MULTIDISCIPLINARY CENTRE FOR ADVANCED RESEARCH AND STUDIES

Outline for the Syllabus for MSc Virology

(100 credits=2500 marks)

Note: The marks distribution for the final examination and internal assessment will be as per the JMI rules.

S. No.	Paper code	Paper title	Credits	Maximum Marks
FIRST SEMESTER				
01	MMV-101	Basic Microbiology	4	100
02	MMV-102	Introduction to Animal Viruses	4	100
03	MMV-103	Introduction to Plant Viruses	4	100
04	MMV-104	Biochemistry and Cell Biology **(CBCS)**	4	100
05	MMV-105	Immunology	4	100
06	MMV-106	Lab Course-I	4	100
SECOND SEMESTER				
07	MMV-201	Molecular Genetics	4	100
08	MMV-202	Molecular Biology **(CBCS)**	4	100
09	MMV-203	Pathogenesis and Epidemiology	4	100
10	MMV-204	OMICs-based Technology and Bioinformatics	4	100
11	MMV-205	Biostatistics and Data analysis	4	100
12	MMV-206	Recombinant DNA Technology **(SWAYAM)**	4	100
13	MMV-207	Lab Course-II	4	100
THIRD SEMESTER				
14	MMV-301	Viral Diagnostics	4	100
15	MMV-302	Computational Structure Based-Drug Designing **(SWAYAM)**	4	100
16	MMV-303	Viral Vectors and Gene Therapy	4	100
17	MMV-304	Antiviral and Viral Vaccines	4	100
18	MMV-305	Emerging Viruses and Oncoviruses	4	100
19	MMV-306	Research Ethics, Biosafety and Science Communication **(CBCS)**	4	100
20	MMV-307	Lab Course-III	4	100
FOURTH SEMESTER				
21	MMV-401	Indian Traditional Knowledge System **(SWAYAM)**	2	50
22	MMV-402	Entrepreneurship and IPR **(SWAYAM)**	2	50
23	MMV-403	MSc Dissertation and Viva Voce	16	400
Total Credits/Marks			**100**	**2500**

SYLLABUS

FIRST SEMESTER

MMV-101: Basic Microbiology (4 Credits=100 Marks)

Unit-I: Fundamentals of Microbiology (15 Hours):
History and Scope of Microbiology: Contributions of Leeuwenhoek, Pasteur, Koch, and others, Spontaneous generation vs. germ theory, Classification and Taxonomy of Microorganisms. 16srRNA based classification. Microbial Cell Structure and Function: Prokaryotic vs. eukaryotic cell structure, Bacterial cell wall (Gram-positive, Gram-negative), Bacterial transport system. Microbial Growth and Nutrition: Growth phases, generation time, Culture media: types and preparation.

Unit-II: Antimicrobial Therapy and Resistance (15 Hours)
Recent advancements in microbial diagnostics and pathogen detection techniques (including molecular and culture-independent methods). Principles of antibiotic therapy and mechanism of action: Inhibitors of cell wall synthesis (e.g., β-lactams, glycopeptides)., Inhibitors of protein synthesis (e.g., aminoglycosides, macrolides, tetracyclines), Inhibitors of nucleic acid synthesis (e.g., quinolones, rifampin). Concept of Antimicrobial Resistance (AMR): Mechanisms of resistance: enzymatic degradation, efflux pumps, target modification, Horizontal gene transfer and its role in resistance spread, Global health impact and strategies to combat AMR.

Unit-III: Microbiological Techniques and Laboratory Diagnostics (15 Hours)
Techniques for pure culture isolation: streak plate, pour plate, and spread plate methods, Serial dilution and quantification methods (e.g., CFU counting), Cultivation of aerobic and anaerobic bacteria: special requirements and equipment, Growth factors, types of culture media (selective, differential, enriched), and bacterial preservation methods. Microscopy and staining techniques: Gram staining, acid-fast staining, spore staining. Determination of Minimum Inhibitory Concentration (MIC): broth dilution and agar dilution methods. Methods of specimen collection and transport for pathological examination (e.g., swabs, blood, urine, sputum). Microbiological Diagnostics in Clinical Settings: Conventional and molecular methods for disease diagnosis (culture-based, PCR, ELISA, rapid tests), Role of next-generation sequencing and metagenomics in clinical microbiology.

Unit-IV: Applications of Microbiology in Human Health and Therapeutics (15 Hours)
Role of Microbiota in Health and Disease: Human microbiome composition (gut, oral, skin, etc.), dysbiosis and its association with diseases (e.g., IBD, obesity, diabetes). Probiotics, prebiotics, and synbiotics in health maintenance and disease prevention. Therapeutic Applications of Microorganisms: Production of antibiotics, enzymes, vitamins, and immunomodulators, Microbial fermentation for biopharmaceuticals (e.g., insulin, vaccines, monoclonal antibodies), Use of genetically engineered microbes in therapeutic delivery. Microbiome and Precision Medicine: Use of microbiome data in personalized treatment strategies, Fecal microbiota transplantation (FMT), microbiome-based diagnostics, and future of microbiome therapeutics.

Recommended Books & references:

- Molecular Microbiology: Diagnostic Principles and Practice David H. Persing, Fred C. Tenover, James Versalovic, Yi-Wei Tang, Elizabeth R. Unger, David A.; Relman, and Thomas J. White, (Eds.) ASM Press 2003 ISBN: 155581221X.
- Jawetz, Melnick, & Adelberg's Medical Microbiology (2004), Geo F. Brooks, Stephen A. Morse, Janet S. Butel.

- Medical Microbiology (1997), Edited by Greenwood, D, Slack, R and Peutherer, J, ELST Publishers.
- Parasitology (1997), Chatterjee K.D, Chatterjee Medical Publishers.

MMV-102: Introduction to Animal Viruses (4 Credits=100 Marks)

Unit-I: Fundamentals of Animal Virology (15 Hours): History and origin of animal viruses, nature and evolutionary importance of viruses, classification and diversity of animal viruses. General properties of viruses, structure and chemical composition, morphology, and organization of viral genomes.

Unit-II: Methods in Virology (15 Hours): Principles and applications of cell and tissue culture, sterility maintenance, use of antibiotics, and elimination of mycoplasma or other contaminants. Virus culture systems, focus-forming units, isolation, purification, and quantification of viruses, as well as detection methods. Principles of biosafety, levels of containment facilities, and maintenance/handling of laboratory equipment.

