

Department: National Institute of Virology, Pune (Under the aegis of Institute of Bioinformatics & Biotechnology, SPPU, Pune)

Course: M.Sc. Virology

Duration: Two years

Total Number of Credits: 82

| Semester I | | |
|--------------------------|--------------------------------------|-------------------|
| Core Courses: | | |
| Subject Code | Subject Title | Number of Credits |
| VR-111(T) | Basic Virology | 1 |
| VR-112(T) | Tissue Culture | 1 |
| VR-114(T) | Immunology-I | 2 |
| VR-115(T) | Basic Epidemiology & Biostatistics | 2 |
| VR-116(T) | Vector Biology | 1 |
| VR-117(T) | Virological Methods | 1 |
| VR-133(P) | Virus/Antigen Detection | 2 |
| VR-134(P) | Statistical Methods | 1 |
| VR-135(P) | Entomological Methods | 1 |
| VR-136(P) | Propagation of Viruses | 1 |
| | Total | 13 |
| Elective Courses: | | |
| Subject Code | Subject Title | Number of Credits |
| VR-113(T) | Cell Biology | 1 |
| VR-118(T) | Analytical Techniques | 2 |
| VR-119(T) | Introduction to General Biochemistry | 1 |
| VR-131(P) | Analytical Methods | 2 |
| VR-132(P) | Tissue Culture Techniques | 2 |
| VR-120(T) | General Microbiology | 1 |
| | Total | 9 |

| Semester II | | |
|--------------------------|--|-------------------|
| Core Courses: | | |
| Subject Code | Subject Title | Number of Credits |
| VR-212(T) | Virus Cell Interaction | 1 |
| VR-213(T) | Virus Replication | 1 |
| VR-214(T) | Immunology-II | 1 |
| VR-215(T) | Biosafety and Biosecurity | 1 |
| VR-216(T) | Applied Epidemiology | 1 |
| VR-218(T) | Antivirals and Vaccines | 2 |
| VR-233(P) | Serological Methods | 2 |
| VR-234(P) | Immunological Techniques | 2 |
| VR-235(P) | Biosafety and Biosecurity | 1 |
| VR-236(P) | Epidemiological Data Management and Analysis | 1 |
| | Total | 13 |
| Elective Courses: | | |
| Subject Code | Subject Title | Number of Credits |
| VR-211(T) | Recombinant DNA technology | 2 |
| VR-217(T) | Bioinformatics | 1 |
| VR-219(T) | Molecular Biology | 2 |
| VR-231(P) | Molecular Techniques | 2 |
| VR-232(P) | Biochemical/Biophysical Methods | 2 |
| VR-237(P) | Practical Bioinformatics | 2 |
| VR-220(T) | Mathematical Biology | 1 |
| | Total | 12 |

| Semester III | | |
|--------------------------|--|-------------------|
| Core Courses: | | |
| Subject Code | Subject Title | Number of Credits |
| VR-311(T) | Viral Enteric Diseases & Cancers | 1 |
| VR-312(T) | Viral Hepatitis | 1 |
| VR-313(T) | Viral Respiratory Diseases | 1 |
| VR-314(T) | Exanthematous Diseases of viral Aetiology | 1 |
| VR-315(T) | Viral Haemorrhagic Fevers | 1 |
| VR-316(T) | Viral Encephalitis | 1 |
| VR-317(T) | HIV / AIDS (Conducted at NARI) | 1 |
| VR-331(P) | Viral Enteric Diseases | 2 |
| VR-332(P) | Viral Hepatitis | 2 |
| VR-333(P) | Viral Respiratory Diseases | 2 |
| VR-334(P) | Viral Exanthematous Diseases | 1 |
| VR-335(P) | Viral Hemorrhagic Fevers (Special reference to Dengue) | 2 |
| VR-336(P) | Viral Encephalitis | 2 |
| VR-337(P) | HIV / AIDS (Conducted at NARI) | 2 |
| | Total | 20 |
| Elective Courses: | | |
| Subject Code | Subject Title | Number of Credits |
| VR-318(T) | Special Topics & Veterinary & Agricultural Viruses | 1 |
| | Total | 1 |

| Semester IV | | |
|------------------------------|----------------------------------|-------------------|
| Core Courses | | |
| Subject Code | Subject Title | Number of Credits |
| VR-431(P) | Research Project & Presentations | 14 |
| | Total | 14 |
| Elective Courses: Nil | | |

