M.Sc. Virology Course Syllabus

From Academic year 2023-24
(As per NEP 2020)

Conducted at the
ICMR-National Institute of Virology (NIV)
130/1, Pashan-Sus Road,
Pashan, Pune 411 021

Under the aegis of
Department of Biotechnology
Savitribai Phule Pune University

ICMR-National Institute of Virology,

Under the aegis of Department of Biotechnology, SPPU

M.Sc. Virology Syllabus Structure (As per NEP 2020)

Semester I		
Core Courses		
Major Core- 10 (T) + 4 (P)		
Course Code	**Course Title**	**Number of Credits**
VR-111MC(T)	Cell Biology & Tissue Culture	**2**
VR-112MC(T)	Basic Virology	**2**
VR-113MC(T)	Immunology-I	**2**
VR-114MC(T)	Basic Epidemiology & Biostatistics	**2**
VR-115MC(T)	Analytical Techniques	**2**
VR-131MC(P)	Tissue Culture Techniques & Analytical Methods	**2**
VR-132MC(P)	Propagation of Viruses & Virus/Antigen Detection	**2**
Major Elective 2 (T) + 2 (T/P) (Any 2 Courses)		
VR-116ME(T)	a)Vector Biology b) General Biochemistry	**2**
VR-117ME(T)	Microbiology	**2**
VR-133ME(P)	a) Entomological Methods b) Statistical Methods	**2**
VR-150(RM)	**Research Methodology**	**4**
		Total Credit 22

Semester II		
Core Courses		
Major Core- 10 (T) + 4 (P)		
Course Code	**Course Title**	**Number of Credits**
VR-211MC(T)	Molecular Biology	**2**
VR-212MC(T)	Antivirals & Viral Vaccines	**2**
VR-213MC(T)	a) Bioinformatics b) Applied Epidemiology	**2**
VR-214MC(T)	Virus Replication & Virus Cell Interaction	**2**
VR-215MC(T)	Recombinant DNA technology	**2**
VR-231MC(P)	Serological Methods & Immunological Techniques	**2**
VR-232MC(P)	a) Epidemiological Data Management and Analysis b) Practical Bioinformatics	**2**
Major Elective 2 (T) + 2 (T/P) (Any 2 Courses)		
VR-216ME(T)	Immunology-II	**2**
VR-217ME(T)	Mathematical Biology	**2**
VR-233ME(P)	Biosafety and Biosecurity	**2**
VR-250(OJT)	**Internship/ On job Training (OJT)** **DBC- OJT- After completion of Sem II exam**	**4**
		Total Credit 22

Exit option: Award PG Diploma in Virology on completion of 44 credits after Three Year UG degree **OR** continue with PG second year.

Semester III		
Core Courses		
Major Core- 6 (T) + 8 (P)		
Course Code	**Course Title**	**Number of Credits**
VR-311MC(T)	a) Viral Enteric Diseases b) Viral Hepatitis and Cancers	**2**
VR-312MC(T)	a) Viral Haemorrhagic Fevers b) Viral Encephalitis	**2**
VR-313MC(T)	Viral Respiratory Diseases & Exanthematous Diseases	**2**
VR-331MC(P)	Viral Enteric Diseases	**2**
VR-332MC(P)	Viral Hepatitis	**2**
VR-333MC(P)	Viral Respiratory Diseases	**2**
VR-334MC(P)	a) Viral Haemorrhagic Fevers b) Viral Encephalitis	**2**
Major Elective 2 (T) + 2 (T/P) (Any 2 Courses)		
VR-314ME(T)	a) Veterinary & Agricultural Viruses b) HIV / AIDS	**2**
VR-335ME(P)	HIV / AIDS	**2**
VR-336ME(P)	Special Techniques in Virology	**2**
VR-350(RP)	**Research Project I**	**4**
		Total Credit 22

Note:As per the provision in the credit framework, we have assigned more credits to the practical courses in place of theory since virology requires more hands on training. Total number of credits in the semester remains 22.

Semester IV		
Core Courses		
Major Core- 8 (T) + 4 (P)		
Course Code	**Course Title**	**Number of Credits**
VR-411MC(T)	Quality Control, Bioethics and IPR	**2**
VR-412MC(T)	Applications of R and Python software in biological sciences	**2**
VR-413MC(T)	Genomics and Transcriptomics	**2**
VR-414MC(T)	One Health	**2**
VR-431MC(P)	Applications of R and Python software in biological sciences	**2**
VR-432MC(P)	Molecular Techniques and Biochemical Methods	**2**
Major Elective 2 (T) + 2 (T/P) (Any 2 Courses)		
VR-415ME(T)	Proteomics & Metabolomics	**2**
VR-416ME(T)	Biosensor & Nanobiotechnology	**2**
VR-433ME(P)	Genomics and Transcriptomics	**2**
VR-450(RP)	**Research Project II**	**6**
		Total Credit 22

Total 4 Semesters	**Major Core**	**Major Elective**	**Research Methodology**	**Internship On Job Training (OJT)**	**Research Project (RP)**	**Total Credit**
	54	**16**	**4**	**4**	**10**	**88**

2 Years- 4 SEM. Award PG Degree in Virology on completion of 88 credits after Three years UG Degree or 1 Year-2 SEM PG Degree (44 Credits) after Four-Year UG Degree

Notes: Abbreviations: T- Theory, P- Practical

M.Sc Virology: Semester I

Major Core

VR-111MC(T): Cell Biology & Tissue Culture (2 Credit) (Theory)

Cell Biology:

1. Microscopy: a) Simple, b) Compound, c) Phase contrast [1 hr]
2. Cell ultra-structure and electron microscopy [3 hrs]
3. Structure and function of cellular organelles, cytoskeleton, biomembranes, cell adhesion and junctions, extracellular matrix. [3 hrs]
4. Cell division and cell cycle: Mitosis and meiosis, steps in cell cycle, regulation and control of cell cycle. [2 hrs]
5. Cell signaling: Cell-cell interactions, Cell surface, receptors and signal transduction [2 hrs]
6. Cell growth—hyperplasia, hypertrophy, transformation, development and differentiation—cell lineages, growth and differentiation [2 hrs]
7. Stem cells -adult and embryonic [1 hr]
8. Cell dynamics, cell death [1 hr]

Recommended Books:

1. Essential Cell Biology. Bruce Alberts, Dennis Bray, Keith Roberts, Julian Lewis, Martin Raff. Latest edition / Pub. Date: October 2003. Publisher: Taylor & Francis, Inc.
2. Molecular Cell Biology. Harvey Lodish, James Darnell, Paul Matsudaira, Arnold Berk, S. Lawrence Zipursky. Latest edition / Pub. Date: August 2003. Publisher: W. H. Freeman Company.