Unit-III: Virus–Host Interactions (15 Hours): Viral entry mechanisms: interactions with cellular receptors, role of lipid rafts, clathrin-dependent and independent endocytosis, and cytoskeletal involvement in infection. Mechanisms of virus uncoating, replication of DNA and RNA viral genomes, viral protein synthesis and transport, genome assembly, maturation, and release. Cellular effects of viral infection: host cell shut-off, apoptosis, necrosis, stress responses, alteration of signaling pathways, cytopathic effects, and cellular transformation.

Unit-IV: Pathogenesis and Host Responses (15 Hours): Cellular injury markers, mechanisms of viral persistence and latency, and host immune responses to viral infection. Viral immune evasion strategies, progression of viral infections, and disease outcomes.

Recommended Books & references:

- Acheson NH. 2006. Fundamentals of Molecular Virology. Wiley.
- Carter J & Saunders V. 2007. Virology: Principles and Applications. 1st Ed. Wiley.
- Knipe DM, Howley PM, Griffin DE. 2006. Fields Virology. 5th Ed. Vols. I,II. Lippincott, Williams & Wilkins.
- Mahy, BWJ & Kangaroo HO. 1996. Virology Methods Manual. AcademicPress.
- Murphy FA, Gibbs, EPJ, Holzmek MK &Studdert MJ. 1999. Veterinary Virology. 3rd Ed. Academic Press.
    - Laboratory Biosafety Manual, WHO, http://www.who.int/csr/resources/publications/ biosafety/WHO_cds_csr_l yo_20034/en/
    - Epidemiology: An Introduction. Kenneth J.J.Rothman. Latest Edition/Pub Date: May 2002. Publisher: Oxford University Press.
    - Epidemiology: Leon Gordis, Latest Edition/ Pub Date: November 2004. Publisher: Elsevier Health Sciences.

MMV-103: Introduction to Plant Viruses (4 Credits=100 Marks)

Unit-I: Fundamentals of Plant Virology (15 Hours): Introduction, history, and origin of plant viruses; nomenclature, classification, and diversity of plant viruses. General properties, structure, and chemical composition; morphology and organization of viral genomes; and evolutionary significance of plant viruses.

Unit-II: Plant Virus Life Cycle and Disease Manifestation (15 Hours): Life cycles of representative plant viruses such as Tobacco Mosaic Virus (TMV), Cauliflower Mosaic Virus, and Potato Virus X. Effects of viruses on plant morphology, physiology, and cytology. Host–virus interactions, mechanisms of resistance, role of genetic engineering, ecology, and management of plant viral diseases. Case studies of economically important plant diseases: mosaic diseases of apple, papaya, tobacco, and potato; leaf curl in tobacco, chili, and tomato; tungro disease in paddy; yellow vein mosaic; and bunchy top of banana. Transmission of plant viruses and their relationship with insect and non-insect vectors.

Unit-III: Epidemiology of Plant Viruses (15 Hours): General overview of plant virus epidemiology, basic principles of plant disease epidemiology, and epidemiological strategies for management of viral diseases. Genetic diversity of plant virus populations, and the role of evolutionary dynamics in the epidemiology of plant virus diseases.

Unit-IV: Detection and Control of Plant Viruses (15 Hours): Traditional and advanced methods for control of plant viral diseases, including basic control measures and production of virus-free plants. Modern concepts such as organic viruses, viroids, virusoids, satellite viruses, and prions. Virus isolation, detection, and diagnosis using PCR, microscopy, and other advanced molecular methods.

Recommended Books and References:

- R. K. Gaur, S. M. Paul Khurana, et al. *Plant Virus-Host Interaction: Molecular Approaches and Viral Evolution*, 2021. ISBN: 0128216298.
- Jesús Navas-Castillo & Elvira Fiallo-Olivé (Eds.). *Plant Viruses: From Ecology to Control*, 2021. ISBN: 978-3036520186.
- Anne Marte Tronsmo, Lisa Munk, Annika Djurle, Arne Tronsmo, Jonathan Yuen, David B. Collinge. *Plant Pathology and Plant Diseases*, 2020. ISBN: 978-1789243185.
- John Thresh (Ed.). *Plant Virus Epidemiology*, 1st Edition, 2006. eBook ISBN: 9780080466378.
- L. P. Awasthi (Ed.). *Applied Plant Virology: Advances, Detection, and Antiviral Strategies*, 1st Edition, 2020. ISBN: 978-0128186541.

MMV-104: Biochemistry and Cell Biology (CBCS) (4 Credits = 100 Marks)

Unit-I: Biomolecules and Macromolecular Structures (15 Hours):
Carbohydrates: Monosaccharides—cyclization of aldoses and ketoses, conformations, mutarotation, anomers, epimers, derivatives (sugar phosphate, sugar alcohol, sugar acids, deoxy- and amino-sugars); Disaccharides—structure, reducing and non-reducing sugars; Polysaccharides—starch, glycogen, and cellulose. Lipids: Fatty acids, triacylglycerols, glycerophospholipids, sphingolipids, and steroids (cholesterol and derivatives). Amino Acids and Peptides: Structure and classification of amino acids, ionization, chemistry of peptide bond, essential vs. non-essential amino acids, amino acids as precursors of bioactive molecules, zwitterions, isoelectric point, optical properties, and Lambert-Beer law. Peptide structure: peptide unit, bond length, cis/trans conformation, Ramachandran plot; structural hierarchy—primary, secondary (α-helix, β-sheet, β-

turn, collagen helix), tertiary, and quaternary structures (with examples). Nucleotides: Sugars and bases, conformation of sugar–phosphate backbone, phosphodiester bonds, hydrogen bonding, DNA forms (A, B, Z), base tautomers, nucleotide derivatives, nucleotides as regulatory molecules, and concept of antisense molecules.

Unit-II: Macromolecular Function and Cellular Architecture (15 Hours):
Structure and function of DNA, RNA, proteins, carbohydrates, and lipids. Membrane organization and transport—diffusion across phospholipid bilayer and overview of transport proteins. Cell theory, structure of prokaryotic vs. eukaryotic cells. Cellular organelles—endoplasmic reticulum, Golgi complex, lysosomes, mitochondria, nucleus. Cytoskeleton, cell adhesion, and junctions.

Unit-III: Enzymes and Cellular Machineries (15 Hours):
Enzymes: Lock-and-key vs. induced-fit models, activation and binding energy. Enzyme kinetics—Michaelis-Menten equation, physiological significance, Lineweaver-Burk plots, turnover number, enzyme inhibition (types and examples), catalytic RNAs.
Cytoskeletal elements: Structure, assembly, and functions of microtubules (axonemal, cytoplasmic; cilia, flagella, centrioles, basal bodies), microfilaments (G-actin, F-actin, overview of myosin), and intermediate filaments (different classes).