| UGC recommended courses (Additional 10 credits) | | |
|--|-------------------------------------|-------------------|
| Subject Code | Subject Title | Number of Credits |
| VR-501(T+P) | Cyber security/Information security | 4 |
| VR-502(T+P) | Chromatography | 4 |
| VR-503(T) | Human rights education | 2 |
| | Total | 10 |

| Courses which can be opted for by students from outside departments: | | |
|---|------------------------------------|-------------------|
| Subject Code | Subject Title | Number of Credits |
| VR-111(T) | Basic Virology | 1 |
| VR-115(T) | Basic Epidemiology & Biostatistics | 2 |
| VR-116(T) | Vector Biology | 1 |
| VR-212(T) | Virus Cell Interaction | 1 |
| VR-213(T) | Virus Replication | 1 |
| VR-215(T) | Biosafety and Biosecurity | 1 |
| VR-218(T) | Antivirals and Vaccines | 2 |
| | Total | 9 |

M.Sc. Virology Course Syllabus

From Academic year 2018-19

**Conducted at the
National Institute of Virology
130/1, Pashan-Sus Road,
Pashan, Pune 411 021**

**Under the aegis of
Institute of Bioinformatics and Biotechnology
Savitribai Phule Pune University**

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

| SN | Course No. | Title | Credits |
|---------------------------------------|------------|--|-----------|
| Semester I | | | |
| 1. | VR-111(T)* | Basic Virology # | 1 |
| 2. | VR-112(T)* | Tissue Culture | 1 |
| 3. | VR-113(T) | Cell Biology | 1 |
| 4. | VR-114(T)* | Immunology-I | 2 |
| 5. | VR-115(T)* | Basic Epidemiology & Biostatistics # | 2 |
| 6. | VR-116(T)* | Vector Biology # | 1 |
| 7. | VR-117(T)* | Virological Methods | 1 |
| 8. | VR-118(T) | Analytical Techniques | 2 |
| 9. | VR-119(T) | General Biochemistry | 1 |
| 10. | VR-120(T) | General Microbiology (Optional) | 1 |
| 11. | VR-131(P) | Analytical Methods | 2 |
| 12. | VR-132(P) | Tissue Culture Techniques | 2 |
| 13. | VR-133(P)* | Virus/Antigen Detection | 2 |
| 14. | VR-134(P)* | Statistical Methods | 1 |
| 15. | VR-135(P)* | Entomological Methods | 1 |
| 16. | VR-136(P)* | Propagation of Viruses | 1 |
| Total Credits for Semester I | | | 22 |
| Semester II | | | |
| 17. | VR-211(T) | Recombinant DNA technology | 2 |
| 18. | VR-212(T)* | Virus Cell Interaction # | 1 |
| 19. | VR-213(T)* | Virus Replication # | 1 |
| 20. | VR-214(T)* | Immunology-II | 1 |
| 21. | VR-215(T)* | Biosafety and Biosecurity # | 1 |
| 22. | VR-216(T)* | Applied Epidemiology | 1 |
| 23. | VR-217(T) | Bioinformatics | 1 |
| 24. | VR-218(T)* | Antivirals and Vaccines # | 2 |
| 25. | VR-219(T) | Molecular Biology | 2 |
| 26. | VR-220(T) | Mathematical Biology (Optional) | 1 |
| 27. | VR-231(P) | Molecular Techniques | 2 |
| 28. | VR-232(P) | Biochemical/Biophysical Methods | 2 |
| 29. | VR-233(P)* | Serological Methods | 2 |
| 30. | VR-234(P)* | Immunological Techniques | 2 |
| 31. | VR-235(P)* | Biosafety and Biosecurity | 1 |
| 32. | VR-236(P)* | Epidemiological Data Management and Analysis | 1 |
| 33. | VR-237(P) | Practical Bioinformatics | 2 |
| Total Credits for Semester II | | | 25 |
| Semester III | | | |
| 34. | VR-311(T) | Viral Enteric Diseases and Cancers | 1 |
| 35. | VR-312(T) | Viral Hepatitis | 1 |
| 36. | VR-313(T) | Viral Respiratory Diseases | 1 |
| 37. | VR-314(T) | Exanthematous Diseases of viral Aetiology | 1 |
| 38. | VR-315(T) | Viral Haemorrhagic Fevers | 1 |
| 39. | VR-316(T) | Viral Encephalitis | 1 |
| 40. | VR-317(T) | HIV / AIDS (Conducted at NARI) | 1 |
| 41. | VR-318(T)* | Special Topics and Veterinary & Agricultural Viruses | 1 |
| 42. | VR-331(P) | Viral Enteric Diseases | 2 |
| 43. | VR-332(P) | Viral Hepatitis | 2 |
| 44. | VR-333(P) | Viral Respiratory Diseases | 2 |
| 45. | VR-334(P) | Viral Exanthematous Diseases | 1 |
| 46. | VR-335(P) | Viral Hemorrhagic Fevers (Special reference to Dengue) | 2 |
| 47. | VR-336(P) | Viral Encephalitis | 2 |
| 48. | VR-337(P) | HIV / AIDS (Conducted at NARI) | 2 |
| Total Credits for Semester III | | | 21 |
| Semester IV | | | |
| 49. | VR-431(P) | Research Project & Presentations | 14 |
| Total credits for Semester IV | | | 14 |
| Total credits | | | 82 |