Tissue Culture:

1. Introduction to tissue culture: Principles of tissue culture, applications, maintenance of sterility, use of antibiotics, mycoplasma and other contaminations [3hrs]
2. Cell environment—nutritional requirements, substrates. [3 hrs]
3. In vitro cultures—primary, diploid and established cell lines, organ culture, cell types in culture. [3 hrs]
4. Cell characterization—karyotyping, growth rates, isoenzymes [2 hrs]
5. Large scale production—suspension cultures, microcarriers, hollow fiber reactors, etc. [2 hrs.]
6. Quality assurance in animal tissue culture. [1 hr]
7. Generating a new cell line [1 hr]

Recommended Books:

1. Culture of Animal Cells: A Manual of Basic Technique. R. Ian Freshney. Latest edition / Pub. Date: September 2005. Wiley.
2. Culture of Cells for Tissue Engineering. R. Ian Freshney. Pub.Date: March 2006. Wiley.
3. Invertebrate Tissue Culture Methods. Jun Mitsuhashi. Latest edition /Pub. Date: February 2002. Publisher: Springer-Verlag New York, LLC.

VR-112MC(T): Basic Virology (2 Credit) (Theory)

1. History and principles of virology, virus taxonomy, introduction to replication strategies. [6 hrs.]
2. Virus structure and morphology. [4 hrs]
3. Viruses of veterinary importance and zoonotic viruses. [6 hrs.]
4. Principles of bio-safety, containment facilities, maintenance and handling of laboratory animals and requirements of virological laboratory. [4 hrs]
5. Plant viruses, plant virus propagation. [4 hrs]
6. Bacteriophages, bacteriophage propagation and viroids. [3 hr]
7. Oncolytic viruses [3 hr]

Recommended Books:

1. Fields Virology Vol 1 and 2. B.N. Fields, D.M. Knipe, P.M. Howley, R.M. Chanock, J.L. Melnick, T.P. Monath, B. Roizman, and S.E. Straus, eds.), 3rd Edition. Lippincott-Raven, Philadelphia, PA.
2. Principles of Virology: Molecular Biology, Pathogenesis, and Control of Animal Viruses. S. J. Flint, V. R. Racaniello, L. W. Enquist, V. R. Rancaniello, A. M. Skalka. Latest edition / Pub. Date: December 2003 Publisher: American Society Microbiology---Chapters 3-13.
3. Laboratory Animal Medicine: Principles and Procedures. Margi Sirois. Latest edition / Pub. Date: November 2004. Publisher: Elsevier Health Sciences.
4. Guides for the Care and Use of Laboratory Animals. National Research Council. Latest edition / Pub. Date: January 1996. Publisher: National Academy Press.
5. Laboratory Biosafety Manual, WHO, http://www.who.int/csr/resources/publications/biosafety/who_cds_csr_l yo_20034/en/
6. Virology: 1994. 3rd ed. FrankelConrat et al, Prentice Hall.
7. Introduction to Modern Virology. 2001. 5th ed. Dimmock et al., Blackwell Scientific Publ.
8. Basic Virology, 1999. By Waginer and M. Hewlett, Blackwell Science Publ.

VR-113MC(T): Immunology-I (2 Credits) (Theory)

1. Introduction and history; Cells and organs of the immune system, [5 hrs.]
2. Innate immune response & inflammation complement system. [3 hrs.]

3. Hapten/antigen; antibody, structure & function, Immunoglobulin classes. Antigen & antibody interaction, Antibody diversity. [6 hrs.]
4. Ontogeny of immune cells [2 hrs.]
5. B and T cell receptors and signaling [4 hrs.]
6. Major histocompatibility complex, Polymorphisms, Human leukocyte antigen association with disease. [4 hrs.]
7. Antigen processing and presentation, Cytokines & Chemokines. [6 hrs.]

Recommended Books:

1. Abbas AK & AH Lichtman (2006): Basic Immunology: Functions and Disorders of the Immune System. With Student Consult Online Access. Edn. 3. WB Saunders Co.
2. Delves PJ, SJ Martin, DR Burton & IM Roitt (2006): Roitt's Essential Immunology. Edn. 11. Blackwell Publishing.
3. Kindt TJ, RA Goldsby & BA Osborne (2007): Kuby Immunology. Edn. 6. WH Freeman & Co.
4. Paul W.B. (2012) Fundamental Immunology, Edn 7, Lippincott Williams & Wilkins
5. Mak TW, M Saunders & W Tamminen (2008): Primer to the Immune Response. Elsevier.
6. Male D, J Brostoff, D Roth & I Roitt (2007): Immunology: With Veterinary Consult Access. Edn. 7. CV Mosby & Co.
7. Roitt I, J Brostoff, D Male & D Roth (2006): Immunology. With Student Consult Online Access. Edn. 7. CV Mosby & Co.
8. Sompayrac L (2008): How the Immune System Works. Wiley- Blackwell.
9. Wood P (2006): Understanding Immunology. Edn. 2. Prentice Hall/ Pearson Education, Harlow, England.

