

SRI VENKATESWARA UNIVERSITY COLLEGE OF SCIENCES

TIRUPATI - 517 502

DEPARTMENT OF VIROLOGY



Two-Year M.Sc., Virology Program

**Semester Pattern Syllabus (Choice Based Credit
System) 2021-22 onwards**



Sri Venkateswara University Department of Virology

Program code	Program Name	Name of the Department
VIR	M. Sc. Virology	Dept. of Virology

Vision:

To serve as a “centre for academic excellence” by assuring systematic and focussed teaching and research in the frontier areas of Virology and to provide a conducive environment to the students for learning and quality training to promote professional development and individual well-being.

Mission:

1. Providing quality post graduate education of high standards in Virology and achieving excellence in teaching and research.
2. Introducing students to basic and advanced concepts/technologies/methods related to identification, characterization, detection and management of economically important, emerging and reemerging viruses infecting microbes, plants, animals and humans along with wide practical frameworks that can provide quality training of international standards and employability opportunities.
3. Pursuing cutting edge research in the key areas of Virology and microbiological sciences through sponsored research projects.
4. Establishing national/international collaborations with premier research institutes/universities for advancing scientific knowledge in contemporary areas of Virology and interdisciplinary areas of life sciences.
5. Preparing students to have qualities such as honesty, integrity, carefulness, courage, resilience, self-discipline, openness, innovative thinking and determination to keep going forward, which make them ethically strong and to contribute to the betterment of society and human kind.

About the Program

The unique M.Sc. Program of Virology at Sri Venkateswara University College of Sciences (SVUCS), Tirupati started in 1987, is committed to achieve excellence in education, research, and extension through systematic and focused teaching and hands-on-practical training in contemporary areas of Virology. The program brings together a variety of researchers as faculty members, who made significant contributions in their specializations and are working together for a common goal of identification, characterization, diagnosis, and management of viruses. The program is strengthened by various research projects, sophisticated instrumentation to conduct advanced research and periodical update of the curriculum. The platform aims at equipping the students with necessary scientific skills for Virology related careers, in research, industry and higher education sectors. The students in this program acquire wide knowledge, critical thinking skills and experience in conducting advanced strategic research and entrepreneurship in core Virology and other major interdisciplinary areas. The curriculum of M.Sc. Virology program is developed keeping in view of the student centric learning practices, which are entirely outcome-oriented and curiosity-driven. Emphasis will be given to train students in theoretical concepts and practical hands-on experience to face the challenges that are recurrent in the field of Virology and to foster employability, responsibility, and lifelong learning, which is the need of the hour to make India's emergence as a global leader in innovation and manufacturing of pharma and biotech products.

The M.Sc. Virology program curriculum framework focuses on pragmatist approach where the applications of theoretical concepts are taught with substantial coverage of practical and field-based studies. The curriculum is designed to educate the students with the basic and advanced concepts of Virology and other major interdisciplinary disciplines by using modern pedagogical tools and concepts such as e-learning platforms, as well as to promote and develop skills and competencies that have enduring value beyond the classroom. While designing these frameworks, emphasis is given on the objectively measurable teaching-learning outcomes to ensure employability of the students. The M. Sc Virology program has two academic years with four semesters. The first semester of the program covers the fundamental concepts of two core courses such as Biological Chemistry, Analytical Techniques and General Microbiology as a compulsory foundation and General Virology as elective foundation along with an audit course of Human and Professional Ethics Part-I (self-study). In the second semester, the students will explore the basic and advanced concepts of Cell Biology and Tissue Culture and Microbial Genetics and Molecular Biology as core subjects and Recombinant DNA Technology as a foundation course and Immunology as elective foundation along with an audit course of Human and Professional Ethics Part-II

(self-study). The theoretical and practical knowledge acquired in the basic and advanced aspects of interdisciplinary courses will help the students to understand the various aspects of viruses in the third and fourth semesters. In the third semester students will have to cover the courses such as Plant Virology and Plant Virus Diseases as core courses and Molecular Virology or Tumor Virology as Generic electives and Medical Lab Technology as skill development course with which students will have a basic understanding of the requirements and tests that are of medical diagnostic importance. Apart from this, Communicative English and Computer Applications in introduced as skill enhancement add-on course (self-study) to improve communicative skills of students and ability to use the computers for academic and research purposes. The forth semester covers courses such as Animal and Human Virology, Animal and Human Virus Diseases as core subjects and Applied Virology or Virus-based Biotechnology as Generic Electives and project work related to Virology or Industrial Biotechnology as Multidisciplinary course, where student can choose either of this as per their interest. Apart from these courses, students will get an opportunity to select one of the open elective courses of other programs offered by different Departments in the University in the third and fourth semesters and the M. Sc Virology program offers Veterinary and agricultural Viruses and their management or Emerging Infectious Virus Diseases in the third semester and Human Virus Diseases or Clinical Virology in the fourth semester as open electives to the students of other programs of various departments. Apart from these subjects, teaching and research aptitude has been introduced as add-on course in the 4th semester. Guest lectures and special invited lectures will be arranged for all the non-credited self-study add-on courses. The pragmatic core of the framework has been designed such a way to enable the learners implementing the concepts to address the real-world problems. Above all, this framework is aimed to mold master graduates to acquire critical thinking, scientific reasoning, moral ethical reasoning qualification descriptors that are specific outcomes pertinent to the discipline and as responsible Indian citizens who have adequate knowledge and skills in reflective thinking, rational skepticism, scientific temper, digital literacy to contribute for betterment of the society and mankind. Students will be encouraged to participate in seminars, webinars, training workshops, conferences and quiz/elocution/essay writing/sports competitions. Time to time, seminars, conferences and training workshops will be organized by the faculty members in the contemporary areas of Virology. Alumni will be visiting the Department whenever it is possible for them and give lectures to motivate the students. Lectures will be arranged with the experts whoever visits the Dept. at various occasions to enlighten students.



S.V. UNIVERSITY, TIRUPATI:: SVU COLLEGE OF SCIENCES
CBCS Pattern (With effect from 2021-2022)
M.Sc.. VIROLOGY

SEMESTER-I

Sl. No.	Components of Study	Course Code	Title of the Course	Credit hours /week	No. of Credits	IA Marks	Sem End Exam Marks	Total
1	Core-Theory	VIR-101	Biological Chemistry	6	4	20	80	100
2	Core-Theory	VIR-102	Analytical Techniques	6	4	20	80	100
3	Compulsory Foundation	VIR-103	General Microbiology	6	4	20	80	100
4	Elective Foundation	VIR-104	General Virology	6	4	20	80	100
5	Practical-I	VR-105	Biological Chemistry and Analytical Techniques	6	4	-	100	100
6	Practical-II	VIR-106	General Microbiology and General Virology	6	4	-	100	100
Total				36	24	80	520	600
7	Audit Course** (Self-Study)	VIR-107	Human and Professional Ethics-I	0	-	100	-	0

****The marks of audit course is not included for overall grade**

SEMESTER-II

Sl. No.	Component s of Study	Cours e Code	Title of the Course	Credi t hours / week	No. of Credit s	IA Mark s	Sem End Exam Mark s	Tota l
1	Core-Theory	VIR-201	Cell Biology & Tissue Culture	6	4	20	80	100
2	Core-Theory	VIR-202	Microbial Genetics & Molecular Biology	6	4	20	80	100
3	Compulsor y Foundation	VIR-203	Recombinant DNA Technology	6	4	20	80	100
4	Elective Foundatio n	VIR-204	Immunology	6	4	20	80	100
5	Practical-I	VIR-205	Cell Biology & Tissue culture and Microbial Genetics & Molecular Biology	6	4	-	100	100
6	Practical-II	VIR-206	Recombinant DNA Technology and Immunology	6	4	-	100	100
Total				36	24	80	520	600
7	Audit Course** (Self-Study)	VIR-207	Human and Professional Ethics-II	0	-	100	-	-

****The marks of audit course are not included for overall grade.**

SEMESTER-III

	Component s of Study	Cours e Code	Title of the Course	Credi t hours / week	No. of Credi t s	IA Ma r ks	Sem End Exa m Marks	Total
1	Core-Theory	VIR-301	Plant Virology	6	4	20	80	100
2	Core-Theory	VIR-302	Plant Virus Diseases	6	4	20	80	100
3	Generic Elective *	VIR-303	A) Molecular Virology B) Tumor Virology	6	4	20	80	100
4	Practical*	VIR-304	A) Plant Virology & Virus Diseases and Molecular Virology B) Plant Virology & Virus Diseases and Tumor Virology	6	4	-	100	100
5	Skill Oriented Course	VIR-305	Medical Lab Technology A) Theory B) Practical	6	4	10	90 (40 Theory + 50 Practica l)	100
6	Open Elective *	VIR-306	A) Veterinary &Agricultural Viruses and their Management B) Emerging Infectious Virus Diseases	6	4	20	80	100
Total				36	24	90	510	600
7	Skill enhanceme nt Add-on Course** (Self-Study)	VIR-307	Communicative English and Fundamentals of Computers	-	-	100	-	-

***Among the electives, the student shall choose one followed by the relevant practical. Open Elective: Courses offered to students of others disciplines. Minimum strength to offer the open elective course is 10 students.**

****The marks of Add-on courses are not included for overall grade.**

SEMESTER-IV

	Course Code	Components of Study	Title of the Course	Credit hours / week	No. of Credits	IA Marks	Sem End Exam Marks	Total
1	Core-Theory	VIR - 401	Animal and Human Virology	6	4	20	80	100
2	Core-Theory	VIR-402	Animal and Human Virus Diseases	6	4	20	80	100
3	Generic Elective *	VIR - 403	A) Applied Virology B) Virus-based Biotechnology	6	4	20	80	100
4	Practical*	VIR - 404	A) Animal and Human Virology & Virus Diseases and Applied Virology B) Animal and Human Virology & Virus Diseases and Virus-based Biotechnology	6	4	-	100	100
5	Multidisciplinary subject***/Project work***	VIR - 405	A) Industrial Biotechnology B) Project Work related to Virology	6	4	-	100	100
6	Open Elective* (For other departments)	VIR - 406	A) Human Virus Diseases B) Clinical Virology	6	4	20	80	100
Total				36	24	80	36	600
7	Skill Enhancement Add-on Course** (Self-Study)	VIR-407	Teaching and Research Aptitude	-	-	100	-	-

***Among the electives, the student shall choose one followed by the relevant practical.**

Open Elective: Courses offered to students of others disciplines. Minimum strength to offer the open elective course is 10 students.

****The marks of Add-on courses are not included for overall grade.**

*****Individual student can choose either project work or multidisciplinary course based on their interest.**

M.Sc. VIROLOGY
(With Effect from 2021-2022 onwards)

SEMESTER-I

VIR-101: BIOLOGICAL CHEMISTRY
(Core Theory-I)

Lecture: 6 hours/week	Internal test Assessment: 20 Marks Seminars and assignments
Tutorial: Textbooks, E-learning resources, study materials, PowerPoint lectures	Semester End Examination: 80 Marks
Semester: I	Credits: 4 Credits

UNIT-I

An overview on basic concepts of Chemistry of life: The major elements and biomolecules of life and their primary characteristics; bonding properties of carbon, stabilizing forces of biomolecules-atomic bonds, covalent and non-covalent bonds, Van der Waals forces; polarity, hydrophilic and hydrophobic interactions; electron transfer and oxidation/reduction; functional groups of organic compounds; hydrogen ion concentration of biological systems, concept of buffers, normal, Molar solutions and physiological buffer systems.

Carbohydrates: Classification, structure, properties and functions of carbohydrates and their identification and analysis.

Lipids: Classification, structure, physico-chemical properties and functions of lipids.

UNIT-II

Amino acids: Classification, structure and physicochemical properties.

Peptides: Characteristics of peptide bond, properties and functions of peptides, determination of amino acid composition and sequence in peptides.

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

Catalytic proteins (enzymes): Classification, nomenclature, composition and structures, enzymes as biocatalysts, outlines of purification and assay of enzymes; Enzyme kinetics-Michaelis-Menten equation, factors influencing enzyme catalyzed reactions, regulation of enzyme activity, activators and inhibitors; mechanism of action of enzymes (e.g., chymotrypsin); regulatory enzymes, allosteric enzymes, isoenzymes, coenzymes, ribozymes, abzymes, immobilized enzymes.

UNIT- III

Nucleic acids: Types and composition of nucleic acids, structure, properties and functions of nitrogenous bases, nucleosides, nucleotides and polynucleotides; functions of nucleotides; denaturation and renaturation of nucleic acids, factors influencing hybridization, cot values.

Hormones and Growth regulators: Introduction to hormones and growth regulators and their functions.

Vitamins: Classification (fat soluble and water soluble), sources and importance of vitamins.

Bioenergetics: Thermodynamic principles in biology, free energy, ATP cycle, pH and buffers, acids and bases, energy transducers, redox potentials, free energy changes in redox reactions.

UNIT- IV

Carbohydrate metabolism: ATP biosynthesis (Glycolysis, TCA and ETC).

Lipid metabolism: Overview of lipid metabolism (synthesis and degradation of triacylglycerides); Oxidation of saturated and unsaturated fatty acids

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

Nucleotide metabolism: Biosynthesis of bases, nucleosides and nucleotides including deoxyribonucleotides, regulation of nucleotide synthesis; exo- and endonucleases (RNases and DNases) and phosphodiesterases

Learning Resources and Suggested Books:

1. Medical Biochemistry, (2018) John W Baynes, Marek H. Dominiczak, Hab Med FRCPath, 5th Edition, 712 pages, Publisher: Elsevier.
2. Biochemistry (2017) by Roger L. Miesfeld, Megan M. McEvoy (First Edition) , Publisher: W. W. Norton & Company.
3. Marks' Basic Medical Biochemistry, A Clinical Approach, (2017) Michael Lieberman, Alisa Peet MD, Publisher: LWW; Fifth, North American edition.
4. Fundamentals of Biochemistry: Life at the Molecular Level. (2016) Donald Voet, J. G. Voet et al.
5. Biochemistry, (2001) Stryer 5th edition, W.H. Freeman,
6. Principles of Biochemistry, (2000) Lehninger, 3rd edition by Nelson and Cox (Worth).
7. NMS Biochemistry 4th edition (1999) Victor L. Davidson and Donald B Sittman.
8. Microbial Physiology (1999), 3rd ed. by A.G. Moat & J.W. Foster, Wiley- Liss.

9. Microbial Physiology and Metabolism. (1995), by D.R. Caldwell. W.M.C. Brown Publ.
10. Physical Biochemistry: Applications to Biochemistry and Molecular Biology (1982), 2nd ed. by David Freifelder. W.H. Freeman and Company.
11. Schaum's Outline of Biochemistry, Philip Kuchel, Simon Easterbrook-Smith, Vanessa Gysbers, Third Edition (Schaum's Outlines) 3rd Edition.
12. Review of Physiological Chemistry (Latest edition) by Harold A. Harper. Lange Medical

VIR-102: ANALYTICAL TECHNIQUES (Core Theory-II)

Lecture: 6 hours/week	Internal test Assessment: 20 Marks
Tutorial: Textbooks, E-learning resources, study materials, PowerPoint lectures	Semester End Examination: 80 Marks
Semester: I	Credits: 4 Credits

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 and diafiltration (tangential flow filtration using membrane cut-offs), membrane filtration and their applications.

Microscopy- Principles, methods and applications of light, bright-field, dark-field, phase-contrast, fluorescent microscopes; Principles, methods and applications of scanning electron microscope (SEM) and transmission electron microscope (TEM); Specimen preparation, fixation and staining techniques for bright field and electron microscopes and microtomy.