Unit-IV: Cell Signaling, Apoptosis, and Cancer Biology (15 Hours):
Signal transduction pathways: cAMP pathway, PI3K/Akt pathway, G-protein coupled receptors, receptor and non-receptor tyrosine kinases. Mitochondrial pathway of apoptosis. Overview of tumor development stages, oncogenes, tumor suppressor genes, and in vitro cell line cultures.

Recommended Books & references:

- R. Ian Freshney, Culture of Animal Cells: A Manual of Basic Technique. Latest edition / Pub.Date: September 2005. Wiley.
- R. Ian Freshney, Culture of Cells for Tissue Engineering. Pub.Date: March 2006. Wiley.
- Jun Mitsuhashi, Invertebrate Tissue Culture Methods. Latest edition /Pub. Date: February, 2002. Publisher: SpringerVerlag New York, LLC.
- Bruce Alberts, Dennis Bray, Keith Roberts, Julian Lewis, Martin Raff, Essential Cell Biology. Latest edition/Pub. Date: October 2003. Publisher: Taylor & Francis, Inc.
- Harvey Lodish, James Darnell, Paul Matsudaira, Arnold Berk, S. Lawrence Zipursky, Molecular Cell Biology. Latest edition/Pub. Date: August 2003. Publisher: W. H. Freeman Company.

MMV-105: Immunology (4 Credits = 100 Marks)

Unit-I: Introduction to the Immune System (15 Hours): Overview of the immune system; primary and secondary lymphoid organs; cells of the immune system and their roles. Innate immunity, complement system, humoral immunity, and cell-mediated immunity.

Unit-II: Antigens and Antibodies (15 Hours): Structure and function of antibodies, classes of immunoglobulins, properties and functions of antigens, and antigen–antibody interactions. Major

Histocompatibility Complex (MHC), Human Leukocyte Antigen (HLA) typing, and activation of macrophages and dendritic cells.

Unit-III: Immune Responses and Effector Mechanisms (15 Hours): Antigen-presenting cells; T- and B-cell activation and stimulation. Hypersensitivity reactions and immune responses in viral infections. Generation and applications of monoclonal and polyclonal antibodies. Effector mechanisms including Antibody-Dependent Cellular Cytotoxicity (ADCC), Natural Killer (NK) cells, and Cytotoxic T Lymphocytes (CTLs).

Unit-IV: Immunological Disorders and Antiviral Responses (15 Hours): Mechanisms of autoimmunity; altered antigens and associated disorders such as systemic lupus erythematosus (SLE), rheumatoid arthritis, and multiple sclerosis. Transplantation immunology and mechanisms of antiviral immune responses.

Recommended Books and References:

- David A. Goldsby, Janis Kuby, Thomas J. Kindt, Barbara A. Osborne. *Immunology*. W. H. Freeman Company, Latest Edition.
- Abul K. K. Abbas, Andrew H. Lichtman. *Cellular and Molecular Immunology*. Elsevier Health Sciences, Latest Edition.
- Arthur G. Johnson. *High-Yield Immunology*. Lippincott Williams & Wilkins, Latest Edition.

MMV-106: Lab Course-I (List of practical)

1. Microbiology Good Laboratory Practices and Biosafety.
2. To study the principle and applications of important instruments (biological safety cabinets,
3. autoclave, incubator, BOD incubator, hot air oven, light microscope, pH meter) used in the
4. microbiology laboratory
5. Preparation of culture media for bacterial cultivation
6. Sterilization of medium using Autoclave and assessment for sterility
7. Sterilization of glassware using Hot Air Oven and assessment for sterility
8. Sterilization of heat sensitive material by membrane filtration and assessment for sterility
9. Demonstration of the presence of microflora in the environment by exposing nutrient agar plates to air.
10. Single colony isolation from soil samples
11. Gram-staining of the bacteria from soil samples
12. Serial dilution analysis
13. Growth curve and C.F.U analysis
14. Nitrate reducing bacteria isolation from soil samples
15. Antibiotic resistant bacteria determination in soil samples

Recommended Books &References:

- Bailey & Scott's Diagnostic Microbiology (2002), Betty A. Forbes, Daniel F. Sahm, Alice S. Weissfeld, Ernest A. Trevino, Published by C.V. Mosby.

- Jawetz, Melnick, &Adelberg's Medical Microbiology (2004), Geo F. Brooks, Stephen A. Morse, Janet S. Butel.

SECOND SEMESTER

MMV-201: Molecular Genetics (4 Credits = 100 Marks)

Unit-I: Cell Cycle and Cell Division (15 Hours): Phases of the cell cycle (G1, S, G2, M) with emphasis on regulation, checkpoints (G1/S, G2/M, spindle assembly), and role of cyclins and cyclin-dependent kinases. Mitosis: detailed study of prophase, metaphase, anaphase, telophase; formation and function of the mitotic spindle, role of centrosomes, mechanisms of chromosome segregation, cytokinesis, and regulation by mitogens and inhibitors. Meiosis: stages (Meiosis I and II), significance in genetic variation, synaptonemal complex formation, crossing-over, recombination nodules, and chiasma formation. Comparison between mitosis and meiosis and their biological significance.

Unit-II: Microbial Genetics (15 Hours): Mutations: molecular basis, types (point mutations, frameshift, missense, nonsense, conditional, lethal), induced vs. spontaneous mutations, mutagenic agents, and DNA repair mechanisms. Mechanisms of bacterial recombination: general (homologous), site-specific, and replicative recombination. Plasmids: structural organization, replication, classification (Fertility factor, col plasmids, resistance plasmids, virulence plasmids), and their applications. Bacterial conjugation (F+, F-, Hfr, F′ strains), mechanism of gene transfer and mapping. Transformation: natural vs artificial, competence, and horizontal gene transfer. Transduction: generalized and specialized; role in bacterial genome evolution. Applications of microbial genetics in biotechnology.

Unit-III: Principles of Inheritance and Chromosome Structure (15 Hours): Mendel's Laws and extensions—dominance, segregation, independent assortment. Concepts of alleles, types of dominance, lethal and multiple alleles. Linkage, recombination, gene mapping, sex-linked inheritance, quantitative inheritance, and cytoplasmic inheritance. Mutations and their roles in diseases and disorders. Chromosome number and structural variations: polyploidy, aneuploidy, and chromosomal rearrangements (deletion, duplication, inversion, and translocation). Chromosome preparations: cell culture, induction of metaphase, and cell cycle arrest.