VR-114MC(T): Basic Epidemiology and Biostatistics (2 Credits) (Theory)

1. Historical aspects and evolution of epidemiology, definitions and concepts in Epidemiology. [5 hrs]
2. Descriptive and analytical epidemiology, disease burden, natural history of diseases and measures of risk and death. [7 hrs]
3. Sample size estimation and introduction to study design in epidemiological investigations. [4 hrs]
4. Introduction, types of data, tabular and graphical presentation of data. [4 hrs]
5. Measures of central tendency. Mean, mode, median, GM, HM, quartiles, Measures of dispersion range, standard deviation, variance, coefficient of variation. Correlation, linear regression. [4 hrs]
6. Concept of probability distribution. Normal distribution—density curves, applications and statistical tables. Concept of significance tests, parametric and non-parametric tests, standard error and confidence intervals. [4 hrs]

7. Introduction to Sampling Methods: Simple Random sampling (with/without replacement), Systematic sampling, Stratified sampling, Cluster sampling [2 hrs]

Recommended Books:

1. Epidemiology: An Introduction. Kenneth J. J. Rothman. Latest edition / Pub. Date: May 2002. Publisher: Oxford University Press.
2. Epidemiology. Leon Gordis. Latest edition / Pub. Date: November 2004. Publisher: Elsevier Health Sciences.
3. Diseases and Human Evolution. Ethne Barnes. Latest edition / Latest edition / Pub. Date: March 2005. Publisher: University of New Mexico Press.
4. Epidemiology: Beyond the Basics. F. Javier Nieto, Moyses Szklo. Latest edition / Pub. Date: November 2003. Publisher: Jones & Bartlett Publishers, Inc.
5. Basic and Clinical Biostatistics. Beth Dawson, Robert G. Trapp, Robert Trapp. Latest edition / Pub. Date: March 2004.
6. Discovering Statistics Using SPSS. Andy Field. Latest edition / Pub. Date: April 2005. Publisher: SAGE Publications.

VR-115MC(T): Analytical Techniques (2 Credits) (Theory)

1. Characterization of biomolecules: Introduction and various approaches for characterization of biomolecules. [2 hr.]
2. Concentration of biomolecules: Salting out with ammonium sulfate, flash evaporation, lyophilization, dialysis, hollow fibre membranes, membrane filtration and their applications. [2 hr.]
3. Electrophoresis (simple theory and applications): Types of electrophoresis paper, gel (starch, acrylamide and agarose) disc, vertical, horizontal submarine, gradient, 2D-PAGE, pulse-field and capillary; isoelectrofocussing; isolation and analysis of molecules from gel and recovery of molecules from paper/gels; southern, northern and western blotting. [6 hrs.]
4. Cell sorting and Flow cytometry: Principles and Applications. [2 hrs.]
5. Radioisotope techniques: Nature and types of radioactivity, half life of isotopes; detection and measurement of radioactivity, GM counter, laboratory safety measures in handling isotopes; biological effects and uses of radioisotopes. Autoradiography. Biological effects of the radiations. [2 hrs.]
6. Spectroscopy: Electromagnetic spectrum of light; simple theory of light absorption by biomolecules; Beers Lambert law; transmittance; extinction coefficient; light sources; monochromators; types of detectors; working principle and applications of visible, UV visible, IR, Raman, ESR, mass, plasma emission, atomic absorption, and NMR spectrophotometry; fluorimetry and flame photometry; isothermal colorimetry, ORD and CD; Xray diffraction and Xray crystallography, surface plasmon resonance. [10 hrs.]
7. Micro array based techniques [2 hrs.]
8. Introduction to Histological techniques [2 hrs.]

9. Detection of molecules in living cells, in situ localization by techniques such as FISH and GISH. [2 hrs.]

Recommended Books

1. Practical Biochemistry: Principles and Techniques 1995, 4th ed. by K. Wilson and J. Walker, Cambridge University Press.
2. Modern Experimental Biochemistry. 1993. 2nd ed. by R.F. Boyer. The Benjamin Cummings Publ. Company.
3. Physical Biochemistry: Applications to Biochemistry and Molecular Biology, 1982, 2nd ed. by David Freifelder. W.H. Freeman and Company.
4. Introduction to Practical Biochemistry. 2000. by S.K. Sawhney and Randhir Singh (eds.) Narosa Publ. House
5. Biochemical Methods for Agricultural Sciences. 1992 by S. Sadasivam and A. Manikam. Wiley Eastern Ltd.
6. Essentials of Nuclear Chemistry by Prof. Hari Jeevan Arnikar, University of Pune. ISBN: 978-81-224-3203-9.
7. Fluorescence In Situ Hybridization (FISH) – Application Guide (Kindle Edition 2010). Editor Thomas Liehr. Springer Publication. ISBN-10: 1607617889, ISBN-13: 978-1607617884.

VR-131MC(P): Tissue culture techniques and Analytical methods (2 Credits) (Practical)

Tissue culture techniques

1. Glassware decontamination, washing, sterilization, packing and sterile handling.
2. Media and reagents preparation, sterility checks
3. Maintenance of cell cultures
4. Growth studies. cell count, mitotic index.
5. Preparation of primary cell culture (CEC)

Analytical methods

1. Preparation of reagents and buffers
2. Protein estimation by Lowry method
3. DNA estimation (spectrophotometric)
4. Polyacrylamide gel electrophoresis
5. Confocal microscopy (Demonstration)
6. Gel Filtration chromatography (Demonstration)

VR-132MC(P): Propagation of viruses and Virus / Antigen detection (2 Credit) (Practical)

Propagation of viruses:

1. Estimation of virus yields-- plaque assay & $TCID_{50}$
2. Preparation virus stocks and determination of mouse LD_{50}
3. Routes of inoculations in embryonated eggs
4. Handling of animals: Rules & Regulations

Virus / Antigen detection

1. ELISA
2. Immunoflourescence assay
3. Heamagglutination
4. Agar gel diffusion
5. Polymerase chain reaction
6. Electron microscopy (Demonstration)

Major Elective (Any 2):

VR-116ME(T): a) Vector Biology , b) General Biochemistry (2 Credits) (Theory)

a) Vector Biology

1. Introduction to general entomology, insect morphology and classification. Insects and other arthropods of medical importance and their structures and functions. Methods for collecting these insects and arthropods, their preservation/ maintenance and transportation. [2 hrs]
2. Biology and life history of *Aedes, Culex* and *Anopheles* mosquitoes, their behavior and ecology with special reference to dengue, chikungunya, Japanese encephalitis and West Nile virus [3 hrs]
3. Biology, morphology and disease relationship of sandflies (sandfly fever and chandipura). Biology and morphology of fleas, lice, culicoides. Biology, ecology, life history of ticks with special reference to Kyasanur Forest Disease (KFD, CCHF). Biology and morphology of mites. [4 hrs]
4. Vector virus interactions: Virus dissemination & mechanism of virus transmission in vectors, natural cycle, maintenance of viruses in nature, basis of vector competence, mechanical transmission, virus dissemination, susceptibility-intrinsic and extrinsic factors. Xenodiagnosis- methods and application. [3 hrs]
5. Vector Control: Various control strategies and environmental management. Control in urban settings, control at aquatic stages, adult population, personal protection, insecticide resistance mechanism and control dynamics. [3 hrs]