* Core courses

Courses which can be opted for by students from outside departments

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

Topics:

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

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-112 (T): Tissue Culture (1 Credit)

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. [4 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]

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-113(T): Cell Biology (1 Credit)

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. [3 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 [1hr]
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.

VR-114(T): Immunology-I (2 Credits)**Topics:**

1. Introduction and history; Primary and secondary organs of the immune system, Cells of the immune system. [5 hrs.]
2. Innate immune response & inflammation, complement system. [5 hrs.]
3. Hapten/antigen; antibody, structure & function, Immunoglobulin classes. Antigen & antibody interaction, Antibody diversity. [6 hrs.]
4. Major histocompatibility complex, Polymorphism, Human leukocyte antigen association with disease, Ontogeny, Positive and negative selection. [8 hrs.]
5. Antigen processing and presentation, Co-stimulation, T and B cell stimulation, 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-115(T): Basic Epidemiology and Biostatistics (2 Credits)

Topics:

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. [8 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. [5 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-116(T): Vector Biology (1 Credit)

Topics:

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. [2 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. [3 hrs.]
4. Vector virus relationship: 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. [5 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

VR-117(T): Virological Methods (1 Credit)

Topics:

1. 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. [5 hrs.]
2. Introduction to PCR,ELISA [1]
3. Immunodiagnosis, IFA, haemagglutination and haemagglutination-inhibition tests, Complement fixation, neutralization, Western blot, RIPA and immunohistochemistry. [6 hrs.]
4. Fluorescence, confocal and electron microscopic techniques - principles and applications. [3 hrs.]

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.

VR-118(T): Analytical Techniques (2 Credits)

Topics:

1. Characterization of biomolecules: Introduction and various approaches for characterization of biomolecules. [1 hr.]
2. Concentration of biomolecules: Salting out with ammonium sulfate, flash evaporation, lyophilization, dialysis, hollow fibre membranes, membrane filtration and their applications. [1 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. [2 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. [12 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 Arnika, 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-119(T): General Biochemistry (1 Credit)

Topics:

1. An overview on basic concepts of Chemistry of life: The major elements of life and their primary characteristics; atomic bonds and molecules bonding properties of carbon, covalent and noncovalent bonds, Vander waals forces; polarity, hydrophilic and hydrophobic interactions; asymmetry of carbon compounds and cis trans isomerism; electron transfer and oxidation/reduction; functional groups of organic compounds; hydrogen ion concentration of biological systems. Dissociable biological compounds and concept of buffers, normal, Molar solutions and physiological buffer systems. [2 hrs.]
2. 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.]
3. 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.]
4. Amino acids: Classification, structures, physicochemical properties, acidbase behavior of amino acids. Peptides: Characteristics of peptide bond, peptides of nonprotein origin, properties and functions of peptides, determination of amino acid composition and sequence in peptides, peptides profiling. [2 hrs.]
5. Proteins: Classification, properties and biological functions of proteins; structural organization of proteins primary, secondary, tertiary and quaternary. [2 hrs.]
6. 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.]
7. 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.]
8. 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 [3 hrs.]
9. Nucleotide metabolism: break down of nucleic acids-exo and endo-nucleases (RNases & DNases); phosphodiesterases, salvage pathways. [3 hrs.]