Unit-IV: Chromosome Visualization and Molecular Cytogenetics (15 Hours): Classical cytogenetic methods: chromosome staining and visualization techniques including karyotyping, and differential banding methods (G-banding, C-banding, R-banding, Q-banding) with their applications. Molecular cytogenetic techniques: chromosome labeling, in situ hybridization, fluorescence in situ hybridization (FISH), and multicolor FISH. Chromosome painting for detecting complex rearrangements. Comparative Genomic Hybridization (CGH) and array-CGH for detecting copy number variations. Applications of cytogenetics in clinical diagnostics, cancer biology, and evolutionary studies.

Recommended Books and References:

- Philip T. Cagle, Timothy C. Allen (Eds.). *Basic Concepts of Molecular Pathology*. Springer, 2009. ISBN: 9780387896250.
- William B. Coleman, Gregory J. Tsongalis (Eds.). *Molecular Pathology: The Molecular Basis of Human Disease*. Academic Press, 2009. ISBN: 9780123744197.
- Lynn B. Jorde, John C. Carey, Michael J. Bamshad. *Medical Genetics*. 4th Edition, Mosby, 2009. ISBN: 9780323053730.

- David H. Persing, Fred C. Tenover, James Versalovic, Yi-Wei Tang, Elizabeth R. Unger, David A. Relman, Thomas J. White (Eds.). *Molecular Microbiology: Diagnostic Principles and Practice*. ASM Press, 2003. ISBN: 155581221X.

MMV-202: Molecular Biology (4 Credits=100 Marks)- **CBCS -course**

Unit-I: Principles of Gene Cloning (15 Hours): Fundamentals of recombinant DNA technology, including the concept of combining DNA fragments from different sources to generate recombinant molecules. Detailed study of restriction enzymes (types, recognition sequences, and cleavage patterns), DNA ligases, and other key enzymes used in cloning such as polymerases, phosphatases, and nucleases. Exploration of different types of cloning vectors—plasmids, bacteriophages, cosmids, bacterial artificial chromosomes (BACs), and yeast artificial chromosomes (YACs)—with emphasis on their structural features, copy number, and host range. Strategies for introducing recombinant DNA into host cells, covering transformation, transfection, electroporation, liposome-mediated transfer, and microinjection. Principles of selection and screening of recombinant clones using selectable markers, blue-white screening, and colony PCR.

Unit-II: DNA Manipulation and Applications (15 Hours): Comprehensive study of Polymerase Chain Reaction (PCR), including conventional PCR, RT-PCR, qPCR, and advanced variants such as multiplex PCR and digital PCR. Site-directed mutagenesis for targeted sequence changes and its applications in functional genomics and protein engineering. Expression vectors designed for prokaryotic and eukaryotic systems, with focus on promoters, regulatory sequences, and optimization of gene expression. Role of reporter genes (GFP, luciferase, β-galactosidase) and selectable markers in monitoring expression. Strategies for gene tagging and protein tracking, RNA interference (RNAi) for gene silencing, and methods for achieving controlled overexpression of genes of interest.

Unit-III: Advanced Cloning Techniques (15 Hours): Principles of complementary DNA (cDNA) synthesis using reverse transcriptase, and construction of genomic and cDNA libraries for gene discovery and functional analysis. Subcloning strategies and Gateway cloning technology for efficient transfer of DNA fragments between vectors. Development and use of fusion proteins with affinity tags (His-tag, GST, FLAG-tag) for purification and characterization. Cloning in specialized host systems such as yeast (Saccharomyces cerevisiae), insect cells (baculovirus expression system), mammalian cell lines, and plant transformation systems (Agrobacterium-mediated and biolistic methods).

Unit-IV: Applications of Gene Cloning (15 Hours): Applications of recombinant DNA technology in producing therapeutic proteins, enzymes, hormones (e.g., insulin, growth hormone), and next-generation vaccines. Gene therapy strategies, including ex vivo and in vivo approaches, for treating genetic and acquired diseases. Development of transgenic animals and plants for improved traits, disease resistance, and production of biopharmaceuticals. Molecular diagnostics leveraging recombinant DNA methods, such as probe-based detection, recombinant antigens, and PCR-based kits.

Recommended Books and References:

- Brown, T.A. *Gene Cloning and DNA Analysis: An Introduction.* 7th Edition, Wiley-Blackwell, 2016.
- Primrose, S.B. and Twyman, R.M. *Principles of Gene Manipulation and Genomics.* 7th Edition, Wiley-Blackwell, 2006.
- Glick, B.R. and Pasternak, J.J. *Molecular Biotechnology: Principles and Applications of Recombinant DNA.* 4th Edition, ASM Press, 2010.

- Sambrook, J. and Russell, D.W. *Molecular Cloning: A Laboratory Manual.* Cold Spring Harbor Laboratory Press, 2001.

V-203: Pathogenesis and Epidemiology (4 Credits = 100 Marks)

Unit-I: Human Pathogenic Viruses and Mechanisms of Disease (15 Hours): Overview of important human pathogenic viruses and their life cycles, including retroviruses (HIV), herpesviruses, hepatitis viruses, respiratory viruses, and viruses causing viral diarrhea. Pathogenic mechanisms of viral disease: implantation of viruses at portals of entry, local replication at the entry site, dissemination to target organs, and spread to sites of shedding. Factors influencing viral pathogenicity: accessibility of virus to host tissues, cellular susceptibility to viral replication, and viral sensitivity to host immune defenses.

Unit-II: Cellular Pathogenesis (15 Hours): Molecular and cellular mechanisms of viral pathogenesis. Diversion of host cellular energy by viruses, shutoff of host macromolecular synthesis, and competition of viral mRNA for cellular ribosomes. Mechanisms of viral transcriptional control, including competition between viral promoters and host transcriptional enhancers. Viral inhibition of interferon-mediated defense pathways. Integration of viral genomes into host chromosomes and induction of mutations. Host responses to viral infection, including inflammation, innate immunity, and adaptive immune responses.

Unit-III: Tissue Tropism and Host Factors (15 Hours): Determinants of viral tissue tropism: viral receptor recognition and binding, host transcription factors regulating viral promoters and enhancers, and host cell capacity to support viral replication. Influence of physiological and environmental barriers: mucosal surfaces, temperature, pH, digestive enzymes, and bile salts. Case studies of viral tropism in different host systems.

Unit-IV: Epidemiology of Viral Infections (15 Hours): Principles of viral epidemiology: sporadic, endemic, epidemic, and pandemic infections. Modes of transmission—direct contact, airborne spread, vector-borne transmission, zoonotic infections. Tools and methods of epidemiological investigation: surveillance systems, outbreak investigation, and molecular epidemiology. Role of host, environmental, and social factors in shaping disease spread. Preventive strategies: vaccination, antivirals, infection control practices, and global health initiatives for viral disease management.