Recommended Books:

1. Gordon RM, Lavoipierre MMJ (1962) *Entomology for students of Medicine*. Blackwell Scientific Publ.
2. Service MW (1996) *Medical entomology for students*. Chapman and Hall
3. Kettle DS (1984) Medical and veterinary entomology CAB international
4. Richard and Davies Imm's general Text book of Entomology, Vol I & II. Chapman and Hall
5. Roy DN and Brown AWA (1970) Entomology (Medical & veterinary) Bangalore printing and Publishing co.
6. Bates M (1949) Natural History of mosquitoes The Macmillan Co
7. Baker RH and Wharton R(1952) Introduction to Acarology The Macmillan Co

b) General Biochemistry

1. Carbohydrates: Classification of carbohydrates; outline structure and properties of important mono-, di-, and oligosaccharides and their identification and analysis; structure, occurrence and biological importance of structural polysaccharides (cellulose, chitin, agar, alginic acids, pectins, proteoglycans, sialic acids, ATP biosynthesis (Glycolysis, TCA and ETC) [2 hrs.]
2. Lipids: Building blocks of lipids. Classification of lipids. Fatty acids- physico-chemical properties, separation, distribution in nature, characterization and saponification and iodine number. Nomenclature, outline structures, properties and functions of glycerides, neutral lipids (waxes, fats, oils), phospholipids, sphingolipids and glycolipids. Steroids-plant sterol, ergosterol, stigmasterol, cholesterol. Lipoproteins- classification, composition and importance. Lipid metabolism; oxidation of saturated and unsaturated fatty acids. [2 hrs.]
3. Amino acids: Classification, structures, physicochemical properties, acid-base behavior of amino acids. Peptides: Characteristics of peptide bond, peptides of non-protein origin, properties and functions of peptides, determination of amino acid composition and sequence in peptides, peptides profiling. [2 hrs.]
4. Proteins: Classification, properties and biological functions of proteins; structural organization of proteins primary, secondary, tertiary and quaternary. [2 hrs.]
5. Protein metabolism: hydrolysis of proteins exo and endoproteinases, only outlines of biosynthesis and catabolism of amino acids (interlinking with carbohydrate and lipid metabolism) in microbes. Importance of deamination, decarboxylation and transamination reactions. Urea cycle. [2 hrs.]
6. Catalytic proteins (enzymes): Classification, nomenclature, composition and structures, enzymes as biocatalysts, outlines of purification and assay of enzymes, kinetics of enzyme catalyzed reactions, factors influencing enzyme catalyzed reactions, regulation of enzyme activity activators and inhibitors and mechanism of action of enzymes

(chymotrypsin). Regulatory enzymes allosteric enzymes. Isoenzymes, coenzymes, ribozymes, abzymes. [2 hrs.]

7. Nucleic acids: types and their composition, structures of purines, pyrimidines, modified bases, nucleosides, nucleotides and polynucleotides; properties of bases and functions of nucleotides; types and structural polymorphism of DNA and RNA; denaturation and renaturation of nucleic acids, factors influencing hybridization, cot curves [2 hrs.]
8. Nucleotide metabolism: break down of nucleic acids-exo and endo-nucleases (RNases & DNases); phosphodiesterases, salvage pathways. [1 hr.]

Recommended Books:

1. Principles of Biochemistry, Lehninger, 3rd edition by Nelson and Cox (Worth) 2000.
2. Biochemistry, Stryer 5th edition, W.H. Freeman, 2001.
3. Review of Physiological Chemistry (Latest edition) by Harold A Harper. Lange Medical Publication.

VR-117ME(T): Microbiology (2 Credit) (Theory)

1. Origin and evolution of microorganisms. Distinguishing of different groups of microorganisms, Classification of microorganisms. [4 hrs.]
2. Cultivation of microorganisms: Types of media- natural and synthetic; autotrophic, heterotrophic and phototrophic media; basal, defined, complex, enrichment, selective, differential, maintenance and transport media. [5 hrs.]
3. Isolation from different natural samples. Approaches for obtaining pure cultures. Cultivation of aerobes and anaerobes. [5 hrs.]
4. Enumeration / measurement of growth of microorganisms, Maintenance and preservation of microbial cultures: Repeated sub-culturing, sterile soil/sand preservation, glycerol-deep freezing, oil overlay, drying methods, freeze-drying. [4 hrs.]
5. Fungi: Classification, structure, composition, reproduction and other characteristics of fungal divisions. [4 hrs.]
6. Protozoan parasites: Classification, morphology and structure, reproduction and other characteristics of pathogenic protozoa like *Entamoeba, Plasmodium, Leishmania, Cryptosporidium, Trichomonas, Taxoplasma, Trypanosoma, Giardia*. [4 hrs.]
7. Medical Microbiology: *Vibrio cholera, Salmonella typhii, S. pneumoniae*. [4 hrs]

Recommended Books:

1. Principles of Microbiology. 1997. 2nd ed. R.M. Atlas. Wm.C. Brown. Publ.
2. Foundations in Microbiology. 1996. 2nd ed. K. Talaro and A. Talaro. Wm.C. Brown Publ.
3. Microorganisms, Biotechnology and Disease: Students Book. 1997 by Pauline Lourie and Susanwells. Cambridge University Press.

