Course syllabus

for

M.Sc. Virology

Conducted at the

National Institute of Virology

130/1, Pashan-Sus Road,
Pashan, Pune 411 021

Under the aegis of IBB

University of Pune

M. Sc. Virology: List of courses offered at NIV

Sr. No.	Course no.	Title	Credits
	Semester I		
1.	VR-111(T)	Basic Virology	1
2.	VR-112(T)	Tissue culture & Cell Biology	2
3.	VR-113(T)	Basic Immunology	2
4.	VR-114(T)	Basic Epidemiology & Biostatistics	2
5.	VR-115(T)	Vector Biology	1
6.	VR-116(T)	Virological Methods	2
7.	VR-131(P)	Analytical Methods	2
8.	VR-132(P)	Tissue culture techniques	3
9.	VR-133(P)	Virus/antigen Detection	3
10.	VR-134(P)	Statistical Methods	1
11.	VR-135(P)	Entomological Methods	3
12.	VR-136(P)	Propagation of viruses	3
	Semester II		
13.	VR-211(T)	Gene regulation and recombinant DNA technology	2
14.	VR-212(T)	Virus Cell Interaction	1
15.	VR-213(T)	Virus Replication	1
16.	VR-214(T)	Advance Immunology	1
17.	VR-215(T)	Applied Entomology	1
18.	VR-216(T)	Applied Epidemiology	1
19.	VR-217(T)	Bioinformatics	1
20.	VR-218(T)	Antivirals and Vaccines	2
21.	VR-231(P)	Molecular techniques	3
22.	VR-232(P)	Biochemical/Biophysical methods	3
23.	VR-233(P)	Serological Methods	3
24.	VR-234(P)	Immunological techniques	3
25.	VR-235(P)	Medical Entomology	1
26.	VR-236(P)	Epidemiological data management and analysis	1
27.	VR-237(P)	Practical Bioinformatics	1
	Semester III		
28.	VR-311(T)	Viral Enteric Diseases & Cancers	1
29.	VR-312(T)	Viral Hepatitis	2
30.	VR-313(T)	Viral Respiratory Diseases	1
31.	VR-314(T)	Exanthematous Diseases of viral aetiology	1
32.	VR-315(T)	Viral Haemorrhagic Fevers	1
33.	VR-316(T)	Viral Encephalitis	2
34.	VR-317(T)	HIV / AIDS (Conducted at NARI)	1
35.	VR-318(T)	Veterinary and Agricultural Viruses	1
36.	VR-331(P)	Viral Enteric Diseases	2
37.	VR-332(P)	Viral Hepatitis	3
38.	VR-333(P)	Viral Respiratory Diseases	2
39.	VR-334(P)	Viral Exanthematous Diseases	1
40.	VR-335(P)	Viral Hemorrhagic Fevers	2
41.	VR-336(P)	Viral Encephalitis	2
42.	VR-337(P)	HIV / AIDS (Conducted at NARI)	2
43.	VR-338(P)	Veterinary and Agricultural Viruses	1
	Semester IV		
44.	VR-411(T)	Special topics	1
44.	VR-431(T+P)	Research Project	24
	Total credits		**100**

One credit= 15 hr of interaction of students with facilitator

Semester I: Theory courses

VR-111(T): Basic Virology **1 Credit**

Module 1: Introduction 5 hrs.

History and principles of virology, virus taxonomy, introduction to replication strategies.

Module 2: Virus structures, animal and plant viruses 5 hrs.

Virus structure and morphology, viruses of veterinary importance and plant viruses.

Module 3: Infrastructure 5 hrs.

Principles of bio-safety, containment facilities, maintenance and handling of laboratory animals and requirements of virological laboratory.

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/

VR-112(T): Tissue Culture and Cell Biology **2 Credits**

Module 1: Cell structure 5 hrs.

Structure and function of cellular organelles, cytoskeleton, cell division, biomembranes, cell adhesion and junctions.

Module 2: Macromolecules: 5 hrs.

Structure and function of DNA, RNA, proteins, carbohydrates and lipids.

Module 3: Molecular biology 6 hrs.

Replication of DNA, transcription and post-transcriptional modifications, protein biosynthesis, posttranslational modifications.

Module 4: Cell signaling 2 hrs.

Signal transduction pathways.

Module 5: Tissue culture methods: 7 hrs.

In vitro cultures—primary, diploid and established cell lines, organ culture, fish and invertebrate cultures, cell types in culture. Cell environment—nutritional requirements, substrates. Cell characterization—karyotyping, growth rates, isoenzymes, and differentiation—normal and transformed cells. Large scale production—suspension cultures, microcarriers, hollow fiber reactors, etc.