Recommended Books and References:

- Flint, S.J., Enquist, L.W., Racaniello, V.R., and Skalka, A.M. *Principles of Virology*, 5th Edition, ASM Press, 2020.
- Nathanson, N. *Viral Pathogenesis and Immunity*, 2nd Edition, Academic Press, 2007.
- Morse, S.S. (Ed.) *Emerging Viruses*, Oxford University Press, 1996.
- Fields, B.N., Knipe, D.M., Howley, P.M. *Fields Virology*, 7th Edition, Lippincott Williams & Wilkins, 2020.
- Morens, D.M. and Fauci, A.S. *Emerging Infectious Diseases: Threats to Global Health and Security*, ASM Press, 2019.

MMV-204: OMIC-based Technology and Bioinformatics (4 Credits=100 Marks)

Unit-I: Fundamentals of Molecular Biology and Genomics (15 Hours): Introduction to the molecular basis of omics sciences. Central dogma of molecular biology, structure and function of DNA, RNA, and

proteins, and regulation of gene expression in prokaryotes and eukaryotes. Organization of genomes, concepts of open reading frames (ORFs), genetic code and its variations, and mechanisms of genetic regulation and variation. Overview of large-scale genome projects with emphasis on the Human Genome Project and its implications in biomedical sciences.

Unit-II: Next-Generation Sequencing and Omics Platforms (15 Hours): Principles, workflows, and applications of next-generation sequencing (NGS) technologies. NGS-based transcriptomics methods, sequencing depth, read quality, and coverage. Genome assembly, mapping, and functional annotation strategies. Introduction to RNA-sequencing for gene expression profiling and differential transcript analysis. Overview of proteomics platforms with emphasis on mass spectrometry principles, workflows, and applications in protein identification, quantification, and post-translational modification studies.

Unit-III: Biological Databases and Data Integration (15 Hours): Introduction to primary and secondary biological databases used in omics research. Genome and protein sequence databases (e.g., GenBank, UniProt), motif and domain databases (e.g., Pfam, PROSITE), and pathway and interaction databases (e.g., KEGG, Reactome, BioCyc). Protein structure databases (e.g., PDB) and specialized databases for transcriptomics, metabolomics, and disease associations. Methods for data integration, cross-referencing, and use of curated databases in functional and comparative genomics.

Unit-IV: Bioinformatics Tools and Applications (15 Hours): Computational methods and algorithms for sequence analysis. Pairwise sequence alignment (Needleman-Wunsch, Smith-Waterman) and multiple sequence alignment approaches. Database similarity searching using BLAST and PSI-BLAST. Scoring matrices and their applications (PAM, BLOSUM). Motif and domain searches, promoter and gene prediction strategies, and computational methods for epitope prediction. Phylogenetic analysis: tree construction methods and evolutionary inference. Applications of bioinformatics tools in functional genomics, molecular evolution, and personalized medicine.

Recommended Books & References:

- Lesk, A. M. (2017). *Introduction to Genomics*. Oxford University Press, 3rd Edition. ISBN: 9780198754831.
- Mount, D. W. (2001). *Bioinformatics: Sequence and Genome Analysis*. Cold Spring Harbor Laboratory Press, 1st Edition.
- Brown, T. A. (2017). *Genomes 4*. CRC Press, 4th Edition. ISBN: 9780815345084.
- Chen, C., Huang, H., & Wu, C. H. (2017). Protein Bioinformatics Databases and Resources. *Methods in Molecular Biology*, 1558:3–39. doi:10.1007/978-1-4939-6783-4_1.

<u>MMV-205: Biostatistics and Data Analysis:</u> (4 Credits = 100 Marks)

Unit-I: Introduction to Biostatistics and Data Presentation (15 Hours): Introduction to the scope, role, and applications of biostatistics in life sciences, biomedical research, and public health. Types of data (qualitative, quantitative, discrete, continuous) and scales of measurement (nominal, ordinal, interval, ratio). Methods of data collection and sample selection: random, stratified, systematic, and cluster sampling techniques. Presentation of data using tables and graphical methods, including histograms, frequency polygons, ogives, pie charts, and box plots. Concepts of variability and correlation: types of correlation (positive, negative, zero) and their significance in biological studies.

Unit-II: Measures of Central Tendency and Dispersion (15 Hours): Computation and interpretation of measures of central tendency: arithmetic mean, median, mode, geometric mean, and harmonic mean. Quartiles, deciles, and percentiles for describing data distribution. Measures of dispersion: range, mean deviation, variance, standard deviation, and coefficient of variation. Applications of central tendency and variability in biological data, including clinical trial outcomes, epidemiological surveys, and experimental biology. Introduction to correlation and regression: scatter plots, correlation coefficients, regression equations, and their applications in analyzing biological and medical datasets.

Unit-III: Probability Distributions and Their Applications (15 Hours): Fundamental principles of probability and random variables. Overview of probability distributions relevant to biological sciences: binomial distribution and its applications in genetics (Mendelian inheritance), Poisson distribution and its use in rare event modeling (mutations, disease incidence), and normal distribution with applications in biometrics, physiological parameters, and clinical measurements. Concepts of probability density functions, cumulative distribution functions, and their role in data analysis. Statistical tables (Z, t, χ^2, F) and their use in hypothesis testing.

Unit-IV: Hypothesis Testing and Statistical Inference (15 Hours): Concept of sampling distributions, standard error, and confidence intervals. Fundamentals of hypothesis formulation and testing. Parametric tests: t-test (one-sample, two-sample, paired), F-test, and analysis of variance (ANOVA) for comparing groups. Non-parametric tests: χ^2 test for independence and goodness of fit, Mann–Whitney U test, and Kruskal–Wallis test. Applications of statistical inference in biomedical research, clinical trials, diagnostics, and epidemiological studies. Limitations of statistical testing and importance of proper experimental design in generating reliable results.

Recommended Books & references:

- Dawson, B., & Trapp, R. G. (2004). *Basic and Clinical Biostatistics*. McGraw-Hill, Latest Edition.
- Field, A. (2005). *Discovering Statistics Using SPSS*. SAGE Publications, Latest Edition.
- Rosner, B. (2015). *Fundamentals of Biostatistics*. Cengage Learning, 8th Edition. ISBN: 9781305268920.
- Daniel, W. W., & Cross, C. L. (2018). *Biostatistics: A Foundation for Analysis in the Health Sciences*. Wiley, 11th Edition. ISBN: 9781119496579.