VR-133ME(P): a) Entomological Method, b) Statistical Methods (2 Credits)(Practical)

a) Entomological Methods

1. Mosquito collection & taxonomy
2. Taxonomy of ticks and sandflies
3. Processing of arthropods
4. Mosquito inoculation & immunoflourescence
5. Insecticide testing
6. Collection of rodents

b) Statistical Methods

1. Graphical presentation of data
2. Measures of central tendency and dispersion
3. Correlation and regression analysis
4. Significance tests
5. Statistical packages
6. Epidemiological exercise
7. Introduction to various available softwares (demo)

VR-150(RM): Research Methodology (4 Credits)

1. Safety and Behavior at Workspace, Laboratoryand InstitutionalCampus:

General safety and accident prevention guidelines, Good personnel safety practices, Laboratory safety practices (Do's and Don'ts), Fire safety principles and fire handling, Care in handling chemicals, Understanding materials safety data sheet (MSDS), Storing and indexing of materials & chemicals, Disposal of materials, chemicals and biological wastes, First aid, Reporting accidents and requisitioning help, Combating accidents. Awareness about members of the Institutional Safety Committee and emergency contact numbers. Lab bench co-operation with colleagues and co-workers, cultivating practice of collectivism, shared responsibilities and team-spirit among fellow researchers, Advancing culture of scientific sharing and discussion in campus and lab

2. Research ProblemIdentification andResearch Design/Plan:

Scientific methods, Types of reasoning (Logics) - Induction – Deduction – Abduction, Identifying a topic/area of research, Reviewing literature, Identifying a question to be answered/solution of a problem to be sought, Critically weighing investment (time, money and efforts) to reward (size and scale of answer/solution), Finalizing the research question/problem to be worked on, Cross-disciplinary thoughts and inter-disciplinary research approaches of addressing the question. Design of experiment/research work process and its implementation, Serendipity research.

3. Good Experimental,Observational and DataAnalysis includingComputer Applications:

Maintenance of laboratory records & e-Note books, Management of data and self-navigation of research project and academic program progress (objectives, milestone as well as timeline compliance), Data integrity & archiving of observational data for re-tracing, Basic mathematical and statistical treatments of data for appropriate/rational interpretation, Reporting data in inference perspectives, Common computational tools like Process flow diagram, Chemical structure drawing, statistical analyses, Data tabulation and figure presentation (graph, bar diagram,Venn Diagram, heat maps etc.)

4. Writing & Communication ofResearch Results and Inferences:

Scientific writing (including Language proficiency), State-of-the-art scientific literature comprehension, Art and ethics of writing research report/paper, writing of an abstract for scientific community and general public, Skills of making powerpoint presentations, Art of web-meeting,Interactions & presentations using latest video-meeting modes, Letterwriting and official correspondence

Recommended Books:

1. Research Methodology: Methods and Techniques (New Age International).
2. Introduction to Biostatistics and Research Methods: P. S. S. Sundar Rao and J. Richard (PrenticeHall India).
3. Essentials of Research Design and Methodology: G. R. Marczyk, D. DeMatteo, D. Festinger(John Wiley & Sons).
4. Managing Science:Methodology and Organization of Research : Frederick Betz (Springer-Verlag).
5. Maths from Scratch for Biologists: A. J. Cann (Wiley).
6. Experimental Design and Data Analysis for Biologists: G. P. Quinn and M. J. Keough (Cambridge Research Methodology in the Social, Behavioural and Life Sciences - Designs, Models and
7. Methods: H. J. Ader and G. J. Mellenbergh (SAGE Publications)

M.Sc Virology: Semester II

Major Core:

VR-211MC(T): Molecular Biology (2 Credits) (Theory)

1. Genomes: types, diversity in size, structure and organization in viruses, prokaryotes (nucleoid) and eukaryotes (chromosomes, ploidy, chromatin and nucleosomes). Chloroplast and mitochondrial genomes. Genome complexity and sequence components. Central dogma theory and flow of genetic information. [4 hrs]
2. Genes: The modern concept of the genes, gene structure and architecture, types of genes [1 hr]
3. Plasmids: detection, types, properties, purification, transfer, replication and curing, significance / importance. [1 hr]
4. Mobile genetic elements: Prokaryotes - types and structure of bacterial transposons, and molecular mechanism of transposition. Eukaryotes – types and their structure, and molecular mechanism of transposition. Exploitation of transposable elements in genetics [1 hr]
5. Gene transfer mechanisms and gene mapping in bacteria: Natural and artificial transformation. Conjugation and sexduction. Transductions (generalized; abortive, specialized and co-transduction). [1 hr]
6. Genetic recombination: Requirements for recombination. Molecular models / basis of recombination. [2 hrs]
7. Replication / perpetuation of nucleic acids: Concepts, definitions, and strategies / models for replication. Relation between cell cycle and DNA replication. Molecular mechanisms of DNA replication in prokaryotes and eukaryotes. Replication of single stranded DNA. Inhibitors of DNA replication [3 hrs]
8. DNA damage and repair: Classes / types of damage. Repair mechanisms – mismatch repair, short patch repair, nucleotide / base excision repair, recombination repair and SOS system. [1 hr]
9. Mutations: Types, causes and consequences of mutations. Mutagens and their mode of action. Isolation and analysis of bacterial / phage mutants. Importance of mutants in genetic analysis, point mutation [2 hrs]
10. Transcription (RNA biosynthesis): Types of RNA and their role. Organization of protein and RNA encoding transcription units and their transcription in prokaryotes and eukaryotes. Types of RNA polymerases. Protein binding sites on DNA - DNA foot printing. Promoters, enhancers, silencers, insulators. Transcription factors and characteristics of DNA binding proteins. Sigma factors. Events of transcription. Maturation and processing of different RNA transcripts- capping, methylation, polyadenylation, splicing, RNA editing and modification of nucleosides in tRNAs.

Regulation of transcription. *In vitro* transcription systems. Inhibitors of transcription. [4 hrs]

11. Translation (protein biosynthesis): Genetic code and its elucidation, structure and composition of prokaryotic and eukaryotic ribosomes, structural features of rRNA, mRNA and tRNAs in relation to function, steps of protein biosynthesis (activation of amino acids, initiation, elongation, termination) in prokaryotes and eukaryotes; post-translational modification of proteins and their sorting and targeting; regulation of translation; inhibitors of protein biosynthesis; in vitro translation systems. [4 hrs]
12. Regulation of gene expression: An overview on levels of regulation, terminology and operon concepts, enzyme induction and repression; positive and negative regulation in *E. coli*- lac, regulation by attenuation - trp operons; Eukaryotic Gene Regulation. Organization and regulation of nif and nod gene expression in bacteria; Global regulatory responses- heat shock response, stringent response and regulation by small molecules such as cAMP and PPGPP. [5 hrs]
13. Gene silencing mechanisms: Transcriptional and post-transcriptional silencing. RNA silencing, CRISPR/Cas9 technology and gene regulation. [1 hr]

Recommended Books

1. Molecular Biology of the Gene. 4th Edition. 2004. Pearson Education.
2. Molecular Cell Biology. 2003, by Lodish et al., Scientific american books, W.H. Freeman & Co.
3. Molecular Biology. 1995, by David Freifelder, Narosa Publ. House.
4. Text Book of Molecular Biology. 1994, by Sivarama Sastry et al, Macmillan India Ltd.
5. Advanced Molecular Biology: A Concise Reference. 1998, by R.M. Twyman. Viva Books Pvt. Ltd.
6. Microbial Genetics. 1995, by David Freifelder. Narosa Publ. House
7. Biology of the Gene. 1998, 5th ed. Watson et al, Addison Wesley Longman.