Module 6: Developmental biology: 5 hrs.

Cell growth—hyperplasia, hypertrophy, development and differentiation—cell lineages, growth and differentiation factors. Stem cells --adult and embryonic.

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.
4. Essential Cell Biology. Bruce Alberts, Dennis Bray, Keith Roberts, Julian Lewis, Martin Raff. Latest edition / Pub. Date: October 2003. Publisher: Taylor & Francis, Inc.
5. 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.

VR-113(T): Basic Immunology **2 Credits**

Module 1: Introduction to immunology:
Introduction and history; Primary and secondary organs of the immune system. Cells of the immune system. 4 hr

Module 2: Innate immunity:
Innate immune response & inflammation, complement system. 4 hr

Module 3: Antigens & Immunoglobulins:
Hapten/antigen; antibody, structure & function. Immunoglobulin classes. Antigen & antibody interaction. Antibody diversity. 5 hr

Module 4: Antigen recognition:
Major histocompatibility complex. Polymorphism. Human leuko-cyte antigen association with disease. Ontology. Positive and negative selection. 5 hr

Module 5: Acquired immune response:
Antigen presenting cells. Co-stimulation. T and B cell stimulation. Cytokines & Chemokines. 6 hr

Module 6: Assignments/ Presentations:
These will be based on the above 5 modules. 6 hr

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. Mak TW, M Saunders & W Tamminen (2008): Primer to the Immune Response. Elsevier.
5. Male D, J Brostoff, D Roth & I Roitt (2007): Immunology: With Veterinary Consult Access. Edn. 7. CV Mosby & Co.
6. Roitt I, J Brostoff, D Male & D Roth (2006): Immunology. With Student Consult Online Access. Edn. 7. CV Mosby & Co.
7. Sompayrac L (2008): How the Immune System Works. Wiley- Blackwell.
8. Wood P (2006): Understanding Immunology. Edn. 2. Prentice Hall/ Pearson Education, Harlow, England.

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

Module 1: Introduction 5 hrs.
Historical aspects and evolution of epidemiology, definitions and concepts in Epidemiology.

Module 2: Approaches in epidemiology 8 hrs.
Descriptive and analytical epidemiology, disease burden, natural history of diseases and measures of risk and death.

Module 3: Study design and sampling 4 hrs.
Sample size estimation and introduction to study design in epidemiological investigations.

Module 4: Fundamentals of biostatistics 4 hrs.
Introduction, types of data, tabular and graphical presentation of data.

Module 5: Measures of location, dispersion and correlation 4 hrs.
Measures of central tendency. Mean, mode, median, GM, HM, quartiles Measures of dispersion—range, standard deviation, variance, coefficient of variation.

Module 6: Probability and statistical inference 5 hrs.
Concept and probability distribution. Normal distribution—density curves, applications and statistical tables. Concept of significance tests, parametric and non-parametric tests, standard error and confidence intervals.

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-115(T): Vector Biology **1 Credit**

Module 1: Insect morphology, collection and preservation 5 hrs.

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.

Module 2: Biology and ecology of mosquitoes 5 hrs.

Biology and life history of *Aedes, Culex* and *Anopheles,* their behavior and ecology with special reference to dengue, chikungunya, Japanese encephalitis and West Nile

Module 3: Biology and ecology of other blood sucking insects, Ticks and mites 5 hrs.

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). Biology and morphology of mites.

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*

VR-116(T): Virological methods **2 Credits**

Module 1: Cultivation and purification of viruses 5 hrs.

In vivo, in vitro and in ovo systems for virus growth, estimation of yields, methods for purification of viruses with special emphasis on ultracentrifugation methods.

Module 2: Diagnostic methods 10 hrs.

Immnuodiagnosis, haemagglutination and haemagglutination-inhibition tests, Complement fixation, neutralization, Western blot, RIPA, flowcytometry and imunohistochemistry.

Module 3a) Nucleic acid based diagnosis 7 hrs.

Nucleic acid hybridization, polymerase chain reaction, microarray and nucleotide sequencing.

Module 3b) Microscopic techniques : 3 hrs.

Fluorescence, confocal and electron microscopic techniques -- principles and applications.

Module 4: Analytical techniques 5 hrs.

Electrophoresis, chromatography, membrane filtration, NMR, X-ray crystallography.