UNIT-II

Chromatography: Principle, theory and applications of partition (paper chromatography), adsorption (TLC), column (ion-exchange, gel permeation, affinity); Principle and applications of GLC, HPLC, FPLC, GC/LC-MS, MALDI-TOF.

Centrifugation: Theory and applications of preparative and analytical centrifugation and rotors (differential, rate zonal and equilibrium density gradient), sedimentation analysis; isolation of cells, sub-cellular organelles, viruses and macromolecules.

Electrophoresis: Principle, theory and applications of electrophoresis- paper, gel (starch, acrylamide and agarose), vertical, horizontal submarine, gradient, 2D-PAGE, pulse-field, capillary and isoelectric focusing; isolation, blotting techniques (southern, northern and western blotting) and their applications.

UNIT- III

Radioisotope techniques: Nature and types of radioactivity, half-life of radioisotopes, detection and measurement of different types of radioisotopes normally used in biology, incorporation of radioisotopes in biological tissues and cells, autoradiography, molecular imaging of radioactive material, biological effects and applications of radioisotopes, safety guidelines in handling isotopes.

Spectroscopy: Properties of light (absorption, transmission, refraction, reflection, phase formation, scattering, interference), Beers- Lambert law; Principle, instrumentation and theory and applications of UV-visible, IR, ESR, mass, MALDI, NMR spectrophotometry; fluorimetry, CD; X-ray diffraction, X-ray crystallography, surface plasmon resonance.

Cell counting: Detection of molecules in living cells, in situ localization (FISH), hemocytometer, cell viability and cytotoxicity; immunofluorescence, flow cytometry, MTT based assays.

UNIT-IV

Introduction: Definition and scope of Biostatistics, statistical diagrams and graphs.

Measures of central tendency: arithmetic mean, median and mode.

Measures of dispersion: standard deviation, variance and coefficient of variation.

Analysis: Introduction to correlation analysis and regression analysis.

Probability and probability distribution: Binomial, Poisson and normal distributions.

Tests of significance: Applications of t-test, F-test, analysis of variance (ANOVA), χ^2 test.

Learning Recourses and Suggested books:

1. Biomolecular Thermodynamics: From Theory to Application (Foundations of Biochemistry and Biophysics) (2017) 1st Edition, Publisher: CRC Press.
2. Study Guide with Student Solutions Manual and Problems Book for Garrett/Grisham's Biochemistry (2016) Reginald H. Garrett , Charles M. Grisham 6th Edition, Publisher: Cengage Learning.
3. Biochemical Calculations: How to solve Mathematical Problems in General Biochemistry(2010) Irwin H. Segel International Edition Paperback – 1910, 2nd edition, Publisher: Wiley India Private Limited.
4. Analytical techniques in Biochemical and biophysics for macromolecules (2009) Avinash Upadhyay, Nirmalanedu Upadhyay and Nath.
5. Discovering Statistics Using SPSS. Andy Field. Latest edition (2005). Publisher: SAGE Publications.
6. Basic and Clinical Biostatistics. Beth Dawson, Robert G. Trapp, Robert Trapp. Latest edition. (2004).
7. Jerrold H.Zar. (2010). Bio-Statistical Analysis. 5th edition, New Jersey, Prentice Hall.
8. Gupta, S.C. (2010). Fundamentals of Statistics. Himalayan Publishers

9. Arora, P.N. Sumeet Arora & S. Arora (2007). Comprehensive Statistical Methods. S. Chand & Company, New Delhi.
10. Misra, B.N. & M.K. Misra (1998). Introductory Practical Biostatistics. Naya Prakash, Kolkata

VIR-103: GENERAL MICROBIOLOGY
(Compulsory Foundation related to subject)

Lecture: 6 hours/week	Internal test Assessment: 20 Marks
	Seminars and assignments
Tutorial: Textbooks, E-learning resources, study materials, PowerPoint lectures	Semester End Examination: 80 Marks
Semester: I	Credits: 4 Credits

UNIT – I

Fundamentals of microbiology: Origin and evolution of microorganisms, Pioneers in microbiology, different groups of microorganisms, Importance of microorganisms in plants, animal and human welfare; recent trends and development in modern microbiology.

Microbial taxonomy: General criteria for microbial classification- Hackel's three kingdom concept - Whittaker's five kingdom concept - three domain concept of Carl Woese, Outline of Bergey's manual and its importance in systematic bacteriology; General characteristics of Archaea, evolutionary significance; general characteristics of Spirochetes, Rickettsias.

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, endospores, bacterial cell division.

UNIT-II

Microbiological media and isolation of microorganisms: Types of media- natural and synthetic; basal, defined, complex, enrichment, selective, differential, maintenance and transport media; Isolation /enumeration methods from different natural samples (streak plate, pour plate, spread plate, stab culture, slant culture and hanging drop methods); pure cultures techniques for microorganisms.

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 (lyophilization), and revival of microbial cultures.

UNIT-III

Microbial nutrition: Microbial nutrient requirements – macro-nutrients, micro-elements, growth factors, sources of nutrients, nutritional classification of bacteria - Phototroph, Chemotroph, Autotroph (lithotroph), Heterotroph (organotroph), Photoautotroph, Photoheterotroph, Chemoautotroph, Chemoheterotroph, nutritional patterns of pathogens – Saprophytes, Auxotroph.

Control of Microorganisms: Sterilization by physical and chemical agents-heat, radiation, pH, surface tension, osmotic pressure, filters, acids, bases, alcohols, aldehydes, ketones, phenols, soaps, antimicrobial agents, antibiotics-classification, mode of action and resistance.

UNIT-IV

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

Actinomycetes: General characteristics, structure and economic importance of actinomycetes.

Algae: General characteristics, structure and economic importance of algae -*Chlorella*, Cyanobacteria and *Gracellaria*.

Protozoan parasites: General characteristics, structure of pathogenic protozoan parasites-*Entamoeba* and *Leishmania*.

Microbial Diseases and Host pathogen interaction: Normal microbiota, reservoirs of infections; Nosocomial infections, emerging infectious diseases, human diseases caused by bacteria, fungi, protozoa, parasitic helminths of clinical importance (e.g., TB, Aspergillosis, Malaria, filariasis).

Learning Resources and Suggested Books:

1. Brock Biology of Microorganisms 16th Edition (2020) Madigan MT, Martinko JM, Dunlap PV, Clark DP Prentice Hall publisher USA.
2. *Foundations in Microbiology*, (10th Edition) (2018) Kathleen Park Talaro and Barry Chess, Tata McGraw, India.
3. Microbiology, 10th Edition (2017) Lansing M Prescott, Donald A Klein, John P Harley, Mc Graw Hill publisher.
4. Microbiology and Parasitology (2016) B. S. Nagoba, Elsevier Health Sciences.
5. Textbook of Microbiology (2016) R. Ananthanarayan, Orient Blackman publications.
6. Textbook of Microbiology, (2013) Dubey RC, Maheswari DK S. Chand & Co.
7. Microbiology, 8th Edition International Student Version Jacquelyn G. Black (Marymount University) (2012), Wiley publication.

8. Understanding Microbes: An Introduction to a Small World Jeremy W. Dale (2012), Wiley-Blackwell.
9. Microbiology, 7th Edition (2009) Michael J Pelczar, Microbiology, Tata McGraw, India.
10. Advances in Applied Microbiology. (2007) Wayne W. Umbreit and D. Pearlman. Academic Press
11. Molecular Microbiology: Diagnostic Principles and Practice (2004) Persing DH, Tenover FC, Versalovic J, eds. American Society for Microbiology Press,
12. Microbial Physiology 4th Edition (2002) John W. Foster Michael P. Spector John Wiley & Sons, Inc.
13. Advances in Microbial Physiology (2002) A.H. Rose. Academic Press, New York.
14. Microbial Physiology and Metabolism (1995) Caldwell D.R. Brown Publishers.

VIR-104: GENERAL VIROLOGY (Elective Foundation)

Lecture: 6 hours/week	Internal test Assessment: 20 Marks Seminars and assignments
Tutorial: Textbooks, E-learning resources, study materials, PowerPoint lectures	Semester End Examination: 80 Marks
Semester: I	Credits: 4 Credits

UNIT-I

History: History, origin and evolution of viruses, pioneers of Virology.

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

Morphology and properties of viruses: Physical- morphology and structure, sedimentation, electrophoretic mobility, buoyant density; Biochemical- chemical composition, nucleic acids, proteins, enzymes, lipids, carbohydrates, polyamines, cations, virus stability; Biological- Host range, inclusion bodies and transmission.

Transmission of viruses: Non-vector and vector mode of transmission of viruses.

UNIT-II

Isolation, cultivation and maintenance of viruses: Isolation and cultivation of plant and animal viruses (experimental plants and tissue culture, experimental animals, embryonated eggs, organ cultures, primary and secondary cell cultures, suspension and monolayer cell cultures, cell strains, cell lines).

Purification of viruses: Extraction of viruses from tissues, clarification, and 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

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

Major characteristics of the following virus families: *Adenoviridae, Bromoviridae, Bunyaviridae, Caulimoviridae, Flaviviridae, Geminiviridae, Hepadnaviridae, Herpesviridae, Orthomyxoviridae, Paramyxoviridae, Parvoviridae, Picornaviridae, Potyviridae, Poxviridae, Reoviridae, Retroviridae, Rhabdoviridae, Virgaviridae.*

UNIT-IV

Bacteriophages: Biology of major RNA (MS2, Q β) and DNA (T4, lambda, ϕ x174, M13) bacteriophages, replication of M13, T4 and lambda phages; biology of cyanophages.

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

Biology of sub-viral agents: Satellite viruses, sat-RNAs, DI particles, viroids, virusoids and prions.

Learning Resources and Suggested Books:

1. Evidence-Based Diagnosis: An Introduction to Clinical Epidemiology 2nd Edition, by Thomas B. Newman, Michael A. Kohn (2020). 2 edition, Publisher: Cambridge University Press.
2. Virusphere: From Common Colds to Ebola Epidemics--Why We Need the Viruses That Plague Us (2020). 1st edition, Frank Ryan (Author), Publisher: Prometheus.
3. Guide to Clinical and Diagnostic Virology (2019), (ASM Books) 1st Edition, by Reeti Khare, Publisher: ASM Press.
4. Virology (2019), P. Saravanan.
5. Recent Advances in Animal Virology (2019) 1st Edition, Kindle Edition, by Yashpal Singh Malik, Raj Kumar Singh, Mahendra Pal Yadav, 471 pages, Publisher: Springer
6. Virology (2017) Ren Warom, Titan Books.
7. Virus: An Illustrated Guide to 101 Incredible Microbes (2016), 1st Edition (ASM Books) Fourth Edition, by Marilyn J. Roossinck, Carl Zimmer, Publisher: Princeton University Press.
8. A Planet of Viruses: (2015) 2nd ed, by Carl Zimmer (2015) University of Chicago Press.
9. Schaechter's Mechanisms of Microbial Disease (2012). Fifth, North American Edition, by N. Cary Engleberg MD, Terence Dermody, Victor DiRita Publisher: LWW; Fifth, North American edition
10. Introduction to Modern Virology. (2001). 5th ed. Dimmock et al., Blackwell Sci.

Publ.

11. Plant Virology. (2001). 4th edi. By R. Hull. Academic Press.
12. Fundamental Virology, 4th ed. (2001). D.M. Knipe and P.M. Howley.
13. Principles of Virology: (2000). by S.J. Flint et al., ASM Press.
14. Basic Virology, (1999). By Waginer and Hewelett, Black Well Science Publ.
15. Veterinary Virology. 3rd ed. (1999). Murphy et al., Academic Press.
16. Principles of Molecular Virology. (1997). 2nded. A. Cann. Academic Press.
17. Medical Virology. (1994). 4th edition. D.O. White and F.J. Fenner. Academic Press.
- Plant Virology. (2001). 4thed. By R. Hull. Academic Press.
18. Field's Virology Vol 1 and 2. B.N. Fields, D.M. Knipe, P.M. Howley, R.M. Chanock, J.L.Melnick, T.P. Monath, B. Roizman, and S.E. Straus, eds.), (2007) 3rd Edition. Lippincott-Raven, Philadelphia, PA.
19. Principles of Molecular Virology. (1997). 2nded. A. Cann. Academic Press.
20. Virology: (1994). 3rded. Frankel Conrat et al, Prentice Hall.

PRACTICAL: VIR-105: BIOLOGICAL CHEMISTRY & ANALYTICAL TECHNIQUES

Practicals: 9 hours/week	Semester End Examination: 100 Marks
Tutorial: Lab manuals, E-learning resources, textbooks and study materials	
Semester: I	Credits: 4 Credits

List of Experiments:

1. Qualitative tests for identification of carbohydrates
2. Qualitative tests for identification of amino acids
3. Qualitative tests for identification of nucleic acids
4. Estimation of proteins (Lowry method)
5. Estimation of glucose (Anthrone method)
6. Estimation of glycine
7. Estimation of bilirubin
8. Estimation of cholesterol
9. Estimation of inorganic phosphorous
10. Determination of activity of peroxidase and polyphenol oxidase from leaves
11. Isolation and assay of an enzyme (amylase or phosphorylase) from potato extract
12. Measurement of pH
13. Cell counting by Hemocytometer
14. Determination of \square max for colored solutions
15. Determination of \square max of DNA & RNA by UV spectrophotometry
16. Separation of lipids by TLC
17. Separation of amino acids by paper chromatography
18. Separation of leaf or virus proteins by SDS-PAGE
19. Separation of DNA by submarine agarose gel electrophoresis
20. Isolation of chloroplasts by sucrose density gradient centrifugation (demo)

Learning Resources and Suggested Books/Manuals:

1. Biomolecular Thermodynamics: From Theory to Application (Foundations of Biochemistry and Biophysics) (2017), 1st Edition, Publisher: CRC Press.
2. Study Guide with Student Solutions Manual and Problems Book for Garrett/Grisham's Biochemistry (2016), Reginald H. Garrett , Charles M. Grisham 6th Edition, Publisher: Cengage Learning.
3. Microbiology Tools & Techniques (2008) Kanika Sharma-Ane books, India.
4. Protein Purification Techniques 2nd ed.-(2001)-Simon Roe-Oxford University Press.
5. Practical Biochemistry: Principles and Techniques (1995), 4th ed. by K. Wilson and J. Walker, Cambridge University Press.
6. Introduction to Practical Biochemistry. (2000). by S.K. Sawhney and Randhir Singh (eds.) Narosa Publ. House
7. Laboratory Manual in Biochemistry, (1996). By J. Jayaraman.
8. Modern Experimental Biochemistry. (1993). 2nd ed. by R.F. Boyer. The Benjamin Cummings Publ. Company.
9. Biochemical Methods for Agricultural Sciences, (1992). By S. Sadasivam and A. Manikam.
10. Physical Biochemistry: Applications to Biochemistry and Molecular Biology, (1982), 2nd ed. by David Freifelder. W.H. Freeman and Company.

PRACTICAL: VIR-106: GENERAL MICROBIOLOGY & GENERAL VIROLOGY

11.

Practicals: 9 hours/week	Semester End Examination: 100 Marks
Tutorial: Lab manuals, E-learning resources, textbooks and study materials	
Semester: I	Credits: 4 Credits

List of Experiments:

1. Microbiological laboratory safety measures (theory)
2. Sterilization Methods (dry, wet, UV, chemical agents)
3. Preparation of media for cultivation of bacteria, fungi and actinomycetes
4. Enumeration of bacteria, actinomycetes and fungi from soil
5. Plating techniques- streak plate, pour and spread plate methods
6. Bacterial staining techniques: Simple, Gram and spore staining
7. Lactophenol-cotton blue staining for fungi
8. Hanging drop method for bacterial motility
9. Determination of bacterial growth curve
10. Effect of pH on bacterial growth
11. Effect of temperature on bacterial growth
12. Effect of salt concentration on bacterial growth
13. Antimicrobial activity of heavy metals and antibiotics
14. Isolation of bacteriophages from sewage water

15. Cultivation of viruses in embryonated eggs: different routes of inoculation.

16. Sap, aphid and graft transmission of plant viruses.
17. Determination of stability of plant virus in cell sap- TIP, DEP, LIV.
18. Determination of chlorophylls in healthy and virus infected leaves.

