literature. Opportunities and challenges in nutritional genomics and metabolomics.

Suggested readings

1. Brown SM, Next-generation DNA Sequencing Informatics. (2015). Cold Spring Harbor Laboratory Press. 2nd edition
2. David WM. Bioinformatics Sequence and genome analysis. (2006). Cold Spring Harbor Laboratory press. 2nd edition
3. Edward I. Gut Microbiota: Interactive effect on nutrition and health. (2018). Academic Press. 1st edition.
4. Faintuch J and Faintuch S. Microbiome and Metabolome in Diagnosis, Therapy, and other Strategic Applications. (2019). Academic Press. 1st edition.
5. Fanos V. Metabolomics and Microbiomics. (2016). Academic Press. 1st edition.
6. Glenn RG and Marcel R. Handbook of Prebiotics. (2008). CRC press. 1st edition.
7. Jenny Gu and Bourne PE. Structural Bioinformatics. Wiley-Blackwell; 2nd edition.
8. Kochhar S. and Martin FP. Metabolomics and Gut Microbiota in Nutrition and Disease. (2015). Springer London Heidelberg New York Dordrecht. 1st edition.
9. Lee YK and Salminen S. Handbook of Probiotics and Prebiotics. (2009). A John Willey and Sons Inc. Publication. 2nd edition.
10. Maria A and Moise R. The Gut Microbiome: Exploring the Connection between Microbes, Diet, and Health. (2017). Greenwood. 1st edition.



PHMOL1E002T

ELECTIVE 2: MOLECULAR GENETICS

Course Code: **Credits 4**

Course description: This course is designed to make students familiar with the field of basic and advanced molecular genetics. Open discussions of fundamental topics of molecular genetics will also be conducted.

Learning outcome: Provide students with an understanding of a) organization of genome and the concept of genes b) inheritance of genetic information in living organisms c) causes of variation in the genetic material d) genetic models used for the study of molecular genetics e) genetics of human diseases e) concepts of genomics, epigenomics, and transcriptomics.

Unit I: Chromosome, genome and gene

1.1. Chromatin and Chromosome organization: Histones, nucleosome and higher-level organization; Functional states of chromatin and alterations in chromatin organization. Metaphase chromosomes, centromere and kinetochore, telomere and its maintenance, holocentric chromosomes, heterochromatin and euchromatin, position effect variegation, Chromosomal domains (matrix, loop domains) and their functional significance.

1.2. Genome and the concept of gene: Organization of nuclear and organellar genomes, C-value paradox, Repetitive DNA-satellite DNA and interspersed repeated DNAs, Transposable elements, LINES, SINES, Alu family and their application in genome mapping. Fine structure of gene, split genes, pseudogenes, non-coding genes, overlapping genes and multi-gene families.

Unit II: Inheritance, variation and genetic models

2.1 Inheritance and genetic models; Laws of inheritance, Linkage and linkage disequilibrium, Chromosome inheritance, Cytoplasmic inheritance, Sex-linked inheritance, Quantitative inheritance. Genetic models-E. coli, Yeast, Arabidopsis, Drosophila, C. elegans, Mouse.

2.2. Mutation and chromosome variations; Classification, mechanism, repair, role in evolution. Ploidy (Polyploidy, aneuploidy), chromosomal rearrangements - duplication, deletion, inversion, and translocation.

Unit III: Molecular evolutionary genetics

3.1. Genetic variability in population: Nucleotide sequence variation, adaptive genetic polymorphism, balanced polymorphism.

3.2. Molecular evolution and Phylogenetics: Molecular evolution, molecular clock. Construction of phylogenetic tree using nucleotide and protein sequences, DNA-DNA hybridization, nucleotide sequence comparison, amino acid sequence comparison, homology.

Unit IV: Genetics of Diseases

4.1. Chromosomal, Single gene and epigenetic disorders: Structural and numerical, Autosomal/sex chromosomal, Some examples (Syndromes/Cancer/Infertility). Inborn errors of metabolism, haemoglobinopathies. Mechanisms-Imprinting/methylation, chromatin remodeling); Current understanding; examples. Mitochondrial myopathies.

4.2. Candidate gene identification; Genetic polymorphism and disease susceptibility; Association studies- markers from candidate gene/pathways; whole genome association (Single nucleotide polymorphism, CNVs); Sporadic cases; Common examples.