Recommended Books:

1. Virology Methods Manual. Brian W.J. Mahy (Editor), Hillar O. Kangro (Editor). Latest edition / Pub. Date: January 1996. Publisher: Elsevier Science & Technology Books.
2. Methods and Techniques in Virology. Pierre Payment, Trudel (Editor). Latest edition / Pub. Date: July 1993. Publisher: Marcel Dekker.
3. Diagnostic Virology Protocols: Methods in Molecular Medicine. John R. Stephenson (Editor), Alan Warnes Latest edition / Pub. Date: August 1998. Publisher: Humana Press.
4. Diagnostic Procedures for Viral, Rickettsial, and Chlamydial Infections. Edwin H. Lennette (Editor), David A. Lennette, Evelyne T. (Eds.) Lennette, Evelyne T. Lennette (Editor). Latest edition / Pub. Date: January 1995. Publisher: American Public Health Association Publications.

Semester I: Practical Courses

VR-131(P): Analytical methods	**2 Credits**
1. Protein estimation (Lowry)	5 hrs.
2. DNA estimation (colorimetric and spectrophotometric)	8 hrs.
3. Gel filtration chromatography	5 hrs.
4. Polyacrylamide gel electrophoresis	8 hrs.
5. Confocal microscopy	4 hrs.

VR-132(P): Tissue culture techniques	**3 Credits**
1. Glassware decontamination, washing, sterilization, packing and sterile handling	5 hrs.
2. Media and reagents preparation, sterility checks	8 hrs.
3. Maintenance of cell cultures	16 hrs.
4. Preparation of primary cell culture (CEC)	16 hrs.

VR-133(P): Virus / Antigen detection	**3 Credits**
1. ELISA	8 hrs.
2. Immunoflourescence assay	8 hrs.
3. Heamagglutination	8 hrs.
4. Agar gel diffusion	5 hrs.
5. Polymerase chain reaction	8 hrs.
6. Electron microscopy	8 hrs.

VR-134(P): Statistical Methods	**1 Credits**
1. Graphical presentation of data	3 hrs.
2. Measures of central tendency	3 hrs.
3. Correlation and regression analysis	3 hrs.
4. Significance tests	3 hrs.
5. Statistical packages	3 hrs.
6. Epidemiological exercise	3 hrs.

VR-135(P): Entomological methods	**3 Credits**
1. Mosquito collection & taxonomy	8 hrs.
2. Taxonomy of ticks and sandflies	8 hrs.
3. Processing of arthropods	8 hrs.
4. Mosquito inoculation & immunoflourescence	8 hrs.
5. Insecticide testing	8 hrs.
6. Collection of rodents	5 hrs.

VR-136(P): Propagation of viruses	**3 Credits**
1. Estimation of virus yields-- plaque assay & $TCID_{50}$	18 hrs.
2. Preparation virus stocks and determination of mouse LD_{50}	18 hrs.
3. Routes of inoculations in embryonated eggs	9 hrs.

Semester II: Theory courses

VR-211(T): Gene Regulation & Recombinant DNA technology 2 Credits

Module 1: Prokaryotic gene expression 5 hrs.
Polymerase-promoter interactions, control of transcription initiation and termination.

Module 2: Eukaryotic gene expression 5 hrs.
Chromosomes, chromatin structure, regulatory elements, splicing and RNA processing.

Module 3: Cloning vectors 5 hrs.
Plasmids, cosmids, lambda phage, M13 phage, BAC and YAC

Module 4: Expression vectors 10 hrs.
Prokaryotic, Eukaryotic vectors—yeast, mammalian and insect cell systems. Viral vectors—retroviral, pox, rhabdo and adeno virus vectors. Fusion proteins—signals for protein secretion, purification of recombinant proteins.

Module 5: Novel strategies 5 hrs.
Phage display libraries, reverse genetics, viral replicons (SFV and HCV).

Recommended Books:

1. Molecular Biology of the Gene. James D. Watson, Michael Levine, Richard Losick, Bell, Baker Latest edition / Pub. Date: December 2003 Publisher: Benjamin Cummings.
2. Molecular Biotechnology: Principles and Applications of Recombinant DNA. Bernard R. R. Glick, Jack J. Pasternak. Latest edition / Pub. Date: July 2002. Publisher: ASM Press.
3. Genes VIII. Benjamin Lewin. Latest edition / Pub. Date: December 2003. Publisher: Prentice Hall.
4. DNA Microarrays: A Molecular Cloning Manual. David Bowtell (Editor), Joseph Sambrook (Editor). Latest edition / Pub. Date: September 2002. Publisher: Cold Spring Harbor Laboratory Press.