Learning Resources and 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 Methods Manual, (1996). B.W.J. Mahy and H.O. Kangro. Academic Press
5. Molecular Virology: A Practical Approach. (1993). Davison and R.M. Elliot. Oxford University Press.
6. Virology Lab Fax. (1993). D.R. Harper. Bioscientific Publication. Academic Press.
7. Virology - A Laboratory Manual, (1992). By Burleson, et al., 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.

VIR-107: HUMAN VALUES AND PROFESSIONAL ETHICS– I (Audit Course-Self Study)

Self-Study	Internal test Assessment: 100 marks
Tutorial: Textbooks, E-learning resources, study materials, PowerPoint lectures by experts	Assignments, quizzes and seminars
Semester: I	Non credited course

UNIT-I

Definition and nature of Ethics, its relation to religion, politics, business, legal, medical and environment; need and importance of professional ethics - goals - ethical values in various professions.

UNIT-II

Nature of Values - good and bad, ends and means, actual and potential values, objective and subjective values, analysis of basic moral concepts- right, ought, duty, obligation, justice, responsibility and freedom, good behavior and respect for elders.

UNIT-III

Ahimsa (Non-Violence), Satya (Truth), Brahmacharya (Celibacy), Asteya (Non possession) and Aparigraha (Non- stealing); Purusharthas (Cardinal virtues)-Dharma (Righteousness), Artha(Wealth), Kama (Fulfillment Bodily Desires), Moksha (Liberation).

UNIT-IV

Bhagavad Gita - (a) Niskama karma (b) Buddhism- The Four Noble Truths - Arya astanga marga, (c) Jainism- mahavratas and anuvratas; Values embedded in various religions, religious tolerance, Gandhian ethics.

Crime and Theories of punishment: (a) Reformative, Retributive and Deterrent (b) Views on manu and Yajnavalkya.

Learning Resources and Suggested Books:

1. John S Mackenjie: A manual of ethics.
2. “The Ethics of Management” by Larue Tone Hosmer, Richard D. Irwin Inc.
3. “Management Ethics - integrity at work’ by Joseph A. Petrick and John F. Quinn, Response Books:New Delhi.
4. “Ethics in Management” by S.A. Sherlekar, Himalaya Publishing House.
5. Harold H. Titus: Ethics for Today
6. Maitra, S.K: Hindu Ethics
7. William Lilly: Introduction to Ethics
8. Sinha: A Manual of Ethics
9. Manu: Manu Dharma Sastra or the Institute of Manu: Comprising the Indian System of Duties: Religious and Civil(ed.) G.C.Haughton.
10. Susruta Samhita: Tr.Kaviraj Kunjanlal, Kunjalal Brishagratha, Chowkamba Sanskrit series, Vol I,II and III, Varnasi, Vol I OO, 16-20, 21-32 and 74-77 only.
11. Caraka Samhita:Tr. Dr.Ram Karan Sarma and Vaidya Bhagavan Dash, Chowkambha Sanskrit Series office, Varanasi I, II, III Vol I PP 183-191.
12. Ethics, Theory and Contemporary Issues., Barbara Mackinnon, Wadsworth/Thomson Learning, (2001).
13. Analyzing Moral Issues, Judith A. Boss, Mayfield Publishing Company, (1999).
14. An Introduction to Applied Ethics (Ed.) John H.Piet and Ayodhya Prasad, Cosmo Publications.
15. Textbook for Intermediate logic, Ethics and Human Values, board of Intermediate Education&Telugu Academic Hyderabad
16. Sharma I.C Ethical Philosophy of India. Nagin&co Jalandhar.

SEMESTER-II

VIR-201: CELL BIOLOGY AND TISSUE CULTURE (Core Theory-1)

Lecture: 6 hours/week	Internal test Assessment: 20 Marks Seminars and assignments
Tutorial: Textbooks, E-learning resources, study materials, PowerPoint lectures	Semester End Examination: 80 Marks
Semester: II	Credits: 4 Credits

UNIT – I

Prokaryotic and eukaryotic cells: Discovery of cell, cell theory, prokaryotic and eukaryotic cell structure; structural organization and functions of intracellular organelles-cell wall, cell membranes, nucleolus, nucleus (chromosomes, ploidy, chromatin and nucleosomes), mitochondria, golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplasts; Sub-cellular fractionation and criteria of functional integrity; Cytoskeleton - Microtubules, microfilaments and their dynamics; centrosome, cilia.

Cell cycle: Mitosis and meiosis, molecular events and regulation of cell cycle in eukaryotes, check points (role of Rb and p53), cyclins and protein kinases, MPF (maturation promoting factor).

Apoptosis: Neurotrophic factors, caspases, pathways of apoptosis; Cancer–Cellular, molecular and genetic basis of cancer.

UNIT – II

Membrane transport: Structural organization of plasma membrane in relation to transport of nutrients; Diffusion (simple and facilitated) and active transport (primary and secondary), carrier proteins (uni, sym and antiporters), channel proteins (voltage and ligand gated); Bulk transport-pino, phago and exocytosis; receptor mediated endocytosis, coupling of transport of ions and metabolites to ATP/proton gradient.

Cell Signaling and cell-cell interactions: Cell surface receptors -ion channel-linked, G-protein-linked and enzyme-linked receptors and intracellular receptors; Types of intracellular signaling – autocrine, paracrine, contact-dependent, synaptic and endocrine signaling; Intracellular signaling proteins- Types and their role; cAMP pathway of signal transduction; cGMP, phospholipids and calcium ions, MAP kinase pathway, JAK – STAT pathway; Cell junctions - tight junction, desmosome, hemidesmosome and gap junctions; Cell adhesion molecules - cadherins, integrins and selectins; Bacterial chemotaxis and quorum sensing.

UNIT – III

Animal tissue culture: Types of tissues – Epithelial, muscle, connective, nerve and blood; Culture media - balanced salt solutions; Composition and metabolic functions of media; Defined media and their applications; role of serum and supplements, serum-free media; Role of antibiotics in media; 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.

Cell counting: Hemocytometer, coulter counter; Cell viability and cytotoxicity; Dye exclusion and inclusion tests, clonogenic assay, MTT based assay.

Three dimensional culture: Organ culture and histotypic culture; Normal vs. transformed cells, growth characteristics of transformed cells.

UNIT – IV

Plant tissue culture: Introduction to totipotency of plant cell; Tissue cell culture- 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; Cryopreservation and germplasm conservation.

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

Learning Resources and Suggested books:

1. Molecular biology of the cell 5th Edition (2008) Alberts A et al. Garland Publishers, New York
2. Cell and Molecular Biology (2006) De Robertis, E. D. P and E.M.F. De Robertis. Lippincott Williams and Wilkins.
3. Molecular Cell Biology. 6th edition (2006) Lodish, H., A. Berk, C. A. Kaiser, M. P. Scott. 6th Edn. Ploegh and Paul Matsudaria.
4. Gupta and Jangir . Cell Biology (Fundamentals and Applications). Agrobios, India.
5. Geoffrey M. Cooper. The cell (A Molecular Approach). 2nd Ed, 2000.
6. EDR De Robertis and EMR De Robertis Jr. cell and Molecular Biology. Indian Edition, B.I. Publications, Pvt. Ltd.
7. Bruce Alberts Molecular biology of the cell.
8. J.D. Watson, N.H. Hopkins, J.W. Roberts, J.A. Steitz and A.M. Weiner, Molecular Biology of the Gene, 5th edition, The Benjamin/Cummings Publ., Inc., California, 2004..
9. J. Darnell, H. Lodish and D. Baltimore, Molecular Cell Biology, Scientific American Books, Inc., USA, 1998.
10. Benjamin Lewin, Gene VII , Oxford University Press, U.K., 2000
11. William H Elliott and D C. Elliott , Biochemistry & Molecular biology, Oxford University press. 2000.
12. David freifelder and G.M. Malacini, Essentials of molecular biology 1996.

13. T.A. Brown (Ed. Molecular Biology LabFax), Bios Scientific Publishers Ltd., Oxford, 1981
14. B. Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts, and J.D. Watson Molecular Biology of the Cell (2nd Edition), Garland publishing, Inc. New York, 1994.

VIR-202: MICROBIAL GENETICS AND MOLECULAR BIOLOGY (Core Theory-1I)

Lecture: 6 hours/week	Internal test Assessment: 20 Marks Seminars and assignments
Tutorial: Textbooks, E-learning resources, study materials, PowerPoint lectures	Semester End Examination: 80 Marks
Semester: II	Credits: 4 Credits

UNIT-I

Genetic notations, conventions and terminology

Evidences for nucleic acids as information carriers: Genomes- types, diversity in size, structure and organization in viruses, prokaryotes (nucleoid) and eukaryotes (chromosomes, ploidy, chromatin and nucleosomes); Chloroplast and mitochondrial genomes; **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; Transduction (generalized, abortive, specialized and cotransduction).

Genetic recombination: Requirements for recombination; Molecular models of recombination.

Genetics of viruses: Recombination in bacteriophages-T2 and fine structure of rII locus of T4 phage.

Replication of nucleic acids: Concepts and strategies / models of replication, molecular mechanisms of DNA replication in prokaryotes and eukaryotes; rolling circle replication, inhibitors of DNA replication.

UNIT-III

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

Transcription (RNA biosynthesis): Transcription factors (transcription activators and repressors), and machinery, types of RNA polymerases, steps involved in transcription, RNA processing, RNA editing, splicing and polyadenylation, inhibitors of transcription, RNA transport.

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 in protein biosynthesis in prokaryotes and eukaryotes; post-translational modification of proteins and their sorting and targeting; inhibitors of protein biosynthesis.

UNIT-IV

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- trp operon; antitermination- N protein in lambda phage; Global regulatory responses- heat shock response.

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.

Gene silencing mechanisms: Transcriptional and post-transcriptional gene silencing; RNA silencing (RNA interference).

Learning Resources and Suggested books:

1. Lewin's Gene XII (2017) Jocelyn E. Krebs Elliott S. Goldstein Stephen T. Kilpatrick
2. *Principles of Genetics, 7th Edition* (2016) D. Peter Snustad, Michael J. Simmons. Wiley publications
3. Molecular biology 5th Edition (2015) Robert F. Weaver *McGraw-Hill*.
4. Molecular Biology of the Gene 7th Edition (2013) James D. Watson / Tania A. Baker et al. Pearson publications.
5. Molecular Genetics of Bacteria, 5th Edition (2010) Jeremy W. Dale, Simon F. Park, Wiley publications
6. Molecular biology of the cell 5th Edition (2008) Alberts A et al. Garland Publishers, New York
7. Cell and Molecular Biology (2006) De Robertis, E. D. P and E.M.F. De Robertis. Lippincott Williams and Wilkins.
8. Concepts of Genetics, Seventh edition (2007), William S. Klug & Michael R. Cummings. Darling Kindergluy.
9. Molecular Cell Biology. 6th edition (2006) Lodish, H., A. Berk, C. A. Kaiser, M. P. Scott. 6th Edn. Ploegh and Paul Matsudaria.

10. The cell (molecular approach) 4th Edition (2004) Cooper G. M Hausman R, ASM press
11. Molecular Genetics of Bacteria. 2nd Edition, (2003). By S. Snyder and W. Champness. ASM press.
12. Advanced Molecular Biology: A Concise Reference. (1998), by R.M. Twyman. Viva Books Pvt. Ltd.
13. Molecular Biology. (1995) David Freifelder, Narosa Publ. House.
14. Essentials of *Molecular Biology* (1994) George M. Malacinski and *David Freifelder*.

VIR-203: RECOMBINANT DNA TECHNOLOGY (Compulsory Foundation)

Lecture: 6 hours/week	Internal test Assessment: 20 Marks Seminars and Assignments
Tutorial: Textbooks, E-learning resources, study materials, PowerPoint lectures	Semester End Examination: 80 Marks
Semester: II	Credits: 4 Credits

UNIT-1

Scope and importance of recombinant DNA technology

Tools for Recombinant DNA Technology: Gene vectors-Plasmids, bacteriophage vectors, cosmids, yeast vectors, artificial chromosomes (YACs, BACs), Ti plasmid-based vectors, baculovirus-based vectors, plant and animal virus vectors, shuttle vectors, expression vectors (prokaryotic-e.g., *E. coli* and eukaryotic-e.g., yeast)

Enzymes: DNA and RNA polymerases, Restriction endonucleases, DNA joining enzymes, nucleases 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: bacteria, yeast, insect cells, plants and animal cells.

UNIT-II

Techniques for gene manipulation: DNA sequencing-Chemical, dideoxy chain termination, primer walking, automated DNA sequencing and pyrosequencing methods.

PCR: principle, factors affecting PCR, different types of PCR and their applications.

DNA profiling: RFLP, AFLP, RAPD and DNA finger printing and their applications.

Nucleic acid blotting and hybridization: Preparation of DNA and RNA probes, hybridization formats and applications of hybridization-based tests.

Microarray Technology: DNA microarrays and chips- principles and applications.

Site directed mutagenesis and protein engineering: Different types of site-directed mutagenesis approaches for changing genes and introduction to protein engineering.

UNIT-III

Gene cloning strategies: Construction of genomic DNA and cDNA libraries; construction of cell specific recombinant vectors, introduction of recombinant vectors into targeted cells by different approaches, screening and identification of recombinant clones.

Omics: Genomics-Mapping and sequencing genomes, functional genomics-transcriptome and gene expression profiling; **Proteomics**- proteome and tools for proteomics, protein microarrays, Yeast two hybrid systems (protein-protein interactions); Introduction to metagenomics, metabolomics, viromics.

Bioinformatics tools: Glossary, Biological databases-GenBank, Swiss-Prot, UniProt, EMBL, NCBI and PDB; database searching using BLAST and FASTA; Protein structure prediction approaches, sequence analysis using multiple sequence alignment and phylogenetic tree construction, primer designing for PCR

UNIT-IV

Production of recombinant molecules in heterologous expression systems: *Bacterial cell system*- optimization of cloned gene expression, affinity tags, fusion proteins and purification of recombinant proteins (e.g., *E. coli*-Insulin); **Yeast cell system** – Expression of cloned genes [e.g., *Pichia*: hepatitis b surface antigen (induction with methanol) using AOX promoter; *Saccharomyces*: HSA protein expression constitutive expression]; **Insect cell system** - Overexpression of cloned genes using baculovirus based vectors (e.g., bacmid).

Plant cell system: High level expression of cloned genes using *Agrobacterium*-mediated transformation and plant virus-based vectors (e.g., CaMV), 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;

Animal cell system-High level expression of cloned genes in CHO cells (Mab production) and using virus-based vectors (e.g., Adenovirus-based vector-Covishield),genetic

modification of animals like mice, sheep and cow for new /improved traits like body size and milk quantity, transgenic animals as bioreactors, gene editing (CRISPER), gene knock out.