Unit V: Omics

5.1 Genomics and Epigenomics: Introduction to genomics, genomic sequencing, gene annotation, metagenomics. Introduction to epigenomics, DNA methylation, Chip-seq technology, chromatin topology.

5.2 Transcriptomics: Introduction to Transcriptomics, Overview of Non-Coding RNAs and iCLIP, Coding RNA, scRNA – seq, Metatranscriptomics, Assembly and Annotation.

Suggested readings

1. Klug WS, Cummings MR., Spencer CA, Palladino MA; Concepts of Genetics, 2013; Pearson Education Inc.
2. Krebs JE, Goldstein ES, Kilpatrick ST.; Lewin's Genes XII, 2017; Jones & Bartlett Learning.
3. Brown TA, Brown T; Introduction to Genetics: A Molecular Approach, 2012; Garland Science Press.
4. Russell PJ; iGenetics: A Molecular Approach, 2017; 3rd edition.
5. Brooker RJ; Genetics: Analysis and Principles, 2005; McGraw-Hill Higher Education.
6. Snustad DP, Simmons MJ; Genetics, 2011; Wiley-Blackwell Press; 6th Edition.
7. Pevsner J; Bioinformatics and functional genomics, 2015; Wiley-Blackwell Press.
8. Nielsen R and Slatkin M; An introduction to population genetics theory and applications, 2013; Sinauer Associates, Inc. Publishers Sunderland, Massachusetts U.S.A.
9. Campbell MA and Heyer LJ; Discovering genomics, proteomics and bioinformatics, 2009; Pearson Education Inc. 2nd Edition.
10. William K. Essentials of genetics, 2015; Pearson Education Inc. 9th Edition

PHMOL1E003T

ELECTIVE 3: PROTEIN ENGINEERING AND ENZYME TECHNOLOGY

Course Code:

Credits 4

Course Objective: The objective of the course is to provide students with an understanding of fundamentals of enzyme structure and function and kinetics of soluble and immobilized enzymes, as they are produced and applied in biotechnological industries. To impart knowledge on various protein structures and to learn and understand the strategies of protein engineering.

Learning outcome: On successful completion of this course the students will be able to understand the basics of enzyme, structure, function, enzyme kinetics, enzyme immobilization, protein engineering, protein purification and the applications of enzymes in different industries.

Unit I: Protein structure and function

1.1. Introduction to protein engineering; physicochemical classification of amino acids, and their –R groups; conformation of proteins, the Ramachandran plot, folding, tertiary structure and structural domains and motifs of proteins.

1.2. Aanalysis of protein structure by CD spectroscopy, MALDI-TOF, NMR, X-ray diffraction studies; prediction of protein structure and conformation from sequence data, relationship between structure and function.

Unit II: Protein Engineering and Design

2.1. Methods in protein engineering and design – physical, computational, biochemical and molecular techniques; protein engineering in lipase class of enzymes; chemical modifications of proteins

2.2. Protein design, in vivo and in vitro mutagenesis (random, semi random), site directed mutagenesis, sequence comparisons and predictions, directed evolution, DNA shuffling, examples.

Unit III: Enzyme and Enzyme Technology

3.1 Aim and scope of enzymes and enzyme technology, classification of enzymes, sources of enzymes, approaches for isolation and screening strategies for novel enzymes, media for enzyme production, purification of enzyme,

3.2. Enzyme assay methods, specific activity, activity units, advantages of enzyme catalysis, chemo-, regio-, and enantioselectivity, biotransformation with isolated enzyme and whole cells, business, major manufacturers of enzymes in India and World.

Unit IV: Enzyme kinetics and Mechanism

4.1 Mechanism of enzyme catalysis, concept of active site and energetics of enzyme, Michaelis-Menten parameters, determination of V_{max}, K_m, K_{cat}, turnover number, Lineweaver-Burk plots.

4.2 Effect of pH, ionic strength, temperature and pressure on enzyme activity, reversible reaction, enzyme inhibition, substrate and product inhibition, competitive, non-competitive, uncompetitive and mixed inhibition.

