

SRI VENKATESWARA UNIVERSITY COLLEGE OF SCIENCES

TIRUPATI - 517 502

DEPARTMENT OF VIROLOGY



Two-Year M.Sc. Virology Programme

SEMESTER PATTERN SYLLABUS

CHOICE BASED CREDIT SYSTEM (CBCS)-2015

SRI VENKATESWARA UNIVERSITY::TIRUPATI

S.V.U.COLLEGE OF SCIENCES

DEPARTMENT OF VIROLOGY

(Revised syllabus for regular students those who study in S.V.U. College (Campus), Tirupati)

(with effect from the batch of students who admitted during the academic year 2015-16)

M.Sc. VIROLOGY

(CHOICE BASED CREDIT SYSTEM)

SCHEME OF INSTRUCTION AND EXAMINATION

Sem	Course code	Title of the course	Core / Elective	No. of Credits	IA	SEE	Total Marks
I	VR-101	General Microbiology	Core	04	30	70	100
	VR-102	General Virology	Core	04	30	70	100
	VR-103	Biological Chemistry	Core	04	30	70	100
	VR-104	Analytical Techniques	Core	04	30	70	100
	VR-105	Practical: General Microbiology and Virology	--	04	--	100	100
	VR-106	Practical: Biological Chemistry and Analytical Methods	--	04	--	100	100
II	VR-201	Cell Biology and Tissue culture	Core	04	30	70	100
	VR-202	Microbial Genetics and Molecular Biology	Core	04	30	70	100
	VR-203	Recombinant DNA Technology	Core	04	30	70	100
	VR-204	Immunology	Core	04	30	70	100
	VR-205	Practical: Cell Biology and Immunology	--	04	--	100	100
	VR-206	Practical: Microbial Genetics and Molecular Biology & RDNA technology	--	04	--	100	100
	--	Human Values and Professional Ethics-I	Common	04	30	70	100
III	VR-301	Molecular Virology	Core	04	30	70	100
	VR-302	Biostatistics and Bioinformatics	Core	04	30	70	100
	VR-303	Plant Virology	IE	04	30	70	100
	VR-304	Plant Viruses and Diseases	IE	04	30	70	100
	VR-305	Practical: Molecular Virology & Biostatistics and Bioinformatics	--	04	--	100	100
	VR-306	Practical: Plant Virology and Plant Virus Diseases	--	04	--	100	100
IV	VR-401	Applied Virology	Core	04	30	70	100
	VR-402	Animal and Human Virology	Core	04	30	70	100
	VR-403	Animal and Human Virus Diseases	IE	04	30	70	100
	VR-404	Tumor Biology and Viruses	IE	04	30	70	100
	VR-405	Practical: Animal and Human Viruses and Diseases	--	04	--	100	100
	VR-406	Practical: Applied Virology and Tumor Biology	--	04	--	100	100
	--	Human Values and Professional Ethics-II	Common	04	30	70	100
	VR-407	Fundamentals of Virology	EEC	04	30	70	100
	VR-408 VR-409	Biology of Viruses of Microorganisms OR Biology of Virus Vectors and their Management	SSC SSC	04 04	-- --	100 100	100 100

VR = Virology, CC = Core Course, IEC = Internal Elective Course, EEC = External Elective Course, SSC= Self Study Course.

SEMESTER-I

VR-101: GENERAL MICROBIOLOGY (CC)

UNIT – I

Fundamental microbiology: Origin and evolution of microorganisms. Pioneers in microbiology, Branches in microbiology, different groups of microorganisms. An overview on the importance of microorganisms in plants, animal and human welfare.

Microscopy- principles and applications of light, phase - contrast, dark-field, fluorescent, scanning and transmission electron microscopes. – Microbial staining techniques Preparation of microbiological specimens for microscopy -

Morphology and structure of bacteria - Morphological types - cell walls of Gram negative - Gram positive bacteria - cell wall, antigenic properties - capsule - cell membranes - structure - composition - properties. Structure and function of flagella - cilia - pili. Nucleoid - cell division- endospores, structure, formation and germination

UNIT-II

Microbiological media: Types of media- natural and synthetic; basal, defined, complex, enrichment, selective, differential, maintenance and transport media.

Isolation, cultivation and enumeration methods of microorganisms: Isolation /enumeration methods from different natural samples. Streak plate, pour plate, spread plate and hanging drop methods, Pure cultures techniques for microorganism.

Microbial growth: Definition, Microbial growth curve, Batch culturing, Continuous, synchronous, Biphasic culturing, generation time, factors influencing the growth, physical chemical and biological, Microbial growth measurement methods.

Maintenance and preservation of microbial cultures: Short term and long term preservation methods: Repeated sub-culturing, oil overlay, sterile soil/sand, glycerol-deep freezing, , drying methods, freeze-drying. Revival of bacterial cultures.

UNIT-III

Microbial Taxonomy: General criteria for microbial classification- Hackel's three kingdom concept - Whittaker's five kingdom concept - three domain concept of Carl Woese. General characteristics of Archaea evolutionary significance. General characteristics of Spirochetes, Rickettsias, Actinomycetes, Cyanobacteria,

Transport of nutrients in microbes- structural organization of plasma membrane in relation to transport, types and mechanisms of transport (passive, simple, facilitated, active) chemical modification methods for studying of transport, coupling of transport of ions and metabolites to ATP/proton gradient.

Control of Microorganism: Physical agents :Heat, radiation, pH, Surface tension, osmotic pressure, filters, **Chemical agents**, Acids, Bases, Alcohols, Aldehydes, Ketones, Phenols, Soaps, Antibiotics, secondary metabolites, Antiseptics.

UNIT-IV

Eukaryotic microorganisms (Fungi, Algae and Protozoan parasites) :

Fungi: General characteristics structure and reproduction and importance of fungi- *Saccharomyces*, *Pichia*, *Pencillium*, *Rhizopus*, *Aspergillus*, *Trichoderma*,

Algae: General characteristics, structure, reproduction of algae *Chlorella*, and *Gracellaria*. Economic importance of algae.

Protozoan parasites: General characteristics, morphology and structure, reproduction of pathogenic protozoan parasites *Entamoeba*, *Plasmodium*, *Leishmania*,

Suggested Books:

1. Brock Biology of Microorganisms. 1997, 8th ed. Madigan et al., Prentice-Hall International, Inc.
2. Microbiology. 1999. 3rd ed. Prescott et al. Wm. C. Brown Publ.
3. Principles of Microbiology. 1997. 2nd ed. R.M. Atlas. Wm.C. Brown. Publ.
4. Foundations in Microbiology. 1996. 2nd ed. K. Talaro and A. Talaro. Wm.C. Brown Publ.
5. Microbiology. 1996. 5th ed. Pelczar et al. Tata McGraw-Hill Publ. Company Ltd.
6. General Microbiology, 1999 by S.B. Sullia, Oxford and IBH Publishers.
7. General Microbiology, 1999 by Stainer et al., Macmillan Educational Ltd.
8. Instant Notes in Microbiology. 1999. J. Nicklin et al. Viva Books Pvt. Ltd.
9. Microorganisms, Biotechnology and Disease : Students Book. 1997 by Pauline Lourie and Susanwells. Cambridge University Press.
10. Introductory Mycology. 1996. 4th ed. Alexopoulos et al., John Wiley and Sons.
11. Introductory Phycology by H.D. Kumar. 2nd ed. 1999. East-West Press.
12. Biology of the prokaryotes. 1998. By J.L. Lengeler et al., Blackwell Science Publ.
13. Microbiology, 8th Edition International Student Version Jacquelyn G. Black (Marymount University) April 2012, ©2011, Wiley publication.
14. Understanding Microbes: An Introduction to a Small World Jeremy W. Dale December 2012, Wiley-Blackwell
15. Brock Biology of Microorganisms :Global Edition, 13th Edition, Michael Madigan, John Martinko, David Stahl, David Clark Apr 2011.

VR-102: GENERAL VIROLOGY (CC)

UNIT-I

History: Discovery of viruses and development of Virology (contributions of pioneers). Nature, origin and evolution of viruses.

Properties of viruses : Physical- morphology and structure, sedimentation, electrophoretic mobility, buoyant density. Biochemical- chemical composition, nucleic acids, proteins, enzymes, lipids, carbohydrates, polyamines, cations. Antigenic nature of viruses. Biological- host range, transmission (vector and non-vector), virus stability.

Nomenclature and classification of viruses: Criteria used for naming and classification. Current ICTV classification of viruses of bacteria, plants and animals and humans.

UNIT-II

Isolation, cultivation, assay and maintenance of bacterial, plant and animal viruses : Experimental plants and tissue cultures. Experimental animals, embryonated eggs, organ cultures, primary and secondary cell cultures, suspension and monolayer cell cultures, cell strains, cell lines.

Purification of viruses : Need for virus purification. Extraction of viruses from tissues, clarification, concentration of viruses in clarified extracts by physical and chemical methods,

further purification of viruses by rate zonal / equilibrium density gradient centrifugation. Criteria of virus purity. Quantitation and preservation of purified virus preparations.

UNIT-III

Quantitation of viruses: Infectivity assay methods (plaque, pock, end point, local / systemic assay of plant viruses), physical (EM), serological (HA, HI, immunofluorescence, ELISA) and chemical (viral protein and nucleic acid based) approaches.

Major characteristics of the following virus families / genera / groups :

Adenoviridae, Bromoviridae, Bunyaviridae, Caulimoviridae, Flaviviridae, Geminiviridae, Hepadnaviridae, Herpesviridae, Orthomyxoviridae, Paramyxoviridae, Parvoviridae, Picornaviridae, Potyviridae, Poxviridae, Reoviridae, Retroviridae, Rhabdoviridae, Tobamovirus,

Insect Viruses: Biology of major RNA and DNA viruses of insects and their applications

UNIT-IV

Bacteriophages: Biology of major RNA (MS₂, Q β , ϕ 6) and DNA (T-even and T-odd, lambda, Mu, ϕ x174, M₁₃) bacteriophages. Biology of Cyanophages.

Algal and fungal viruses : Biology of viruses of *Phycodnaviridae, Partitiviridae* and *Totiviridae*.

Biology of sub-viral agents: Satellite viruses, sat-RNAs, viroids virusoids and prions. Concept of molecular parasitism.

Importance of viruses in human welfare with suitable examples.

Suggested Books :

1. Virology: Principles and Applications: John B Carter Reviews, John Wiley & Sons, Limited, 08-Mar-2013 - 400 page
2. Virology : 1994. 3rd ed. Frankel-Conrat et al, Prentice- Hall.
3. Principles of Virology : 2000. by S.J. Flint et al., ASM Press.
4. Introduction to Modern Virology. 2001. 5th ed. Dimmock et al., Blackwell Sci. Publ. Principles of Molecular Virology. 1997. 2nd ed. A. Cann. Academic Press.
5. Basic Virology, 1999. By Waginer and Hewelett, Black Well Science Publ.
6. Medical Virology. 1994. 4th edition. D.O. White and F.J. Fenner. Academic Press. Plant Virology. 2001. 4th edi. By R. Hull. Academic Press.
7. Fundamental Virology, 4th ed. 2001. D.M. Knipe and P.M. Howley.
8. Veterinary Virology. 3rd ed. 1999. Murphy et al., Academic Press.

VR-103: BIOLOGICAL CHEMISTRY (CC)

UNIT-I

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 non-covalent bonds.

Bioenergetics: Concepts of free energy and thermodynamic principles in biology, energy transformation, ATP cycle, energy transducers, redox potentials, free energy changes in redox reactions.

Carbohydrates : Classification; outline structure and properties of carbohydrates, identification and analysis; and biological importance of polysaccharides.

Carbohydrate metabolism: Pathways underlying the utilization of different sugars (EMP, ED, HMP and phosphoketolase) in microorganisms, gluconeogenesis.