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

Learning Resources and Suggested books:

1. Recombinant DNA technology (2019) Siddra Ijaz and Imran Ul Haq, Cambridge Scholar publishing, UK.
2. Application of Recombinant DNA technology (2018). Vance Hunter and Franky Stickland, ED-Tech Press, UK.
3. Wilson and Walkers Principles and Techniques of Biochemistry and Molecular Biology. (2018). Andreas Hofmann, Samuel Clokie, Kindle Edition.
4. Basic concepts of Recombinant DNA technology (2016) by Somnath De. Edu Pedia Publications, New Delhi.
5. Genetic Engineering: Principles and Methods (2012) Jane K. Setlow (Editor)
6. From Genes to Genomes: Concepts and Applications of DNA Technology. (2011) Jeremy W. Dale, Malcolm von Schantz, Nicholas Plant.
7. Principles of Gene Manipulation and Genomics. Seventh edition (2008) S.B. Primrose and R.M . Twyman. Blackwell pub.
8. Recombinant DNA Genes and Genomes: A Short course. Third edition (2007) James D. Watson, Amy A. Caudy, Richard M. Mayes & Jan A. Witkow.
9. Gene Cloning and DNA Analysis – An Introduction. Fifth edition (2006) T.A Brown. Blackwell Pub.
10. An introduction to genetic engineering. 2nd edition. (2004) By D.S.T. Nicholl. Cambridge University Press.
11. DNA Science: A First course. Second edition (2003) David A. Micklos Grag, A. Freyer & David A, Crotty.
12. Principles of genome analysis and genomics. (2003). 3rd edition. S.B. Primrose and R.M.Twyman. Blackwell Science.
13. Prokaryotic genomics. (2003). Michel Blot (Ed). Springer International.
14. Recombinant DNA and biotechnology: A guide for Teachers: 2nd ed. H. Kreuzer and A. Massey. ASM Press.
15. Recombinant DNA and biotechnology: A guide to students: 2nd ed. H. Kreuzer and A. Massey. ASM Press.
16. Principles of Gene Manipulation: An introduction to genetic engineering. (2001). 6th ed. Old and Primrose. Blackwell Scientific Publ.
17. Functional Genomics: A Practical Approach. (2000), by S.P. Hunt and R. Liveey (eds.). Oxford University Press.
18. Genome analysis. (2000). 4 Vols. CSH Press.

VIR-204:IMMUNOLOGY
(Elective Foundation)

Lecture: 6 hours/week	Internal test Assessment: 20 Marks Seminars and assignments
Tutorial: Textbooks, E-learning resources, study materials, PowerPoint lectures	Semester End Examination: 80 Marks
Semester: II	Credits: 4 Credits

UNIT-I

History: Historical perspectives and milestones in immunology.

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

Types of immunity: innate and adaptive immunity.

Antigens: Types, properties, immunogenicity versus antigenicity, factors influencing immunogenicity; epitopes, haptens, mitogens, super antigens.

UNIT-II

Antibodies: Types, structures and biological activities of Immunoglobulins, antigenic determinants; principle, production and applications of polyclonal and monoclonal antibodies; Introduction to recombinant antibodies and their advantages.

Antigen and antibody interactions: Affinity, Avidity, Cross reactivity; *In vivo* serological reactions- Phagocytosis, Opsonization, Neutralization; *In vitro* serological tests- Precipitation tests, Immunoelectrophoresis (AGDD, rocket), Agglutinations tests- HA & HI, latex agglutination, Enzyme linked immunosorbent assays (ELISAs), Radio immunoassay (RIA), Immunofluorescent and Immunosorbent electron microscopy.

Immune effector mechanisms: Cytokines- properties and functions; Toll-like receptors (TLRs); Complement cascade system- complement components, functions, activation pathways.

UNIT-III

Humoral immune response: Primary and secondary humoral immune responses; induction and mechanism.

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

Major histocompatibility complex (MHC): Organization and cellular distribution of MHC molecules, HLA antigens- Class I, II, III and their functions.

Hypersensitivity: Type I, II, III and IV hypersensitivity reactions.

UNIT-IV

Immunopathology: Immunodeficiency disorders (congenital and acquired).

Autoimmunity: Induction, mechanisms of tissue damage in autoimmunity; Autoimmune diseases- thyroid diseases, Diabetes mellitus, Multiple sclerosis, Rheumatoid arthritis and their therapy.

Transplantation Immunology: Transplantation antigens, types of transplants, Graft versus host reactions; Immunosuppressive therapy of allograft response, clinical transplantation.

Immune response: Immune mechanisms against viral, bacterial and parasitic infections.

Vaccines: Conventional and modern vaccines and their applications.

Learning Resources and Suggested books:

1. Immunology: A short course, 8th edition (2020) Coico, John Wiley & Sons, Limited
2. Immunology, 9th Edition (2020) David Male, Victoria Male, Ray Stokes Peebles, Elsevier
3. Advances in Immunology (2019) Frederick W. Alt. Elsevier
4. Applied Immunology and Biochemistry (2019) Taylor Barker, ED-Tech Press, UK.
5. Cellular and Molecular Immunology (2019), Reece Davis, ED-Tech Press, UK.
6. Immunology (2015) I. Kannan, MJP Publishers, Chennai.
7. Immunology. (2000). 4th edition. J. Kuby. W.H. Freeman and Company.
8. Immunology. (1996). 4th edition. I.Roitt, J. Brostoff and David Male. Mosby publications.
9. Fundamental Immunology. (1992). 2nd edition. R.M. Coleman, M.F. Lombard and R.E.Sicard. Wm. C. Brown Publishers.
10. Immunology. (1997). 3rd edition. R.M. Hyde. B.I. Waverly Pvt. Ltd.
11. Immunology. (1995). 4th edition. I.R. Tizard. Saunders College Publishing.
12. Immunology – The Science of self and non-self-discrimination. (1982). Jon Klein. John Wiley and Sons.
13. Immunology – An illustrated outline. (1986). David Male. Churchill Living Stone.
14. Viruses that affect immune system. (1991). H.Y. Fan, I.S.Y. Chen, N.Rosenberg and W. Sugden. American Society for Microbiology.
15. Immunobiology: The immune system in health and disease.(1994). C.A.Janeway, Jr., P.Travers. Current biology Ltd.
16. Advanced Immunology. D.M. Male *et al.*, The C.V.Mosby Co.

PRACTICAL: VIR-205: CELL BIOLOGY & TISSUE CULTURE AND MICROBIAL GENETICS & MOLECULAR BIOLOGY

Lecture: 9 hours/week	Semester End Examination: 100 Marks
Tutorial: Textbooks, E-learning resources, Lab manuals	
Semester: II	Credits: 4 Credits

List of Practicals:

1. Preparation of cytological studies for identification of stages of mitosis using onion root tips
2. Examination of cells isolated from sheep kidney.
3. Demonstration of chromosomal (structural and numerical) aberrations (theory exercise).
4. Study of polytene chromosomes (theory exercise).
5. Preparation of sucrose density gradients (step and linear).
6. Safety practices and precautions to be followed to set up Molecular Biology lab with ribonuclease free environment (theory exercise)
7. Isolation of microbial DNA
8. Isolation of microbial RNA
9. Curing of plasmids.
10. Isolation of microbial mutants by gradient plate method.
11. Induction of mutations in bacteria by physical / chemical agents by replica plate method.
12. Problems related to microbial genetics and molecular biology

Learning Resources and Suggested books / manuals:

1. Molecular Biology Techniques. A Classroom Laboratory Manual 4th Edition. (2020). Sue Carson Heather Miller Melissa Srougi D. Scott Witherow, Academic Press.
2. Biotechnology: DNA to Protein: A laboratory project in molecular biology. (2002). T. Thiel, S. Bissen, E.M. Lyons. Tata McGraw-Hill publishing company.
3. Methods in Biotechnology. (2001). By Ignacimuthu.
4. Molecular cloning- A laboratory manual. (2001). I, II, III Vols. By Russell and Sambrook. CSH Pubs.
5. Current Protocols in Molecular Biology, (2000). Ausubel et al.
6. Current Protocols in Molecular Biology, (2000). Ausubel et al.
7. Biotechnology: A Laboratory Course. (1996). 2nd ed. J.M. Becker, et al., Acad. Press.

PRACTICAL VIR-206: RECOMBINANT DNA TECHNOLOGY AND IMMUNOLOGY

Lecture: 9 hours/week	Semester End Examination: 100 Marks
Tutorial: Textbooks, E-learning resources, Lab manuals	
Semester: II	Credits: 4 Credits

List of Practicals:

1. Creating ribonuclease free environment in the laboratory (theory exercise).
2. Preparation of phenol for nucleic acid isolation (theory exercise).
3. Concentration of nucleic acids (theory exercise).
4. Isolation of plasmids from bacteria through alkaline lysis method.
5. Restriction enzyme analysis of plasmids.
6. Recovery of DNA from gels – low melting point agarose extraction of DNA
7. Transformation of bacteria with recombinant plasmid DNA
8. Southern blotting (demo).
9. Preparation of dot-blot for hybridization (demo).
10. Problems related to recombinant DNA technology.
11. Bioinformatics tools: NCBI, PDB search, BLAST-n, BLAST-p, multiple sequence alignment, phylogenetic tree construction, Bioedit, expasy tools (demo and learning exercises).
12. Total counting of RBC & WBC
13. Differential count of W.B.C.
14. Hemoglobin estimation.
15. Blood typing & Rh determination.
16. Latex agglutination test.
17. Primary & secondary lymphoid organs (theory exercise).
18. Production of polyclonal antibodies- demonstration of different routes of antigen inoculation, bleeding of experimental animals, and collection of serum.
19. Purification of immunoglobulins and analysis.
20. *In vitro* serological tests:
 - a) Single & double immunodiffusion tests
 - b) Counter current & rocket electrophoresis
 - c) DAC- ELISA (indirect)
 - d) Dot-ELISA
 - e) Electroblot immunoassay (EBIA)

Learning Resources and 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. Handbook of Immunology. G.P. Talwar, (1983), Vikas Publishing House, India.
5. Bioinformatics - From Nucleic Acids and Proteins to Cell Metabolism. 1995, by Schomburg and Label VCH Publ.
6. Bioinformatics : Sequence and Genome Analysis. By D.W. Mount. CSHL Press.
7. Bioinformatics : Methods and Protocols,. Ed by S.Misener and S.A. Krawetz. Humana Press, 2000.

VIR 207 - HUMAN VALUES AND PROFESSIONAL ETHICS-II
(Audit Course-Self Study)

Self-Study	Internal test Assessment: 100 Marks Seminars, quizzes and assignments
Tutorial: Textbooks, E-learning resources, study materials, PowerPoint lectures by experts	
Semester: II	Non-credited course

UNIT-I

Value Education: Definition, relevance to present day, Concept of Human Values - self introspection, Self-esteem; Family values-Components, structure and responsibilities of family, Neutralization of anger, Adjustability, Threats of family life, Status of women in family and society, Caring for needy and elderly, Time allotment for sharing ideas and concerns.

UNIT-II

Medical ethics: Views of Charaka, Sushruta and Hippocrates on moral responsibility of medical practitioners; Code of ethics for medical and healthcare professionals; Euthanasia, Ethical obligation to animals, Ethical issues in relation to health care professionals and patients; Social justice in health care, human cloning, problems of abortion; Ethical issues in genetic engineering and Ethical issues raised by new biological technology or knowledge.

UNIT-III

Business ethics: Ethical standards of business-Immoral and illegal practices and their solutions; Characteristics of ethical problems in management, ethical theories, causes of unethical behavior, ethical abuses and work ethics.

sUNIT-IV

Environmental ethics- Ethical theory, man and nature: Ecological crisis, pest control, Pollution and waste, Climate change, Energy and population, Justice and environmental health.

Social ethics: Organ trade, Human trafficking, Human rights violation and social disparities, Feminist ethics, Surrogacy/pregnancy; Ethics of media- Impact of Newspapers, Television, Movies and Internet.

Learning resources and suggested books:

1. John S Mackenzie: A manual of ethics.
2. “The Ethics of Management” by Larue Tone Hosmer, Richard D. Irwin Inc.
3. “Management Ethics - integrity at work’ by Joseph A. Petrick and John F. Quinn, Response Books:NewDelhi.
4. “Ethics in Management” by S.A. Sherlekar, Himalaya Publishing House.
5. Harold H. Titus: Ethics for Today
6. Maitra, S.K: Hindu Ethics
7. William Lilly: Introduction to Ethics
8. Sinha: A Manual of Ethics
9. Manu: Manava Dharma Sastra or the Institute of Manu: Comprising the Indian System of Duties: Religious and Civil (ed.) G.C.Haughton.
10. Susruta Samhita: Tr.Kaviraj Kunjanlal, Kunjalal Brishagratha, Chowkamba Sanskrit series, Vol I,II and III, Varnasi, Vol I OO, 16-20, 21-32 and 74-77 only.
11. Caraka Samhita:Tr. Dr.Ram Karan Sarma and Vaidya Bhagavan Dash, Chowkambha Sanskrit Series office, Varanasi I, II, III Vol I PP 183-191.
12. Ethics, Theory and Contemporary Issues., Barbara Mackinnon, Wadsworth/Thomson Learning, 2001.
13. Analyzing Moral Issues, Judith A. Boss, Mayfield Publishing Company, (1999).
14. An Introduction to Applied Ethics (Ed.) John H.Piet and Ayodhya Prasad, Cosmo Publications.
15. Textbook for Intermediate First Year Ethics and Human Values, Board of Intermediate Education-Telugu Akademi, Hyderabad.
16. I.C Sharma Ethical Philosophy of India. Nagin&co Jalandhar

SEMESTER-III

VIR-301: PLANT VIROLOGY (Core Theory -I)

Lecture: 6 hours/week	Internal test Assessment: 20 Marks Seminars and assignments
Tutorial: Textbooks, E-learning resources, study materials, PowerPoint lectures	Semester End Examination: 80 Marks
Semester: III	Credits: 4 Credits

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, local and systemic symptoms.

Movement/transport of viruses: Cell to cell and long-distance movement, virus distribution in plants.

UNIT-II

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

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

UNIT-III

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

Assessment of disease incidence and yield losses: Field surveys for determination of incidence of virus diseases, Impact of viruses on crop yield, approaches for assessment of yield losses.

Detection of plant viruses: Biological, physical, chemical, immunological and molecular approaches for identification and diagnosis of plant viruses.

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, suppression of disease symptoms by chemicals / botanicals.

Production of virus resistant plants: Somatic hybridization, virus resistant transgenic plants; plant quarantine and its role in virus disease control.

Learning resources and suggested books:

1. Molecular Plant Virology, Volume 1 (2017) Davis, Taylor & Francis Group.
2. Applied Plant Virology (2014), Calum Rae Wilson.
3. Handbook of Plant Virology (Crop Science) (2006), Jawaid Khan, Jeanne Dijkstra.
4. Plant Virology, 4th ed. 2001 by R. Hull (R.E.F. Matthews). Academic Press.
5. Plant Viruses. By M.V. Nayudu. (2008). Tata –McGraw Hill.
6. Techniques in diagnoses of Plant Viruses (Plant Pathogens-6) (2008) Govind P.Rao, Rodrigo A. Valverde & C.I. Doval, Stadium Press.
7. Plant viruses as molecular pathogens. (2001). J. A. Khan and J. Dijkstra (Eds). CBS Publishers and distributors, New Delhi.
8. Control of Plant virus diseases by Hadidi et al (editors), (1998), American Phytopathological Society, USA.
9. Diagnosis of Plant Virus Diseases. (1993) by R.E.F. Matthews. CRC Press.
10. Plant Virus Epidemics- Monitoring, modeling and predicting outbreaks. (1986). G.D. McLean, et. al., Academic Press.
11. Applied Plant Virology. (1985). D.G.A. Walkey. Heinemann Publications.
12. Symptoms of Plant Virus Diseases (1978) by L. Bos.
13. Plant Virology - The Principles. (1976) by A. Gibbs and B.D. Harrison, Edward Arnold.

