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 microbial 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 cotribute to the betterment of society and human kind.

About the Program

The unique M.Sc. Program of Virology at Sri Venkateshwara 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 whereby application of theoretical concepts is 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 Program has two academic years with four semesters. The first semester of the program covers the fundamental concepts of Biological Chemistry, Analytical Techniques and General Microbiology and Virology with a foundation course on Human and Professional Ethics-I. In the second semester, the students will explore the basic and advanced concepts of Cell and Molecular Biology, Recombinant DNA Technology, Immunology and Human and Professional Ethics-II. 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, where third semester covers courses such as

Plant Virology, Plant Viruses and Diseases and Molecular Virology or Tumor Virology (Generic elective) and forth semester covers courses such as Animal and Human Virology, Animal and Human Viruses and Diseases and Applied Virology or Virus-based Biotechnology (Generic Elective). 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 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 to the other departments. 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.

S.V. UNIVERSITY, TIRUPATI :: SVU COLLEGE OF SCIENCES
CBCS Pattern (With effect from 2020-2021)
M.Sc., VIROLOGY

SEMESTER-I

Sl. No.	Course Code	Components of Study	Title of the Course	Contact hours	No. of Credits	IA Marks	End Sem Exam Marks	Total
1	VR-101	Core-Theory	Biological Chemistry	6	4	20	80	100
2	VR-102	Core-Theory	Analytical Techniques	6	4	20	80	100
3	VR-103	Core-Practical	Biological Chemistry and Analytical Techniques	6	4	-	-	100
4	VR-104	Core-Practical	General Microbiology and Virology	6	4	-	-	100
5	VR-105	Compulsory Foundation **(Related to Subject)**	General Microbiology and Virology	6	4	20	80	100
6	VR-106	Elective Foundation **(Human values and ethics)**	Human values and Professional ethics - I	6	4	20	80	100
		Total		**36**	**24**			**600**

SEMESTER-II

Sl. No.	Course Code	Components of Study	Title of the Course	Contact hours	No. of Credits	IA Marks	End Sem Exam Marks	Total
1	VR-201	Core-Theory	Cell and Molecular Biology	6	4	20	80	100
2	VR-202	Core-Theory	Recombinant DNA Technology	6	4	20	80	100
3	VR-203	Core-Practical	Cell and Molecular Biology & Recombinant DNA Technology	6	4	-	-	100
4	VR-204	Core-Practical	Immunology	6	4	-	-	100
5	VR-205	Compulsory Foundation	Immunology	6	4	20	80	100

		(Related to Subject)						
6	VR-206	Elective Foundation **(Human values and ethics)**	Human values and Professional ethics - II	6	4	20	80	100
		Total		**36**	**24**			**600**

SEMESTER-III

	Course Code	**Components of Study**	**Title of the Course**	**No. of Credits**	**IA Marks**	**End Sem Exam Marks**	**Total**
1	VR-301	Core-Theory	Plant Virology	4	20	80	100
2	VR-302	Core-Theory	Plant Viruses and Diseases	4	20	80	100
3	VR-303	Core-Practical	Plant Virology and Plant Virus Diseases	4	-	-	100
4	VR-304	Core-Practical	a) Molecular Virology (OR) b) Tumor Virology	4	-	-	100
5	VR-305	Generic Elective* **(Related to subject)**	(a) Molecular Virology (OR) (b) Tumor Virology	4	20	80	100
6	VR-306	Open Elective* **(For other departments)**	(a) Veterinary and agricultural Viruses and their management (OR) (b) Emerging Infectious Virus Diseases	4	20	80	100
		Total		**24**			**600**

***Among the Electives a student shall choose one.**

SEMESTER-IV

	Course Code	**Components of Study**	**Title of the Course**	**No. of Credits**	**IA Marks**	**End Sem Exam Marks**	**Total**

1	VR-401	Core-Theory	Animal and Human Virology	4	20	80	100
2	VR-402	Core-Theory	Animal and Human Virus Diseases	4	20	80	100
3	VR-403	Core-Practical	Animal and Human Virology & Virus Diseases	4	-	-	100
4	VR-404	Core-Practical	(a) Applied Virology (OR) (b) Virus-based Biotechnology	4	-	-	100
5	VR-405	Generic Elective* **(Related to subject)**	(a) Applied Virology (OR) (b) Virus-based Biotechnology	4	20	80	100
6	VR-406	Open Elective* **(For other departments)**	(a) Human virus diseases (OR) (b) Clinical Virology	4	20	80	100
		Total		**24**			**600**