VR-212(T): Virus-cell Interaction 1 Credit

Module 1: Cellular receptors and virus entry 5 hrs.
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.

Module 2: Virus morphogenesis 3 hrs.
Replication sites and their characterization, IRES, replicones, transport of viral proteins.

Module 3: Mechanism of host cell damage 3 hrs.
Host cell 'shut off', apoptosis, necrosis, stress response, alteration of signaling pathways, cellular basis of transformation, types of cenotaphic effects, ultrastructural cytopathology.

Module 4: Cellular gene expression 4 hrs.
Cellular injury associated markers, mechanism of viral persistence and latency—in vivo and in vitro models (JE, measles, LCM and HIV).

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-213(T): Virus Replication **1 Credit**

Module 1: RNA viruses: 5 hrs.
General strategies, replication of plus stranded RNA virus (polio), negative strand RNA viruses (VSV and influenza).

Module 2: Other RNA viruses 5 hrs.
Replication of double stranded RNA virus (rota), ambisense RNA (LCM) and retroviruses (HIV and HTLV).

Module 3: DNA viruses 3 hrs.
Replication of double stranded DNA viruses (SV40, pox), ssDNA virus (AAV)

Module 4: Miscellaneous. 2 hrs.
Prion proteins, replication of plant virus (Poty).

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. Field Virology. Vol. 1 and 2.

VR-214(T): Advanced Immunology **1 Credits**

Module 1: Mucosal Immunity:
Cells and organs of the mucosal immune system. Mucosal effector mechanisms. 3 hr

Module 2: Effector Mechanisms:
Phagocytosis. Cytotoxic and T helper response. Natural killer and gamma delta cells. 3 hr

Module 3: Immunoregulation:
Antigen-antibody, cytokine-mediated immune regulation. Complement mediated regulation. Hypersensitivity. Autoimmunity; immunodeficiency. Transplantation immunology. 6 hr

Module 4: Assignments:
These will be based on the above three modules. 3 hr

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-215(T): Applied Entomology **1 Credit**

Module 1: Vector virus relationship 3 hrs.

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.

Module 2: Epizootiology of vector borne viral diseases 2 hrs.

Formation of natural foci of diseases, spatial structure and geographic variations. Animal movements, host preferences of vectors and their influence. Influence of man in natural focality, natural cycles and population biology of vector borne pathogens, GIS in vector borne viral diseases.

Module 3: Vector Control 5 hrs.

Various control strategies and environmental management. Control in urban settings Control at aquatic stages, adult population, personal protection, insecticide resistance mechanism and control dynamics.

Module 4: Molecular Entomology 5 hrs.

Mosquito Genetics**:** Basic Genetics--mutants of special interest, chromosomal variants, genetics of populations, evolutionary Genetics] Applied Genetics [Breeding systems, Genetic control] Transgenic vectors: Transgenic mosquitoes, genetic manipulation, interfere with arbovirus infections, ecological aspects, possible usage of transgenic mosquitoes. Molecular Characterization of vectors: Species complexes, molecular approach to Taxonomy, proteins as Taxonomic markers, biochemical and molecular Taxonomy for detection of intra -species variation.

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.*

VR-216(T): Applied epidemiology **1 Credit**

Module 1: Public health surveillance 5 hrs.

Types and methods of public health and infectious disease surveillance, establishing surveillance system.

Module 2: Analytical epidemiology 4 hrs.

Case control and cohort studies.

Module 3: Outbreak investigations 6 hrs.

Needs and steps to be taken for outbreak investigations, collaboration with State and national health authorities.

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-217(T): Bioinformatics **1 Credit**

Module 1: Introduction and biological data bases 4 hrs.

Nucleic acid, proteins, genomes—structure data bases, search engines, sequence data forms and submission tools, scoring matrices for sequence alignments, algorithms—pairwise sequence alignments, database similarity searches—BLAST, FASTA.

Module 2: Methods for sequence analysis 6 hrs.

Multiple sequence alignment, phylogenetic analysis and tree building methods, motif searches, epitope prediction, data mining tools and applications, promoter and gene prediction, comparative analysis.

Module 3: Structure based approaches 5 hrs.

Protein secondary structure prediction, threading approaches, homology based methods for protein tertiary structure prediction, visualization tools, structure evaluation and validation, antigen-antibody interactions.

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.

VR-218(T): Antivirals and Viral Vaccines **2 Credits**

Module 1: Viral Vaccines 10 hrs.