Lipids : Building blocks of lipids. Fatty acids- physico-chemical properties, separation, distribution in nature, characterization and saponification and iodine number. Classification of lipids. Nomenclature, outline structures, properties and functions of lipids. Steroids- plant sterol, cholesterol. Lipoproteins- classification, composition and importance. Salient features of bacterial lipids.

Lipid metabolism: Biosynthesis of triacyl glycerols,; oxidation of saturated and unsaturated fatty acids; microbial metabolism of aromatic and aliphatic hydrocarbons.

UNIT-II

Amino acids: Classification, structures, functions, physico-chemical properties, acid-base behaviour of amino acids.

Peptides: Characteristics of peptide bond, peptides of non-protein origin, properties and functions of peptides,

Proteins: Classification, properties and biological functions of proteins; structural organization of proteins - primary, secondary, tertiary and quaternary with examples; Ramachandran's plot; chaperones.

Protein metabolism : Assimilation of inorganic nitrogen, biochemistry of nitrogen fixation; hydrolysis of proteins- exo- and endo-proteinases, outlines of biosynthesis and catabolism of amino acids in microbes (deamination, decarboxylation and transamination reactions). Urea cycle.

UNIT-III

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.

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 values.

Nucleotide metabolism : biosynthesis of bases, nucleosides and nucleotides including deoxyribonucleotides, regulation of nucleotide synthesis; break down of nucleic acids- exo- and endo-nucleases (RNases and DNases) and phosphodiesterases, salvage pathways; catabolism of purines and pyrimidines.

UNIT-IV

Hormones and Growth regulators : Classification, outline structures and functions of major animal and plant hormones.

Vitamins : Discovery and outline Chemistry of fat soluble (A,D,E and K) and water soluble (riboflavin, pantothenic acid and niacin, pyridoxine, biotin, cobalamine, folic acid and ascorbic acid) vitamins and their role in body functions.

Porphyryns and other pigments: Classification, structures and biological functions of porphyryns, brief account of haemoglobin and chlorophylls, cytochromes, xanthophylls and carotenoids of microorganisms.

Suggested Books :

1. Principles of Biochemistry, Lehninger, 3rd edition by Nelson and Cox (Worth) 2000.
2. Biochemistry, Stryer 5th edition, W.H. Freeman, 2001.
3. Microbial Physiology and Metabolism. 1995, by D.R. Caldwell. Wm.C. Brown Publ.
4. Microbial Physiology. 1999, 3rd ed. by A.G. Moat & J.W. Foster. Wiley- Liss.
5. Foundations in Microbiology. 1996. By K. Talaro & A. Talaro, Wm. C. Brown Publ.
6. Microbial Physiology and Metabolism. 1995, by D.R. Caldwell. Wm.C. Brown Publ.
7. Microbial Physiology. 1999, 3rd ed. by A.G. Moat & J.W. Foster. Wiley- Liss.
8. Foundations in Microbiology. 1996. By K. Talaro & A. Talaro, Wm. C. Brown Publ.
9. Molecular Cell Biology. 2000 - by Lodish et al.
10. Text Book of Biochemistry, by Voet and Voet.

VR-104: ANALYTICAL TECHNIQUES (CC)

UNIT-I

Characterization of biomolecules: Introduction and various approaches for characterization of biomolecules.

Concentration of biomolecules : Salting out with ammonium sulfate, flash evaporation, lyophilization, dialysis, hollow fibre membranes, membrane filtration and their applications.

Chromatography : Principle, simple theory and applications of partition, adsorption, ion-exchange, gel permeation and affinity chromatography based techniques - paper, thin-layer-TLC, column, GLC, HPLC, FPLC.

UNIT-II

Centrifugation: Simple theory of preparative and analytical centrifuges and rotors; sedimentation analysis; differential, rate-zonal and equilibrium density gradient centrifugations. Applications- isolation of cells, subcellular organelles, viruses and macromolecules.

Electrophoresis: (simple theory and applications): Types of electrophoresis- paper, gel (starch, acrylamide and agarose) disc, vertical, horizontal submarine, gradient, 2-dimensional, pulse-field and capillary; isoelectrofocussing; isolation and analysis of gel separated molecules- recovery of molecules from paper/gels; southern, northern and western blottings.

UNIT-III

Electrochemical techniques (Principles and Applications): Redox reactions; pH and Clarke oxygen electrodes; biosensors.

Cell sorting and Flow cytometry : Principles and Applications.

Radioisotope techniques : Nature and types of radioactivity, half-life of isotopes; detection and measurement of radioactivity- GM counter, liquid scintillation counter, gamma-ray counter, Cerenkov counting and autoradiography; quenching and quench correction; laboratory safety measures in handling isotopes; biological uses of radioisotopes.

UNIT-IV

Spectroscopy : Electromagnetic spectrum of light; simple theory of light absorption by biomolecules; Beers- Lambert law; transmittance; extinction co-efficient; light sources; monochromators; types of detectors; working principle and applications of visible, UV-visible, IR, Raman, ESR, mass, MALDI, plasma emission, atomic absorption, and NMR spectrophotometry; fluorimetry and flame photometry; ORD and CD; X-ray diffraction and X-ray crystallography, Microarray.

Amino acid and nucleotide sequencers: Basic principles of functioning and applications.

Suggested 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.

VR-105: PRACTICAL: GENERAL MICROBIOLOGY AND VIROLOGY

1. Microbiological laboratory safety measures
2. Sterilization Methods
3. Phenol coefficient method
4. Preparation of media for cultivation of bacteria, fungi and actinomycetes
5. Enumeration of bacteria, actinomycetes and fungi from soil
6. Plating techniques- streak plate, pour and spread plate methods
7. Microbiological staining techniques: Simple staining , Gram staining , Spore staining
8. Lactophenol-cotton blue staining for fungi
9. Hanging drop method for bacterial motility
10. Determination of Bacterial growth curve
11. Effect of pH on bacterial growth
12. Effect of temperature on bacterial growth
13. Effect of salt concentration on bacterial growth
14. Oligodynamic action of heavy metals and antibiotics
15. Isolation of bacteriophages from sewage water
16. Cultivation of viruses in embryonated Eggs: different routes of inoculation.
17. Sap, Aphid and Graft transmission of a plant viruses.
18. Virus inclusion bodies (slides)
19. Determination of stability of plant virus in cell sap- TIP, DEP, LIV.
20. Determination of chlorophylls in healthy and virus diseased leaves.
21. Purification of viruses by different chemical and physical methods
22. Isolation of viral proteins and nucleic acids
23. Analysis of viral proteins and nucleic acids by gel electrophoresis

24. Isolation and analysis of dsRNA from ssRNA infected tissues
25. Study of inactivation of viruses by various physical and chemical agents.
26. Identification of type and strandedness of viral genomes.

Suggested Books / Manuals :

1. Diagnostic Microbiology. 11th Edition. 2002. By B.A. Forbes et al., Mosby publisher
2. Practical Microbiology, 2002 by R.C. Dubey and D.K. Maheshwari.
3. Laboratory Manual in Microbiology, 2000. By P. Gunasekaran
4. Virology - A Laboratory Manual, 1992. By Burleson, et al., Academic Press.
5. Virology Methods Manual, 1996. B.W.J. Mahy and H.O. Kangro. Academic Press
6. Molecular Virology : A Practical Approach. 1993. Davison and R.M. Elliot. Oxford University Press.
7. Virology Lab Fax. 1993. D.R. Harper. Bioscientific Publication. Academic Press
8. Microbiological Applications : Laboratory Manual in General Microbiology, 7th ed. by J. Benson.
9. Microbiology : A Laboratory Manual. 4th edition. By J.G. Cappuccino and N. Sherman.
10. Experiments in Microbiology, Plant Pathology, Tissue culture and Mushroom cultivation. 3rd edition. By K.R. Aneja.
11. Laboratory Experiments in Microbiology by Johnson.
12. Laboratory Manual in Microbiology by Alcamo.

VR-106:PRACTICAL: BIOLOGICAL CHEMISTRY AND ANALYTICAL METHODS

1. Qualitative tests for identification of Carbohydrates, amino acids, nucleic acids
2. Quantitative determination of Protein, glucose, glycine, bilirubin, cholesterol, Inorganic phosphorous
3. Determination of activity of peroxidase and polyphenol oxidase from leaves
4. Measurement of pH
5. Micrometry for cell size determination
6. Cell counting by Haemocytometer
7. Verification of Beer's Law
8. Determination of λ max for coloured solutions
9. Determination of DNA & RNA by UV spectrophotometry
10. Determination of nucleic acid Bases by UV spectrometry
11. Paper chromatography for separation of amino acids / pigments
12. TLC for separation of lipids / amino acids.
13. Dialysis of different samples.
14. SDS-PAGE for separation of proteins
15. Submarine agarose gel electrophoresis for DNA separation
16. Isolation of chloroplasts by sucrose density gradient centrifugation
17. Concentration of biomolecules by flash evaporation / freeze-drying.
18. Separation of amino acids by ion-exchange column chromatography
19. Gel permeation column chromatography (demonstration).
20. Spun column chromatography (demonstration).

Suggested books:

1. Microbiology Tools & Techniques -2008-Kanika Sharma-Ane books, India.
2. Protein Purification Techniques 2 nd ed.-2001-Simon Roe-Oxford University Press
3. Introduction to Practical Biochemistry. 2000. by S.K. Sawhney and Randhir Singh (eds.) Narosa Publ. House
4. Laboratory Manual in Biochemistry, 1996. By J. Jayaraman.
5. Practical Biochemistry : Principles and Techniques 1995, 4th ed. by K. Wilson and J.Walker, Cambridge University Press.
6. Modern Experimental Biochemistry. 1993. 2nd ed. by R.F. Boyer. The Benjamin Cummings Publ. Company.
7. Biochemical Methods per Agricultural Sciences, 1992. By S. Sadasivam and A. Manikam.
8. Physical Biochemistry : Applications to Biochemistry and Molecular Biology, 1982, 2nd ed. by David Freifelder. W.H. Freeman and Company.

SEMESTER-II

VR-201: CELL BIOLOGY AND TISSUE CULTURE (CC)

UNIT – I

Cell biology: Diversity of cell size and shape. Cell theory. Prokaryotic and eukaryotic cell. Nucleus – Ultrastructure of nucleus and nuclear envelope. Nomenclature of chromosome, C-value paradox, dosage compensation. Euchromatin and heterochromatin (constitutive and facultative). Nucleolus. Polytene and Lampbrush chromosomes. Cell cycle – Overview of eukaryotic cell cycle, regulation of cell cycle and extra cellular signals. Cell cycle check points. Regulators of cell cycle progression – MPF, cyclins and cyclin-dependent kinases. Cell differentiation. Cell death and proliferation – Apoptosis: definition, mechanism and significance.

UNIT – II

Cell Communication – General principles: Cell surface receptors (ion channel-linked, G-protein-linked and enzyme-linked receptors) and intracellular receptors. Forms of intracellular signaling – Autocrine, paracrine, contact-dependent, synaptic and endocrine signaling. Response of cell to signals. Intracellular signaling proteins: Types and their role. Second messengers – cAMP pathway and role of calcium. Extracellular matrix, cell-matrix interactions. Cell-cell interactions – Adhesion junctions, tight junctions, gap junctions. Electrical coupling, connexon, factor-mediating cell-self recognition (aggregation factor). Cytoskeleton – Structure and functions of microtubules, microfilaments and intermediary filaments. Structure of microvillus.

UNIT – III

Plant tissue culture- Introduction to totipotency of plant cell, Tissue cell culture media composition & preparation. Initiation and maintenance of callus and suspension culture, single cell clones, organogenesis, somatic embryogenesis synthetic seeds, shoot tip culture, rapid clonal propagation and production of virus-free plants.