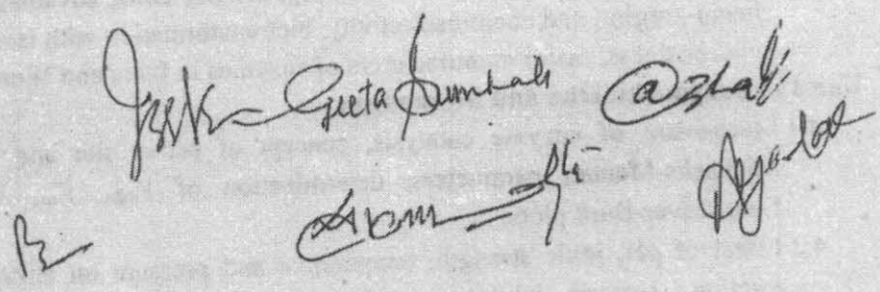
Unit V: Immobilised enzymes and enzyme biosensor

5.1. Application of enzymes in analysis, types of biosensors, calorimetric, potentiometric, amperometric, optical piezoelectric biosensors and immunosensors.

5.2. Enzyme reactors, design of immobilized enzyme reactors, selection of bioprocess equipment (upstream and downstream) stirred tank reactors, plug flow reactors, continuous flow stirred tank fluidized bed reactor, membrane/hollow fiber reactors, batch and fed-batch bioreactors, continuous bioreactors, bioreactor operation.

Suggested Reading:

1. Kun LY. Microbial Biotechnology: Principles and Applications. World Scientific Publishing Company. (2013). 4th edition
2. Weetal H. Immobilized enzyme technology: Research and applications. (2012) Springer science and Bussiness media. 1st edition.
3. El-Mansi EMC, Nielsen J, Mousdale D, Carlson RP. Fermentation Microbiology and Biotechnology. (2019). CRC Press. 4th edition.
4. Trevor P. Enzymes: Biochemistry, Biotechnology and Clinical Chemistry. (2007). Horwood Publishing Limited, United Kingdom. 2nd edition.
5. Brown SM, Next-generation DNA Sequencing Informatics. (2015). Cold Spring Harbor Laboratory Press. 2nd edition.
6. Price N and Stevens L. Fundamentals of enzymology. (2009). Oxford University Press, India. 3rd edition.
7. Sambrook J and Russel DW. Molecular Cloning: A Laboratory Manual, Vols 1-3. (2001). Cold Spring Harbor Laboratory Press. 3rd edition.
8. Brown TA, An Introduction: Gene Cloning and DNA Analysis. (2007). Wiley-Blackwell. 6th edition.
9. Stanbury P, Whitaker A and Hall S. Principles of Fermentation Technology. (1997) Butterworth Heineman, Aditya Books (P) Ltd. 2nd edition.
10. Shuler M and Kargi F. Bioprocess Engineering: Basic Concepts. (2002). Pearson Education. 2nd edition.



PHMOL1E0047

ELECTIVE IV: MICROBIAL PATHOGENICITY

Course Code: **Credits – 4**

Course objective: This course aims to apprise researchers about the role of microbes as pathogens. Students will be imparted knowledge of different fundamentals concepts and specialized knowledge of medical and diagnostic microbiology. It will help to create skilled professionals with expertise in molecular diagnosis of diseases.

Learning outcome: Study of this course will contribute to clinical research in industries and academicia.

Unit I Classical view of microbial pathogenicity

1.1. Normal flora of human body, Introduction to bacterial diseases *i.e* Gram positive bacteria Gram negative bacteria of medical importance

1.2. Introduction to medically important fungi and diseases caused, General characters & classification of significant human parasites

Unit II Current perspective of microbial pathogenicity

2.1. Epidemiology and biology of emerging and re-emerging microbial pathogens, Disease outbreaks, integrated disease surveillance program by National Centre for disease control- Ebola, Swine Flu, SARS, Plague, Dengue, Zika, Chikungunya

2.2. Current topics in fungal, bacterial and viral genetics with the emerging knowledge of sequence databases available and ongoing projects

Unit III Molecular basis of disease development

3.1 Understanding the mechanisms available for genetic variability in different pathogens to defy host immune system, Role of bacterial adhesions and virulence factors in inducing pathogenicity

3.2. Host signaling in response to infections, general concepts in the molecular mechanism of gene transfers and their significance

Unit IV Advances in disease detection

4.1. Current DNA/RNA and protein based approaches in clinical microbiology in diagnosis of out breaks/infections used in routine and advanced clinical microbiology laboratories

4.2. Use of next generation sequencing approaches in qualitative and quantitative microbial assays-their introduction and significance

Unit V Control of microbial pathogenesis

5.1 Advances in the field of antimicrobials and vaccine technology in combating microbial diseases

5.2 Molecular basis of antimicrobial resistance, Case studies on Tuberculosis with emergence of MDR, XDR and TDR TB.