Conventional vaccines -killed and attenuated, modern vaccines—recombinant proteins, subunits, DNA vaccines, peptides, immunomodulators (cytokines), vaccine delivery and adjuvants, large scale manufacturing—QA/QC issues.

Module 2: Antivirals 10 hrs.

Interferons, designing and screening for antivirals, mechanisms of action, antiviral libraries, antiretrovirals—mechanism of action and drug resistance.

Module 3: Modern approaches of virus control 5 hrs.

Anti-sense RNA, siRNA, ribozymes, in silico approaches for drug designing.

Module 4: Assignments, group discussions and presentations 5 hrs.

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 Vacc ines. 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.

Semester II: Practical Courses

VR-231(P): Molecular techniques **4 Credits**

1. Growth & Preparation of competent cells	1 2hrs.
2. Plasmid transformation	12 hrs.
3. Purification of plasmid	12 hrs.
4. Restriction endonuclease digestion	8 hrs.
5. DNA and RT-PCR	16 hrs.

VR-232(P): Biochemical/ Biophysical methods **3Credits**

1. Protein A Affinity chromatography	8 hrs.
2. Protein estimation	4 hrs.
3. Polyacrylamide gel electrophoresis	8 hrs.
4. Western Blot	10 hrs.
5. Ultrafitration	8 hrs.
6. Ultracertifugation	8 hrs.

VR-233(P): Serological methods **3 Credits**

1. Heamagglutination inhibition test	12 hrs.
2. IgM capture ELISA	12 hrs.
3. Complement Fixation test	9 hrs.
4. Plaque reduction neutralization test	12 hrs.

VR-234(P): Immunological techniques **3 Credits**

1. Organs of the immune system (from mouse).
2. Isolation of PBMCs by various methods.
3. Assay for the separation of B and T cells.
4. Separation of adherent and non-adherent cells (both from splenocytes and PBMCs).
5. Assay for antigen presentation by phagocytosis.
6. Flowcytometry.
7. Lymphocyte proliferation assay.
8. Cytokine assay.
9. Elispot assay.
10. Hybridoma (fusion and limiting dilution).

VR-235(P): Medical entomology **2 Credits**

1. Mosquito inoculation and IFA	8 hrs.
2. Bird, Rodents, Bat trapping	4 hrs.
3. Dissection of mosquitoes	4 hrs.
4. Native PAGE and isoenzyme analysis.	6 hrs.
5. Insecticide (larval & adult) bioassays	8 hrs.

VR 236(P): Epidemiological data management and analysis **1Credit**

1. MS Excel 2000	4 hrs.
2. MS Access 2000	4 hrs.
3. Statistical softwares	7 hrs.

VR-237(P): Practical Bioinformatics **1 Credit**

1. Biological data banks	3 hrs.
2. Pairwise sequence alignment	3 hrs.
3. Phylogeny & tree building	3 hrs.
4. Motif data bases, Epitope prediction	3 hrs.
5. Molecular modeling & visualization	3 hrs.

Semester III: Theory courses

VR-311(T): Viral Enteric Diseases and Cancers **1 credit**

Module-1: Perspectives of Viral Diarrhoea: 8 hrs.

Clinical course, disease burden, risk factors, epidemiology, prevention, and treatment. Rotavirus diversity, emerging strains, immunopathogenesis and vaccines under development. Other viruses associated with diarrhoea and gastroenteritis: Adenoviruses, astroviruses, Norwalk and Sapporo-like viruses and Enteroviruses Other enteroviral diseases.

Module-2: Viral Cancers 7 hrs.

Role of papilloma, HIV, Epstein Barr Virus, HTLV and herpes in pathogenesis of cancers, diagnosis, prevention.

Recommended books:

1. Fields Virology, 4th Ed., Vol 2 Ed by David M Knipe, and Peter M Howley Chapters: 24, 28, 34, 54, 55, 67 and 68.
2. Gastroenteritis Viruses, Vol. 238. Novartis Foundation Symposium, Mary Estes, Latest edition / Pub. Date: June 2001.
3. Viral Infections of the Gastrointestinal Tract, Vol. 10. Albert Z. Kapikian, Z. Kapikian A. 2nd ed., rev. and expanded. Latest edition / Pub. Date: March 1994.
4. Human Enterovirus Infections, Harley A. Rotbart (Editor), American Society Microbiology, January, 1995.
5. Viral Gastroenteritis, Edited By U. Desselberger, J. Gray. Elsevier Perspectives In Medical Virology. Series Editor: Arie J. Zuckerman , Uk Isa K. Mushahwar. 2003.
6. Human Papilloma Viruses. Edited by D.J. McCance. Elsevier Perspectives In Medical Virology. Series Editor: Arie J. Zuckerman , Uk Isa K. Mushahwar. 2002.
7. Viruses and Liver Cancer. Edited by E. Tabor. Elsevier Perspectives In Medical Virology. Series Editor: Arie J. Zuckerman , Uk Isa K. Mushahwar. 2002.
8. Viruses, Cell Transformation, and Cancer. Edited by J.A. Grand. Elsevier Perspectives In Medical Virology. Series Editor: Arie J. Zuckerman , Uk Isa K. Mushahwar. 2001.