Somatic hybridization: Protoplast isolation, culture and fusion, selection of hybrid cells & regeneration of hybrid plants, cybrids. Embryo culture, anther, pollen & ovary culture for production of haploid plants and its significance. Cryopreservation and germplasm conservation

UNIT – IV

Animal tissue culture- Equipment and materials (culture vessels, CO₂ incubator, inverted microscope, cell counters). Principles of sterile techniques. Sources of tissues. **Types of tissues** – Epithelial, muscle, connective, nerve and blood. Culture media - balanced salt solutions, Components of the medium, physical, chemical and metabolic functions of media. Defined media and their applications. Role of serum and supplements, serum-free media, Role of antibiotics in media.

Cell count – Hemocytometer, coulter counter. Cell viability and cytotoxicity. Dye exclusion and inclusion tests, clonogenic assay, MTT based assay.

Primary culture – Mechanical and enzymatic mode of disaggregation, establishment of primary culture. Subculture - Passage number, split ratio, seeding efficiency, criteria for subculture.

Cell lines – Definite and continuous cell lines, characterization, authentication, maintenance and preservation of cell lines.

Three dimensional culture – Organ culture and Histotypic culture; Normal vs. transformed cells, growth characteristics of transformed cells.

Stem cells – Isolation and culture, embryonic and adult stem cells, plasticity and concept of regenerative medicine.

Suggested books:

1. The World of the Cell. Becker, W.M., L.J. Kleinsmith and J.H. Hardish. 2007. 6th Edn. Pearson Education, Delhi.
2. Molecular Cell Biology. Lodis, H., A. Berk, C. A. Kaiser, M. P.Scott. 2006. 6th Edn. Ploegh and Paul Matsudaria.
3. Cell and Molecular Biology concepts and experiments. Karp, G. 2005. 4th Edn. John Wiley and Sons, USA.
4. Cell and Molecular Biology. De Robertis, E.D.P and E.M.F. De Robertis. 2001. Lippincott Williams and Wilkins, Bombay.
5. The cell – a molecular approach. Cooper Geoffrey, M. 2000. 2nd Edn. ASM Press, Washington.
6. Molecular biology of the cell. Alberts A et al. 1994. Garland Publishers, New York
7. Cell Biology: organelle structure and function. Sadava, D.E. 1993. Jones and Bartlett Publishers, USA.
8. R. Ian Freshney, “Culture of animal cells – A manual of basic techniques” 4th edition, John Wiley & Sons, Inc, publication, New York. 2000.
9. Daniel R. Marshak, Richard L.Gardner, David Gottlieb “Stem cell Biology” edited by Daniel Cold Spring Harbour Laboratory press, New York. 2001.

10. M.M. Ranga, Animal Biotechnology; Agrobios (India) ,2006. Butterworth “ Invitro cultivation of Animal Cells”– Heinemann publishers – Open Universities. Nederland, 1994.
11. J. Kruzer , “Recombinant DNA & Biotechnology for Teachers”, 2nd Edition, Adrienne Massey, A. Massey & Association.
12. John R.W. Master “Animal Cell culture”, University College London, Oxford University press, 2000.
13. ANN A. KIESSLING, SCOTT ANDERSON, Human Embryonic Stem Cells, Jones & Bartlett Publishers, Sudbury, Massachusetts, Boston, Toronto, London, 2003.
14. A.J. Thomson, Gene Targeting & embryonic Stem Cells, Bios Scientific Publishers, Taylor & Francis Group London & New York.

VR-202 : MICROBIAL GENETICS AND MOLECULAR BIOLOGY (CC)

UNIT-I

Genetic notations, conventions and terminology. Evidences for nucleic acids as information carriers. Overview of Mendilian Genetics

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.

Genes: The modern concept of the genes, gene structure and architecture, types of genes.

Plasmids: detection, types, properties, purification, transfer, replication and curing, significance / importance.

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.

UNIT-II

Gene transfer mechanisms and gene mapping in bacteria: Natural and artificial transformation. Conjugation and sexduction. Transductions (generalized; abortive, specialized and cotransduction).

Genetic recombination : Requirements for recombination. Molecular models / basis of recombination.

Genetics of viruses- Recombination in bacteriophages- T_2 and fine structure of rII locus of T_4 phage. Eukaryotic viruses - recombination and reassortment, cross- and multiplicity reactivation, complementation, phenotypic mixing, ploidy, DI particles, transduction of genes by retroviruses, evolution of viruses (influenza, HIV, herpesviruses).

Central dogma theory and flow of genetic information.

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.

UNIT-III

DNA damage and repair: Classes / types of damage. Repair mechanisms – mismatch repair, short patch repair, nucleotide / base excision repair, recombination repair and SOS system.

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.

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.

UNIT-IV

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.

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 and ara operons; regulation by attenuation- his and trp operons; antitermination- N protein and nut sites in Lambda phage. Organization and regulation of nif and nod gene expression in bacteria; Gal operon in yeast. Global regulatory responses- heat shock response, stringent response and regulation by small molecules such as cAMP and PPGPP.

Gene silencing mechanisms: Transcriptional and post-transcriptional silencing. RNA silencing and gene regulation.

Suggested Books:

1. Concepts of Genetics, Seventh edition -2007, William S. Klug & Michael R. Cummings. Darling Kindergluy.
2. Molecular Biology of the Gene. 4th Edition. 2004. Pearson Education.
3. Molecular Cell Biology. 2003, by Lodish et al., Scientific american books, W.H. Freeman and Company.
4. Molecular Genetics of Bacteria. 2nd Edition, 2003. By S. Snyder and W. Champness. ASM press.
5. DNA Science : A First course. Second editon -2003-David A. Micklos grag, A. Freyer & David A, Crotty.
6. Bacterial and Bacteriophage Genetics. 4th ed. 2000. By E.A. Birge. Springer.
7. Molecular Biology. 1995, by David Freifelder, Narosa Publ. House.
8. Text Book of Molecular Biology. 1994, by Sivarama Sastry et al, Macmillan India Ltd.
9. Advanced Molecular Biology : A Concise Reference. 1998, by R.M. Twyman. Viva Books Pvt. Ltd.

VR-203 : RECOMBINANT DNA TECHNOLOGY (CC)

UNIT-1

Scope and importance of recombinant DNA technology

Tools for Recombinant DNA Technology: Gene vectors-Plasmid, transposon, bacteriophage and plant and animal virus based 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, Ori, marker genes. **Source DNA** - genomic DNA, cDNA, PCR products and chemically synthesized oligonucleotides. **Cloning and expression host systems** -Gram positive and negative bacteria, yeast and other fungi, plants and animal cells.

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

UNIT-II

Techniques for gene manipulation : DNA sequencing -Chemical, dideoxy chain termination, primer walking , automated sequencing and pyrosequencing methods. **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, factors affecting PCR , different types of PCR and their applications and limitations. **DNA profiling** - RFLP, AFLP, RAPD and DNA finger printing and their applications. **Microarray Technology** - DNA microarrays and chips, protein, antibody / antigen arrays - principles and applications.

Site directed mutagenesis and protein engineering : Different approaches for changing genes. Approaches for protein engineering to generate novel enzymes like subtilisin.

Yeast two hybrid system for assaying protein interactions.

UNIT-III

Gene cloning strategies: Construction of genomic DNA and cDNA libraries and different strategies for selection, screening and analysis of recombinants. Recombinogenic engineering. **Gene cloning 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. **Genomics** - Mapping and sequencing genomes. Comparative genomics of viruses, prokaryotes and eukaryotic microbes. **Functional genomics** - transcriptome and gene expression profiling. **Proteomics**- proteome and analysis of protein expression. Introduction to structural and comparative proteomics. **Metabolomics** - introduction to metabolome and its analysis.

UNIT-IV

Production of recombinant molecules in expression systems: Bacterial cell system- Construction of expression vectors. optimization of cloned gene expression. Purification and analysis of generated recombinant molecules. **Yeast cell system** - Construction of vectors for overexpression of genes, optimization of generation of recombinant molecules. **Insect cell system** - Overexpression of cloned genes using baculovirus based vectors. **Plant cell system** - high level expression of cloned genes using plant virus based vectors.

Genetic modification of plants to improve agronomic traits like resistance to herbicides, pests, pathogens, drought, salt; control of fruit ripening and to improve nutritional quality and crop yields. Transgenic plants as bioreactors. Genetic trait control technology (traitor technology)

Genetic modification of animals like mice, sheep, pig and cow for new /improved traits like body size and milk quantity. Transgenic animals as bioreactors. Gene targeting, gene knockin and knockout and disease models. Gene therapy.

Nanobiotechnology : scope and importance.

Applications and implications of recombinant DNA technology in biology, agriculture, medicine and industry.

Suggested Books :

1. Principles of Gene Manipulation and Genomics. Seventh edition -2008, S.B. Primrose and R.M. Twyman. Blackwell pub.
2. Recombinant DNA Genes and Genomes: A Short course. Third edition -2007 James D. Watson, Amy A. Caudy, Richard M. Mayes & Jan A. Witkow.
3. Gene Cloning and DNA Analysis – An Introduction. Fifth edition-2006 .T.A Brown. Blackwell Pub.
4. An introduction to genetic engineering. 2nd edition. 2004. By D.S.T. Nicholl. Cambridge University Press.
5. DNA Science: A First course. Second edition -2003-David A. Micklos, A. Freyer & David A, Crotty.
6. Principles of genome analysis and genomics. 2003. 3rd edition. S.B. Primrose and R.M.Twyman. Blackwell Science.
7. Prokaryotic genomics. 2003. Michel Blot (Ed). Springer International.
8. Recombinant DNA and biotechnology: A guide for Teachers: 2nd ed. H. Kreuzer and A. Massey. ASM Press.
9. Recombinant DNA and biotechnology: A guide to students : 2nd ed. H. Kreuzer and A. Massey. ASM Press.
10. Molecular biology and Biotechnology, 2002, 4th ed. ed. by J.M. Walker and R. Rapley, Panama.
11. Basic Biotechnology, 2001. 2nd ed. ed. by C. Ratledge & B. Kristiansen. Cambridge University Press.
12. Principles of Gene Manipulation: An introduction to genetic engineering. 2001. 6th ed. Old and Primrose. Blackwell Scientific Publ.
13. Functional Genomics: A Practical Approach. 2000, by S.P. Hunt and R. Liveey (eds.). Oxford University Press.

Reference Books :

1. Molecular Cloning, 2001. Vol. I-III by Sambrook and Russel, CSH Press.
2. Current Protocols in Molecular Biology, 2000. Ausbel et al.
3. Genome analysis. 2000. 4 Vols. CSH Press.

VR-204 : IMMUNOLOGY (CC)

UNIT-I

History: Historical perspectives and milestones in immunology.

Cells and Organs of the Immune system: Hematopoiesis. Lymphoid cells, stem cells, Mononuclear cells, Granulocytes, Mast cells, Dendritic cells. Lymphoid organs- primary and secondary lymphoid organs.

Types of immunity: Innate, adaptive and comparative immunity. Immune dysfunction and its consequences.

Immune responses to viral, bacterial and parasitic infections.

Antigens: types, properties, study of antigenicity, immunogenicity versus antigenicity, factors influencing immunogenicity. Epitopes, haptens, mitogens, superantigens. Viral and bacterial antigens.

UNIT-II

Antibodies: Types, structures and biological activities of Immunoglobulins. Antigenic determinants- Iso, allo and idiotypes. Immunoglobulin super family, antibody diversity, organization and expression of immunoglobulin genes.

Production of conventional polyclonal antibodies - animals, additives, adjuvants, routes, dose, collection and preservation of antisera, purification and analysis of immunoglobulins.

Monoclonal antibodies: Hybridoma technology—principle and production of monoclonal antibodies, advantages and disadvantages over polyclonal antibodies, application of monoclonal antibodies.

Recombinant antibodies: Production and their advantages over conventional antibodies.

Antigen and Antibody interactions: Affinity, Avidity, Cross reactivity.