VR-212MC(T): Antivirals and Viral Vaccines (2 Credit)(Theory)

Antivirals:

1. Antiviral Drug Classification [1 hr]
2. Designing / Screening of antivirals [1 hr]
3. Target identification & molecular modeling [1 hr]
4. Systems Biology approach & drug repurposing [1 hr]
5. Preclinical evaluation of antiviral agents [1 hr]
6. Clinical trial design [1 hr]
7. Mechanism of Antiviral drug resistance [1 hr]
8. Traditional & synthetic antivirals [1 hr]
9. Drug delivery approache [1 hr]
10. Pharmacogenomics [1 hr]

11. Pharmacokinetics & pharmacodynamics [1 hr]
12. Interferons [1 hr]
13. Anti-sense RNA, siRNA, miRNA, ribozymes [1 hr]
14. Antibody based therapeutics [1 hr]
15. Drug discovery to clinics [1 hr]

Recommended Books:

1. Antiviral Agents, Vaccines, and Immunotherapies. Stephen K. Tyring. Latest edition / Pub. Date: October 2004. Publisher: Marcel Dekker.
2. Antiviral Drug Discovery for Emerging Diseases and Bioterrorism Threats. Paul F. Torrence (Editor). Latest edition / Pub. Date: July 2005. Publisher: Wiley, John & Sons, Incorporated.
3. Chimeric Virus -like Particles as Vaccines. Wolfram H. Gerlich (Editor), Detlev H. Krueger (Editor), Rainer Ulrich (Editor). Latest edition / Pub. Date: November 1996 Publisher: Karger, S. Inc.
4. Vaccines. Stanley A. Plotkin, Walter A. Orenstein. Latest edition / Pub. Date: September 2003. Publisher: Elsevier Health Sciences.

Viral Vaccines:

1. Conventional vaccines -killed and attenuated, [3 hrs]
2. Modern vaccines—recombinant proteins, subunits, DNA vaccines, peptides, immunomodulators (cytokines) [4 hrs]
3. Vaccine delivery and vaccination strategies, vaccine components- adjuvants, preservatives, large scale manufacturing-QA/QC issues. [4 hrs]
4. Animal models and vaccine potency testing. [2 hrs]
5. Clinical trial of vaccines [2 hr]

Recommended Books:

1. Chimeric Virus -like Particles as Vaccines. Wolfram H. Gerlich (Editor), Detlev H. Krueger (Editor), Rainer Ulrich (Editor). Latest edition / Pub. Date: November 1996 Publisher: Karger, S. Inc.
2. Vaccines. Stanley A. Plotkin, Walter A. Orenstein. Latest edition / Pub. Date: September 2003. Publisher: Elsevier Health Sciences.

VR-213MC(T): a) Bioinformatics, b) Applied Epidemiology (2 Credit) (Theory)

a) Bioinformatics

1. Introduction and biological data bases: Nucleic acid, proteins, genomes, structure data bases, search engines, sequence data formats and submission tools, scoring matrices for sequence alignments, algorithms—pairwise sequence alignments, database similarity searches - BLAST, FASTA. [3 hrs.]
2. Methods for sequence analysis: Multiple sequence alignment, phylogenetic analysis and tree building methods, data mining tools and applications–secondary/ derived databases, motif & family searches, epitope prediction, etc [7 hrs.]
3. Structure based approaches: Protein secondary structure prediction, threading approaches, homology based methods for protein tertiary structure prediction, visualization tools, structure evaluation and validation [3hrs]
4. Primer designing for PCR. [2hrs]

Recommended Books:

1. Introduction to Bioinformatics---Lesk, A.
2. Introduction to Bioinformatics--- Attwood.
3. Instant notes in Bioinformatics---Westhead, Parish &Twyman.
4. Bioinformatics: A practical guide to the analysis of genes and proteins-Baxevanis, Qoellette, John Wiley & Sons, NY.
5. Mount David: Bioinformatics

b) Applied Epidemiology:

1. Syndromic surveillance for viral diseases, ICD- codes, case reports and case series [2 hrs.]
2. Outbreak investigations, special studies (surveys/case control and cohort studies) in viral diseases [3 hrs.]
3. Assessment of viral disease burden, disease causality, mortality, morbidity aspects and quantification of risk indicators [3 hrs.]
4. Public health strategies for prevention and control of viral diseases, Infectious diseases surveillance of viral diseases and its veterinary epidemiology [3 hrs.]
5. Health Technology Assessment specific to viral diseases, evidence-based medicine, systematic review & meta-analysis, costing methods and economic evaluation of viral diseases and infectious diseases modeling [4 hrs.]

Recommended Books:

1. Epidemiology: An Introduction. Kenneth J. J. Rothman. Latest edition / Pub. Date: May 2002. Publisher: Oxford University Press.

2. Epidemiology. Leon Gordis. Latest edition / Pub. Date: November 2004. Publisher: Elsevier Health Sciences.
3. Diseases and Human Evolution. Ethne Barnes. Latest edition / Pub. Date: March 2005. Publisher: University of New Mexico Press.
4. Epidemiology: Beyond the Basics. F. Javier Nieto, Moyses Szklo. Latest edition / Pub. Date: November 2003. Publisher: Jones & Bartlett Publishers, Inc.
5. Basic and Clinical Biostatistics. Beth Dawson, Robert G. Trapp, Robert Trapp. Latest edition / Pub. Date: March 2004.
6. Discovering Statistics Using SPSS. Andy Field. Latest edition / Pub. Date: April 2005. Publisher: SAGE Publications.