VR-312(T): Viral Hepatitis **2 credits**

Module 1: Clinical presentation and epidemiology of viral hepatitis. 7 hrs.

Physiology of Jaundice, clinical features and differential diagnosis, presentations of hepatitis caused by different hepatitis viruses.

Module 2: Structure & genomic organization 7 hrs.

Structure & genomic organization, replication, genotypes, serotypes of HAV, HBV, HCV & HEV. Mutations in hepatitis viruses.

Module 3:Diagnostics 6 hrs.

Serological and molecular diagnosis of different hepatitis viruses.

Module 4: Immunopathogenisis & animal models 4 hrs.

Immunopathogenisis of different hepatitis viruses. Animal models and their uses.

Module 5: Prevention & therapeutic approaches 6 hrs.

Historical aspects, types of hepatitis vaccines, vaccines presently used & vaccines of the future. Vaccination as preventive measure in public health. Therapeutic possibilities of the present and future.

Recommended books:

1. Fields Virology, Volume 2, 4th edition:- (2001).
2. Clinical Virology, Second Edition (Richmans Hayden).
3. Hepatitis Viruses (Japan medical research fourm).
4. Viral Hepatitis and Liver disease, A.J. Zuckerman.
5. Viral Infection of Humans (S. Svans & A Kaslow).
6. Viral Hepatitis Molecular Biology Diagnosis and Control, By Isa Mushahwar. Elsevier Perspectives In Medical Virology. Series Editor:Arie J. Zuckerman , Uk Isa K. Mushahwar.2003.

VR-313(T): Viral Respiratory Diseases **1 credit**

Module 1: Origin and evolution of viral respiratory diseases 5 hrs.

History, clinical features, epidemiology, of influenza, RSV and other respiratory diseases.

Module 2: Biology of respiratory viruses. 3 hrs.

Biology and pathogensis of SARS, Metapneumovirus, human rhino virus and Corona virus etc.

Module 3: Diagnostics 3 hrs.

Differential diagnosis of different respiratory diseases.

Module4: Vaccines 4 hrs.

Vaccines against different viral respiratory diseases.

Recommended books:

1. Viral Infections of Respiratory Tract by Raphael Dolin and Peter Wright. Mercel Dekker.
2. Clinical Virology Manual Ed: Specter, RL Hodinka, SA Young,. ASM Press.
3. Influenza. Edited by C.W. Potter. Elsevier Perspectives In Medical Virology. Series Editor:Arie J. Zuckerman , Uk Isa K. Mushahwar. 2002.

VR-314(T): Viral Exanthematous Diseases **1 credit**

Module1 : Measles and SSPE 5 hrs.

Clinical features, disease burden, case definition and associated risk factor, strategies for prevention and treatment, biology and immunopathogenesis.

Module 2: Rubella, CRS, mumps and Poxviruses 7 hrs.

Clinical features, disease burden of Rubella, CRS and mumps,case definition and risk factors. Preventive and therapeutic modalities. Pathogenesis of disease. .Clinical aspects of Parvovirus B –19.

Module 3:Pox diseases 3 hrs.

Common features of viral pox diseases and case definitions. Paraspecific immunity due to pox vaccination, eradication and control programs.

Recomended books:

1. Krugman's Infectious Diseases of children By Saul Krugman.
2. Immunization Safety Review: Vaccines and Autism Immunization Safety Review Committee (Editor) The National Academies Press, USA.
3. Measles and Rubella. Alvin Silverstein, Robert Silverstein, Virginia B. Silverstein, Virginia Silverstein. July 1997.
4. Immunization Safety Review: Measles-Mumps-Rubella Vaccine and Autism. Kathleen R. Stratton, Alicia R. Gable, Padma Shetty. June 2001.

VR-315(T): Viral Haemorrhagic Fevers **1 credit**

Module1:Clinical course of viral infections 3 hrs.