In vivo serological reactions : Phagocytosis, Opsonization, Neutralization, Protection tests.

In vitro serological tests: Precipitation tests in liquid and semisolid media, Immunoelectrophoresis tests (Rocket, counter current). Agglutinations tests- HA & HI, latex agglutination. Complement fixation tests, Labeled antibody based tests- Enzyme linked immunosorbent assays (ELISAs), Western blotting, Radio immunoassay (RIA), Immunofluorescent and Immuno specific microscopy. Infectivity neutralization test. The relative advantages and disadvantages and their applications in Microbiology.

UNIT-III

Humoral immune response: Primary and secondary immune responses, induction, regulation of the immune effector response

Cell mediated immune response: Antigen processing and presentation, Induction and mechanism, antibody-dependent cell mediated cytotoxicity (ADCC).

Immune effector mechanisms: Cytokines, Lymphokines, Chemokines and their classification, properties and functions. Toll-like receptors (TLRs)

Complement cascade system: Complements nomenclature, classification, complement components, functions, activation, regulation, biological consequences, complement deficiencies.

Major histocompatibility complex (MHC): Organization and Inheritance of MHC, cellular distribution of MHC molecules, regulations of MHC expression, MHC- immune responsiveness, disease susceptibility, MHC restriction, HLA antigens- Class I, II, III and their functions, Murine antigens and its functions.

Hypersensitivity and Immunedisorders: Type I – common allergens associated with type I hypersensitivity. Mediators involved in type-I hypersensitivity. Consequences of type I reactions – localized and systemic anaphylaxis. Detection and therapy for type I hypersensitivities. **Type II**– Transfusion reactions, hemolytic disease of the new born, drug induced hemolytic anemia. **Type III** –

Localized and generalized type III reactions. **Type IV-** and its importance in host defense against infections.

UNIT-IV

Immunopathology: Immunodeficiencies- SCID, ADA. Phagocyte and complement defects. Autoimmunity- induction, mechanisms of tissue damage in autoimmunity. Autoimmune diseases- thyroid diseases, Diabetes mellitus, Multiple sclerosis, Rheumatoid arthritis and their therapy.

Transfusion Immunology: Blood cell components, blood group systems in human and in animals, Rh typing, transfusion reactions, diseases associated with blood transfusion – Hemolytic anemias, Erythroblastosis fetalis.

Transplantation Immunology: Transplantation antigens, types of transplants, Graft versus host reactions – immunological basis of graft rejection mechanism, prevention of graft rejection, clinical manifestations of graft rejection, Immunosuppressive therapy of allograft response, clinical transplantation.

Vaccines: Conventional and modern, production, merits and demerits, applications. Mass immunization programs against pathogens

Suggested Books :

1. Immunology. 2000. 4th edition. J. Kuby. W.H. Freeman and Company.
2. Immunology. 1996. 4th edition. I.Roitt, J. Brostoff and David Male. Mosby publications.
3. Fundamental Immunology. 1992. 2nd edition. R.M. Coleman, M.F. Lombard and R.E.Sicard. Wm. C. Brown Publishers.
4. Immunology. 1997. 3rd edition. R.M. Hyde. B.I. Waverly Pvt. Ltd.
5. Immunology. 1995. 4th edition. I.R. Tizard. Saunders College Publishing.
6. Immunology – The Science of self and non-self discrimination. 1982. Jon Klein. John Wiley and Sons.
7. Immunology – An illustrated outline. 1986. David Male. Churchill Living Stone.
8. Viruses that affect immune system. 1991. H.Y. Fan, I.S.Y. Chen, N.Rosenberg and W. Sugden. American Society for Microbiology.
9. Immunobiology: The immune system in health and disease.1994. C.A.Janeway, Jr., P.Travers. Current biology Ltd.
10. Advanced Immunology. D.M. Male *et al.*, The C.V.Mosby Co.

VR-205 : CELL BIOLOGY AND IMMUNOLOGY

1. Preparation of cytological studies for identification of stages of mitosis using root tips
2. Examination of cells isolated from chick epithelium.
3. Demonstration of chromosomal (structural and numerical) aberrations.
4. Study of polytene chromosomes.
5. Isolation of mitochondria by density gradient centrifugation.
6. Karyotypic study.
7. Culturing of Sheep kidney cells.
8. Culturing of Chicken embryo fibroblast cells.
9. Sub-culturing of Sheep kidney cells
10. Total counting of RBC & WBC
11. Differential count of W.B.C
12. Haemoglobin estimation.

13. Blood typing & Rh determination.
14. Latex agglutination test for HBV.
15. Primary & Secondary lymphoid organs.
16. Production of polyclonal antibodies- demonstration of different routes of antigen inoculation, bleeding of experimental animals, and collection of serum.
17. Purification of immunoglobulins.
18. In vitro serological tests: Single & Double immunodiffusion tests; HA & HI tests; Immuno electrophoresis; counter current & rocket electrophoresis; DAC- ELISA (indirect).

Suggested books/Manuals:

1. Culture of Animal Cells : A Manual of Basic Technique. 1987. R.I. Freshney. Alan R. Liss Inc.
2. Plant tissue culture: Theory and Practice, 1996. S.S. Bhojwani and M.K. Razdan, Elsevier Pub.
3. Immunology: A Laboratory Manual Spiral-bound – November 1, 1994 by Myers.
4. Hand Book of Immunology. G.P. Talwar, 1983, Vikas publishing house, India.

VR-206 : MICROBIAL GENETICS AND MOLECULAR BIOLOGY & R DNA TECHNOLOGY

1. Creating of ribonuclease free environment in the laboratory.
2. Preparation of phenol for nucleic acid isolation.
3. Concentration of nucleic acids.
4. Isolation of microbial DNA and RNA.
5. Curing of plasmids.
6. Demonstration of Ames test.
7. Replica plating techniques.
8. Demonstration of conjugation in bacteria.
9. Transformation of bacteria.
10. Isolation of microbial mutants by gradient plate method.
11. Induction of mutations in Bacteria by physical / chemical agents.
12. Observation of mitotic divisions in onion root tips and meiotic divisions in onion flower buds.
13. Problems related to microbial molecular biology and genetics.
14. Isolation of plasmids from Bacteria .
15. Restriction enzyme analysis of plasmids.
16. Recovery of DNA from gels - Electroelution and extraction of DNA from low melting agarose gels.
17. Southern blotting.
18. Electroblood immunoassay.
19. Preparation of dot-blot for hybridization.
20. Preparation of competent bacterial cells and transformation with recombinant.
21. Plasmid DNA, identification of positive clones by different approaches.
22. Problems related to recombinant DNA technology.

Suggested Books / Manuals :

1. Biotechnology: DNA to Protein: A laboratory project in molecular biology. 2002. T. Thiel, S. Bissen, E.M. Lyons. Tata McGraw-Hill publishing company.
2. Molecular cloning- A laboratory manual. 2001. I, II, III Vols. By Russell and Sambrook. CSH Publs.
3. Methods in Biotechnology. 2001. By Ignacimuthu.
4. Biotechnology : A Laboratory Course. 1996. 2nd ed. J.M. Becker, et al., Acad. Press.

SEMESTER-III

VR-301 : MOLECULAR VIROLOGY (CC)

UNIT-I

Molecular architecture of viruses: Principles of virus structure- Icosahedral and helical tubes (TMV), cubic symmetry, in vitro reconstitution experiments, structured-based categories of viral designs and their characteristics- simple icosahedral symmetric capsids with Jelly-Roll Beta barrel subunits (Polio, TBSV, SBMV, SeMV), ds DNA (Pox virus, Baculovirus, HSV, Adeno) dsRNA viruses (Reovirus), enveloped positive-stranded RNA viruses, enveloped viruses with trimeric, alpha helical, coiled-coil fusion proteins. Viruses with head-tail morphology- (T4). Occurrence of different morphologies, principles of disassembly- particles are metastable.

Molecular mode of inactivating agents on viruses : physical agents – ionizing radiation; non-ionizing radiation, temperature (heat); ultrasonic vibration. Chemical agents – inorganic; organic solvents; ions; chelating agents; hydroxylamine; dyes.

UNIT-II

Viral genomes: Structure and complexity of viral genomes, diversity among viral genomes- DNA genomes- linear and circular double and single stranded. RNA genomes- Positive and Negative, linear, circular, double and single stranded, mono, bi, tri and multipartite genomes.

Replication of viruses: Investigation of virus replication , an overview of virus replication cycles , replication strategies, host cell functions required in virus replication, sites of replication and assembly, importance of mutants in assembly studies.

Replication strategies of DNA viruses: Baltimore strategies on viral genome expression, Replication of DNA viruses, transcription of viral DNA, preparing the cell for viral DNA replication, universal mechanism of viral DNA replication, strategies to ensure complete replication, genome resolution, packaging, replication of circular dsDNA - Papoviruses, replication of linear dsDNA that conform circles- Herpes, Lambda; replication of linear dsDNA genomes- Adeno, Pox , replication of ss circular DNA- phi x 174, replication of linear ssDNA - parvo, dependence versus autonomy among DNA viruses. Gene expression and its regulation in DNA viruses- Polyoma, Adeno, Pox, Parvo, Retro, Hepadna, DNA phages, papilloma and Herpes viruses.

UNIT-III

Expression and replication of RNA Viruses : Structure and organization of viral RNA genomes, regulatory elements for RNA virus genome synthesis, synthesis of the RNA genomes. Viruses with positive sense ssRNAs - MS2/ Q β , Picorna- Toga-, Tobamo-, Poty-, Nepo- and Bromo- viruses. Negative and Ambisense ss RNA viruses- Ortho-, Paramyxo, Bunya and Rhabdo- viruses. dsRNA viruses- Reo- and Birna- viruses. ssRNA viruses with DNA intermediate - RSV and HIV. dsDNA viruses with RNA intermediate- CaMV, Hepatitis B.

UNIT-IV

Regulation of viral genome expression: MS2, T4, Lambda phage, Corona virus, HIV, Adenovirus and Herpesvirus. Functions of virus encoded products . Assembly of viruses- self assembly from mature virion components, assembly of virus with helical structure (TMV), isometric structure (Adeno, Picorna) and with complex structure (T4). Assembly of enveloped viruses (Herpes, Filo, Retroviruses). Maturation of virus particles.

Tumor Virology: Terminology. Viruses associated with tumors. Molecular mechanisms of tissue transformation and tumorigenesis by viruses.

Replication of sub-viral agents: Viroids, Hepatitis D, Sat-viruses, Sat-RNAs, DI particles, Prions.

Suggested Books :

1. Principles of Virology- Molecular biology, pathogenesis and control. 2004. S.J.Flint, L.W.Enquist, R.M.Krug, V.R.Racaniello and A.M.Skalka. ASM press.
2. Principles of Molecular Virology. 1997.Second edition. A.J. Cann. Acad. Press.
3. Medical Virology. 2001. 5th edition. D.O. White, F.J. Fenner. Academic Press.
4. Introduction to Modern Virology. 2001. 5th edition. Dimmock et al. Blackwell Sci.
5. Matthews' Plant Virology. 2001. 4th edition. R. Hull. Academic Press.
6. Virology. 1994. 3rd edition. Fraenkel Conrat, P.C. Kimbal and J.A. Levy. Printice Hall.
7. Basic Virology.1999.E.K.Wagner and M.J.Hewlett. Blackwell Science, INC.,
8. Fundamental Virology.2001.4th Edition. Editors-in-Chief David M.Knipe, Peter.M.Howley. Lippincott.
9. Fields Virology. 1996. 3rd Edition. B.N. Fields, D.M. Knipe, P.M. Howley.
10. Encyclopedia of Virology. 1994. R.G. Webster and A. Granoff (9ed.). Vol. I,II and III.