VIR-302: PLANT VIRUS DISEASES (Core Theory-2)

Lecture: 6 hours/week	Internal Assessment: 20 Marks Seminars and assignments
Tutorial: Textbooks, E-learning resources, study materials, PowerPoint lectures	Semester End Examination: 80 Marks
Semester: III	Credits: 4 Credits

UNIT-I

Cereals and millets:

Rice - Tungro, dwarf, grassy stunt, stripe, and yellow mottle; **Wheat**- soil-borne wheat mosaic, streak 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, stripe virus diseases.

Oil seed 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 (tobamovirus), yellow mosaic/golden yellow mosaic, fern leaf / shoestring; **Chilli** – leaf curl, vein banding and mosaic caused by TMV, CMV and Chilli vein mottle virus (ChiVMV); **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, leaf curl, watermelon mosaic, bud necrosis and cucumber green mottle mosaic; **Radish** – mosaic. **Carrot** – red leaf, mottled 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 by PVX, PVM and PVS and potato spindle tuber viroid diseases; **Sweet potato** – chlorotic stunt and feathery mottle; **Cassava** – common, African and Indian mosaic virus diseases; **Colocasia and Cocoyam** – Feathery mottle, Babone and Alomae diseases; **Greater yam** – mosaic.

UNIT-III

Food legumes: French bean- Common mosaic, yellow/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** –bean leaf roll and yellow mosaic; **Black gram / Green gram** - yellow mosaic and leaf crinkle; **Horse gram** - yellow mosaic.

Fruit crops: Banana / Plantain - bunchy top, streak, infectious chlorosis (CMV) and bract mosaic; **Citrus** - Tristeza, 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, streak mosaic, Fiji disease, yellow leaf virus; **Sugarbeet** -curly top yellows, western yellows, beet mosaic, beet necrotic yellow vein; **Cotton** -yellow mosaic,leaf curl; **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**–bean yellow mosaic; **Orchids** – cymbidium mosaic and odontoglassum ring spot viruses; **Carnations** - mottle, ring spot and etched ringspot; **Chrysanthimum** – aspermy, ring mottle and stunt viroid; **Aroids** – dasheen mosaic and Konjac mosaic viruses.

Learning resources and 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-Studium 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. Sigaret. 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.American Phytopathological Society- Monographs on disease of different crops.
12. CMI/AAB Descriptions of Plant Viruses.

VIR-303A: MOLECULAR VIROLOGY
(Generic Elective)

Lecture: 6 hours/week	Internal Assessment: 20 Marks Seminars and assignments
Tutorial: Textbooks, E-learning resources, study materials, PowerPoint lectures	Semester End Examination: 80 Marks
Semester: III	Credits: 4 Credits

UNIT-I

Molecular architecture of viruses: Principles of virus structure- Icosahedral and helical tubes (TMV), cubic symmetry, virus structure designs and their characteristics- simple icosahedral symmetric capsids with Jelly-Roll Beta barrel sub-units (Polio, TBSV, SeMV), ds DNA (Pox virus, Adeno), dsRNA viruses (Reovirus), enveloped positive-stranded RNA viruses (tospo), T4 phage; principles of disassembly.

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, hydroxylamines, dyes.

UNIT-II

Viral genomes: Structure and diversity of 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: An overview of virus replication cycles, Baltimore classification of viruses based on viral genome expression; Replication strategies, host cell functions required in virus replication, sites of replication and assembly; importance of mutants in assembly studies.

Expression and replication of DNA viruses: Replication of dsDNA (pox, lambda), ssDNA (phi x 174, parvo).

UNIT-III

Expression and replication of RNA Viruses: Viruses with positive sense ssRNA - Q β , Picorna-, Toga-, Tobamo-, Poty-, and Bromoviruses; Negative and Ambisense ss RNA viruses- Orthomyxo-, Bunya- and Rhabdoviruses; dsRNA viruses- Reo- and Birnaviruses; ssRNA viruses with DNA intermediate - RSV and HIV; dsDNA viruses with RNA intermediate- CaMV, HBV.

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

UNIT-IV

Regulation of viral genome expression: T4, lambda phage, influenza, HIV and adenovirus; Functions of virus encoded products; Assembly of viruses- self-assembly from mature virion components, assembly of virus with helical structure (TMV), isometric structure (Picorna) and with complex structure (T4), enveloped viruses (Retroviruses); maturation of virus particles; Eukaryotic viruses - recombination and re-assortment, cross- and multiplicity reactivation, complementation, phenotypic mixing, ploidy, transduction of genes by retroviruses.

Tumor Virology: Genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes, cancer and the cell cycle, virus-induced cancers, metastasis, interaction of cancer cells with normal cells, apoptosis, molecular mechanisms of tissue transformation and tumorigenesis by viruses; therapeutic interventions of uncontrolled cell growth, oncolytic viruses and mechanism.

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

(OR)

VIR-303B: TUMOR VIROLOGY (GENERIC ELECTIVE)

Lecture: 6 h ours/week	Internal Assessment: 20 Marks
	Seminars and assignments
Tutorial: Textbooks, E-learning resources, study materials, PowerPoint lectures	Semester End Examination: 80 Marks
Semester: III	Credits: 4 Credits

UNIT-I

Tumor: Terminology, types of tumors, transformation and tumorigenesis, angiogenesis, differences between normal and transformed cells.

Oncogenes: Cellular/proto oncogenes, viral oncogenes; gene products and their role in cell cycle and growth regulation.

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

UNIT-II

Carcinogens and carcinogenesis: Physical, chemical and biological carcinogens and their mechanism and screening.

Chromosome abnormalities in neoplasms: Molecular mechanisms in carcinogenesis- Translocation, amplification, deletion of oncogenes and consequences.

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

UNIT-III

RNA Viruses: Retroviruses causing tumors in animals and humans; 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.

DNA Viruses: Tumors caused by *Adeno-*, *Hepadna-*, *Herpes-*, *Papilloma-*, *Polyoma-* and *Poxviridae* members.

UNIT-IV

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

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

Tumor therapy: Physical (radiation), chemical and immunotherapy; inhibitors of angiogenesis; oncolytic viruses and their mechanism.

Learning resources and suggested books:

- 1) Devita, Cancer, Principles and Practice of Oncology: (2019) Review 4 by Govindan.
- 2) Textbook of Medical Virology (2018), by B. Mishra (Author), details, 256 pages, Publisher: CBS Publishers & Distributors Pvt Ltd, India.
- 3) Practical clinical oncology, 2nd edition, Edited by Louise Hanna, Tom Crosby and Fergus Macbeth, (2015) 2 edition, Cambridge University Press.
- 4) Field's Virology (Knipe, Fields Virology) (2013), 2 Volume Set. by David M. Knipe and Peter Howley.

- 5) The Cell – A molecular approach. Fourth edition (2007). G. M. Cooper & R.E. Hausman. ASM Press.
- 6) Cell signaling. Second edition (2005). John T. Hancock. Oxford University press.
- 7) Principle of Virology: Molecular Biology, pathogenesis and control of animal viruses. (2004). By S.J. Flint et al., ASM press
- 8) Culture of Animal Cells: A Manual of Basic Technique. (1987). R.I. Freshney. Alan R. Liss. Inc.
- 9) Oncogenes. 1995. 2nd Edition. By G.M. Cooper. Jones and Bartlett publishers.

PRACTICAL: VIR-304A: PLANT VIROLOGY & VIRUS DISEASES AND MOLECULAR VIROLOGY

Lecture: 12 hours/week	Semester End Examination: 100 Marks
Tutorial: Textbooks, E-learning resources, study materials	
Semester: III	Credits: 4 Credits

List of Practicals:

1. Study of symptoms of local virus diseased plants through field work, 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. Effect of virus on total carbohydrates in healthy and virus infected seeds
6. Effect of virus on total proteins in healthy and virus infected seeds
7. Effect of virus on total lipids in healthy and virus infected seeds.
8. Identification of unknown plant virus by ELISA.
9. Local field surveys and visit to local research stations.
10. Diagnosis of virus diseases (theoretical exercise).
11. Collection and identification of local insect vectors.
12. Determination of disease progress curves (field study).
13. Study of seed transmission of viruses

Recommended books / Manuals:

1. Methods in Virology, (1998) K. Marmorosch and H. Koprowski. Vol. I and II. Academic Press.
2. Diagnosis of Plant Virus Diseases, (1993). R.E.F. Matthews (ed.) CRC Press.
3. Serological Methods for detection and identification of viral and bacterial plant pathogens: A Laboratory Manual. (1990). R. Hampton et al., APS Press.
4. Methods in Plant Virology, (1984). S.A. Hill. Blackwell Publications.

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 - A Laboratory Manual, 1992. By Burleson, et al., Academic Press.
8. Virology Lab Fax. 1993. D.R. Harper. Bioscientific Publication. Academic Press.

(OR)

PRACTICAL: VIR-304B: PLANT VIROLOGY & VIRUS DISEASES AND TUMOR VIROLOGY

Lecture: 12 hours/week	Semester End Examination: 100 Marks
Tutorial: Textbooks, E-learning resources, study materials	
Semester: III	Credits: 4 Credits

List of practicals:

1. Study of symptoms of local virus diseased plants and through field work, 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. Effect of virus on total carbohydrates in healthy and virus infected seeds
6. Effect of virus on total proteins in healthy and virus infected seeds
7. Effect of virus on total lipids in healthy and virus infected seeds.
8. Identification of unknown plant virus by ELISA.
9. Local field surveys and visit to local research stations.
10. Diagnosis of virus diseases (theoretical exercise).
11. Collection and identification of local insect vectors.
12. Determination of disease progress curves (field study).
13. Study of seed transmission of viruses
14. Demonstration of transmission of viruses through vegetative propagules.
15. Detection of carcinogens and mutagens using Ames test.
16. Histopathology of animal tumor viruses (specimens and slides)
17. Detection of tumor viruses using PCR
18. Observation of specimens (visiting Veterinary University and SVIMS).
19. Cell viability test
20. Cell culture and cultivation of Chicken/bird tumor viruses
21. MTT assay
22. Preventive and control measures of tumor viruses (theory exercises)

Learning resources and suggested books:

- 1) Methods in Virology, (1998) K. Marmorosch and H. Koprowski. Vol. I and II. Academic Press.
- 2) Diagnosis of Plant Virus Diseases, (1993). R.E.F. Matthews (ed.) CRC Press.
- 3) Serological Methods for detection and identification of viral and bacterial plant pathogens: A Laboratory Manual. (1990). R. Hampton et al., APS Press.
- 4) Methods in Plant Virology, (1984). S.A. Hill. Blackwell Publications.
- 5) Virology Methods Manual, 1996. B.W. J. Mahy and H.O. Kangro. Academic Press
- 6) Modern Techniques in Cytopathology (Monographs in Clinical Cytology, Vol. 25) (2020) 1st Edition, by Marilyn M. Bui (Editor), Liron Pantanowitz (Editor), Philippe Vielh (Series Editor), Series: Monographs in Clinical Cytology, Vol. 25, pages: 110, Publisher: S. Karger; 1 edition.
- 7) Medical Biochemistry, John W Baynes PhD (2018), Marek H. Dominiczak Dr Hab Med FRCPATH (Author), 5th Edition, 712 pages, Publisher: Elsevier.
- 8) Manual of Clinical Oncology Paperback – Dec 2017, by Chmielowski (Author), 900 pges, Publisher: Wolters Kluwer India Private Limited; Eighth edition (2017), price
- 9) Devita et al (2011), Cancer, Principles and Practice of Oncology: Review 4 by Govindan
- 10) CBS Oncology entrance examination (PB 2017) by BHATIA M.S. P.

VIR-305A: MEDICAL LAB TECHNOLOGY (Skill Development Course-Theory)

Lecture: 3 hours/week	Internal Marks; 10 Marks
Tutorial: Textbooks, E-learning resources, study materials, PowerPoint lectures	Semester End Theory Examination : 40 Marks
Semester: III	Credits: 2 Credits

UNIT-I

Requirements of Clinical Diagnostic Laboratory: GCP, GLP GCLP and GDP; Knowledge of lab organization, reporting and recording procedures; Ethics of laboratory practice, confidentiality of reports, Maintenance & Equipments of Pathology Lab; Preparation of Reagents; Concept of universal precautions, biohazard, Biomedical waste management (Handling of waste, waste segregation and management including disposal); Laboratory biosafety, Risk assessment and risk management, Laboratory accidents, prevention, first aid; Principles and methods of ensuring of quality assistance in the laboratory; Types of Specimens, Method of specimen collection, transport, packing and storing of samples (Blood, serum, Urine and others); Health education and health communication.

UNIT –II

Haematology: Clinical biochemistry-Blood Composition and general functions of blood; Description of blood cells - normal counts & function, Total blood cell count; Importance of blood groups composition in human, Rh typing, Blood group – ABO system, significance of coombs test; Blood donor selection, screening; Transfusion transmitted diseases & their lab diagnosis; Types of anaemia and diagnosis; Liver function test (LFT); Renal function test (RFT).

UNIT –III

Molecular Pathology - Infectious diseases and Pathogens; Types, Standards and Standardization of Molecular Diagnostics, Serological and molecular Diagnosis of human diseases-bacteria (Tuberculosis-*M. tuberculi*, Peptic ulcer-*H. pylori*), fungi (Aspergillosis, Candidiasis), viruses (HPV, HIV, Hepatitis- Hepatitis virus, dengue; SARS-CoV-2); parasites (filarial and malaria); Histopathology and histotechniques; Artificial intelligence in disease diagnosis;

UNIT –IV

Urine & Feces Analysis - Urine- Formation and composition, changes in relation to disease, collection, preservation; Examination–physical and chemical, Sugar, ketone bodies, bile, blood, crystals, parasites & abnormal cells; Feces–formation, physical & chemical Examination; Preparation of stool sample for microscopic examination; Sputum examination and assessment.

Learning resources and suggested books:

1. Text book of clinical chemistry - Teitz
2. Varley's Practical Clinical Biochemistry by Alan H Gowenlock, published by CBS Publishers and distributors, India Sixth Edition
3. Practical Biochemistry – Wilson & Walker
4. Clinical Biochemistry Principle and Practice – Praful B Godkar
5. Essential Immunology : Ivan Roitt (Blackwell Science Publishers, UK, 1997)
6. A Hand Book of Practical Immunology : GP Talwar (Vikas Publishing House, 1983)
7. Principles of Statistics.
8. Textbook of Medical Physiology by G.K. Pal.
9. Text book of Medical Biochemistry by Ramakrishna
10. Baily & Scott's Diagnostic Microbiology Edited by Sydney M. Finegold, C.V. Mosby Company, London.

PRACTICAL: VIR-305B: MEDICAL LAB TECHNOLOGY

Practicals: 3 hours/week	Semester End Examination: 50 Marks
Tutorial: Textbooks, E-learning resources, study materials, PowerPoint lectures	
Semester: III	Credits: 2 Credits

List of Practicals:

1. Good laboratory practice (GLP), Good clinical practice (GCP), good clinical laboratory practice (GCLP) and good document practice (GDP): Universal safety precaution, importance of personal hygiene, disposal of organic waste, washing and cleaning of glass ware, sterilization of glassware and lab ware (Theory exercise).
2. Methods of collection of clinical material for culture-urine, blood, throat swab, faeces, body fluids.
3. Microscopic examination of pathogens
4. Preparation of antibiotic discs and antibiotic susceptibility tests.
5. Blood collection & preservation using different anticoagulants& preservative solutions.
6. Preparation of blood films
3. Staining of blood smears.
7. Blood grouping & typing, Rh system-Rh factor.
8. Differential count of blood leukocytes.
9. Analysis of serum, urine and blood using biochemical tests.
10. Oxygen percentage, blood pressure and blood glucose recording.
11. Coombs test
12. HBsAg & HIV antibody testing in blood banks.
13. Visiting local hospitals and private diagnostic clinics.