Common clinical features of Viral Haemorrhagic Fevers, History and Disease burden, Risk factors and geographical distribution of viruses associated with haemorrhagic fevers and their impact on global health. Clinical samples required, choice of laboratory diagnostic tests and their interpretation for differential diagnosis.

Module2:Dengue and DHF 6 hrs.

Virus replication strategy, Pathogenesis, Prevention and treatment of Dengue Role of humoral and cell mediated immunity and viral factors in development of DHF, differential diagnosis of DF and DHF on the basis of clinical symptoms.

Module 3: Haemorrhagic manifestations caused by other viruses 6 hrs.

Virus replication strategy, Pathogenesis, Prevention and treatment of Yellow Fever, KFD, Chikungunya, Rift Valley Fever, Hanta, Marburg and Ebola, and Rickettsial fevers Development of killed KFD vaccine.

Recommended books:

1. CRC Handbook of Viral and Rickettsial Hemorrhagic Feverby James H. S. Gear.
2. Viral Haemorrhagic Fevers. By C.R. Howard. Elsevier. Perspectives In Medical Virology. Series Editor:Arie J. Zuckerman , Uk Isa K. Mushahwar. 2004.
3. Dengue and Dengue Hemorrhagic Fever, D. J. Gubler (Editor), G. Kuno (Editor), Latest edition / Pub. Date: January 1998.
4. Bioterrorism Hemorrhagic Viruses Manual: For Healthcare Workers and Public Latest edition / Pub. Date: April 2004.

VR316(T): Viral Encephalitis **2 Credits**

*Module 1 Overview**:*** 7 hrs.

Viral Encephalitis, encephalopathy and meningitis clinical symptoms and causative agents, treatment modalities, Transmission, spread of the outbreak in relation to causative agent Laboratory diagnosis of viral encephalitic agents, basic principles, preferred methods and problems.

Module 2 JE, WN CHP 8 hrs.

Japanese encephalitis and West Nile viral infections, endemic areas, disease burden, seasonality, role of non human hosts, genotypes vaccines Chandipura encephalitis, endemic areas, disease burden, seasonality, role of non human hosts, genotypes, other rhabdoviral neurotropic agents.

Module 3 Other viruses 8 hrs.

Encephalitis/ encephalopathy caused by measles virus, Enteroviral encephalitis and meningitis, Causative agents, spread of the disease, seasonality, differential diagnosis, Mumps encephalitis, Encephalitis caused by alpha viruses Encephalitis caused by Nipah and hendra virus, Herpes virus encephalitis, diagnosis in sporadic cases, association with immunosuppression, reactivation vs primary infections, treatment

Module4 Pathogenesis 7 hrs.

Routes and modalities of infections of the nervous tissue, blood brain barrier, factors affecting the neurovirulence, Animal models and vaccine potency testing.

Recommended books:

1. Viral Encephalitis in Humans. John Booss (Editor), Margaret M. Esin, Margaret Esiri (Editor). Latest edition / Pub. Date: June 2003. Publisher: ASM Press.
2. Encephalitis Protection. Qingshan Liang. Latest edition / Pub. Date: January 2004. Publisher: Cozy Graphics Corporation.

VR-317(T): HIV/ AIDS **1 credit**

Module:1 Natural History of AIDS 5 hrs.

Global epidemiology of HIV, epidemiology of HIV in India. Sexually transmitted diseases and their relation with HIV, opportunistic infections in HIV infected individuals. Social and behavioural aspects of prevention and control.Natural history.

Module:2 Biology of HIV and its detection 5 hrs.

Structure and replication of HIV, immunopathogenesis of infection, laboratory diagnosis of HIV infection. HIV isolation, characterization and viral estimation.

Module:3 Preventive and therapeutic approaches 2 hrs.

Trials pertaining to prevention and therapy, Antiviral therapy and drug resistance HIV vaccines.

Module 4: origin of HIV, HIV -2, SIV 3 hrs.

Recommended books:

1. HIV and Aids by Michael A. Palladino, David Wessner. Latest edition / Pub. Date: March 2005 Publisher: Benjamin Cummings.
2. HIV Libman, Harvey J. Makadon. Royal Society of Medicine Press Ltd. 2006.
3. Textbook of Aids Medicine. Thomas C. Merigan, John G. Bartlett (Editor), Dani Bolognesi (Editor). Latest edition / Pub. Date: September 1998 . Publisher: Lippincott Williams & Wilkins.
4. Aids Therapy. Raphael Dolin, Henry Masur (Editor), Michael S. Saag (Editor). Latest edition / Pub. Date: November 2002. Latest edition / Pub. Date: November 2002.
5. API Textbook. Chapter by DA Gadkari.