VR-302: BIOSTATISTICS AND BIOINFORMATICS (CC)

UNIT-I

Introduction : Definition of statistics: population and universe, the sample and population, statistical inference; parameter and statistics. Construction of a histogram; Interpretation of histogram, the normal distribution, the mean, mode, median and standard deviation.

Uncertainties in estimation of mean, comparison of means and variances- t, F, and Z tests.

Proportion data : examples of proportion data; (MPN, sterility testing of medicines, animal toxicity, therapeutic trial of drugs and vaccines, animal toxicity, infection and immunization studies) statistical treatment to proportion data. Chi-square test, goodness of fit.

Count data: examples of count data (bacterial cell count, radioactivity count, colony and plaque counts) statistical treatment to count data: Poisson distribution, standard error, confidence limits of counts.

UNIT-II

Analysis of variance : Analysis of variance: Introduction, procedure and tests for one-way and two-way classified data. Multiple comparisons. Analysis of CRD, RBD and LSD. Factorial experiments-main effects and interaction in a 2^2 design.

Correlation and regression, formulae and application. Fitting the best straight line through a series of points. Fitting of different curves. Standard curves and interpolation of unknown Y-values. Multiple linear regression.

Statistical basis of biological assays: Response-Dose metameter. Delusion Assays, Direct and indirect assays. Quantal Responses, Probit, logit, LD₅₀, ED₅₀, PD₅₀ - Standard line interpolation assay, parallel assay (4 point, 6 point assays), slope ratio assay.

UNIT-III

Basics of personal computer and its components. Concept of Programming Languages. Hardware and Software. The idea of operating systems.

Windows Operating system - Simple commands do create directories and handle files. Windows based software for creating biological databases- MS access

Microsoft Office- 2000 : Introduction and facilities available. Shortcut Bar; customizing toolbars; using common office techniques- starting an office application. Microsoft Word, Microsoft Excel, Microsoft Powerpoint,

Introduction to Internet and Biologist: Internet basics, getting onto the internet, e-mail, file transfer protocols, gopher, the world-wide web, browsing and down loading from sites.

Networking of Computers and overview of International and Indian networks. Virtual Library-I: Searching MEDLINE; Pubmed. Virtual Library II: Science Citation Index and current awareness services; Virtual Library III: Electronic Journal; International and Indian Networks- NICNET, INFLIBNET, AGRIS.

Information Networks: WWW, HTTP, HTML, URLs, EMB net, NCBI net, Virtual tourism.

UNIT-IV

Databases and Tools: Primary information resources- Protein and genomic information resources- Biological databases; primary, secondary and composite protein sequence databases, structure classification databases, DNA sequence databases, specialized genomic resources; DDBJ, Gen Bank and EMBL public DNA sequence databases; SWISSPROT Database, information retrieval from biological databases; the NCBI data model. Submitting DNA sequences to the Database and updating.

Sequence analysis: Wisconsin GCG, DNASIS, DNASTAR, CLONE MANAGER packages for nucleotide sequence analysis; sequence alignment and database searching; practical aspects of multiple sequence alignment.

Phylogenetic analysis: Phylogenetic models; multiple alignment procedures (CLUSTAL, ALIGN, PHYLIP); tree building methods and trees evaluation; rooting trees, phylogenetic software.

Predictive methods using nucleotide and protein sequences: Detecting regulatory elements in the DNA; physical properties of proteins based on sequences, different protein structural motifs, RNA binding domains and folding classes; Transcription factors and their DNA binding. Protein structure predictions.

Suggested Books:

1. Biostatistics by Daniel.
2. Campbell R.C. (1974 : Statistics for Biologists, Cambridge University Press, Cambridge.
3. Statistics made simple- Do it yourself on PC. 2001. By K.V.S. Sarma. Printice Hall of India Publ.

4. An introduction to Biostatistics. 1997. Third Edition. P.S.S. Sundar Rao and J. Richard, Prentice-Hall of India Pvt. Ltd., New Delhi.
5. Fundamentals of Biostatistics. 1994. First Edition. Irfan A. Khan and Atiya Khanum, Ukaaz Publications.
6. Biostatistics. 1996. First Edition. P.N. Arora and P.K. Malhan, Himalaya Publishing House.
7. Statistics for Biologists. 1980. D.J. Finney.
8. Statistics and Experimental design: An Introduction for Biologists and Biochemists. 1994. 3rd edition. G.M. Clarke. Edward Arnald Publications.
9. Statistical methods. 1967. 6th edition. Snedecor and Cochran, Oxford Press. 1967.
10. Elements of Computer Science, 1998. S.K. Sarkar, A.K. Gupta. S. Chand & Company (Chapters-1,2,9,12,14).
11. Microsoft Office. 1997. Stultz. Office 2000 - The Basics and Beyond, 2000. A Lan Neibauer. Tata Mc Graw-Hill Publishing Comp. Part I, II, III, IV, V.
12. Windows-98, 2000, Vickram Crishra. Tata Mc Graw-Hill Publishing.
13. The Internet : Complete Reference, Harley Hahn. 1996. Second Edition. Tata Mc Graw-Hill Publication.
14. Introduction to Bioinformatics, 2001 by T.A. Attwood & D.J. Parry-Smith, Pearson Education Asia Publ.
15. Bioinformatics : Methods and Protocols, Edited by Stephem Misener and Stephen A. Krawetz. 2000. Methods in Molecular Biology Series. Humana Press.
16. Bioinformatics : A Practical guide to the analysis of genes and proteins. 1998. Edited by A.D. Baxevanis and B.F.
17. Francis Ouellette. Wiley - Interscience. Computational Methods in Molecular Biology by S.L. Saizberg.
18. Computer Applications in Biotechnology. 1998. by T. Yosida. Introduction to Bioinformatics by Atwood.
19. Bioinformatics - From Nucleic Acids and Proteins to Cell Metabolism. 1995, by Schomburg and Label VCH Publ.
20. Bioinformatics : Sequence and Genome Analysis. By D.W. Mount. CSHL Press.
21. Bioinformatics : Methods and Protocols,. Ed by S.Misener and S.A. Krawetz. Humana Press, 2000.

VR-303 : PLANT VIROLOGY (IEC)

UNIT-I

Virus-host interactions : Effects of virus infection on host metabolism; molecular mechanisms of plant viral pathogenesis - role of viral genes in disease induction, host proteins induced by virus infection, processes involved in disease induction. Cytological and histological changes in infected plants. Macroscopic external symptoms (local and systemic). Induction of disease- kinds of host response to virus inoculation, factors influencing the course of infection and disease development.

Movement/transport of viruses: Cell to cell and long distance movement. Distribution of the viruses in the plants.

UNIT-II

Transmission of viruses: Non-vector – sap / mechanical, seed and pollen, graft, dodder, contact. Vector- arthropods (aphids, leaf and plant hoppers, whiteflies, beetles, thrips, mealy bugs), mites, fungi, nematodes. Virus-vector relationships, Molecular mechanisms of virus-vector interactions. Effects of viruses on vectors. Agroinfection.

UNIT-III

Characterization and identification of viruses and virus strains: Biological, physical, molecular and immunological approaches.

Detection of Viruses by different approaches: Biological, serological and molecular assays/tests

Virus ecology and epidemiology of diseases : Epidemiological concepts. Biological and physical factors influencing survival and spread of viruses and diseases. Cropping practices and virus spread. Disease gradients, disease progress curves, mono- and polycyclic diseases. Monitoring of insect vectors. Forecasting of diseases.

Assessment of disease incidence and yield losses : Field surveys for determination of incidence of diseases. Approaches for assessment of yield losses. Impact of viruses on crop yields.

UNIT-IV

Management of virus diseases : Direct and indirect approaches- antiviral agents, crop cultural practices, elimination / avoidance of sources of infection, use of virus-free seeds and planting materials, production of virus-free plants by tissue culture technology, avoidance/control of vectors (chemical and non-chemical approaches). Cross- protection/ immunization. Suppression of disease symptoms by chemicals / botanicals. Control through breeding for disease tolerance / resistance. Production of resistant plants by non-conventional approaches- somatic hybridization, transgenic plants exploiting viral and non-viral genes. Plant quarantine and its role in disease control.

Suggested Books :

1. Plant Virology, 4th ed. 2001 by R. Hull (R.E.F. Matthews). Academic Press.
2. Plant viruses as molecular pathogens. J. A. Khan and J. Dijkstra (Eds). CBS Publishers and distributors, New Delhi.
3. Plant Viruses. By M.V. Nayudu. 2008. Tata –McGraw Hill.
4. Applied Plant Virology. 1985. D.G.A. Walkey. Heinemann Publications.
5. Symptoms of Plant Virus Diseases by L. Bos.
6. Diagnosis of Plant Virus Diseases. 1993 by R.E.F. Matthews. CRC Press.
7. Control of Plant virus diseases by Hadidi et al (editors), 1998, American Phytopathological Society, USA.
8. Plant Virus Epidemics- Monitoring, modeling and predicting outbreaks. 1986. G.D. Mc Lean, et. al., Academic Press.
9. Plant Virology - The Principles. 1976 by A. Gibbs and B.D. Harrison, Edward Arnold.
10. Techniques in diagnoses of Plant Viruses (Plant Pathogens -6)-2008 Govind P.Rao, Rodrigo A. Valverde & C.I. Dovas, Stadium Press.

VR-304 (T): PLANT VIRUSES AND DISEASES (IEC)

Note: Emphasis shall be on disease distribution, incidence and impact, symptoms, causal virus characteristics, diagnosis, disease cycle and management.

UNIT-I

Cereals and millets :

Rice - tungro, dwarf, ragged stunt, grassy stunt, stripe, and yellow mottle. **Wheat**- soil-borne wheat mosaic, streak mosaic, yellow mosaic / spindle streak mosaic and mosaic caused by BYDV. **Barley and Oat** – yellow dwarf, stripe mosaic and yellow mosaic. **Maize and Sorghum** – sugarcane mosaic, maize streak , dwarf mosaic, mosaic and stripe viruses caused diseases.

Oil seeds crops : **Groundnut** – bud necrosis, stem necrosis, mottle, stripe, rosette and clump. **Sunflower** – necrosis and mosaic. **Sesamum** – leaf curl. **Rape seed and mustard** – mosaic. **Coconut** – cadang - cadang viriod disease.

UNIT – II

Vegetables: **Tomato** – leaf curl, spotted wilt, mosaic and fern leaf / shoe string. **Chilli** – leaf curl, vein banding and mosaic caused by TMV, CMV and TEV. **Brinjal** – mosaic caused by CMV / TMV/ PVY. **Okra** – yellow vein mosaic and leaf curl. **Onion and garlic** – yellow dwarf mosaic, latent and iris yellow spot. **Cucurbits** – CMV. squash mosaic and leaf curl, watermelon mosaic and bud necrosis, and cucumber green mottle mosaic. **Radish** – mosaic. **Carrot** – red leaf, mottley dwarf and thin leaf. **Cabbage and Cauliflower**- turnip mosaic, cauliflower mosaic and turnip yellow mosaic. **Tuber crops:** **Potato**- leaf roll, rugose mosaic, mild mosaic / latent caused PVX, PVM and PVS and spindle tuber viriod diseases. **Sweet potato** – mild and feathery mottle. **Cassava** – common, African and Indian mosaic diseases. **Colocasia and Cocoyam** – Feathery mottle, Babone and Alomae diseases. **Greater yam** – mosaic.

UNIT-III

Food legumes: **French bean**- Common mosaic, yellow mosaic, golden mosaic, leaf roll and CMV infection. **Soybean** – mosaic, dwarf and TRSV infections. **Pea** - seed-borne mosaic, enation mosaic, BYMV. **Cowpea** – yellow and severe mosaic, golden yellow mosaic, SBMV and CMV. **Chickpea** – stunt, chlorotic dwarf, CMV and AMV infections. **Pigeonpea** – sterility mosaic. **Lentil** – diseases caused by Bean leaf roll and yellow mosaic viruses. **Black gram / Green gram** – yellow mosaic and leaf crinkle. **Horse gram** - yellow mosaic. **Fruit crops :** **Banana / Plantain** - bunchy top, streak, infectious chlorosis and bract mosaic. **Citrus** - tristera, yellow mosaic, psorosis and exocortis. **Papaya**- ring spot, leaf curl and mosaic. **Grapevine** - fern leaf and leaf roll. **Apple** - mosaic. **Pineapple** - wilt.