VR-214MC(T): Virus Replication and Virus-cell Interaction (2 Credit) (Theory)

Virus Replication:

1. Replication of positive sense RNA virus (polio virus, any flavivirus), negative sense RNA viruses (VSV and influenza) [5 hrs.]
2. Replication of double stranded RNA virus (Rotavirus), ambisense RNA (LCM) and retroviruses (HIV and HTLV). [5 hrs.]
3. Replication of double stranded DNA viruses (SV40, pox), ssDNA virus (AAV) [3 hrs.]
4. Prion proteins, replication of plant virus (Poty). [2 hrs.]

Recommended Books:

1. Principles of Virology: Molecular Biology, Pathogenesis, and Control of Animal Viruses. S. J. Flint, V. R. Racaniello, L. W. Enquist, V. R. Rancaniello, A. M. Skalka Latest edition / Pub. Date: December 2003 Publisher: American Society Microbiology.
2. DNA Virus Replication. Alan J. Cann. Latest edition / Pub. Date: March 2000. Publisher: Oxford University Press.
3. Principles of Molecular Virology. Alan Cann J. Cann. Latest edition / Pub. Date: June 2005. Publisher: Elsevier Science & Technology Books.
4. Fields Virology. Vol. 1 and 2.

Virus-cell Interaction:

1. Definition, structure and methods of discovery of viral receptors (polio, herpes, VSV, HIV). Kinetics of receptor binding. Cellular interactions—clathrin coated pits, lipid rafts, caveolae, endocytosis and virus uncoating mechanisms. Nuclear localization signals and nuclear pore transit, virus –cytoskeletal interactions, chaperons. [5 hrs.]

2. Replication sites and their characterization, IRES, replicons, transport of viral proteins. [3 hrs.]
3. Host cell 'shut off', apoptosis, necrosis, stress response, alteration of signaling pathways, cellular basis of transformation, types of cenotaphic effects, ultrastructural cytopathology [3 hrs.]
4. Cellular injury associated markers, mechanism of viral persistence and latency—*in vivo* and *in vitro* models (JE, measles, LCM and HIV). [4 hrs.]

Recommended Books:

1. Principles of Virology: Molecular Biology, Pathogenesis, and Control of Animal Viruses. S. J. Flint, V. R. Racaniello, L. W. Enquist, V. R. Rancaniello, A. M. Skalka Latest edition / Pub. Date: December 2003 Publisher: American Society Microbiology.
2. Virus Dynamics: Mathematical Principles of Immunology and Virology. Martin A. Nowak, Robert May.Latest edition / Pub. Date: January 2000. Publisher: Oxford University Press.
3. Molecular Aspects of Host-Pathogen Interactions. Malcolm A. McCrae (Editor), J. R. Saunders (Editor), C. J. Smyth (Editor), N. D. Stow (Editor) Latest edition / Pub. Date: September 1997. Publisher: Cambridge University Press.
4. Cell Biology of Virus Entry, Replication, and Pathogenesis. Richard W. Compans, Ari Helenius (Editor), Michael B. Oldstone (Editor). Latest edition / Pub. Date: December 1988. Publisher: Wiley, John & Sons, Incorporated.

VR-215MC(T): Recombinant DNA Technology (2 Credits) (Theory)

1. Scope and importance of recombinant DNA technology. [1 hr.]
2. Tools for Recombinant DNA Technology: Gene vectors-Plasmid, transposon, bacterophage and plant and animal virus based vectors (retroviral, pox, rhabdo and adeno virus vectors) for manipulation of genes in bacteria, yeast, plant and animal cell systems. Enzymes–different nucleases, DNA and RNA polymerases, DNA joining enzymes (ligases, topoisomerase, recombinase) and other nucleic acid modifying enzymes. Oligonucleotides - linkers, adaptors, homopolymer tails, primers, promoters, reporter/ marker genes. Source DNA - genomic DNA, cDNA, PCR products and chemically synthesized oligonucleotides. [3 hrs.]
3. Cutting and joining of DNA molecules-generation and joining of blunt and sticky ended DNA molecules using linkers, adaptors and homopolymer tails and PCR amplicons, TdT. [2 hrs.]
4. Techniques for gene manipulation: DNA sequencing -Chemical, dideoxy chain termination, primer walking, automated sequencing, pyrosequencing, next generation sequencing methods [3 hrs.]

5. Molecular diagnostics: Nucleic acid blotting and hybridization - Preparation of DNA and RNA probes, hybridization formats, factors influencing hybridization and applications of hybridization based tests. PCR- principles, Primer designing, factors affecting PCR, different types of PCR and Real time PCR, RT-PCR and their applications and limitations. DNA profiling - RFLP, AFLP, RAPD and DNA finger printing and their applications. [4 hrs.]
6. Site directed mutagenesis and protein engineering: Different approaches for changing genes. Approaches for protein engineering to generate novel enzymes like subtulisin. [2 hrs.]
7. Gene cloning strategies: Construction of genomic DNA and cDNA libraries and different strategies for selection, screening and analysis of recombinants. Recombinogenic engineering, Green Fluorescence protein, Fusion proteins—signals for protein secretion, purification of recombinant proteins. [2 hrs.]
8. Gene cloning & Expression in bacteria, yeast, plant and animal cells-construction of cell specific recombinant vectors, introduction of them into targeted cells by different approaches and screening and isolation of recombinant cell clones. Insect cell system – Over expression of cloned genes using baculovirus based vectors. Production of recombinant molecules; Purification and analysis of generated recombinant molecules. Construction of vectors for over expression of genes, optimization of generation of recombinant molecules. In vitro translational systems like RBCs and Wheat Germ systems. [7 hrs]
9. Phage display libraries, reverse genetics, viral replicons (SFV and HCV) [3 hrs.]
10. Functional genomics - transcriptome and gene expression profiling. In vitro mutagenesis and deletion techniques, genes knock out in bacterial and eukaryotic organisms. [2 hrs.]
11. Proteomics- proteome and analysis of protein expression. Introduction to structural and comparative proteomics. [1 hrs.]