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-120(T): General Microbiology (1 Credit) (Optional)

Topics:

1. Origin and evolution of microorganisms. Distinguishing of different groups of microorganisms, Classification of microorganisms. [3 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. [2 hrs.]
3. Isolation from different natural samples. Approaches for obtaining pure cultures. Cultivation of aerobes and anaerobes. [2 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. [2 hrs.]
5. Fungi: Classification, structure, composition, reproduction and other characteristics of fungal divisions. [2 hrs.]
6. Protozoan parasites: Classification, morphology and structure, reproduction and other characteristics of pathogenic protozoa like *Entamoeba*, *Plasmodium*, *Leishmania*, *Cryptosporidium*, *Trichomonas*, *Taxoplasma*, *Trypanosoma*, *Giardia*. [1 hr.]
7. Medical Microbiology: *Vibrio cholera*, *Salmonella typhi*, *S. pneumoniae*. [3 hrs]

Books to be added

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.

Semester I: Practical Courses

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

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-132(P): Tissue culture techniques (2 Credits)

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)

VR-133(P): Virus / Antigen detection (2 Credits)

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

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

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

VR-135(P): Entomological methods (1 Credit)

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

VR-136(P): Propagation of viruses (1 Credit)

1. Estimation of virus yields-- plaque assay & TCID₅₀
2. Preparation virus stocks and determination of mouse LD₅₀
3. Routes of inoculations in embryonated eggs
4. Handling of animals: Rules & Regulations

VR-211(T): Recombinant DNA Technology (2 Credits)

Topics:

1. Scope and importance of recombinant DNA technology. [1 hr.]
2. Tools for Recombinant DNA Technology: Gene vectors-Plasmid, transposon, bacteriophage 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. [4 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. [6 hrs.]
6. Site directed mutagenesis and protein engineering: Different approaches for changing genes. Approaches for protein engineering to generate novel enzymes like subtilisin. [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. [8 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. 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-212(T): Virus-cell Interaction (1 Credit)

Topics:

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

Topics:

1. General strategies, replication of positive sense RNA virus (polio), 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.

VR-214(T): Immunology-II (1 Credit)

Topics:

1. Cells and organs of the mucosal immune system. Mucosal effector mechanisms. [4 hrs.]
2. Phagocytosis. Cytotoxic and T helper response. Natural killer and gamma delta cells. [4hrs.]
3. Antigen-antibody, cytokine-mediated immune regulation. Complement mediated regulation. Hypersensitivity. Autoimmunity; immunodeficiency. Transplantation immunology. [7 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-215(T): Biosafety & Biosecurity (1 Credit)

Topics:

1. Concepts of biosafety and biosecurity-Part-1: [Overview of microorganisms and types of viruses, bacteria, prions, etc. [Differences, Vegetative versus spore forms. Cell Tropism and Species Specificity, Infectivity/Pathogenicity/Virulence, Routes of entry/exit, Modes of transmission, Secondary spread, Immune status of staff and immunization issues] [1 hr]
2. Concepts of biosafety and biosecurity-Part-2: [Biosafety Levels and Risk group, Classification, Containment, Good microbiological practices, Disinfection, Decontamination and Sterilization, Agents used, Solid versus liquid waste] [1 hr]
3. Concepts of biosafety and biosecurity-Part-3: [Primary Barriers, Respiratory protection (N95, PAPR), Laboratory specific requirement, Fit testing required through Employee Health, Secondary Barriers, isolated zone, Double-door entry, negative pressure with different zoning and BSC] [1 hr]
4. Concepts of biosafety and biosecurity-Part-4: [Risk & Hazard Assessment, Factors associated with a risk, Pre-requisites for assessing risk, Main parameters of Risk Assessment, Behavioral Elements etc] [1 hr]
5. Safe laboratory Practices: [Classification of pathogens based on risk, Code of safe laboratory practices, Decontamination & disposal, Health & Medical surveillance, ABSL facilities, Safe shipment of specimens & infectious materials, Safety rules for domestic & cleaning staff, Good microbiological practices, Good clinical practices (GCP), Good clinical and laboratory practices (GCLP), Good Laboratory practices (GLP)] [1 hr]
6. Decontamination procedures: [Solid & Liquid & Biomedical waste, autoclaves principals and types, incinerators; Liquid: chemical kill tank, STP and BLED tanks, Disinfection: What is sterilization?, Methods of sterilization, What is Disinfection?, Should be sterilized or disinfected?, Decontamination of: Surfaces, Large Spaces, Equipment & sharps: BSC, Centrifuge, Vortex, Sharps, Microscope etc., Segregation, Packaging, Transportation and Storage, Mandatory Authorization, Maintenance of Records, Accident Reporting, Waste categories & Color coding [MPCB], Label For Transport of Bio-Medical Waste Containers/Bags, Standards:

- Standards for Incinerators, Standards for Waste Autoclaving, Standard for Liquid Waste, Standards for Deep Burial, Biomedical waste log for incineration and Radioactive waste, International norms & local government regulations] [2 hrs]
7. Regulatory Framework: [Code of conduct for scientists; Statutory roles of Department of Biotechnology (DBT), Indian Council of Medical Research (ICMR), Committee for the Purpose of Control and Supervision of Experiments on Animals [CPCSEA] & IAEC (Institutional Animal ethical Committee), MPCB (Municipal pollution control board). Institutional Biosafety Committee (IBSC), Institutional Human Ethics Committee (IHEC), Local Government laws in safe disposal of waste i.e. PMC, BARC & BRIT for Gamma irradiation, Shipping and Transportation [IATA & ICMR for material movement], BWC, and India as State party, Recent International Issues for Biosafety & biosecurity, Laboratory certification, accreditation and standards, Commissioning, Certification & Validation, Accreditation, ISO, NABL, Bioethics: Ethical principles in medical research, ICMR ethical guidelines for humans, Ethical committees on human research (IHEC, HMSC), Ethical committees on animal research (IAEC, CPCSEA), Use of archived specimens for research, Ethical issues during outbreak investigation / public health emergencies, Consent] [2 hrs]
 8. Public health structure / system: [Disease surveillance and reporting, Disease control program, National / state / district / municipal health services structure / systems, Public health regulations, Outbreak response management system] [1 hr]
 9. Medical surveillance: [Medical first aid, Requirements for certification of fitness, Vaccination requirements, Accident reporting and investigation, post-exposure assessments & management, Hospital infection control] [1 hr]
 10. Preparedness and Response for emerging infections and outbreaks: [2 hrs]
 - a. Field bio-safety including standard precautions
 - b. Role of Advisories, Guidelines, Recommendations during medical emergency
 - c. Epidemic Investigation for suspected high risk viruses or unknown or BT agent and biosafety procedures including logistics and preparedness / preparations
 - d. Clinical and epidemiological investigations of emerging infectious diseases
 - e. Epidemic Investigation related work with regards to viz. Bat, Rodents, domestic and wild Birds, domestic animals; procedures for samples collections, transporting to Laboratory and biosafety procedures
 - f. Field surveys including household interviews / serosurveys
 - g. Liquid & Solid waste decontamination in the field conditions
 - h. Maintenance of cold chain for samples, transportation, Liquid nitrogen container uses and logistic issues related to road, rail and by air transportation following biosafety in field.
 - i. Data management including forms/formats/questionnaires
 - j. Reporting and coordination/communications
 11. Engineering and laboratory maintenance: [Particle & contaminant, Non viable counting and viable count, Clean rooms & its classification contaminant, Cross contamination, Source and resource for cross contamination, ISO standard for clean rooms and containment laboratory.] Overview general maintenance program of facility, Routine checks [laboratory & engineering side] for safeguarding the facility, Maintenance Program Development, Functioning of BMS & Facility environment controls, Laboratory AHUs, filters etc and other decontamination procedures, Maintenance Program implementation, HVAC components; Functioning of Fan, Dampers, Solenoid valves, VAVs etc., Facility equipments

related issues: Various Alarms, Biosafety Cabinets: Types, safe working, precautions, Autoclaves: Types, operation, precautions, Safeguard & record keeping, Freezers, Incubators, Centrifuges etc. -- [2 hrs]

Recommended Books:

1. Furr, A.K. ed. CRC Handdbook of Laboratory Safety.--3rd ed.-- Boca Raton, Florida: CRC Press, 1990.p. 704. ISBN 0849303532
2. Collins CH and Kennedy DA. Laboratory-acquired Infections: History, incidence, causes and preventions.--4th ed.--Oxford: Butterworth Heinemann, 1999. p. ix + 324 p. ISBN 9780750640237
3. World Health Organization. Laboratory Biosafety Manual.--3rd. ed.- Geneva: World Health Organization, 2004. p. viii + 178 p. ISBN 9241546506
4. Hawkins MD. Technician Safety and Laboratory Practice.- London: Cassell, 1980. p. xiii + 239 p. ISBN 0304305502