UNIT-IV

Cash crops: **Sugarcane**- mosaic, Fiji disease, bacilliform virus. **Sugarbeet** -curly top yellows, western yellows, beet mosaic, BNIV. **Cotton** - leaf curl diseases, **Kenaf**- yellow vein mosaic. **Tobacco** - mosaic and leaf curl. **Spice and beverage crops:** **Small cardamom** – mosaic. **Large cardamom** - foorkey and chirke diseases. **Black Pepper** - stunt and yellow mottle. **Zinger** – chlorotic fleck. **Vanilla**-mosaic. **Cocoa** - swollen shoot. **Flowering and foliage ornamentals:** **Tulips** – Flower breaking. **Rose** – mosaic. **Gladiolus** – BYMV. **Orchids** – cymbidium mosaic and odontoglassum ring spot viruses. **Carnations** - mottle, ring spot and etched ringspot. **Chrysanthimum** – aspermy, ring mottle and stunt viriod. **Aroids** – DSMV and Konjac mosaic viruses.

Suggested Books:

1. Characterization, Diagnosis & Management of Plant Viruses : Industrial crops (vol.I) (Plant pathogens series-I) 2008-Govind P.Rao, S.M. Paul Khurana & S L.Lenardan-Studium press LLC, U.S.A
2. Characterization, Diagnosis & Management of Plant Viruses : Horticultural crops (vol.2) (Plant pathogens series-2) 2008-Govind P.Rao, Arben Myrta and Kal-Shu Ling-Studium press LLC, U.S.A
3. Characterization, Diagnosis & Management of Plant Viruses : Vegetables & Pulse crops(vol.3) (Plant pathogens series-3) 2008-Govind P.Rao, P.Lava kumar and R.J. Holguin-Pena-Studium press LLC, U.S.A

4. Characterization, Diagnosis & Management of Plant Viruses : Grain crops & Ornamentals(vol.4) (Plant pathogens series-4) 2008-Govind P.Rao, Claude Bragard and B S.M.Lebas-Stadium press LLC, U.S.A
5. Plant pathology, Fifth edition-2008- Georgen Agrios-Elsevier.
6. Techniques in diagnoses of Plant Viruses (Plant Pathogens -6)-2008 Govind P.Rao, Rodrigo A. Valverde & C.I. Dovas, Stadium Press.
7. Viruses and Virus-Like Diseases of Major crops in Developing Countries-2003. G Loebenstein & G. Thottappilly. Kluwer Academic Pub.
8. Viruses and Virus diseases of Poaceae (Gramineae)-2004.H.Lapierre & P.A. Siganoret. INRA editions-France.
9. Viruses of Plants. 1996. By A.A. Brunt et al., CAB International.
10. Virology in the Tropics. 1994. N. Rishi, et al., (editors). Malhotra Publishing House.
11. Control of Plant Virus diseases by Hadidi et al., 1998. American Phytopathological Society, USA.
12. American Phytopathological Society- Monographs on disease of different crops.
13. CMI/AAB Descriptions of Plant Viruses.

VR-305 : MOLECULAR VIROLOGY & BIostat AND BIOINFORMATICS

- 1 Purification of viruses by different chemical and physical methods
- 2 Isolation of viral proteins and nucleic acids
- 3 Analysis of viral proteins and nucleic acids by gel electrophoresis
- 4 Isolation and analysis of dsRNA from ssRNA infected tissues
- 5 Study of inactivation of viruses by various physical and chemical agents
- 6 Cut, copy, paste operations in MS Office
- 7 Creating & editing tables in MS-Word
- 8 Creating database & Statistical graphs in EXCEL
Histogram, pie, line diagram, scatter diagram, error bars
- 9 Simple Statistics with Excel
- 10 Creating and use of spread sheet to biological applications
- 11 Use of internet, worldwide web, searching for data bases
- 12 Locating research material on Medline
- 13 Learning to use NCBI and EMBL, phylogenetic trees.
- 14 Analysis of Viral genome sequences using programmes like Bioedit.

Suggested Books / Manuals :

1. Virology - A Laboratory Manual, 1992. By Burleson, et al., Academic Press.
2. Virology Methods Manual, 1996. B.W.J. Mahy and H.O. Kangro. Academic Press
3. Molecular Virology : A Practical Approach. 1993. Davison and R.M. Elliot. Oxford University Press.
4. Virology Lab Fax. 1993. D.R. Harper. Bioscientific Publication. Academic Press
5. Elements of Computer Science, 1998. S.K. Sarkar, A.K. Gupta. S. Chand & Company (Chapters- 1,2,9,12,14).
6. Microsoft Office. 1997. Stultz. Office 2000 - The Basics and Beyond, 2000. A Lan Neibauer. Tata Mc Graw-Hill Publishing Comp. Part I, II, III, IV, V.
7. Bioinformatics : Methods and Protocols, Edited by StepheM Misener and Stephen A. Krawetz. 2000. Methods in Molecular Biology Series. Humana Press.
8. Bioinformatics : A Practical guide to the analysis of genes and proteins. 1998. Edited by A.D. Baxevanis and B.F.

9. Francis Ouellette. Wiley - Interscience. Computational Methods in Molecular Biology by S.L. Saizberg.
10. Computer Applications in Biotechnology. 1998. by T. Yosida. Introduction to Bioinformatics by Atwood.
11. Bioinformatics - From Nucleic Acids and Proteins to Cell Metabolism. 1995, by Schomburg and Label VCH Publ.
12. Bioinformatics : Sequence and Genome Analysis. By D.W. Mount. CSHL Press.
13. Bioinformatics : Methods and Protocols,. Ed by S.Misener and S.A. Krawetz. Humana Press, 2000.

VR-306 : PLANT VIROLOGY AND PLANT VIRUS DISEASES

- 1 Study of symptoms of local virus diseased plants and through slides/photographs
- 2 Determination of virus effect on chloroplast number.
- 3 Determination of virus effect on cell size.
- 4 Observation of inclusions by light microscopy
- 5 Determination of concentration of carbohydrates, proteins and lipids in seeds of virus infected plants.
- 6 Identification of unknown virus by ELISA.
- 7 Transmission of plant viruses by leaf hoppers / whiteflies / cuscuta.
- 8 Determination of virus effect on yield components
- 9 Isolation of single lesion virus isolates
- 10 Local field surveys and research stations.
- 11 Diagnosis of virus diseases (theoretical exercises).
- 12 Collection and identification of local insect vectors.
- 13 Determination of disease progress curves.
- 14 Study of seed transmission of viruses
- 15 Demonstration of transmission of viruses through vegetative propagules
- 16 Production of virus-free plants by tissue culture technology

Suggested Books / Manuals:

1. Serological Methods for detection and identification of viral and bacterial plant pathogens: A Laboratory Manual. 1990. R. Hampton et al., APS Press.
2. Diagnosis of Plant Virus Diseases, 1993. R.E.F. Matthews (ed.) CRC Press.
3. Methods in Plant Virology, 1984. S.A. Hill. Blackwell Publications.
4. Methods in Virology, K. Marmorosch and H. Koprowski. Vol. I and II. Academic Press.

SEMESTER-IV

VR-401 : APPLIED VIROLOGY (CC)

UNIT – I

Cell culture methods: Principles of plant and animal cell and organ culture technologies for cultivation and propagation of viruses and for production of Mabs. .

Antibodies: Production of conventional and rDNA technology based polyclonal and monoclonal antibodies to viruses and their applications.

Diagnostic virology: Collection, transport and processing of samples. Biological, Physical, Chemical, immunological and molecular approaches for identification and diagnosis of plant and animal and human viruses.

UNIT-II

Public health Virology: Biology, prevention and control of common nosocomial, enteric (food and water-borne, hepatitis A & E, polio, rotaviruses), blood-borne (hepatitis B & C, HIV), contact transmitted (common cold, flu) and insect-borne (Japanese encephalitis, dengue, chikungunya) viruses

Major viruses of silkworm, poultry, fish and prawn: Biology, prevention and management

Emerging and reemerging animal and human viruses: HIV, SARS, avian flu, swine flu, Marburg and Ebola viruses.

Vaccines to viruses: Type of immunization procedures, active and passive immunization, designing of vaccines, classical and novel/modern approaches for the production of vaccines, purified macromolecules as vaccines, Recombinant – vector vaccines, DNA vaccines, Synthetic peptide vaccines, Multivalent sub-unit vaccines, uses of vaccines, benefits of vaccination, mass immunization programmes.

UNIT-III

Selection of virus-free plant propagules (seeds, vegetative propagules): Sampling and large scale screening of materials and certification.

Virus-free plants: Production and mass multiplication of virus-free field and horticultural crops and ornamental plants by tissue culture technologies.

Virus resistant / tolerant crops: Production of virus resistant / tolerance crops through transgenic technology by exploiting genes derived from viruses, natural resistant plants and from other sources. Guidelines for testing and field release of transgenic crops in India.

Emerging and reemerging plant viruses: Gemini-, tospo-, ilar-, badna- and nanoviruses.

UNIT-IV

Viruses as molecular model systems in Biology and Molecular Biology: Viral nucleic acids as genetic materials. Exploitation of viruses as model systems in the development of new technologies in biology.

Viruses as unique genetic resources: Exploitation of viral genes / sequences in the construction of varied types of gene vectors (cloning, shuttle, expression and transcription) and their applications. Virus genes as a source of novel enzymes, gene expression activators and silencers. Molecular model systems in understanding the replication of nucleic acids and regulation of gene expression strategies and cancer biology (SV-40, adeno and papillomaviruses). Display of foreign peptides on virion surface and applications.

Viruses as biocontrol agents (viral biopesticides): Bacterial, algal, fungal and insect viruses – mass production and their application as biocontrol agents against bacterial and fungal pathogens of plants, algae and insect pests.

Phage therapy: Isolation, identification and exploitation of promising bacteriophages to control bacterial infections in humans.

Gene therapy: Exploitation of viruses (retro-, adeno- and parvoviruses) as functional gene delivery systems.

Viruses as biological warfare, biocrime and bioterrorism agents: Small poxvirus (variola), viral encephalitis and viral hemorrhagic fevers; HIV, viral hemorrhagic fevers (Ebola) and yellow fever virus.

Exploitation of viruses for nano biotechnological applications

Suggested books:

1. Techniques in diagnoses of Plant Viruses (Plant Pathogens -6)-2008 Govind .Rao, Rodrigo A. Valverde & C.I. Dovas, Stadium Press.
2. Epidemiology , diagnosis and Management of Zoonoses. 2004. K.G. Narayana Sri Kuldeep Sharma Pub.
3. Field's Virology. 2002. Vol. I, II.
4. Bailey and Scotts' Diagnostic Microbiology. 11th Edition. 2002. By B.A. Forbes et al., Mosby publisher.
5. Principles of Virology- Molecular biology, pathogenesis and control. 2000. S.J.Flint, L.W.Enquist, R.M.Krug, V.R.Racaniello and A.M. Skalka. ASM press.
6. Clinical Virology. 2002. 2nd edition. D.D.Richman *et al.*, ASM
7. Principles of gene manipulation. 6th edition. 2002. By S. Primrose, R. Twyman and B. Old. Blackwell Science.
8. Matthews' Plant Virology. 2001. By R. Hull. Academic Press.
9. Control of Plant Virus Diseases. By Hadidi *et al.*(Eds). APS. USA.
10. Medical Virology. 1994. 4th ed. D.O. White and F. Fenner. Academic Press.
11. Veterinary Virology. 1993. 4th ed. F. Fenner *et al.*, Academic Press (Part-II).