MMV-206: Recombinant DNA Technology: (4 Credits = 100 Marks)- SWAYAM course

Unit-I: Fundamentals of Gene Cloning and Gene Regulation (15 Hours): Introduction to recombinant DNA technology and its applications in modern biology. Regulation of gene expression in prokaryotes and eukaryotes: lac operon, inducible operon, and repressible operon systems. Cloning strategies and design of vectors: bacterial expression vectors, shuttle vectors, and mammalian expression vectors. Role of promoters in bacterial and mammalian systems for regulating gene expression. Gene knockdown and overexpression approaches; RNA interference strategies including siRNA and miRNA-mediated gene silencing.

Unit-II: Genome Editing Principles and Delivery Systems (15 Hours): Historical perspective and evolution of genome editing. Mechanisms of DNA double-strand break (DSB) repair: non-homologous end joining (NHEJ) and homologous recombination (HR). Methods for gene delivery with emphasis on electroporation and related approaches. Genome screening strategies and their applications. Cre-Lox

recombination system for gene knockout and knock-in studies. Conditional and inducible gene expression systems and their role in functional genomics.

Unit-III: CRISPR-Cas Systems and Mechanisms of Action (15 Hours): Introduction to clustered regularly interspaced short palindromic repeats (CRISPR) and CRISPR-associated (Cas) systems. Mechanism of bacterial adaptive immunity by CRISPR-Cas. Structural and functional basis of Cas9, Cas12a, and Cas13-mediated genome editing. Key molecular elements: protospacer adjacent motifs (PAMs), CRISPR RNA (crRNA), trans-activating crRNA (tracrRNA), and development of single-guide RNA (sgRNA). Applications of different CRISPR systems in gene modification, regulation, and therapeutic research.

Unit-IV: Genome Editing Applications and Diagnostics (15 Hours): Screening and validation of genome editing: gel electrophoresis, surveyor assays, PCR-based methods, and sequencing approaches. Advanced CRISPR applications: precise genome editing, gene activation and knockdown, and genome illumination technologies. CRISPR-based diagnostics including SHERLOCK and DETECTR assays for cancer detection and infectious disease diagnosis (parasitic, bacterial, and viral pathogens). Ethical, biosafety, and translational considerations of genome editing technologies in biomedical and therapeutic research.

Recommended Books & References:

- Watson, J. D., et al. (2013). *Molecular Biology of the Gene*. Pearson, 7th Edition. ISBN: 9780321762436.
- Brown, T. A. (2016). *Gene Cloning and DNA Analysis: An Introduction*. Wiley-Blackwell, 7th Edition. ISBN: 9781119072568.
- Doudna, J. A., & Sternberg, S. H. (2017). *A Crack in Creation: Gene Editing and the Unthinkable Power to Control Evolution*. Houghton Mifflin Harcourt. ISBN: 9781328915368.
- Hsu, P. D., Lander, E. S., & Zhang, F. (2014). Development and Applications of CRISPR-Cas9 for Genome Engineering. *Cell*, 157(6):1262–1278. doi:10.1016/j.cell.2014.05.010.
- Komor, A. C., Badran, A. H., & Liu, D. R. (2017). CRISPR-Based Technologies for the Manipulation of Eukaryotic Genomes. *Cell*, 168(1-2):20–36. doi:10.1016/j.cell.2016.10.044.

MMV-207: Lab Course-II

1) Preparation of reagents and buffers
2) Protein estimation by Lowry and Bradford method
3) DNA estimation (spectrophotometric)
4) Polyacrylamide gel electrophoresis
5) Western blotting
6) Polymerase Chain Reaction (PCR)
7) Isolation of plasmid using plasmid DNA extraction assay
8) Surveillance case-study using web-based tools
9) Plasmid transformation and purification
10) Restriction endonuclease digestion
11) Competent cells preparation
12) How do we convert DNA sequence in RNA sequence manually as well as using online resources?
13) How do analyze a promoter, transcription start site and ribosome binding site in a given DNA sequence.
14) How do we identify introns and exons in given DNA sequence using bioinformatics tools?

15) How do we identify potential sequence variants for a given DNA sequence/gene using Ensembl genome browser?
16) How do we store transport various biological specimens for RNA seq analysis?
17) How do we perform Gene Ontology, gene enrichment analysis using KEGG database?

Recommended Books & References:

- Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology (8thed.). Andreas Hofmann, Samuel Clokie. ISBN: 9781108365253.
- Genome Editing. Editors: Turksen, Kursad (Ed.). ISBN 978-3-319-34148-4.
- CRISPR Gene Editing Methods and Protocols. Editors: Luo, Yonglun (Ed.). ISBN978-1-4939-9170-9.
- In Situ Hybridization Protocols. Editors: Darby, Ian A., Hewitson, Tim D. (Eds.). ISBN 978-1-59745-007-2.
- Ran FA, Hsu, Wright Jgoo, Agarwala V, Scott DA, Zhang. Nat Protoc. Genome engineering using the CRISPR-Cas9 system. 2013 Nov;8(11):2281-2308.
    - Sequence Analysis in a Nutshell – A Guide to Common Tools & Databases (2003), Scott Markel. O′Reilly, 1st edition. ISBN-13: 978-0596004941.
    - Metagenomics: Theory, Methods and Applications (2010). Diana Marco. Caister Academic Press. ISBN-10: 1904455549.

THIRD SEMESTER

MMV-301: Viral Diagnostics: (4 Credits = 100 Marks)

Unit-I: Fundamentals of Viral Diagnostics and Molecular Foundations (15 Hours): Introduction and historical perspectives of viral diagnostics. Role of molecular biology and recombinant DNA technology in advancing diagnostic methods. Principles and procedures for clinical sample collection, handling, storage, and shipping under biosafety guidelines. Isolation and purification methods for DNA, RNA, and proteins from clinical specimens. Complementary DNA (cDNA) synthesis from RNA templates. Analytical techniques including agarose gel electrophoresis for genomic and plasmid DNA, and SDS-PAGE for protein separation and characterization.

Unit-II: Nucleic Acid–Based Viral Detection Methods (15 Hours): Principles of primer and probe design for nucleic acid–based assays. Fundamentals of nucleic acid hybridization, factors influencing hybridization efficiency, and applications of hybridization-based diagnostic tests. Viral genome detection using Polymerase Chain Reaction (PCR): principles, optimization factors, and types of PCR including conventional, nested, multiplex, and quantitative real-time PCR. Reverse transcription PCR (RT-PCR) for RNA viruses: applications, sensitivity, and limitations. Applications of Southern and Northern blotting for detection and characterization of viral genomes and transcripts.

Unit-III: Immunological and Microscopy-Based Approaches (15 Hours): Principles and applications of immunofluorescence microscopy, confocal microscopy, electron microscopy, and flow cytometry in viral diagnostics. Immunohistochemistry and immunoprecipitation for detection and localization of viral proteins.