Reference books/Manuals:

1. Concise Book On Medical Laboratory Technology, 2005 reprint, 1st Edn., C. R. Maiti, New Central Book Agency (p) Ltd, Kolkata, India.
2. Introduction of Medical Laboratory Technique, 1998, 7th Edn., Baker F. J., Silvertown R. E., Pallister C. J., Butterworth-Heinemann, UK.
3. Concise Book On Medical Laboratory Technology, 2005 reprint, 1st Edn., C. R. Maiti, New Central Book Agency (p) Ltd, Kolkata, India.
4. Introduction of Medical Laboratory Technique, 1998, 7th Edn., Baker F. J., Silvertown R. E., Pallister C. J., Butterworth-Heinemann, UK.
5. Molecular Diagnostics: For the Clinical Laboratorian / Edition 2 William B. Coleman (Editor), Gregory J. Tsongalis (Editor) Publisher: Springer-Verlag New York, LLC.
6. Buckingham and Flaw's, "Molecular Diagnostics: Fundamentals, Methods and Clinical Applications", F.A. Davis Company; First edition, 2007

**VIR-306A: VETERINARY & AGRICULTURAL VIRUSES AND THEIR
MANAGEMENT (Open Elective offered to students of other disciplines)**

Lecture: 6 hours/week	Internal Assessment: 20 Marks Seminars and assignments
Tutorial: Textbooks, E-learning resources, study materials, PowerPoint lectures	Semester End Examination: 80 Marks
Semester: III	Credits: 4 Credits

Note: With respect to important veterinary, plant and human virus diseases, emphasis should be on etiology, transmission, clinical manifestations, diagnosis, prevention and control.

UNIT-I

Introduction to Virology: Origin and evolution of viruses.

Morphology and properties of viruses: Physical- morphology and structure, Biochemical- chemical composition, nucleic acids, proteins, enzymes, lipids, carbohydrates, polyamines, cations.

Cultivation of viruses: Experimental plants and experimental animals, embryonated eggs and cell cultures.

Transmission of viruses: Vector and non-vector transmission.

UNIT-II

Veterinary epidemiology: Disease burden, clinical presentation and diagnosis, epidemiology and risk factors, Pathogenesis, importance of zoonosis.

Important animal viruses: Foot and Mouth Disease, Bluetongue, sheep pox, Peste des Petits ruminants, Hog cholera/ swine fever, Swine influenza, Rabies, Infectious canine hepatitis, Canine distemper, infectious bursal disease virus, Newcastle disease, Marek's disease, Avian influenza.

UNIT-III

Important plant viruses: Tobacco mosaic virus, peanut bud necrosis virus, Tomato spotted wilt virus, Tomato yellow leaf curl virus, Cucumber mosaic virus, Potato virus Y, Cauliflower mosaic virus, African cassava mosaic virus, Plum pox virus, Brome mosaic virus, Potato virus X, Chilli leaf curl virus, rice tungro virus, Banana bunchytop virus, sugarcane mosaic virus.

Important human viruses: Polio, HIV, Human corona viruses, Chikungunya, Dengue, Hepatitis B virus, Hepatitis C virus, Human papilloma virus, Influenza virus, West Nile virus, Ebola virus, Marburg, Zika virus.

UNIT-IV

Virus detection methods: Biological, physical, serological and molecular methods.

Management of plant viruses: Cultural practices, control of vectors, production of virus free plants, plant quarantine, production of transgenic plants.

Management of animal and human viruses: Sanitation, vector control, vaccines, antiviral drugs and chemotherapy.

Learning resources and suggested books:

- 1) Devita, Cancer, Principles and Practice of Oncology: (2019) Review 4 by Govindan.
- 2) Textbook of Medical Virology (2018), by B. Mishra (Author), details, 256 pages, Publisher: CBS Publishers & Distributors Pvt Ltd, India.
- 3) Practical clinical oncology, 2nd edition, Edited by Louise Hanna, Tom Crosby and Fergus Macbeth, (2015) 2 edition, Cambridge University Press.
- 4) Field's Virology (Knipe, Fields Virology) (2013), 2 Volume Set. by David M. Knipe and Peter Howley.
- 5) The Cell – A molecular approach. Fourth edition (2007). G. M. Cooper & R.E. Hausman. ASM Press.
- 6) Cell signaling. Second edition (2005). John T. Hancock. Oxford University press.
- 7) Principle of Virology: Molecular Biology, pathogenesis and control of animal viruses. (2004). By S.J. Flint et al.. ASM press
- 8) Culture of Animal Cells: A Manual of Basic Technique. (1987). R.I. Freshney. Alan R. Liss. Inc.
- 9) Oncogenes. 1995. 2nd Edition. By G.M. Cooper. Jones and Bartlett publishers.

(OR)

VIR-306B: EMERGING INFECTIOUS VIRUS DISEASES

(Open Elective offered to students of other disciplines)

Lecture: 6 hours/week	Internal Assessment: 20 Marks
	Seminars and assignments
Tutorial: Textbooks, E-learning resources, study materials, PowerPoint lectures	Semester End Examination: 80 Marks
Semester: III	Credits: 4 Credits

Note:With respect to emerging infectious virus diseases, emphasis should be on etiology, transmission, clinical manifestations, diagnosis, prevention and control.

UNIT-I

Introduction to Virology: Origin and evolution of viruses.

Morphology and properties of viruses: Physical- morphology and structure, Biochemical- chemical composition, nucleic acids, proteins, enzymes, lipids, carbohydrates, polyamines, cations.

Cultivation of viruses: Experimental plants and experimental animals, embryonated eggs and cell cultures.

Transmission of viruses: vector and non-vector transmission.

UNIT-II

Epidemiology and emergence of infectious viral diseases: Biology of emerging infectious diseases, factors influencing for virus epidemics, host defence against infectious diseases, zoonotic infections, Impact of social and environmental change on emergence, Controversies.

Emerging virus disease surveillance: Surveillance methods, evaluation and application of virus surveillance; Quarantine of viral diseases- International and national.

UNIT-III

Non-vector borne emerging virus diseases: Human Immunodeficiency virus, SARS, Corona and Influenza.

Vector-borne emerging infectious virus diseases- Dengue & Haemorrhagic Fever Viruses, Japanese Encephalitis, Chikungunya virus, West Nile virus, Ebola virus, Marburg, Zika virus.

UNIT-IV

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 emerging 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, vector control, and anti-virulence therapies, vaccines, public health measures, Bioterrorism.

Learning resources and suggested books:

1. Epidemiology, diagnosis and Management of Zoonoses. (2004). K.G. Narayana Sri Kuldeep Sharma Pub.
2. Clinical Virology. D.D. Richman *et al.*, 2nd Edition. (2002). ASM Press.
3. 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.
4. Veterinary Virology. F.A. Murphy *et al.* (1999). 3rd Edition. Academic Press.

VIR-307: COMMUNICATIVE ENGLISH AND FUNDAMENTALS OF COMPUTERS (Skill Enhancement Add-on Course-Self Study)

Self-Study	Internal Assessment: 100 Marks Seminars, quizzes and assignments
Tutorial: Textbooks, E-learning resources, study materials, guest lectures by experts.	Semester: IV

UNIT I

Oral and Aural Skills: Sounds of English vowels sounds and constant sounds; Word Accent and connected speech- contractions, questions tags; Listening for information; taking notes while listening to lectures (use of Dictionary, CD- ROM, audio, video for phonetics sounds, pronunciation and listening practice).

UNIT II

Writing Skills: Sentence writing and paragraph writing; use of linkers and appropriate vocabulary; Businessletters and E-mail (writing & etiquette); Descriptive writing (describing a person, product and process).

Job Skills: Group discussions and debates; Presentation skills –kinesis. 3. Interview skills.

Soft Skills: Interpersonal communication-verbal and nonverbal etiquette; Critical thinking; Teamwork.

UNIT III

Basics of personal computer and its components: Components of computer, Concept of programming languages; Hardware and software; Operating systems.

Windows Operating System-2010: System configuration, Simple commands to create directories and handle files.

Microsoft Office- 2017: Introduction and facilities available, shortcut bar, customizing toolbars; using common office techniques- starting an office application, Microsoft Word, Microsoft Excel, Microsoft PowerPoint; Conversion of word file to PDF.

UNIT IV

Introduction to Internet and Biologist: Internet basics, getting onto the internet, e-mail, google drive management, drop box, file transfer protocols, gopher, the world-wide web, browsing (Google Chrome, Internet Explorer, Mozilla Firefox) and down loading from sites; Learning management systems (zoom, webEx, G-meet).

Networking of Computers and overview of International and Indian networks: Virtual Library-I: Searching MEDLINE; NCBI/PubMed; Virtual Library II: Science Citation Index, h-index, impact factor 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.

Learning resources and suggested books:

1. English for Success Suresh Kumar, Cambridge University Press India Pvt.Ltd.2010.
2. Communication Skills & Soft Skills - An Integrated Approach, Dorling Kindersley, India Pvt. Ltd. 2013.
3. A. Goel, Computer Fundamentals, Pearson Education, 2010.
4. P. Aksoy, L. DeNardis, Introduction to Information Technology, Cengage Learning, 2006
5. P. K.Sinha, P. Sinha, Fundamentals of Computers, BPB Publishers, 2007.
6. Elements of Computer Science, 1998. S.K. Sarkar, A.K. Gupta. S. Chand & Company (Chapters- 1,2,9,12,14).
7. 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.
8. Bioinformatics : Methods and Protocols, Edited by Stephen Misener and Stephen A. Krawetz. 2000. Methods in Molecular Biology Series. Humana Press.
9. Bioinformatics : A Practical guide to the analysis of genes and proteins. 1998. Edited by A.D. Baxevanis and B.F.
10. Francis Ouellette. Wiley - Interscience. Computational Methods in Molecular Biology by S.L. Saizberg.
11. Computer Applications in Biotechnology. 1998. by T. Yosida. Introduction to Bioinformatics by Atwood.

SEMESTER-IV

VIR-401: ANIMAL AND HUMAN VIROLOGY

(Core Theory-I)

Lecture: 6 hours/week	Internal Assessment: 20 Marks Seminars and assignments
Tutorial: Textbooks, E-learning resources, study materials, PowerPoint lectures	Semester End Examination: 80 Marks
Semester: IV	Credits: 4 Credits

UNIT-I

Virus-host interactions: Influence of virus on host organism- Cytopathic effects, inclusion bodies, chromosomal aberrations; Response of host cells to viral infection- host specificity, resistance, interference, immunological responses; 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.

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.

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

UNIT-III

Epidemiological concepts of Virus diseases: Definition of terms, types of epidemiological investigations, components of epidemiology, qualitative and quantitative investigation.

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.

Detection of animal and human viruses: Biological, serological and molecular approaches.

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.

Learning resources and suggested books:

1. Epidemiology, diagnosis and Management of Zoonoses. (2004). K.G. Narayana Sri Kuldeep Sharma Pub.
2. Medical Microbiology.(1997). Fifteenth edition. Edited by D.Green wood, R.C.Slack and J.F.Peutherer. Churchill Livingstone.
3. Veterinary Virology. F.A. Murphy *et al.* (1999). 3rd Edition. Academic Press.
4. Medical Virology. (1994). 4th ed. D.O. White and F.Fenner. Academic Press. (chapters— 12,13 to 29).
5. Veterinary Virology. (1993). 4th ed. F. Fenner. Academic Press (Part-II).
6. Textbook of Human Virology, 2nd Edition. (1991). R.W. Belshe. Mosby yearbook.
7. Viruses of vertebrates. (1989). J.S. Porter field, Bailliere Tindals.
8. Veterinary Epidemiology. (1986). M. Thrusfield. Butter Worth Publications.
9. Methods in Environmental Virology. (1982). C.P. Gerba and S.M. Goyal. Marcel Dekker Inc.

VIR-402: ANIMAL AND HUMAN VIRUS DISEASES
(Core Theory-II)

Lecture: 6 hours/week	Internal Assessment: 20 Marks Seminars and assignments
Tutorial: Textbooks, E-learning resources, study materials, PowerPoint lectures	Semester End Examination: 80 Marks
Semester: IV	Credits: 4 Credits

Note: Emphasis should be on etiology, transmission, clinical manifestations, diagnosis, prevention and control. Virus Diseases based on genome and family.

UNIT-I

RNA Viruses:

Picornaviridae-Human Polio, Foot and Mouth disease; *Caliciviridae*- Norwalk virus, Swine Vesicular exanthema; *Coronaviridae*-Human corona virus, Avian infectious bronchitis viruses; *Astroviridae*-Human astroviruses; *Matonaviridae*-Rubella; *Togaviridae*- chikungunya; *Flaviviridae*-Yellow fever, Hepatitis C virus, Kyasanur forest disease, Dengue and Japanese encephalitis, Bovine viral diarrhea, Hog cholera; *Reoviridae*- Human rotavirus, Blue tongue virus, Orthoreovirus; *Birnaviridae*-Infectious bursal disease virus.

UNIT-II

Orthomyxoviridae-Human influenza, birdflu; *Paramyxoviridae*- Measles, Mumps, Canine distemper, rinderpest, peste des petits ruminants virus and Newcastle disease; *Rhabdoviridae*- Rabies, Vesicular stomatitis viruses; *Filoviridae*-Marburg, Zaire and Ebola viruses; *Bunyaviridae*- Hantaan, Rift valley fever; *Arenaviridae*-Lymphocytic choriomeningitis virus; *Retroviridae* –Rous sarcoma virus, HIV.

UNIT-III

DNA Viruses:

Circoviridae-Chicken anemia virus; *Parvoviridae*-Human B19 virus, Feline panleukopenia, Canine and Porcine parvoviruses; *Poxviridae*- Smallpox, Vaccinia, Sheeppox and Fowlpox viruses; *Herpesviridae*- Human herpes viruses, Varicella-Zoster, Cytomegalo, Epstein-Barr and herpes simplex viruses, Infectious Bovine rhinotracheitis; *Papillomaviridae*-Bovine and Human papilloma viruses; *Adenoviridae*- Human adenoviruses causing respiratory, ocular, genitourinary and enteric infections, infectious canine hepatitis virus.

UNIT-IV

Hepadnaviridae - Hepatitis-B virus; *Asfaviridae*- African swine fever virus; *Iridoviridae*- Invertebrate iridescent, Frog iridoviruses; *Polydnaviridae*- Ichnovirus, Bracovirus; *Polyomaviridae*-Simian virus 40.

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

Major viruses of insects: Biology, prevention and management.

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

Emerging and Re-emerging virus diseases: Zika, Nipha, Chikungunya, SARS Coronaviruses, Swineflu, West Nile viruses.