VR0-318(T): Veterinary and Agricultural viruses **1 credit**

Viral diseases of veterinary importance will cover History, Disease burden, Clinical presentation and diagnosis, Epidemiology and risk factors, virus replication strategy, Pathogenesis, zoonotic importance and Prevention and treatment of species of agricultural importance.

Module1:Farm animals 6 hrs.

Cattle diseases: Foot and Mouth Disease, Bovine Ephemeral fever, Rinderpest, Bovine Spongiform encephalopathy Sheep and goat diseases: Bluetoungue, Nairobi sheep disease/ Ganjam, Peste des Pestits ruminants, Rift Valley Fever Pig diseases: Swine influenza, Japanese Encephalitis, Hog cholera/ swine fever Horse diseases: Equine influenza, Equine infectious anemia and equine encephalitis. Dog diseases: Rabies, Infectious canine hepatitis, Canine distemper

Module 2:Poultry and other animals 5 hrs.

Poultry diseases: Newcastle disease, Marek's disease, Avian influenza. Viral diseases of laboratory animals. Viral diseas es of honeybees, silkworm and fishes.

Module 3:Plant viral diseases 4 hrs.

Viral diseases of agricultural crops. Viral diseases of horticultural crops. Viral diseases of forest plants. Viral insecticides.

Recommended books:

1. Veterinary Virology, II edition, authors: Frank Fenner et al, Academic press, Inc, California, USA.
2. Veterinary Medicine by Blood and Henderson.

Semester III: Practical Courses

VR-331(P): Viral Enteric Diseases	**2 Credits**
1. Sample collection and documentation of case reporting form'	5 hrs.
2. Sample processing and ELISA	5 hrs.
3. RNA PAGE	5 hrs.
4. Neutralization Test	5 hrs.
5. MAb based serotyping of rotativiruses	5 hrs.
6. RT_PCR	5 hrs.
VR-332(P): Viral Hepatitis	**3 Credits**
1. Serum ALT, Urine Bile salt, Bile pigments	5 hrs.
2. HBV DNA PCR (DNAzol / Column method)	10 hrs.
3. HAV RNA PCR (TRIzol / Column method)	10 hrs.
4. Real Time PCR quantitation for HBV DNA	10 hrs.
5. Pre-Core mutant analysis	10 hrs.
VR-333(P): Viral Respiratory Diseases	**2 Credits**
1. Sample collection	5 hrs.
2. Sample processing for virus isolation and IFA	5 hrs.
3. IFA	5 hrs.
4. Virus isolation	5 hrs.
5. HA test	5 hrs.
6. HI test	5 hrs.
VR-334(P): Viral Exanthematous Diseases	**1 Credit**
1. Rubella (IgG, IgM) diagnosis	5 hrs.
2. Measles (IgG, IgM) diagnosis	5 hrs.
3. Measles PCR	5 hrs.
VR-335(P): Viral Haemorrhagic Fevers	**2 Credits**
1. MAC-ELISA, Multiplex RT-PCR for serotyping, RNA extraction by Trizol method, Reverse transcription	10 hrs.
2. PCR, agarose gel electrophoresis interpretation	10 hrs.
3. Haemagluttination inhibition assay	10 hrs.
VR-336(P): Viral Encephalitis	**2 Credits**
1. Flavivirus neutralization tests for differential diagnosis	5 hrs.
2. RT PCR of JE and WN viruses	5 hrs.
3. Mouse inoculation and observation of sickness	5 hrs.
4. Diagnosis of Chandipura virus infections	5 hrs.
5. Antigen detection systems	5 hrs.
6. Antigen capture ELISA and Immunofluorescence	5 hrs.
VR-337(P): HIV / AIDS	**2 Credits**
1. HIV Diagnosis	12 hrs.
2. HIV subtyping	10 hrs.
3. CD4, CD8 counts	8 hrs.
VR-338(P): Veterinary and Agricultural viruses	**1 Credit**

Semester IV List of courses

VR-411(T): Special topics **1Credit**

List of special topics

1. How to write a research proposal
2. How to write a scientific paper
3. Role of laboratories in virological studies
4. Ethics in Biomedical Research
5. Ethical and regulatory issue in animal experiment
6. Ethical issues in biotechnology
7. Basics of Intellectual Property Rights
8. Indian patenting system
9. Patenting in biotechnology
10. Trade Related Intellectual Property Rights (TRIPS) and public health
11. Other topics on regulatory issues

VR-431(T+P) Research Project **24 credits**