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

Topics:

1. Types and methods of public health and infectious disease surveillance, establishing surveillance system. [5 hrs.]
2. Case control and cohort studies. [4 hrs.]
3. Needs and steps to be taken for outbreak investigations, collaboration with State and National health authorities. [4 hrs.]
4. Veterinary Epidemiology [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 / 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)

Topics:

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, Quellette, John Wiley & Sons, NY.
5. Mount David: Bioinformatics

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

Topics:

1. Conventional vaccines -killed and attenuated, modern vaccines—recombinant proteins, subunits, DNA vaccines, peptides, immunomodulators (cytokines), vaccine delivery & adjuvants, large scale manufacturing-QA/QC issues. [10 hrs.]
2. Animal models and vaccine potency testing. [2 hrs.]
3. Vaccine induced immune response and immune markers of protection [2 hrs.]
4. Interferons, designing and screening for antivirals, mechanisms of action, antiviral libraries, antiretrovirals-mechanism of action & drug resistance. [10 hrs.]
5. Anti-sense RNA, siRNA, miRNA, ribozymes, *in silico* approaches for drug designing. [8 hrs.]

Recommended Books:

1. Antiviral Agents, Vaccines, and Immunotherapies. Stephen K. Tying. 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.

VR-219(T): Molecular Biology (2 Credits)

Topics:

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 hr.]
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 and gene regulation. [1 hr.]

VR-220(T): Mathematical Biology (1 Credit) (Optional)

Topics:

1. Fundamentals
 - a) Number systems and scientific notations. [1 hr]
 - b) Elements of algebra, functions. [1 hr]
 - c) Understanding equations (Linear, simultaneous and quadratic). [1 hr]
 - d) Graph plotting. [2 hr]
 - e) Matrices. [2 hr]
 - f) Basic Calculus: limits, differentiation, integration. [3 hr]
 - g) Differential Equations. [1 hr]
2. Biological applications
Beer-Lambert's Law, Enzyme kinetics, Radio-carbon dating, estimation of cell viability, survival curves. [2 hr]
3. Population based studies
 - a) Simple population growth models; [1 hr]
 - b) Predator-Prey interactions: Lotka – Volterra interspecies competition logistics equation (theory, applications and problem set). [1 hr]
 - c) Time series analyses (surveillance & outbreak data), baseline data. [2 hr]
 - 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 hr]

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.

Course description and Scope: This course is designed to teach basic mathematics and mathematical biology applications to students of biological sciences. Stress will be given on the theoretical basis and applications of various theories in terms of data analyses (including graph plotting) and interpretation of related mathematical data. This course may be considered as an optional subject for regular students at Master's Level. Limited numbers of interested students from other than biological science disciplines may also attend.

Semester II: Practical Courses

VR-231(P): Molecular techniques (2 Credits)

1. Growth & Preparation of competent cells
2. Plasmid transformation
3. Purification of plasmid
4. Restriction endonuclease digestion
5. Cloning and screening of colonies
6. DNA and RT-PCR

VR-232(P): Biochemical/ Biophysical methods (2 Credits)

1. Protein estimation by Bradford's method
2. Western Blot
3. Ultrafiltration
4. Ultracentrifugation
5. Isoenzyme analysis
6. Affinity chromatography

VR-233(P): Serological methods (2 Credits)

1. Hemagglutination inhibition test
2. IgM capture ELISA, Antigen detection ELISA
3. Complement Fixation test
4. Plaque reduction neutralization test

VR-234(P): Immunological techniques (2 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 & PBMCs)
5. Assay for antigen presentation by phagocytosis
6. Flowcytometry (Demonstration)
7. Lymphocyte proliferation assay
8. Cytokine assay (Demonstration)
9. Elispot assay (Demonstration)
10. Hybridoma (fusion and limiting dilution)

VR-235(P): Biosafety and Biosecurity (1 Credit)

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

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

VR-237(P): Practical Bioinformatics (2 Credits)

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.