Learning resources and suggested books:

1. Emerging and Reemerging Viral Pathogens Volume 2: Applied Virology Approaches Related to Human, Animal and Environmental Pathogens, Moulay Mustapha Ennaji, (2019). Academic Press.
2. Environmental Virology and Virus Ecology, Carolyn M. Malmstrom, (2018), Academic Press.
3. Infectious Diseases, Microbiology and Virology, Luke S. P. Moore, James C. Hatcher, Cambridge Medicine, (2019).
4. Clinical Veterinary Microbiology, 2e 2nd Edition, Markey, Bryan, Leonard, Bryan Markey, Finola Leonard, Marie Archambault, Ann Cullinane, Mosby publication, (2019).
5. Veterinary Virology, Frederick A. Murphy, E. Paul J. Gibbs, Marian C. Horzinek, Michael J. Studdert, (2019), Academic Press.
6. Textbook of Medical Virology, December 14, (2018), by B. Mishra (Author), details, 256 pages, Publisher: CBS Publishers & Distributors Pvt Ltd, India (2018).
7. Recent Advances in Animal Virology 1st ed. (2019) Edition, Kindle Edition, by Yashpal Singh Malik (Editor), Raj Kumar Singh (Editor), Mahendra Pal Yadav (Editor), 471 pages, Publisher: Springer; 1st ed. 2019 edition (November 14, 2019).
8. Clinical Virology. D.D. Richman *et al.*, 2nd Edition. (2002). ASM Press.
9. Bluetongue. –(2007). Gaya Prasad and Meenakshi Yashpal Singh Mallik. Sri Kuldeep Sharma Pub.
10. Epidemiology, diagnosis and Management of Zoonoses. (2004). K.G. Narayana Sri Kuldeep Sharma Pub.
11. Foot and mouth disease –A monograph. (2003). S.C. Adhikari Sri Kuldeep Sharma Pub.
12. Veterinary Virology. F.A. Murphy *et al.* (1999). 3rd Edition. Academic Press.
13. 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.
14. Medical Virology. (1994). 4th ed. D.O. White and F. Fenner. Academic Press. (chapters – 12, 13 to 29).
15. Textbook of Human Virology, 2nd Edition. (1991). R.W. Belshe. Mosby yearbook.
16. Viral Infections of Humans: Epidemiology and control. (1989). 3rd Edition.
17. A.S. Evans (ed). Plenum Medical Book Company.
18. Medical microbiology. (1997). Fifteenth edition. Edited by D. Greenwood, R.C. Slack and J.F. Peutherer. Churchill Livingstone
19. Medical microbiology. (1995). 22nd Edition. G.F. Brooks, J.S. Butel and S.A. Morse. Lange Medical Books/Mc Graw-Hill.
20. Viruses of vertebrates. (1989). J.S. Porter field, Bailliere Tindall.
21. Encyclopedia of Virology. (1994). R.G. Webster and Allan Granoff. 9eds.) Vol. I, II, Academic Press.

VIR-403A: APPLIED VIROLOGY

(Generic Elective)

Lecture: 6 hours/week	Internal Assessment: 20 Marks Seminars and assignments
Tutorial: Textbooks, E-learning resources, study materials, PowerPoint lectures	Semester End Examination: 80 Marks
Semester: IV	Credits: 4 Credits

UNIT – I

Viruses as model systems in Molecular Biology: Exploitation of viruses as model systems in understanding the replication of nucleic acids and regulation of gene expression strategies and cancer biology (SV-40, adenoviruses).

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.

Exploitation of viruses as functional gene delivery/therapy systems: Retro-, adeno- and parvoviruses; 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.

UNIT-II

Phage display and phage therapy: Exploitation of bacteriophages for peptide display and therapy.

Recombinant antibodies: *In vitro* production of rDNA technology-based antibodies (monoclonal antibodies and scFv) to viruses and their applications.

Modern vaccines to viruses: Designing of modern vaccines, modern vaccines—recombinant proteins, subunit vaccines, mRNA-based vaccines, VLP vaccines, DNA vaccines, peptides, immune modulators (cytokines), vaccine delivery & adjuvants, large scale manufacturing-QA/QC issues, Animal models and vaccine potency testing; extraction of antiviral compounds from natural resources and their characterization.

UNIT-III

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, corona) and insect-borne (Japanese encephalitis, dengue, chikungunya) viruses.

Virus resistant crops: Production of virus resistant/tolerant crops through transgenic technology by exploiting genes derived from viruses, guidelines for testing and releasing the transgenic lines in India.

Virus-based nanotechnology: Viral nanoparticles (VNPs), virus-like particles (VLPs), plant virus-derived nanoparticles (PVNs), biodistribution and pharmacokinetics, application of plant viruses as biotechnological tools in medicine, industry and agriculture.

UNIT-IV

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

Biosafety and Biosecurity: Biosafety levels and risk group, classification, Containment, Good microbiological practices, Good Laboratory practices (GLP), Disinfection, Decontamination and Sterilization procedures, solid versus liquid waste, safety rules, preparedness and response for the emergency conditions in the laboratory.

Ethics in Virology: Ethics in Virus-related research, ethical and regulatory issues in animal experiments, issues related to Good Manufacturing Practices (GMP), Importance of Intellectual Property Rights and Indian patent system.

Learning resources and 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. Clinical Virology. (2002). 2nd edition. D.D.Richman et al., ASM
6. Principles of gene manipulation. 6th edition. (2002). By S. Primrose, R. Twyman and B. Old. Blackwell Science.
7. Matthews' Plant Virology. (2001). By R. Hull. Academic Press.
8. 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.
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).

(OR)

VIR-403B:VIRUS-BASED BIOTECHNOLOGY

(Generic Elective)

Lecture: 6 hours/week	Internal Assessment: 20 Marks
Tutorial: Textbooks, E-learning resources, study materials, PowerPoint lectures	Semester End Examination: 80 Marks
Semester: IV	Credits: 4 Credits

UNIT-I

Viruses as model systems in Molecular Biology: Exploitation of viruses as model systems in understanding the replication of nucleic acids and regulation of gene expression strategies and cancer biology (SV-40, adenoviruses).

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.

Exploitation of viruses as functional gene delivery/therapy systems: Retro-, adeno- and parvoviruses for gene delivery and gene therapy; Display of foreign peptides on virion surface and applications.

UNIT-11

Phage display and phage therapy: Exploitation of bacteriophages for peptide display and therapy.

Viral biopesticides: Mass production and applications of bacterial, fungal and insect viruses and their application as biocontrol agents.

Virus resistant crops: Production of virus resistant/tolerant crops through transgenic technology by exploiting virus or non-viral genes, guidelines for testing and releasing the transgenic lines in India.

Recombinant antibodies: *In vitro* production of rDNA technology-based antibodies (monoclonal antibodies, scFv) to viruses and their applications.

UNIT-III

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

Modern vaccines to viruses: Designing of modern vaccines, modern vaccines—recombinant proteins, subunit vaccines, mRNA-based vaccines, VLP vaccines, DNA vaccines, peptides, immunomodulators (cytokines), vaccine delivery & adjuvants, large scale manufacturing-QA/QC issues, Animal models and vaccine potency testing.

Virus-based nanotechnology: Viral nanoparticles (VNPs), virus-like particles (VLPs), plant virus-derived nanoparticles (PVNs), biodistribution and pharmacokinetics, application of plant viruses as biotechnological tools in medicine, industry and agriculture.

UNIT-IV

Viruses as biological warfare, bio-crime and bioterrorism agents: Small poxvirus (Variola), viral encephalitis and viral hemorrhagic fevers, HIV, viral hemorrhagic fevers, corona, Ebola and yellow fever viruses.

Biosafety and biosecurity: Biosafety Levels and Risk group, Classification, Containment, Good microbiological practices, Good Laboratory practices (GLP), Disinfection, Decontamination and sterilization procedures, safety rules, preparedness and response for the emergency conditions in the laboratory.

Ethics in Virology: Ethics in virus-related research, ethical and regulatory issues in animal experiments, issues related to good manufacturing practices (GMP), basics in Intellectual Property Rights, Indian patenting system.

Learning resources and suggested books:

1. Zoonoses: Infectious diseases transmissible from animals to humans. 3rd Edition. (2003). H. Krauss *et al.* ASM Press.
2. Clinical Virology. (2002). 2nd edition. D.D.Richman *et al.*, ASM
3. Matthews' Plant Virology. (2001). By R. Hull. Academic Press.
4. Control of Plant Virus Diseases. By Hadidi *et al.*(Eds). APS. USA.
5. Field's Virology. (2002). Vol. I, II.
6. Bailey and Scotts' Diagnostic Microbiology. 11th Edition. (2002). By B.A. Forbes *et al.*, Mosby publisher.
7. Principles of gene manipulation. 6th edition. (2002). By S. Primrose, R. Twyman and B. Old. Blackwell Science. .
8. 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.
9. Medical Virology. (1994). 4th ed. D.O. White and F. Fenner. Academic Press.
10. Veterinary Virology. (1993). 4th ed. F. Fenner *et al.*, Academic Press (Part-II).

**PRACTICAL: VIR-404A: ANIMAL AND HUMAN VIROLOGY & VIRUS
DISEASES AND APPLIED VIROLOGY**

Lecture: 12 hours/week	Semester End Examination: 100 Marks
Tutorial: Textbooks, E-learning resources, study materials	
Semester: IV	Credits: 4 Credits

List of Experiments:

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. Culturing of Sheep kidney cells
6. Culturing of Chicken embryo fibroblast cells.
7. Sub-culturing of Sheep kidney cells.
8. Inoculation of virus into sheep kidney cell cultures.
9. Chicken embryo inoculation techniques.
10. Study of pathogenic lesions of animal virus diseases through slides.
11. Serodiagnosis of virus infections (HBV and HCV) of humans using kits.
12. Participation in vaccination programs (extension activity).
13. Application of NPV and its role as biopesticide.
14. Isolation and analysis of human rotavirus genome
15. Participation in vaccination programs (extension activity).
16. Diagnosis of PRSV using ELISA.
17. Visits to local sericulture, poultry, fish and prawn farms.
18. Biosafety guidelines (Theory exercise)

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. Gurlson et al., Academic Press, Inc.
5. Molecular: A Practical Approach. (1993). Edited by A. J. Davson and R.M. Elliott. IRL Press.
6. Evidence-Based Diagnosis: An Introduction to Clinical Epidemiology 2nd Edition, by Thomas B. Newman (Author), Michael A. Kohn (Author), 405 pages, Publisher: Cambridge University Press; 2 edition (June 30, 2020).
7. Guide to Clinical and Diagnostic Virology (ASM Books) 1st Edition, by Reeti Khare (Author), Publisher: ASM Press; 1 edition (March 19, 2019), 460 pages, Publisher: ASM Press; 1 edition (March 19, 2019).
8. Viruses: Molecular biology, host interactions, and applications to biotechnology. 2018. Paula Tennant, Gustavo Femin and Jerome E Foster. Academic Press.

9. Molecular and Cellular biology of viruses. 2019. Phoebe Lostroh, ISBN 9780815345237.
10. Techniques in diagnoses of Plant Viruses (Plant Pathogens -6)-(2008). Govind.Rao, Rodrigo A. Valverde & C.I. Dovas, Stadium Press.
11. Epidemiology, diagnosis and Management of Zoonoses. (2004). K.G. Narayana Sri Kuldeep Sharma Pub.
12. Field's Virology. (2002). Vol. I, II.
13. Bailey and Scotts' Diagnostic Microbiology. 11th Edition. (2002). By B.A. Forbes et al., Mosby publisher.
14. Clinical Virology. (2002). 2nd edition. D.D. Richman et al., ASM
15. Principles of gene manipulation. 6th edition. (2002). By S. Primrose, R. Twyman and B. Old. Blackwell Science.
16. Matthews' Plant Virology. (2001). By R. Hull. Academic Press.
17. 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.
18. Control of Plant Virus Diseases. By Hadidi *et al.* (Eds). APS. USA.
19. Medical Virology. (1994). 4th ed. D.O. White and F. Fenner. Academic Press.
20. Veterinary Virology. (1993). 4th ed. F. Fenner *et al.*, Academic Press (Part-II).

(OR)

PRACTICAL:VIR-404B: ANIMAL AND HUMAN VIROLOGY &VIRUS DISEASES AND VIRUS BASED BIOTECHNOLOGY

Practicals: 6 hours/week	Semester End Examination: 100 Marks
Tutorial: Textbooks, E-learning resources, study materials	
Semester: IV	Credits: 4 Credits

List of Experiments:

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. Culturing of Sheep kidney cells
6. Culturing of Chicken embryo fibroblast cells.
7. Sub-culturing of Sheep kidney cells.
8. Inoculation of virus into sheep kidney cell cultures.
9. Chicken embryo inoculation techniques.
10. Study of pathogenic lesions of animal virus diseases through slides.
11. Serodiagnosis of virus infections (HBV and HCV) of humans using kits.
12. Participation in vaccination programs (extension activity).
13. Application of NPV and its role as biopesticide.
14. Purification of virus-based nanoparticles using differential centrifugation.

15. Characterization of virus-based nanoparticles.
16. Diagnosis of a plant virus using ELISA.
17. Visits to local sericulture, poultry, fish and prawn farms.
18. Biosafety guidelines (Theory exercise)

Suggested Books / Manuals:

21. Diagnostic Microbiology. 11th Edition. (2002). By B.A. Forbes et al., Mosby publisher.
22. Culture of Animal Cells: A Manual of Basic Technique. (1987). R.I. Freshney. Alan R. Liss. Inc.
23. Virology - A Practical Approach. (1985). D.W.J. Mahy. IRL Press.
24. Virology - A Laboratory Manual. (1992). F.G. Gurlson et al., Academic Press, Inc.
25. Molecular: A Practical Approach. (1993). Edited by A. J. Davson and R.M. Elliott. IRL Press.
26. Evidence-Based Diagnosis: An Introduction to Clinical Epidemiology 2nd Edition, by Thomas B. Newman (Author), Michael A. Kohn (Author), 405 pages, Publisher: Cambridge University Press; 2 edition (June 30, 2020).
27. Guide to Clinical and Diagnostic Virology (ASM Books) 1st Edition, by Reeti Khare (Author), Publisher: ASM Press; 1 edition (March 19, 2019), 460 pages, Publisher: ASM Press; 1 edition (March 19, 2019).

VIR-405A: INDUSTRIAL BIOTECHNOLOGY (Multidisciplinary Course)

Lecture: 6 hours/week	Internal Assessment: 20 Marks Seminars and assignments
Tutorial: Textbooks, E-learning resources, study materials, PowerPoint presentations by guest lecturers.	Semester End Examination: 80 Marks
Semester: IV	Credits: 4 Credits

Unit-I

Selection of Microorganisms: Isolation, screening, Preservation and maintenance of industrially important microorganisms; Media for industrial fermentation-natural and synthetic media; media formulations-carbon sources, nitrogen sources, minerals, vitamin sources, nutrient recycle; buffers-precursors and metabolic regulators and oxygen requirement; Air and Media Sterilization.

Strain improvement methods: Conventional and rDNA methods.

Bioreactors: Basic principles of design and construction of Bioreactor; Types and working principles of specialized bioreactors.

Unit-II

Fermentation and its types: Solid state and submerged fermentations; Analysis of batch, fed-batch and continuous fermentations, aerobic and anaerobic fermentation, chemostat fermentation; Planning and identification of in-process controls (specifications) for optimizing the fermentation process.

Scale-up of microbial bioreactors: Analysis of scale-up methods by Constant P/V, K_La , N:P ratio.

Bioprocess control measurements: Physical and chemical measurements and control of bioprocess parameters; Methods for off-line and on-line monitoring of bioreactors; Bioprocess modeling and simulation.

UNIT – III

Down Stream Processing: Cell disruption- physical, chemical and enzymatic methods; biomass separation by centrifugation, filtration and flocculation; extraction- solvent, two phase, liquid extraction, whole broth and aqueous multiphase extraction; Purification – Chromatography (ion exchange, molecular sieve, affinity, HPLC), concentration, ultra-filtration, reverse osmosis, drying and crystallization; Quality assurance techniques and its importance in marketing; economics of industrial fermentation and market potential.