VR-402 : ANIMAL AND HUMAN VIROLOGY (CC)

UNIT-I

Virus-host interactions: Influence of virus on host organism- latent infection, cytopathic effects of viral infections, inclusion bodies, chromosomal aberrations; Response of host cells to viral infection- Host specificity, resistance, interference, immunological responses of the host, host induced modification, patterns of host response-biological gradient, systemic and general syndromes-interactions.

Virus offense meets host defense: Host defense against viral infections, innate and adaptive immune response to viruses.

Molecular mechanisms of viral pathogenesis with respect to poliovirus, rotavirus, herpesvirus (CMV).

UNIT-II

Transmission of viruses: Vertical (Direct) transmission- contact, transplacental, transovarial, sexual, fecal-oral, respiratory; Horizontal (Indirect) transmission- aerosols, fomites, water, food; Vector-arthropod, non-arthropods; Multiple host infections- viral zoonosis.

Persistence of viruses: Pattern of viral infection, mechanism of viral persistence.

Mechanism of infection and viral spread in the body: Routes of entry- skin, respiratory tract, oropharynx and intestinal tract, conjunctiva, genital; Host specificity and tissue tropism- receptors, viral enhancers; Mechanism of virus spread in the body- spread in epithelia, subepithelial invasion and lymphatic spread, spread by the blood stream, invasion of the skin, central nervous system, respiratory and intestinal tracts, other organs.

UNIT-III

Epidemiological concepts and methods of virus diseases: Scope of epidemiology- epidemiological investigation of virus diseases, qualitative and quantitative investigations. Definition of terms, types of epidemiological investigations, components of epidemiology, biological and physical factors influencing the survival and spread of virus diseases.

Describing disease occurrence: Measures of disease occurrence, prevalence, incidence, mapping.

Disease determinants: Host, agent and environment determinants, interactions.

Factors affecting virus ecology and epidemiology: Physical stability and concentration of virus, socio-economic factors, host characteristics- age, sex, morphological and physiological conditions, wild and domestic animals as sources of virus; Physical factors- rainfall, water, wind, air, temperature, soil, seasonal variations.

UNIT-IV

Virus disease surveillance: Types of surveillance, elements and other surveillance methods, evaluation and application of virus surveillance; Quarantine of viral diseases- International and national.

Strategies of virus maintenance in communities: Wild and domestic animals, rural and urban populations.

Surveys: Basic concepts, types of sampling, surveys, collecting information, monitoring vectors, pattern of disease progress.

Prevention and Control of viruses: The infection control policy- aseptic techniques, cleaning and disinfection, protective clothing, isolation; Prevention- sanitation, vector control, vaccines and immunization; Control- chemoprophylaxis, chemotherapy (antiviral drugs, Interferon therapy), efficacy of infection control.

Suggested Books:

1. Epidemiology, diagnosis and Management of Zoonoses. 2004. K.G. Narayana Sri Kuldeep Sharma Pub.
2. Veterinary Virology. F.A. Murphy *et al.* 1999. 3rd Edition. Academic Press.
3. Medical Virology. 1994. 4th ed. D.O. White and F.Fenner. Academic Press. (chapters-12,13 to 29).
4. Veterinary Virology. 1993. 4th ed. F. Fenner. Academic Press (Part-II).
5. Text book of Human Virology, 2nd Edition. 1991. R.W. Belshe. Mosby yearbook.
6. Viral Infections of Humans: Epidemiology and control. 1989. 3rd Edition. A.S.Evans (ed). Plenum Medical Book Company.
7. Medical Microbiology.1997. Fifteenth edition. Edited by D.Green wood, R.C.Slack and J.F.Peutherer. Churchill Livingstone.
8. Medical microbiology.1995. 22nd Edition. G.F. Brooks, J.S.Butel and S.A. Morse. Lange Medical Books/Mc Graw-Hill.

9. Veterinary Epidemiology. 1986. M. Thrusfield. Butter Worth Publications.
10. Methods in Environmental Virology. 1982. C.P. Gerba and S.M. Goyal. Marcel Dekker Inc.
11. Viruses of vertebrates. 1989. J.S. Porter field, Bailliere Tindals.

VR-403: ANIMAL AND HUMAN VIRUSES AND DISEASES (IEC)

Note: Emphasis should be on etiology, transmission, clinical manifestations, diagnosis, prevention and control. Viral Diseases on the basis of genome and family.

UNIT-I

RNA Viruses:

Picornaviridae- Human Polio, Foot and Mouth disease. **Caliciviridae-** Norwalk virus, Swine Vesicular exanthema. **Coronaviridae-** Avian infectious bronchitis viruses. **Astroviridae-** Human astroviruses. **Coronaviridae-** Human corona viruses. **Togaviridae-** Rubella **Flaviviridae-** West Nile, Kyasanur forest disease, Dengue and Japanese encephalitis, Bovine viral diarrhoea, Hog cholera (classical swine fever). **Reoviridae-** Bovine rotavirus, Blue tongue, Orthoreovirus, African horse sickness.

UNIT-II

Orthomyxoviridae- Animal (swine, horse) influenza. **Paramyxoviridae-** Measles, Mumps, respiratory syncytial, Rinderpest, Canine distemper and Ranikhet disease viruses (Newcastle disease) **Rhabdoviridae-** Rabies, Vesicular stomatitis, Bovine ephemeral fever. **Filoviridae-** Marburg and Zaire Ebola viruses. **Bunyaviridae-** Hantaan, Rift Valley fever and Nairobi sheep disease viruses. **Arenaviridae-** Lymphocytic choriomeningitis virus. Retroviridae – HIV.

UNIT-III

DNA Viruses:

Circoviridae- Chicken anaemia virus. **Parvoviridae-** Feline panleukopenia, Canine and Procine parvoviruses. **Poxviridae-** Smallpox, Vaccinia, Sheepox, Goatpox and Fowlpox viruses. **Herpesviridae-** Human herpes viruses (Varicella-Zoster, Cytomegalovirus, Epstein-Barr and herpes simplex viruses), Infectious Bovine rhinotracheitis. **Papillomaviridae-** Bovine papilloma viruses. **Adenoviridae-** Human adenoviruses causing respiratory, ocular, genitourinary and enteric infections. Infectious canine hepatitis virus.

UNIT-IV

Hepadnaviridae - Hepatitis-B viruses. **Asfaviridae-** African swine fever virus. **Iridoviridae-** Invertebrate iridescent, Frog iridoviruses. **Polydnaviridae-** Ichnovirus, Bracovirus. **Polyomaviridae-** Polyomavirus. **Papillomaviridae-** Human papilloma viruses. **Parvoviridae-** B19.

Prion diseases : Scrapie of sheep and goat, Bovine spongiform encephalopathy (Mad cow disease). Kuru and CJD of humans

Suggested Books :

1. Clinical Virology. D.D. Richman *et al.*, 2nd Edition. 2002. ASM Press.
2. Bluetongue. - 2007. Gaya Prasad and Meenakshi Yashpal Singh Mallik. Sri Kuldeep Sharma Pub.
3. Epidemiology , diagnosis and Management of Zoonoses. 2004. K.G. Narayana Sri Kuldeep Sharma Pub.
4. Foot and mouth disease –A monograph.2003. S.C. Adhakhia Sri Kuldeep Sharma Pub.
5. Veterinary Virology. F.A. Murphy *et al.* 1999. 3rd Edition. Academic Press.
6. Principles of Virology- Molecular biology, pathogenesis and control. 2000. S.J.Flint, L.W.Enquist, R.M.Krug, V.R.Racaniello and A.M.Skalka. ASM press.
7. Veterinary Virology. 1993. 4th ed. F. Fenner. Academic Press (Part-II).
8. Medical Virology. 1994. 4th ed. D.O. White and F.Fenner. Academic Press. (chapters – 12,13 to 29).
9. Viral diseases of animal in India, 1994. S.N,Sharma and S.C. Adlakha, V.S. Bhatt Pub.
10. Text book of Human Virology, 2nd Edition. 1991. R.W. Belshe. Mosby yearbook.
11. Viral Infections of Humans: Epidemiology and control. 1989. 3rd Edition.
12. A.S.Evans (ed). Plenum Medical Book Company.
13. Medical microbiology.1997. Fifteenth edition. Edited by D.Green wood, R.C.Slack and J.F.Peutherer. Churchill Livingstone.
14. Medical microbiology.1995. 22nd Edition. G.F. Brooks, J.S.Butel and S.A. Morse. Lange Medical Brooks/Mc Graw-Hill.
15. Viruses of vertebrates. 1989. J.S. Porter field, Bailliere Tindals.
16. Encyclopedia of Virology. 1994. R.G. Webster and Allan Granoff. 9eds.) Vol. I, II, Academic Press

VR-404: TUMOR BIOLOGY AND VIROLOGY (IEC)

UNIT-I

Eukaryotic cell Biology: Principles of cell and organ culture techniques. Cell culture repositories. Storage and revival of cell cultures. Cell cycle and growth regulation, cyclins. Cell-to-cell signaling pathways and mechanisms. Intracellular signaling. Apoptosis.

UNIT-II

Tissue transformation and tumorigenesis: Plants-Induction of galls / tumors by *Agrobacterium* and viruses. **Animals-**Terminology, types of tumors. Experimental approaches to study transformation and tumorigenesis. Stages of transformation and tumorigenesis. Differences between normal and transformed cells. Control of cell proliferation.

Carcinogens and carcinogenesis : Physical, chemical and biological carcinogens. Screening of carcinogens. Molecular mechanisms of carcinogenesis.

Chromosome abnormalities in neoplasms: Translocation, amplification, deletion of oncogenes and consequences.

UNIT-III

Oncogenes: Cellular / proto oncogenes, viral oncogenes. Antioncogenes / tumor suppressor genes: discovery, Characterization and their role in tumor suppression. Gene products and their role in cell cycle and growth regulation.

RNA Viruses: Retroviruses implicated in causing tumors in animals and humans. Tracing of origin of retroviral oncogenes. Viral oncogene products and their role in tumorigenesis. Activation of expression of cellular genes by retroviruses. Viral genetic information in transformed cells.

Hepatitis-C virus associated with hepato cellular carcinoma.

UNIT-IV

DNA Viruses: Members of *Adeno-*, *Hepadna-*, *Herpes-*, *Papilloma-*, *Polyoma-* and *Poxviridae*. Transforming gene products and functions of adenoviruses, papillomaviruses and polyomaviruses.

Transformation by activation of cellular signal transduction pathways. Transformation via cell cycle control pathways. Other mechanisms of transformation and oncogenesis.

Tumor suppressor genes / antioncogenes: Discovery, characterization and their role in tumor suppression.

Tumor immunology: Cancer and the Immune system, tumor specific antigens, tumors of the immune system, immune responses to tumors, cancer immunotherapy.

Tumor therapy: Physical (radiation), chemical and immunotherapy. Angiogenesis and inhibitors of angiogenesis. Genetherapy.

Suggested books:

1. The Cell – A molecular approach. Fourth edition-2007. G. M. Cooper & R.E.Hausman. ASM Press.
2. Cell signaling. Second edition-2005. John T. Hancock. Oxford University press
3. The World of the Cell. 5th Edition. 2003. By Becker, Kleinsmith and Hardin. Pearson Education.
4. Culture of Animal Cells: A Manual of Basic Technique. 1987. R.I. Freshney. Alan R. Liss. Inc.
5. Fields Virology. 2001. 3rd Edition. Vol. 1, 2. B.N. Fields, D.M. Knipe, P.M. Howley.
6. Oncogenes. 1995. 2nd Edition. By G.M.Cooper. Jones and Bartlet publishers.
7. Principle of Virology: Molecular Biology, pathogenesis and control of animal viruses. 2004. By S.J. Flint *et al.*. ASM press.