Semester III: Theory courses

VR-311(T): Viral Enteric Diseases and Oncogenic viruses (1 credit)

Topics:

1. Epidemiological scenario with respect to Viral Enteric Diseases at National and International level [1 hr]
2. Enteric viral infections: Clinical course, disease burden, risk factors, prevention, and treatment. [2hrs]
3. Rotavirus diversity, emerging strains, immunopathogenesis and vaccines under development. [2 hrs]
4. Other viruses associated with diarrhoea and gastroenteritis: Adenoviruses, astroviruses, Norwalk and Sapporo-like viruses and other enteroviral diseases. [6 hrs].
5. Polio & Non-polio Enteroviruses [3 hrs]
6. Viral oncogenesis, oncogenic viruses HPV, HTLV, Epstein Barr virus [2 hrs]

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 (1 credit)

Topics:

1. Physiology of Jaundice, clinical features and differential diagnosis, presentations of hepatitis caused by different hepatitis viruses. [3 hrs].
2. Structure & genomic organization, replication, genotypes, serotypes of HAV, HBV, HCV & HEV. Mutations in hepatitis viruses. [4 hrs].
3. Serological and molecular diagnosis of different hepatitis viruses. [3 hrs].
4. Immunopathogenesis of different hepatitis viruses. Animal models and their uses. [2 hrs].
5. 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. [3 hrs].

Recommended books:

1. Fields Virology, Volume 2, 4th edition:- (2001).
2. Clinical Virology, Second Edition (Richmans Hayden).
3. Hepatitis Viruses (Japan medical research forum).
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, Isa K. Mushahwar.2003.

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

Topics:

1. Epidemiological scenario with respect to respiratory diseases at National and International level [1hr]
2. History, clinical features, epidemiology, of influenza, RSV and other respiratory diseases. [5 hrs.]
3. Biology and pathogenesis of SARS, Metapneumovirus, human rhino virus and Corona virus etc. [3 hrs.]
4. Differential diagnosis of different respiratory diseases. [3 hrs.]
5. Vaccines against different viral respiratory diseases. [4 hrs.]

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 , Isa K. Mushahwar. 2002.

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

Topics:

1. Epidemiological scenario with respect to exanthematous diseases at National and International level [1hr]
2. Viruses associated with Exanthematous Diseases: Clinical features, disease burden, case definition and associated risk factor, strategies for prevention & treatment, biology and immunopathogenesis. [5 hrs]
3. Biology of Measles, mumps, rubella, Parvovirus B-19, Chicken pox and other viral pox diseases. Clinical complications of measles (i.e. SSPE) and rubella (i.e. CRS). Laboratory diagnosis of measles, mumps and rubella. [7 hrs]
4. Common features of viral pox diseases and case definitions. Paraspecific immunity due to pox vaccination, eradication and control programs. [3 hrs]

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.
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.
5. Kingsbury DW. ed. The Paramyxoviruses.--New York: Springer Science + Business Media, 1991. p. xxi + 596 p.
6. Zuckerman AJ. ed. Principles and Practice of Clinical Virology.--Chichester: John Wiley and Sons, 1990. p. ix + 643 p.
7. World Health Organization. Global Measles and Rubella Strategic Plan: 2012-2020.-- Geneva: World Health Organization, 2012. p. 42 p.

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

Topics:

1. Epidemiological scenario with respect to Viral Haemorrhagic Fevers at National and International level [1hr]
2. 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. [3 hrs.]
3. 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. [6 hrs.]
4. Virus replication strategy, Pathogenesis, Prevention and treatment of Yellow Fever, Kyasanur forest disease, Chikungunya, Rift Valley Fever, Crimean Congo haemorrhagic fever, Hanta, Marburg and Ebola, and Rickettsial fevers. [6 hrs.]

Recommended books:

1. CRC Handbook of Viral and Rickettsial Hemorrhagic Fever by 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.

VR-316(T): Viral Encephalitis (1 Credit)

Topics:

1. Epidemiological scenario with respect to Viral Encephalitis at National and International level [1hr]
2. Viral Encephalitis, encephalopathy and meningitis, clinical symptoms and causative agents, treatment modalities, transmission, spread of an outbreak in relation to causative agent. Laboratory diagnosis of viral encephalitic agents, basic principles, preferred methods and problems. [3 hrs.]
3. Japanese encephalitis and West Nile viral infection, endemic areas, disease burden, seasonality, role of non human hosts, genotypes, vaccines. [3 hrs.]
4. Chandipura encephalitis, endemic areas, disease burden, seasonality, role of non human hosts, genotypes, other rhabdoviral neurotropic agents. [2 hrs.]
5. 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. [4 hrs.]
6. Routes and modalities of infections of the nervous tissue, blood brain barrier, factors affecting the neurovirulence [3 hrs.]