***Among the Electives the student shall choose one**

Program Outcomes (POs)

S. No	Program Outcomes (POs)
PO-1 Disciplinary Knowledge	Ability to demonstrate understanding, comprehensive knowledge and skills in various methodological and analytical approaches that are used in contemporary areas of Virology which will make them eligible for higher studies, jobs in various sectors and entrepreneurship abilities.
PO-2 Communication skills	Ability to express, communicate and share thoughts, scientific concepts and ideas and experimental results clearly, concisely, and effectively, both in writing and orally.
PO-3 Critical thinking and problem solving	Capability to evaluate basic concepts, theories and mechanisms related to Virology based on empirical evidence by following strategic scientific approach to acquire knowledge to find solutions to virus problems related to microbes, plants, animals, and humans.
PO-4 Analytical reasoning	Ability to evaluate the reliability and relevance of evidence, identify logical flaws in others argument, analyse and synthesize data from a variety of sources; draw valid conclusions with supporting evidences and examples and address opposing viewpoints.
PO-5 Scientific reasoning and research-related Skills	Develop ability to review of scientific literature, independently carry out a complete scientific work process, including the understanding of theoretical background, defining, and formulating problems, hypothesis generation, collection, analysis and evaluation of data,

	and interpretation and presentation of results of an experiment or investigation in the field of Virology.
PO-6 Collaboration/ Cooperation /Teamwork:	Demonstrate high competence and multidisciplinary subject experience within selected topics related to Virology as a team member and ability to facilitate cooperative or coordinated effort and to contribute to a multidisciplinary team in the interest of common cause.
PO-7 Information/Digital literacy	Ability to use ICT (Information and communication Technology) in a variety of learning situations, demonstrate the ability to access, evaluate and use a variety of relevant information sources and to use appropriate software for analysis of data.
PO-8 Self-directed learning	Ability to work independently, identify appropriate resources required for a project and manage a project through to completion.
PO-9 Usage of modern tools and techniques	Ability to demonstrate the practical skills in use of appropriate modern tools, advanced technologies and methods and skills necessary for designing and conducting experiment or investigation with an understanding of limitations.
PO-10 Moral and ethical awareness/reasoning:	Demonstrate the ability to assess and predict the technological, ethical, and social effects of one's own work /disciplines and of Virology, use ethical practices and avoid unethical behavior such as fabrication, misrepresentation of data or committing plagiarism, not adhering to intellectual property rights, and adopt objective, unbiased and truthful actions in all aspects of work.
PO-11 Leadership readiness/qualities	Acquire teamwork abilities and leadership qualities through various activities during their course work and demonstrate capability to map out the tasks of a team or an organization, and sett direction, formulate an inspiring vision, build a team who can help achieve the vision, motivate, and inspire team members to engage with that vision, and use management skills to guide the team to the right destination in a smooth and efficient way.
PO-12 Lifelong learning	Ability to acquire knowledge and skills that are necessary for participating in learning activities throughout life, through self-paced and self-directed learning aimed at personal development and adopt to meet the demands of workplace through knowledge/skill development/reskilling.

Program Specific Objectives (PSOs)

After completion of M.Sc. program in Virology, the students will be able to

S. No	Program Specific Objectives (PSOs)
1	Demonstrate comprehensive knowledge and practical skills in the area of Virology starting from General Virology, Plant, Animal and Human Virology, Plant, Animal and Human Virus Diseases to advanced Molecular Virology, Applied Virology, Tumor Virology, Clinical Virology, Virus Epidemiology and Disease management, Virus-Host-Vector interactions, Viral Vaccines, Emerging and reemerging Viruses,

	Virus-based Bio-nanotechnology that are relevant and required to create employment opportunities like Faculty/Scientists in academia and industrial jobs like Pharmaceuticals and Biotech-based companies.
2	Develop knowledge and transferable skills in the fields of Biological Chemistry, Analytical Techniques, General Microbiology, Cell and Molecular Biology, Recombinant DNA Technology, and Immunology with an introduction to Biostatistics and Bioinformatics to facilitate interdisciplinary research, which facilitates the participation and qualification in competitive examinations like GATE, UGC-CSIR-NET, APSET, GRE and Civil services.
3	Use knowledge and skills required for identifying problems and issues, collection of relevant quantitative and/or qualitative data, designing strategies for identification, characterization of important, emerging, and reemerging virus pathogens infecting microbes, plants, animals, and humans.
4	Gain in depth knowledge on the overall virus world and their characteristics such as history, origin, classification, nomenclature, etiology, structure, genome organization, transmission, multiplication, pathogenesis, epidemiology, strains, diagnosis and management of pathogenic viruses, which will help to design and develop affordable point of care diagnostics, novel prophylactic and therapeutic interventions to combat the infections caused by harmful viruses of microbes, plants, animals and humans.
5	Get exposure to open elective courses such as Tissue Culture, Mushroom Cultivation, Industrial Microbiology, Psychology, Aquaculture and Fishery Sciences, Medicinal and Ethno Botany, Hydroponics, Herbal drugs, Food and Nutrition etc., which will open new avenues and employment opportunities.
6	Acquire knowledge on human and professional ethical practices and principles, responsibilities and norms that need to be followed in personal and professional life to contribute to the welfare of the society and mankind.