VR-405: ANIMAL AND HUMAN VIROLOGY AND ANIMAL AND HUMAN VIRUS DISEASES

1. Classification of laboratories
2. Preparation of glassware for cell cultures
3. Preparation of buffers and media
4. Collection, filtration and preservation of calf serum
5. Cell culture preparation (Sheep kidney, Chicken embryo fibroblast-CEF)
6. Viral inoculation, CPE observation
7. Chicken embryo inoculation techniques
8. Quantal assay of viruses
9. Study of pathogenic lesions of animal virus diseases through slides
10. Isolation and analysis of human rotavirus genome
11. Participation in vaccination programs

Suggested books / manuals:

1. Diagnostic Microbiology. 11th Edition. 2002. By B.A. Forbes et al., Mosby publisher.
2. Culture of Animal Cells : A Manual of Basic Technique. 1987. R.I. Freshney. Alan R. Liss. Inc.
3. Virology - A Practical Approach. 1985. D.W.J. Mahy. IRL Press.
4. Virology - A Laboratory Manual. 1992. F.G. Gurlerson et al., Academic Press, Inc.
5. Molecular : A Practical Approach. 1993. Edited by A. J. Davson and R.M. Elliott. IRL Press.

VR-406 : APPLIED VIROLOGY AND TUMOR BIOLOGY AND VIROLOGY

- 1 Collection, processing and preservation of clinical samples for diagnosis
- 2 Sero-survey of local animal / human virus diseases.
- 3 Diagnosis of HIV, Hepatitis-B using kits
- 4 Survey of local poultry, Fish farms for viral infections
- 5 Detection of viruses by PCR
- 6 Certification of plant materials for viruses by antibody based techniques
- 7 Production of virus-free plants by meristem tip culture technique
- 8 Isolation and culturing of insect baculoviruses
- 9 Observation and enumeration of NPV polyhedra.
- 10 Testing of crop pests for their susceptibility to NPV
- 11 Isolation of bacteriophages specific to enteric bacteria

Suggested books / manuals:

1. Diagnostic Microbiology. 11th Edition. 2002. By B.A. Forbes et al., Mosby publisher.
2. Culture of Animal Cells : A Manual of Basic Technique. 1987. R.I. Freshney. Alan R. Liss. Inc.
3. Virology - A Practical Approach. 1985. D.W.J. Mahy. IRL Press.
4. Virology - A Laboratory Manual. 1992. F.G. Gurlerson et al., Academic Press, Inc.
5. Molecular : A Practical Approach. 1993. Edited by A. J. Davson and R.M. Elliott. IRL Press.

VR-407 : FUNDAMENTALS OF VIROLOGY (EEC, TO THE STUDENTS OF OTHER DEPARTMENTS)

UNIT-I

Brief history of virology and the impact of viruses on society. Origin and evolution of viruses. Isolation, cultivation / propagation and assay of viruses. Purification of viruses - different approaches

UNIT-II

Virus properties : Biological, physical, chemical, antigenic and molecular properties. Nomenclature and classification of viruses. Detection / diagnosis of viruses-different approaches.

UNIT-III

The interaction between viruses and their hosts-cell, tissue and organism levels. Virus offense and host defense mechanisms. Types of infections. viral pathogenesis-stages of interaction.

Virus replication: Outlines of the virus replication cycles. Replication of lambda, øX-174, ribophages, TMV, CaMV, Poliovirus, influenzavirus, rabies virus, SV-40, poxvirus, retrovirus, geminivirus.

UNIT-IV

Virus diseases:

Plants – tomato leaf curl, papaya ring spot, Mung bean yellow mosaic, sugar cane mosaic, Groundnut bud necrosis, Okra yellow vein. **Animals**- Foot and mouth disease, sheep blue tongue, Avian flu, Gombora, Prawn white spot, NPV. **Humans**- HIV/AIDS, HBV, poliovirus, rabies, Dengue, Japanese encephalitis, Chikungunya, SARS, human rotavirus.

Sub-viral agents : Viroids, satellite viruses, satRNAs / DNAs, DI-particles, prions.

Viruses and Future – Promises and Problems: Sources and causes of emergent virus diseases. Applications of viruses–molecular model systems in Biology, therapeutic agents, biocontrol agents, molecular vectors, enzymes, display of foreign peptides on virion surface.

References:

1. Principles of Virology : Molecular Biology, Pathogenesis and control of animal viruses. 2004. by S.J. Flint et al., ASM Press.
2. Basic Virology by E.K.Wagner and M.J.Hewlett. Blackwell Science,Inc.
3. Fundamental Virology by B.N. Fields and Knipe, D.M. (eds). Raven press.
4. Virology by Levy, J.A; Fraenkelconrat, H and Owens, R.A. Printicea Hall Publ.
5. Principles of Molecular Virology by A.J. Cann. Academic pres.
6. Introduction to Modern Virology by Dimmock, N.J. and Primrose, S.B. Blackwell Science; Inc

VR-408: BIOLOGY OF VIRUSES OF MICROORGANISMS (SSC)

UNIT-I

Viruses of prokaryotes: Bacteriophages- Discovery, isolation, propagation and assay of bacteriophages. Purification and characterization. Nomenclature and classification of bacteriophages. Importance / applications of bacteriophages in biology, agriculture, industry and medicine.

Biology of bacteriophages of enterobacteria (dsDNA phages – T₂, T₄, T₇, lambda, Mu, P₁, P₂₂, PRD. ssDNA phages – øx-174, M₁₃, f₁, fd. ssRNA phages-MS₂, f₂, Qβ, R₁₇)

UNIT-II

Biology of representative widely occurring phages: Phages of *Bacillus*, *Lactobacillus*, *Lactococcus*, *Listeria*, *Staphylococcus*, *Streptococcus*, *Vibrio*, *Clostridium*, *Mycobacterium*, *Coryniform*, *Actinomycetes*, *Pseudomonas*, *Xanthomonas* and *Rhizobium*.

Phages of cyanobacteria: *Podoviridae* – A-4(L), Ac-1, LPP-1, SM-1, *Myoviridae*-AS-1, N1, S-6(L), *Siphoviridae*-S-2L, S-4L

Phages of mycoplasmas: Properties of *Plasmavirus*, *Plectovirus*, *Spiromicroviru* genera.

Phages of Archaea: ψ M1-like viruses, *Lipothrixvirus*, *Rudivurs*, *Fusellovirus*, *Sulfolobus* and SNDV-like viruses.

UNIT-III

Viruses of eukaryotic microorganisms: Fungal viruses: Discovery, isolation, propagation, titration, purification and characterisation of. Nomenclature and classification of viruses. Importance / applications of fungal viruses in biology.

Viruses of yeasts: *Sacchromyces cerevisiae* -*Totiviridae*: ScV-L-A, ScV-L-B6, *Narnaviridae*: ScNV-20S, ScNV-23S. *Pseudoviridae*: SceTY1V, SceTY2V, SceTY3V, *Metaviridae*: SceTY3V, *Schizosaccharomyces pombe* viruses .

UNIT-IV

Viruses of higher fungi: *Penicillium* spp.- *P. chrysogenum* virus (PcV), *P. stolanigerum* (PsV).

Aspergillus spp.- *A. foetidus* (AfV), *A. niger* virus S (AnV-S), *A. ochraceus* virus (AoV).

Viruses of *Gaeumnomyces graminis*, *Rhizoctonia solani*, *Ustilago*, *Agaricus* and *Helminthosporium*.

Algal viruses: Isolation, characterization and properties of *Phycodnaviruses* and their importance.

Biology of protozoan viruses: dsRNA: *Giardia* virus, *Leishmania* virus, *Amoeba* virus.

Suggested books:

1. Bacteriophages. H.W. Auckerman. 2004. In: The desk top encyclopedia of microbiology. Schaechter.M. (ed). Elsevier, Academic Press.
2. Phycodnaviridae-Large DNA algal viruses. 2002. By Van Etten et al.. Archives of Virology. 147: 1479-1516.
3. Virus Taxonomy: Classification and Nomenclature. (Seventh report of ICTV).2000. By M.H.V. Van Regenmortel *et al.*, (Eds) Academic Press.
4. Encyclopedia of Virology. 1999. 2nd Edition. Vol. 1, 2, 3. Webster, R.G. and Granoff, A. (Eds). Academic Press.
5. Wilson, D.R. and Finley, B.B. 1998. Phage Display: Applications, innovations and issues in phage and host biology. Canadian J. Microbiol. 44: 313-329.
6. Viruses of Protozoa. 1991. By T.C. White and C.C. Wang. Ann. Rev. Microb. 45: 251-263.
7. The Bacteriophages. 1988. Vol.1, 2. By Calender, R. (Ed).
8. Viruses of Fungi and Simple Eukaryotes. 1988. By. Y. Koltin and M. Leibowitz. Mareed Dekker.
9. Viruses of prokaryotes. Vol. 1 and 2. 1987. Auckermann. H.W. and Du Bow, M.S. CRC press.
10. Fungal Virology. 1986. By Buck, K.W. (Ed). CRC Press.

VR-409 :BIOLOGY OF VIRUS VECTORS AND THEIR MANAGEMENT (SSC)

UNIT-I

Introduction to general entomology: Insect morphology and classification. Arthropod and other insects of virus vector importance, their structures and functions. Methods for arthropod vector collection, preservation / maintenance and transportation.

Identification of major groups of arthropod vectors - Molecular approaches for identification of vector species.

Arboviruses of animals and humans: Flaviviruses, Togaviruses, Bunyaviruses, Reoviruses, Rhabdoviruses.

UNIT-II

Biology and ecology of mosquitoes: Biology and life history of *Aedes*, *Culex* and *Anopheles* – their behavior and ecology with special reference to dengue, chikungunya, Japanese encephalitis, equine encephalitis and west Nile.

Biology and ecology of other blood sucking insects (Ticks): Biology, morphology and disease relationships of sandflies (Crimean-Congo hemorrhagic fever, sandfly fever and chandipura).

Biology and morphology of fleas, lice and culicoides (blue tongue virus, African horse sickness virus).

Biology, ecology and life history of ticks with special reference to Kyasanur forest disease.

Prevention and management of animal and human virus vectors in urban and rural settings: Physical, chemical, biological and other approaches.

UNIT-III

Plant virus vectors

Arthropods and mites: Collection and identification of aphids, leaf and plant hoppers, whiteflies, thrips, beetles, mealybugs, and mites. Monitoring of these different groups of vectors. Culturing of insect vectors for transmission studies. Virus-vector transmission mechanisms – non-circulative (nonpersistent, semipersistent, bimodal), circulative (propagative and nonpropagative). Experimental transmission of plant viruses by insect and mite vectors. Effects of viruses on vectors.

UNIT-IV

Fungal and nematode vectors: Collection and identification of these vectors. Mechanisms of transmission of viruses by fungi (*Ospidium*, *Polymyxa* and *Spongospora*) and nematodes (*Longidorids* and *trichodorids*). Experimental transmission of plant viruses by fungal and nematode vectors.

Epidemiology of vector-borne viruses: Impact of climatic factors (temperature, rainfall, humidity, wind speed and direction), soil factors and cropping practices.

Management of plant virus vectors: Physical, chemical, biological and other approaches.

Vector resistant crops: Natural and transgenic resistance.

Suggested books:

1. Zoonoses: Infectious diseases transmissible from animals to humans. 3rd Edition. 2003. H. Krauss *et al.* ASM Press.
2. Matthews' Plant Virology. 2001. By R. Hull. Academic Press.
3. Service MW (1996) Medical entomology for students. Chapman and Hall
4. Kettle DS (1984) Medical and veterinary entomology CAB international
5. Richard and Davies Imm's general Text book of Entomology. Vol I & II.. Chapman and Hall.
6. Control of Plant Virus Diseases. By Hadidi *et al.*(Eds). APS. USA.

