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

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<td>VR-334(P)</td>
<td>Viral Exanthematous Diseases</td>
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<td>VR-335(P)</td>
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<td>VR-336(P)</td>
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<td>VR-337(P)</td>
<td>HIV / AIDS (Conducted at NARI)</td>
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<td>Research Project</td>
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<td><strong>Total credits</strong></td>
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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:

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

*Module 1: Introduction to immunology:*

Introduction and history; Primary and secondary organs of the immune system. Cells of the immune system.  

*Module 2: Innate immunity:*

Innate immune response & inflammation, complement system.  

*Module 3: Antigens & Immunoglobulins:*


*Module 4: Antigen recognition:*


*Module 5: Acquired immune response:*


*Module 6: Assignments/ Presentations:*

These will be based on the above 5 modules.  

**Recommended Books:**


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

*Module 1: Introduction*

Historical aspects and evolution of epidemiology, definitions and concepts in Epidemiology.  

*Module 2: Approaches in epidemiology*

Descriptive and analytical epidemiology, disease burden, natural history of diseases and measures of risk and death.  

*Module 3: Study design and sampling*

Sample size estimation and introduction to study design in epidemiological investigations.  

*Module 4: Fundamentals of biostatistics*

Introduction, types of data, tabular and graphical presentation of data.  

*Module 5: Measures of location, dispersion and correlation*


*Module 6: Probability and statistical inference*

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:**


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.

Recommended Books:
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.
Immunodiagnosis, haemagglutination and haemagglutination-inhibition tests, Complement fixation, neutralization, Western blot, RIPA, flowcytometry and immunohistochemistry.

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:
### Semester I: Practical Courses

#### VR-131(P): Analytical methods  
2 Credits

1. Protein estimation (Lowry)  
   - hrs.
2. DNA estimation (colorimetric and spectrophotometric)  
   - hrs.
3. Gel filtration chromatography  
   - hrs.
4. Polyacrylamide gel electrophoresis  
   - hrs.
5. Confocal microscopy  
   - hrs.

#### VR-132(P): Tissue culture techniques  
3 Credits

1. Glassware decontamination, washing, sterilization, packing and sterile handling  
   - hrs.
2. Media and reagents preparation, sterility checks  
   - hrs.
3. Maintenance of cell cultures  
   - hrs.
4. Preparation of primary cell culture (CEC)  
   - hrs.

#### VR-133(P): Virus / Antigen detection  
3 Credits

1. ELISA  
   - hrs.
2. Immunofluorescence assay  
   - hrs.
3. Hemagglutination  
   - hrs.
4. Agar gel diffusion  
   - hrs.
5. Polymerase chain reaction  
   - hrs.
6. Electron microscopy  
   - hrs.

#### VR-134(P): Statistical Methods  
1 Credits

1. Graphical presentation of data  
   - hrs.
2. Measures of central tendency  
   - hrs.
3. Correlation and regression analysis  
   - hrs.
4. Significance tests  
   - hrs.
5. Statistical packages  
   - hrs.
6. Epidemiological exercise  
   - hrs.

#### VR-135(P): Entomological methods  
3 Credits

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

#### VR-136(P): Propagation of viruses  
3 Credits

1. Estimation of virus yields -- plaque assay & TCID$_{50}$  
   - hrs.
2. Preparation virus stocks and determination of mouse LD$_{50}$  
   - hrs.
3. Routes of inoculations in embryonated eggs  
   - 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.

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

Recommended Books:
   Latest edition / Pub. Date: December 2003 Publisher: Benjamin Cummings.

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

Module 1: Cellular receptors and virus entry 5 hrs.

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 cytotoxic 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:
   Latest edition / Pub. Date: December 2003 Publisher: American Society Microbiology.
2. Virus Dynamics: Mathematical Principles of Immunology and Virology. Martin A. Nowak, Robert May.
3. Molecular Aspects of Host-Pathogen Interactions. Malcolm A. McCrae (Editor), J. R. Saunders (Editor), C. J. Smyth (Editor), N. D. Stow (Editor)
**VR-213(T): Virus Replication**

**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:**

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

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

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

**Module 3:** Immunoregulation: 6 hr

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

**Recommended Books:**
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  
mobilation, 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:
5. Roy DN and Brown AWA (1970) Entomology (Medical & veterinary) Bangalore printing and  
   Publishing 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:
   Publisher: Oxford University Press.
   Sciences.
   University of New Mexico Press.
4. Epidemiology: Beyond the Basics. F. Javier Nieto, Moyses Szklo. Latest edition / Pub. Date:  
   Date: March 2004.
   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.

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:
Semester II: Practical Courses

**VR-231(P): Molecular techniques**  
4 Credits  
1. Growth & Preparation of competent cells  
2. Plasmid transformation  
3. Purification of plasmid  
4. Restriction endonuclease digestion  
5. DNA and RT-PCR

**VR-232(P): Biochemical/ Biophysical methods**  
3 Credits  
1. Protein A Affinity chromatography  
2. Protein estimation  
3. Polyacrylamide gel electrophoresis  
4. Western Blot  
5. Ultrafiltration  
6. Ultracentrifugation

**VR-233(P): Serological methods**  
3 Credits  
1. Hemagglutination inhibition test  
2. IgM capture ELISA  
3. Complement Fixation test  
4. Plaque reduction neutralization test

**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.  
10. Hybridoma (fusion and limiting dilution).

**VR-235(P): Medical entomology**  
2 Credits  
1. Mosquito inoculation and IFA  
2. Bird, Rodents, Bat trapping  
3. Dissection of mosquitoes  
4. Native PAGE and isoenzyme analysis.  
5. Insecticide (larval & adult) bioassays

**VR 236(P): Epidemiological data management and analysis**  
1 Credit  
1. MS Excel 2000  
2. MS Access 2000  
3. Statistical softwares

**VR-237(P): Practical Bioinformatics**  
1 Credit  
1. Biological data banks  
2. Pairwise sequence alignment  
3. Phylogeny & tree building  
4. Motif data bases, Epitope prediction  
5. Molecular modeling & visualization
Semester III: Theory courses

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

1 credit

*Module 1: Perspectives of Viral Diarrhoea:*

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*

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

**Recommended books:**


**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: Immunopathogenesis & animal models*

4 hrs.

Immunopathogenesis 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:**

3. Hepatitis Viruses (Japan medical research fourm).
5. Viral Infection of Humans (S. Svans & A Kaslow).
**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 pathogenesis of SARS, Metapneumovirus, human rhino virus and Corona virus etc.

*Module 3: Diagnostics*  
3 hrs.
Differential diagnosis of different respiratory diseases.

*Module 4: Vaccines*  
4 hrs.
Vaccines against different viral respiratory diseases.

**Recommended books:**

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

*Module 1: 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.

*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.

**Recommended 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.
VR-315(T): Viral Haemorrhagic Fevers  

1 credit

**Module 1: 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.

**Module 2: 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 Fever by James H. S. Gear.

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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

**Module 4 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:**

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

Module 1: Natural History of AIDS

Module 2: Biology of HIV and its detection
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
Trials pertaining to prevention and therapy, Antiviral therapy and drug resistance HIV vaccines.

Module 4: origin of HIV, HIV-2, SIV

Recommended books:
5. API Textbook. Chapter by DA Gadhari.

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.

Module 1: Farm animals 6 hrs.

Module 2: Poultry and other animals 5 hrs.

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:
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 rotavirus  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. Haemaglutination 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**

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

1 Credit

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

24 credits