Enzyme-linked immunosorbent assay (ELISA): types (direct, indirect, sandwich, competitive), design, and diagnostic applications. Western blotting: methodology, use of primary and secondary antibodies, detection strategies, and applications in confirmatory viral diagnostics.

Unit-IV: Advanced Molecular Diagnostic Techniques (15 Hours): Viral nucleic acid detection by Fluorescence In-Situ Hybridization (FISH): principles, methodology, and diagnostic applications. DNA profiling techniques including Restriction Fragment Length Polymorphism (RFLP), Random Amplification of Polymorphic DNA (RAPD), and DNA fingerprinting, with applications in viral epidemiology, molecular typing, and forensic virology. Emerging molecular diagnostic platforms integrating next-generation sequencing (NGS), CRISPR-based diagnostics, and point-of-care viral detection systems.

Recommended Books & References:

- Mahy, B. W. J., & Kangro, H. O. (1996). *Virology Methods Manual*. Elsevier Science & Technology Books.
- Payment, P., & Trudel, M. (1993). *Methods and Techniques in Virology*. Marcel Dekker.
- Stephenson, J. R., & Warnes, A. (1998). *Diagnostic Virology Protocols: Methods in Molecular Medicine*. Humana Press.
- Lennette, E. H., Lennette, D. A., & Lennette, E. T. (1995). *Diagnostic Procedures for Viral, Rickettsial, and Chlamydial Infections*. American Public Health Association Publications.
- Carter, J. B., & Saunders, V. A. (2013). *Virology: Principles and Applications*. Wiley-Blackwell, 2nd Edition. ISBN: 9781119991425.

MMV-302: Computational Structure Based-Drug Designing: (4 Credits = 100 Marks)-
(SWAYAM course)

Unit-I: Sequence Analysis and Bioinformatics Foundations (15 Hours): Introduction to sequence databases and bioinformatics tools, concepts of sequence similarity, identity, and homology, multiple sequence alignments and their applications, sequence motifs, patterns, and profiles for functional annotation.

Unit-II: Fundamentals of Biomolecular Structure (15 Hours): Introduction to protein and nucleic acid structures, structural databases and tools for biomolecular analysis, concepts of structural similarity and homology for functional inference.

Unit-III: Molecular Modeling and Simulation Techniques (15 Hours): Homology modeling, fold recognition, threading, ab-initio structure prediction methods, principles and applications of Molecular Dynamics (MD) simulations, visualization techniques for molecular structures and simulation results.

Unit-IV: Structure-Based Drug Design (15 Hours): Chemical and biomolecular databases for drug discovery, concepts and applications of small molecule and peptide docking, integrating computational approaches for rational drug design.

Recommended Books & references:

- Bioinformatics: Sequence and Genome Analysis. David W. Mount, 2004.
- Principles of Nucleic Acid Structure Martin Egli, Wolfram Saenger,1988.
- Introduction to protein structure, Branden and Tooze, 1998.

- Protein structure and function, Voet&Voet
- Molecular Modeling: Principles and Applications, Andrew Leech,2001
- From Cells to Atoms: An illustrated Introduction to Molecular Biology, Anthony R. Rees, Michael J.E. Stemberg, 1984.

MMV-303: Viral Vectors and Gene Therapy (4 Credits = 100 Marks)

Unit-I: Introduction to Gene Cloning and Viral Vectors (15 Hours): Introduction to gene cloning and DNA analysis. Components of cloning vectors. Vehicles for gene cloning including plasmids and bacteriophages. Criteria and strategies for selection of viral vectors. Detailed coverage of lentiviral, retroviral, adenoviral, SV40, and vaccinia vectors. Retroviral promoter-based vectors and their applications in research and therapy.

Unit-II: Cloning and Expression in Viral Vectors (15 Hours): Strategies for cloning and expression using viral vectors, including phage vectors. Methods for DNA delivery such as liposomes, lipoplexes, naked DNA, and transposons. Considerations for efficient gene transfer, vector stability, and controlled gene expression.

Unit-III: Gene Therapy Approaches (15 Hours): Introduction to somatic and germline gene therapy. Approaches including gene replacement and gene addition. Applications in cancer gene therapy and RNA–DNA chimera strategies. Conceptual understanding of therapeutic gene targeting, delivery challenges, and safety considerations.

Unit-IV: Fundamentals and Applications of Gene Therapy (15 Hours): Clinical applications of gene therapy for inherited disorders including cystic fibrosis, Duchenne muscular dystrophy, bleeding disorders, tyrosinemia, and Severe Combined Immunodeficiency (SCID). Gene therapy for non-heritable disorders. Recent advancements in gene therapy and their ongoing clinical trials. Emerging technologies and translational potential for future therapeutic interventions.

Recommended Books & references:

- Hackett NR, Crystal RG. 2000.Adenovirus vectors for gene therapy. In Gene Therapy, ed. NS Templeton, DD Lasic, pp.17-39. New York: Marcel Dekker.
- DNA Microarrays: A Molecular Cloning Manual. David Bowtell (Editor), Joseph Sambrook (Editor). Latest edition / Pub. Date: September 2002. Publisher: Cold Spring HarborLaboratory Press.
- Glick, Jack J. Pasternak. Latest edition / Pub. Date: July 2002. Publisher: ASM Press.
- Genes VIII. Benjamin Lewin. Latest edition / Pub. Date: December 2003. Publisher: Prentice Hall.
- Friedman T. 1999. The Development of Human Gene Therapy. Cold Spring Harbor,NY: Cold Spring Harbor Lab.Press.

MMV-304: Biostatistics analysis

Unit-I: Introduction, types of data, tabular and graphical presentation of data, dispersion and correlation, sample selection.

Unit-II: Measures of central tendency: Mean, mode, median, GM, HM, quartiles, measures of dispersion-range, standard deviation, variance, coefficient of variation.

Unit-III: Probability distributions and density functions: normal distribution, bionomial distribution, poisson distribution, applications and statistical tables.

Unit-IV: Concept of significance tests: χ^2 test, t-test, f-test, parametric and nonparametric tests, standard error and confidence intervals.

Recommended Books & references:

- Basic and clinical Biostatistics- Beth Dawson, Robert.G.Trapp, Robert Trapp. Latest Edition/ Pub Date: March 2004.
- Discovering Statistics using SPSS- Andy Field. Latest Edition/Pub Date: April 2005. Publisher: SAGE Publications.

MMV-305: Emerging Viruses and Oncoviruses: (4 Credits = 100 Marks)

Unit-I: Study of Emerging Viruses (15 Hours): Overview of emerging viruses including Zika, influenza, Ebola, Nipah, chikungunya, measles, mumps, dengue, SARS-CoVs, MERS, SARS-CoV-2, HIV, HCV, HBV, and others. Structure of viruses, their nucleic acids and proteins. Latest trends in animal virus research. Discussion of disease burden, natural history of infection, measures of risk, morbidity, and mortality.