UNIT – IV

Industrial production of Biochemicals: Industrial production of alcohol (ethanol), alcohol beverages (beer), acids (citric acid), solvents (glycerol), antibiotics (penicillin), amino acids (lysine), Enzymes (Amylases), Vitamins(B12.) and their applications; Enzymes in industrial processing- Role of cellulases, hemicellulases, lipases, proteases, laccases and pectinases; Single cell protein; Enzyme immobilization and its industrial applications.

Industrial biotechnology for pollution control, treatment of industrial and other wastes; Bio-mining and bioleaching of ores, Ethanol, methane and hydrogen from biomass; Production of biodiesel, algal biofuel; Bioconversion and Bioremediation, Bioremediation of oil spills; Wastewater treatment; Removal of heavy metals, microbial degradation of pesticides and aromatic compounds; Metabolic engineering-Strategies for optimization of genetic and regulation pathways for increased production of product or strain improvement; Biosensors and Instrumentation-Methods used to interface sensors for biological and biomedical applications with electronics.

Learning resources and suggested Books:

1. Crueger & Crueger Biotechnology: A Text Book of Industrial microbiology 2nd edition
2. Demain, A.L Biology of Industrial Microorganisms
3. Hobbs, B.C. and Rioberts, D 1993 Food Poisoning and Food Hygiene Edward Arnold, London.
4. Hui Y H 2006 Food Biochemistry and Food Processing Blackwell
5. Joshi, V.K. Ashok Pondey 1999 Biotechnology and Food fermentation Vol. I & II.
6. Patel, A.H. Industrial microbiology/
7. Prescott and Dunn's, Industrial Microbiology 4th edition.
8. Reed, G. Industrial Microbiology, CBS Publishers.

9. Microbial Technology Vol. I & II. Peppeler & Perllman (EDS).
10. Microbial Ecology – Fundamentals and applications. Atlas and Bartha.
11. Stanbury and Whittaker – Principles of Sterilization techniques, First Indian reprint Edition (1997). Aditya Book (P) Ltd. New Delhi
12. Michael J. Wailes - Industrial microbiology: an introduction 7th Edition; Wiley-Blackwell 2008.
13. Damien and Davies – Microbial Technology Edition (1994).
14. LE Casida – Industrial Microbiology Edition (1994)
15. H Patel – Industrial Microbiology 4th Edition (2003). 7. KS Bilgrami and AK Pandey – Introduction to Biotechnology Edition 2nd (1998).
16. U Satyanarayan – Biotechnology, First Edition (2005) Books and Allied (P) Ltd. Kolkata.
17. Baily JE and Ollis DF., Biochemical Engineering fundamentals, 2nd Edition, McGraw-Hill Book Co., New York, 1986.
18. Mansi EMTEL, Bryle CFA. Fermentation Microbiology and Biotechnology, 2nd Edition, Taylor & Francis Ltd, UK, 2007.
19. Shara L. Aranoff, Daniel R. Pearson, Deanna Tanner Okun, Irving A. Williamson, Dean A. Pinkert – Industrial Biotechnology; Nova Science 2009.
20. Comprehensive Biotechnology. Volumes 1, 2, 3 & 4. Moo-Young M., Pergamon Press, 2011.

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VIR-405B: PROJECT WORK

Project: 12 hours/week	Dissertation: 60 Marks
Tutorial: Textbooks, E-learning resources, study materials	Presentation: 10 Marks Viva: 20 marks
Semester: IV	Credits: 4 Credits

- Students intended to do project; they need to undertake a project work related to Virology. The project report will be submitted in the form of dissertation duly certified by the supervisor and Head of the Dept. The project will be presented for evaluation at the end of semester by external expert.

VIR-406A: HUMAN VIRUS DISEASES
(Open Elective offered to students of other disciplines)

Lecture: 6 hours/week	Internal Assessment: 20 Marks Seminars and assignments
Tutorial: Textbooks, E-learning resources, study materials, PowerPoint lectures	Semester End Examination: 80 Marks
Semester: IV	Credits: 4 Credits

UNIT-I

Viral Enteric Diseases: Enteric viral infections, clinical course, disease burden, risk factors, prevention and treatment; Rotavirus diversity, emerging strains, immunopathogenesis; Other viruses associated with diarrhea and gastroenteritis.

Viral hepatitis: Physiology of Jaundice, clinical features and differential diagnosis, presentations of hepatitis caused by different hepatitis viruses (HAV, HBV, HCV & HEV); Serological and molecular diagnosis of different hepatitis viruses; vaccines presently used & vaccines of the future.

UNIT-II

Viral Encephalitis: Viral Encephalitis, encephalopathy and meningitis, clinical symptoms and causative agents, treatment modalities, transmission, spread, Laboratory diagnosis, basic principles, preferred methods and problems; Japanese encephalitis and West Nile viral infections, Encephalitis/ encephalopathy caused by measles virus, Enteroviral encephalitis and meningitis, Mumps encephalitis, diagnosis and treatment; routes and modalities of infections of the nervous tissue, blood brain barrier, factors affecting the neurovirulence.

Viral Respiratory Diseases: History, clinical features, epidemiology, of influenza, RSV and other respiratory diseases; Biology and pathogenesis of SARS-CoV-2, Metapneumovirus and Corona virus; Differential diagnosis of different respiratory diseases, Vaccines against different viral respiratory diseases.

UNIT-III

Viral Exanthematous Diseases: Viruses associated with exanthematous diseases, Clinical features, disease burden, case definition and associated risk factor, strategies for prevention & treatment, biology and immunopathogenesis, Biology of Measles, mumps, rubella, Parvovirus B-19, Chicken pox and other viral pox diseases, Laboratory diagnosis of measles, mumps and rubella; Paraspecific immunity due to pox vaccination, eradication and control programs.

Viral Hemorrhagic Fevers: Common clinical features of viral hemorrhagic fevers, history and Disease burden, Risk factors and geographical distribution of viruses associated with

hemorrhagic fevers and their impact on global health, Clinical samples required, choice of laboratory diagnostic tests and their interpretation for differential diagnosis; Virus replication strategies, pathogenesis, prevention and treatment of Dengue; Prevention and treatment of Chikungunya, hemorrhagic fever, Ebola and Rickettsial fevers.

UNIT-IV

HIV/AIDS: Introduction to retroviruses, global epidemiology of HIV, epidemiology of HIV in India, sexually transmitted diseases and their relationship with HIV, opportunistic infections in HIV infected individuals, social and behavioral aspects of prevention and control; Natural History, structure and replication of HIV, immunopathogenesis of infection, laboratory diagnosis of HIV infection, trials pertaining to prevention and therapy, antiviral therapy and drug resistance, HIV vaccines.

Oncogenic viruses: Viral oncogenesis, oncogenic viruses- HPV, HTLV, Epstein Barr virus.

Learning resources and suggested books:

1. Fields Virology, 4th Ed., Vol 2 Ed by David M Knipe, and Peter M Howley Chapters: 24, 28,34, 54, 55, 67 and 68.
2. Gastroenteritis Viruses, Vol. 238. Novartis Foundation Symposium, Mary Estes, Latest edition (2001).
3. Viral Infections of the Gastrointestinal Tract, Vol. 10. Albert Z. Kapikian, Z. Kapikian A. 2nded., rev. and expanded. Latest edition / Pub.(1994).
4. Human Enterovirus Infections, Harley A. Rotbart (Editor), American Society Microbiology, (1995).
5. Viral Gastroenteritis, Edited By U. Desselberger, J. Gray. Elsevier Perspectives In Medical Virology. Series Editor: Arie J. Zuckerman, Uk Isa K. Mushahwar. (2003).
6. Viruses and Liver Cancer. Edited by E. Tabor. Elsevier Perspectives In Medical Virology. Series Editor: Arie J. Zuckerman, Uk Isa K. Mushahwar. (2002).
7. Viruses, Cell Transformation, and Cancer. Edited by J.A. Grand. Elsevier Perspectives I
8. Medical Virology. Series Editor: Arie J. Zuckerman, Uk Isa K. Mushahwar. (2001).
9. Fields Virology, Volume 2, 4th edition, (2001).
10. Clinical Virology, Second Edition (Richmans Hayden).
11. Hepatitis Viruses (Japan medical research forum).
12. Viral Hepatitis and Liver disease, A.J. Zuckerman.
13. Viral Hepatitis Molecular Biology Diagnosis and Control, By Isa Mushahwar. Elsevier
14. Perspectives In Medical Virology. Series Editor: Arie J. Zuckerman, Isa K. Mushahwar.(2003).
- Krugman's Infectious Diseases of children By Saul Krugman.
15. Immunization Safety Review: Vaccines and Autism Immunization Safety Review Committee (Editor) The National Academies Press, USA.
16. Measles and Rubella. Alvin Silverstein, Robert Silverstein, Virginia B. Silverstein, Virginia Silverstein. July 1997.
17. Immunization Safety Review: Measles-Mumps-Rubella Vaccine and Autism. Kathleen R.Stratton, Alicia R. Gable, Padma Shetty. June (2001). Kingsbury DW. ed. The Paramyxoviruses. New York: Springer Science + Business Media, (1991). p. xxi + 596 p.
18. Zuckerman AJ. ed. Principles and Practice of Clinical Virology. Chichester: John Wiley and Sons, (1990). p. ix + 643 p.

19. World Health Organization. Global Measles and Rubella Strategic Plan: 2012-2020.--
20. Geneva: World Health Organization, (2012). p. 42 p.
21. HIV and Aids by Michael A. Palladino, David Wessner. Latest edition / 2005, Benjamin Cummings.
22. HIV Libman, Harvey J. Makadon. Royal Society of Medicine Press Ltd. (2006).
23. Textbook of Aids Medicine. Thomas C. Merigan, John G. Bartlett (Editor), Dani Bolognesi (Editor). Latest edition / Pub. Date: September (1998) . Publisher: Lippincott Williams & Wilkins.
24. Aids Therapy. Raphael Dolin, Henry Masur (Editor), Michael S. Saag (Editor). edition. Pub. Date: November (2002).
25. Viral Encephalitis in Humans. John Booss (Editor), Margaret M. Esin, Margaret Esiri (Editor). Latest edition / Pub. Date: June (2003). Publisher: ASM Press.
26. Encephalitis Protection. Qingshan Liang. Latest edition / Pub. Date: January (2004). Publisher: Cozy Graphics Corporation

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VIR-406B: CLINICAL VIRIOLOGY
(Open Elective offered to students of other disciplines)

Lecture: 6 hours/week	Internal Assessment: 20 Marks Seminars and assignments
Tutorial: Textbooks, E-learning resources, study materials, PowerPoint lectures	Semester End Examination: 80 Marks
Semester: IV	Credits: 4 Credits

UNIT-I

Introduction to Virology: Introduction to Virology, characteristics, taxonomy of animal and human viruses, morphology of viruses, mode of transmission of viruses, replication of viruses, isolation and cultivation of viruses, CPE, virus characterization by various methods.

UNIT-II

Collection and diagnosis: Viral specimen collection, transport and processing, methods used for preservation of virus samples, diagnosis and detection of viruses by using biological, immunological and molecular methods; biosafety levels and risk group, containment, good microbiological practices, good laboratory practices (GLP), disinfection, decontamination and sterilization procedures, safety rules.

UNIT-III

Clinically important viral diseases: Importance of common nosocomial, enteric (food and water-borne, hepatitis A & E, polio, rotaviruses), blood-borne (hepatitis B & C, HIV), contact

transmitted (common cold, flu, corona) and insect-borne (Japanese encephalitis, dengue, chikungunya) viruses; Zoonotic diseases and their role in the society.

UNIT-IV

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.

Learning resources and suggested books:

1. Principles and Practice of Clinical Virology, Carol Shoshkes Reiss, (2009).Editor;, 6th ed. ISBN: 9780470517994. \$450 p. 968.
2. Clinical Virology. D.D. Richman *et al.*, 2nd Edition. (2002), ASM Press.
3. 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.
4. Fields Virology. (2001). 3rd Edition. Vol. 1, 2. B.N. Fields, D.M. Knipe, P.M. Howley.

VIR-407: TEACHING AND RESEARCH APTITUDE (Skill Enhancement Add-on Course-Self-Study)

Self-Study	Internal Assessment: 100 Marks Seminars, quizzes and assignments
Tutorial: Textbooks, E-learning resources, study materials	Semester: IV

UNIT-I

Teaching Aptitude: Learner's Characteristics; Factors affecting Teaching; Methods of Teaching in institutions of higher learning; Teaching aids; Evaluation Systems; Importance of ethics education in science; Importance of honesty, courage, justice, nobility and wisdom in teaching profession; Purity of thought and action to become effective teacher in Science.

Research Aptitude: Research - Meaning, Motivation in Research; Characteristics and Types; Steps of Research; Methods of Research; Identifying research problem, framing objectives, setting hypothesis & research design, testing hypothesis, reviewing literature; Importance of reasoning in research; Thesis and article writing, their characteristics and format; Workshop, Seminar, Conference and Symposium; Research Ethics; Ethics of Scientific Writing.

Comprehension and communication: Communication, effective communication; Barriers to effective communication.

UNIT-II

Mathematical Reasoning and Aptitude: Types of reasoning, number series, letter series, codes, and relationships; Mathematical aptitude.

Logical Reasoning: Understanding the Structure of Argument; Evaluating and distinguishing Deductive and Inductive Reasoning; Verbal Analogies; Word Analogy – Applied Analogy; Verbal Classification; Reasoning Logical Diagrams; Simple Diagrammatic Relationship, Multi – Diagrammatic Relationship; Venn Diagram; Analytical Reasoning.

UNIT-III

Data Interpretation: Sources, Acquisition and Interpretation of Data; Quantitative and Qualitative Data; Representing and Interpreting Data; Data and governance; Graphical Representation and Mapping of Data; Locating ethics in scientific data; Conflict of interest; Ethical Issues of Data Reporting and for Authenticity.

Report Writing: Components, Types of reports, Layout of research report, Principles of writing, References, Appendices, Format of publication in research, Journals, Paper Presentations- Planning, Preparation, Visual aids; Preparation of research proposal.

UNIT-VI

Information and Communication Technology (ICT): ICT-Meaning, Advantages, Disadvantages and Uses; General Abbreviation and Terminology; Basics of Internet, intranet, and E-mail, audio and video conferencing; Digital initiatives in higher education; ICT and governance.

Higher Education System: Institutions of higher learning and education in ancient India; Policies, governance and Administration; Professional, Technical and skill-based education; Oriental, conventional and nonconventional programs in India; Value education and environmental education; Evolution of higher learning and research in post-independence India.

Learning resources and suggested books:

1. Cattell, R. (Ed.). (2012). The scientific use of factor analysis in behavioral and life sciences. Springer Science & Business Media.
2. Chandel, K. S., & Dhiman, R. J. (2014). Teaching aptitude among prospective teachers. Academic Discourse: An International Journal, 7(1), 1-16.
3. Llano, A. (2000). Medical ethics education in Colombia. Med. & L., 19, 415.
4. Mintzes, J. J. (2006). Handbook of college science teaching. NSTA Press.
5. Ogiela, L., & Ogiela, M. R. (2009). Cognitive techniques in visual data interpretation (Vol. 228). Heidelberg: Springer.
6. Reddy, N. K., & Ajmera, S. (2015). Ethics, Integrity and Aptitude. McGraw-Hill Education.
7. Vaishnavi, V. K. (2007). Design science research methods and patterns: innovating information and communication technology. Auerbach Publications.
8. Watson, J. T., & Sparkman, O. D. (2007). Introduction to mass spectrometry: instrumentation, applications, and strategies for data interpretation. John Wiley & Sons.
9. Weyrich, L. S., & Harvill, E. T. (2013). Teaching ethical aptitude to graduate student researchers. Accountability in research, 20(1), 5-12.