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)**Topics:**

1. Epidemiological scenario with respect to HIV/ AIDS at National and International level [1hr]
2. Introduction to retroviruses
3. 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. [5 hrs.]
4. Structure and replication of HIV, immunopathogenesis of infection, laboratory diagnosis of HIV infection. HIV isolation, characterization and viral load estimation. [5 hrs.]
5. Trials pertaining to prevention and therapy, Antiviral therapy and drug resistance, HIV vaccines. [2 hrs.]
6. Origin of HIV-1, 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.

VR-318(T): Special topics and Veterinary & Agricultural viruses (1 credit)

Topics:

1. Ethics in Biomedical Research. [1 hr]
2. Ethical and regulatory issue in animal experiment. [1 hr]
3. Ethical issues in biotechnology. [1 hr]
4. Basics of Intellectual Property Rights. [1 hr]
5. Indian patenting system. [1 hr]
6. Patenting in biotechnology. [1 hr]
7. Trade Related Intellectual Property Rights (TRIPS) and public health. [1 hr]
8. Issues related to Good Manufacturing Practices (GMP). [1 hr]
9. Issues related to Good Clinical Practices (GCP). [1 hr]
10. Issues related to Good Clinical Laboratory Practices (GCLP). [1 hr]
11. Development of consent document for clinical trials. [1 hr]
12. Viral diseases of veterinary importance, History, Disease burden, Clinical presentation and diagnosis, Epidemiology and risk factors, virus replication strategy, Pathogenesis, importance of zoonosis, prevention and treatment of species of agricultural importance. [7 hrs]
 - a) Cattle diseases: Foot and Mouth Disease, Bovine Ephemeral fever, Rinderpest, Bovine Spongiform encephalopathy. Sheep and goat diseases: Bluetongue, 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.
 - b) Poultry diseases: Newcastle disease, Marek's disease, Avian influenza. Viral diseases of laboratory animals. Viral diseases of honeybees, silkworm and fishes.
 - c) 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
2. Sample processing and ELISA
3. RNA PAGE
4. Neutralization Test
5. mAb based serotyping of rotaviruses
6. RT-PCR

VR-332(P): Viral Hepatitis (2 Credits)

1. Serum ALT, Urine Bile salt, Bile pigments-
2. HBV-DNA PCR
3. Preparation of stool suspension and HAV/ HEV-RNA PCR
4. Real Time PCR quantitation for HBV DNA
5. HBV/ HCV genotype analysis
6. HBsAg, Anti-HBsAg, HEV and HAV IgM ELISA

VR-333(P): Viral Respiratory Diseases (2 Credits)

1. Sample collection
2. Sample processing for virus isolation and IFA
3. IFA
4. Virus isolation
5. HA test
6. HI test

VR-334(P): Viral Exanthematous Diseases (1 Credit)

1. Rubella (IgG, IgM) diagnosis
2. Measles (IgG, IgM) diagnosis
3. Measles PCR

VR-335(P): Viral Haemorrhagic Fevers (Special reference to Dengue) (2 Credits)

1. MAC-ELISA, Multiplex RT-PCR for serotyping
2. RNA extraction by Trizol method, Reverse transcription- PCR, agarose gel electrophoresis, interpretation
3. Haemagglutination inhibition assay

VR-336(P): Viral Encephalitis (2 Credits)

1. Flavivirus neutralization tests for differential diagnosis
2. RT PCR of JE and WN viruses
3. Mouse inoculation and observation of sickness
4. Diagnosis of Chandipura virus infections
5. Antigen detection systems
6. Antigen capture ELISA and Immunofluorescence

VR-337(P): HIV / AIDS (2 Credits)

1. HIV Diagnosis
2. HIV subtyping
3. CD4, CD8 counts

Semester IV List of courses

VR-431(P) Research Project & Presentations*

14 Credits

* [Overall performance of the student in seminars and paper presentations of all three (1st, 2nd and 3rd) Semesters will be summed up for final grade points and will be added in 4th Semester.[equivalent to 1 credit]