Unit-II: History, Clinical Features, and Pathogenesis of Viral Diseases (15 Hours): History and clinical manifestations of influenza and respiratory syncytial virus (RSV). Virus-mediated diseases such as bronchitis, gastroenteritis, and encephalomyelitis. Current concepts in animal virus research with respect to viral structure, architecture, virulence, pathogenesis, and persistence.

Unit-III: Virus-Mediated Cell Transformation (15 Hours): Mechanisms of virus-mediated cell transformation. Characterization of transformed cells. Concepts of oncogenes, oncogenic DNA and RNA viruses, and associated diseases. Molecular and cellular basis of viral oncogenesis.

Unit-IV: Tumor Suppressor Genes and Viral Oncogenesis (15 Hours): Mechanisms of viral oncogenesis. Role of human papillomavirus, HIV, Epstein–Barr virus, HTLV, and herpesviruses in the pathogenesis of cancers. Diagnostic strategies, prevention approaches, and emerging therapeutic concepts.

Recommended Books & References:

- Drew Farmer (Editor), *Advanced Molecular Virology*, 2nd Edition, Callisto Reference, 2015, ISBN: 1632390213.
- Harvey O'Brien (Editor), *Advanced Principles of Virology*, Callisto, 2019, ISBN: 1641161272.
- Abubakar Yaro, *Oncoviruses: Cellular and Molecular Virology*, Kindle Edition, ASIN: B0173E9F7E.
- D.J. McCance (Editor), *Human Papilloma Viruses*, Elsevier Perspectives in Medical Virology, 2002.
- E. Tabor (Editor), *Viruses and Liver Cancer*, Elsevier Perspectives in Medical Virology, 2002.
- J.A. Grand (Editor), *Viruses, Cell Transformation, and Cancer*, Elsevier Perspectives in Medical Virology, 2001.
- Raphael Dolin and Peter Wright, *Viral Infections of the Respiratory Tract*, Marcel Dekker, 1999, ISBN 10: 082470195X / ISBN 13: 9780824701956.

MMV-306: Research Ethics and Science Communication (4 Credits = 100 Marks)

Unit-I: Introduction to Research Ethics (15 Hours): Overview of research ethics and moral philosophy. Ethics in science and research, research integrity, nature of moral judgment and reactions. Ethical and legal issues in genetic engineering, stem cell research, cloning, and medical techniques. Discussion of ethical considerations in research involving animals and their rights.

Unit-II: Research Publication Ethics (15 Hours): Importance of ethical practices in research publication. Proper reporting of positive and negative results, managing conflicts of interest, and understanding publication misconduct. Analysis of violations of publication ethics, problems that lead to unethical behavior, and challenges in maintaining ethical standards in research.

Unit-III: Research Project Design and Data Interpretation (15 Hours): Strategies for identifying a research project and formulating research questions. Design of experiments to address specific research objectives. Interpretation and analysis of research data, along with effective representation and visualization of findings.

Unit-IV: Scientific Writing, Grants, and Career Preparation (15 Hours): Introduction to manuscript and grant writing. Understanding plagiarism and avoiding ethical pitfalls. Guidance on preparing job applications, CVs, and other professional documents relevant to scientific careers.

Recommended Books & References:

- Shamoo, A.E., Resnik, D.B. *Responsible Conduct of Research*, Oxford University Press, 3rd Edition, 2015, ISBN: 9780199376025.
- Comstock, G. *Research Ethics: A Philosophical Guide to the Responsible Conduct of Research*, Cambridge University Press, 2013, ISBN: 978-0-52118708-4.
- Hofmann, A. *Writing in the Biological Sciences: A Comprehensive Resource for Scientific Communication*, 2nd Edition, 2015, Oxford Publications, ISBN-13: 978-0190245603.
- *A Student's Guide to Writing in the Biological Sciences*, 2005, http://isites.harvard.edu/fs/docs/icb.topic249275.files/BioSci_Writing_Guide.pdf
- Matthews, J.R., Matthews, R.W. *Successful Scientific Writing: A Step-by-Step Guide for the Biological and Medical Sciences*, 3rd Edition.

MMV-307: Lab Course-III

1) Virus isolation & purification
2) Viral antigen detection using western blot
3) Antigen capture ELISA and Immunofluorescence
4) Viral genome detection using FISH
5) Real Time PCR quantitation for HCV RNA
6) HCV titre quantitation using ffu
7) Viral mRNA expression using PCR
8) Receptor expression using FACS analysis
9) Biological data banks
10) Pairwise sequence alignment
11) Phylogeny & tree building
12) Motif data bases, Epitope prediction
13) Molecular modeling & visualization
14) Introduction to the software: Design data entry form, Importing MS Excel data
15) Preparing frequency distributions/cross tables, computing descriptive statistics and interpretation
16) Graphical presentation of data: bar diagram, Line diagram, pie chart, histogram, epi-curve, interpretations
17) Computing correlation coefficient, comparing proportions using chi-square test, comparing means using t test, computing risk using univariate logistic regression, interpretation
18) Primer and probe designing

Recommended Books & references:

- Virology Methods Manual. Brian W.J. Mahy (Editor), Hillar O. Kangro (Editor). Latest edition / Pub. Date: January 1996. Publisher: Elsevier Science & Technology Books.
- Methods and Techniques in Virology. Pierre Payment, Trudel (Editor). Latest edition / Pub. Date: July 1993. Publisher: Marcel Dekker.
- Diagnostic Virology Protocols: Methods in Molecular Medicine. John R. Stephenson (Editor), Alan Warnes Latest edition / Pub. Date: August 1998. Publisher: Humana P ress.
- Alberts B. et al (2008) Molecular Biology of the cell. 5thedition. Garland Science.
- Weaver, Robert Franklin (2012) Molecular biology. 5thedition. McGraw Hill, New York.
- Molecular Biology of the Gene. James D. Watson, Michael Levine, Richard Losick, Bell,
- Baker Latest edition / Pub. Date: December 2003 Publisher: Benjamin Cummings.

FOURTH SEMESTER

MMV-401: Indian Traditional Knowledge: (2 credits= 50 marks)- Swayam

MMV-402: Entrepreneurship and IPR: (2 credits= 50 marks)- Swayam

MMV-402: Final Seminar Presentation (IV)

MMV-403: MSc dissertation and viva voce (12 Credits=300 Marks)

This will include 4 months dissertation project, either in an industry, diagnostic lab, or in university/institute.