Recommended Books

1. Old, R. W., Primrose, S. B., & Twyman, R. M. (2001). *Principles of Gene Manipulation: an Introduction to Genetic Engineering*. Oxford: Blackwell Scientific Publications.
2. Green, M. R., & Sambrook, J. (2012). *Molecular Cloning: a Laboratory Manual*. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
3. Brown, T. A. (2006). *Genomes* (3rd ed.). New York: Garland Science Pub.
4. Selected papers from scientific journals, particularly Nature & Science.
5. Technical Literature from Stratagene, Promega, Novagen, New England Biolab *etc.*

VR-231MC(P): Serological methods and Immunological techniques (2 Credits) (Practical)

Serological methods:

1. Heamagglutination inhibition test
2. Reagent preparation for ELISA

3. IgM capture ELISA,
4. IgG ELISA
5. Plaque reduction neutralization test

Immunological techniques:

1. Isolation of Peripheral Blood mononuclear cells (PBMCs) from human blood
2. Isolation of splenocytes from mice
3. Separation of B and T cells
4. Setting up of Macrophage culture
5. Phagocytosis assay
6. Phenotyping of immune cells using Flowcytometry
7. Lymphocyte proliferation assay
8. Cytokine assay
9. Elispot assay
10. HLA-DRB1 genotyping by PCR- method

VR-232MC(P): a) Epidemiological data management and analysis, b) Practical Bioinformatics (2 Credit) (Practical)

a) Epidemiological data management and analysis:

Statistical software (EPI-Info)

1: Introduction to the software
Design data entry form
Importing MS Excel data in Epi-Info

2: Basic commands in Epi-Info
Recoding/transforming a variable
Preparing frequency distributions/cross tables
Computing descriptive statistics and interpretation

3: Graphical presentation of data:
Bar diagram, Line diagram, Pie chart, Histogram, EpiCurve
Interpretations

4: Computing correlation coefficient
Comparing proportions using chi-square test
Comparing means using t test
Computing risk using univariate logistic regression
Interpretations

b) Practical Bioinformatics:

1. Biological data banks.
2. Pairwise sequence alignments.
3. Phylogeny & tree building 1.
4. Phylogeny & tree building 2.
5. Secondary structure prediction.
6. Secondary databases – Motif, family searches, Epitope prediction(B-cell).
7. Epitope predictions (T-cell).
8. Biomolecular Structure visualization 1.
9. Biomolecular Structure visualization 2.
10. Primer designing.

Major Elective: (Any 2)

VR-216ME(T): Immunology-II (2 Credit) (Theory)

1. Mucosal effector mechanisms. [4 hrs.]
2. Cell mediated effector mechanisms: Phagocytosis, Cytotoxic and T helper response, Natural killer cells. [6 hrs.]
3. Immunoregulation, Hypersensitivity. Autoimmunity; Immunodeficiency, Transplantation immunology. [10 hrs.]
4. Immunity to viruses and modulation of immune responses by viruses. [5 hrs.]
5. Vaccine induced immune response and immune correlates of protection. [5 hrs.]

Recommended books:

1. Abbas AK & AH Lichtman (2005): Cellular & Molecular Immunology. Elsevier Health Sciences.
2. Kindt TJ, RA Goldsby & BA Osborne (2007): Kuby Immunology. Edn. 6. WH Freeman & Co., New York.
3. Johnson AG (2005): High-yield Immunology. Lippincott/ Williams & Wilkins.
4. Murphy K, P Travers & M Walport (2007): Janeway's Immunobiology. Edn. 7. Garland Science.

VR-217ME(T): Mathematical Biology (2 Credit) (Theory)

1. Fundamentals
   a) Number systems and scientific notations. [2 hrs]
   b) Elements of algebra, functions. [3 hrs]
   c) Understanding equations (Linear, simultaneous and quadratic [2 hrs]
   d) Graph plotting. [2 hrs]

e) Matrices. [3 hrs]
f) Basic Calculus: limits, differentiation, integration. [3 hrs]
g) Differential Equations. [3 hrs]

2. Biological applications
   Beer-Lambart's Law, Enzyme kinetics, Radio-carbon dating, estimation of cell viability, survival curves. [2 hrs]
3. Population based studies
   a) Simple population growth models; [2 hrs]
   b) Predator-Prey interactions: Lotka – Voltera interspecies competition logistics equation (theory, applications and problem set). [3 hrs]
   c) Time series analyses (surveillance & outbreak data), baseline data. [2 hrs]
   d) Epidemics modelling: Concept of epidemic curve, Basic reproduction number, SIR Model; SEIR model; (Basic concepts, calculations, graph plotting, data analyses.); Ronald-Ross malaria model. [3 hrs]

References:

1. Schaum's Outlines College Mathematics. 4th Edition.
2. Mathematical Biology. JD Murray. Springer-Verlag. 1990.
3. Infectious Disease of Humans. RM Anderson & RM May. Oxford Scientific Publications.
4. Principles of mathematical modeling. CL Dym. Academic press. 2004.

VR-233ME(P): Biosafety and Biosecurity (2 Credit) (Practical)

1. Specimen collection from humans
2. Specimen collection from Animals
3. Vector collection
4. Specimen collection from birds, rodents & bats
5. Environmental samples
6. Introduction to Containment Laboratories: [Entry-exit protocols: Complete simulation of the facility with Delta suits/PAPR, Disposable and non-disposable sharps and other materials: Disposal, autoclaving, cleaning, segregation and precautions, Transport within the facility: dunk tanks, pass-boxes, etc., Transport outside the facility [Shipping of infectious material], Safety checks [daily, weekly, monthly and biannual checks], Specific SOPs for various processes & equipments]
7. Laboratory emergency response issues: [Spills: laboratory simulation on Splashes/spills CIP protocol, Needle stick injury, Cuts, & Medical emergencies etc. Air & surfaces decontaminations of the facility based on incidents/accidents, Safeguarding against accidents in the facility, Ventilation failure and emergency protocols, Fire and other

emergencies, Simulation fire alarm system, immediate remedial measures, emergency exit protocol, Safety measures & preparedness for Natural disasters & Terrorist threats]

8. Engineering requirements for Containment laboratory (BSL- II, III): Construction (Civil, Plumbing, drain line), HVAC & BMS, Electrical system (UPS, DG set), Access control system, Furniture, Communication, Fire alarm system, Definition of HEPA/ ULPA filter, Percentage (%) of penetration, In place testing, HEPA filters, Autoclave, BSC working & testing, Equipments use in waste management: Incinerator & Shredder]
9. Visit to health facility [Municipal health service structure, health care facilities]

VR-250(OJT): Internship/ On job Training (OJT) After completion of Sem II exam (4 Credits)