SEMESTER-I

VR-101: BIOLOGICAL CHEMISTRY (Core Theory)

Lecture: 5 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**

Course Educational Objectives:

1. To impart analytical knowledge on aspects of Biochemistry, to learn the basic concepts of chemical processes of living organisms and the classification, structure, properties and functions of biomolecules of life (carbohydrates, nucleic acids, proteins and lipids), classification and mechanism of action of enzymes and enzyme kinetics.

2. To learn about the characteristics and biological functions of hormones, growth regulators, vitamins and principles of thermodynamics and metabolism of nucleic acids, lipids, proteins and carbohydrates.

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, 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.

UNIT- IV

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

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

Lipid metabolism: Overview of lipid metabolism (synthesis and degradation of triacylglycerides)

Protein metabolism: Overview of protein metabolism; Urea cycle.

Nucleotide metabolism: Biosynthesis of nucleotides.

Course Outcomes: At the end of the course the student will be able to

CO1: Acquire knowledge on major elements and biomolecules (carbohydrates, lipids, proteins and nucleic acids) of life and their characteristics.

CO2: Learn the classification, structure, properties and functions of carbohydrates, lipids, proteins, classification and properties of enzymes and enzyme kinetics

CO3: Explain the types, structure and functions of nucleic acids, hormones, growth regulators and vitamins.

CO4: Learn the concepts of bioenergetics and metabolism of carbohydrate, lipid, carbohydrates, and proteins and use the theorical knowledge on concepts and principles of Biological Chemistry to conduct research or to foster employability in national and international Biotech/Pharma industries/ research or educational institutes, to grab the opportunities for higher education in national and international institutes and to compete for the competitive exams such as UGC-CSIR-NET, GATE, APSET and other scientific examinations.

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) Leininger, 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. WM.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

VR-102: ANALYTICAL TECHNIQUES (Core Theory)

Lecture: 5 hours/week	**Internal test Assessment: 20 Marks**
Tutorial:	**Semester End Examination: 80 Marks**
Semester: I	**Credits: 4 Credits**

Course Educational Objectives:

1. To understand the approaches involved in characterization and concentration of biomolecules and to train students in adopting various techniques involved in biological research such as microscopy, chromatography, centrifugation, and electrophoresis.
2. To learn about various radioisotopes, spectroscopy and cell counting techniques that are used for characterization of biomolecules and basic concepts of biostatistics such as measures of central tendency and dispersion, correlation and regression analysis, probability distribution and tests of significance.

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, membrane filtration and their applications.

Microscopic techniques- principles and applications of light, phase-contrast, dark-field, fluorescent, inverted, scanning and transmission electron microscopes, specimen preparation, fixation, and staining techniques.

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), X^2 test.

Course Outcomes: At the end of the course the student will be able to

CO1: Define the list of approaches used for characterization and concentration of biomolecules and understand the types, principle and instrumentation of microscopy and its applications.

CO2: Describe the types, working principles and methodology of chromatography, spectroscopy and cell counting techniques.

CO3: Understand the properties of radioisotopes and their applications, learn the types, principles, and applications of spectroscopic and centrifugation techniques.

CO4: Learn the basic concepts and methods of statistics and apply them to Virology related research experiments or investigations involving statistical data and use the theorical knowledge on Analytical Techniques to conduct research or to foster employability in national and international Biotech/Pharma industries/ research or educational institutes, to grab the opportunities for higher education in national and international institutes and to compete for the competitive exams such as UGC-CSIR-NET, GATE, APSET and other scientific examinations.

Learning Resources 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 Upadyay, Nirmalanedu Upadyay 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.

VR-103: CORE PRACTICAL BIOLOGICAL CHEMISTRY AND ANALYTICAL TECHNIQUES

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

Course Educational Objectives:

1. To estimate carbohydrates, nucleic acids, amino acids, proteins, glucose, bilirubin, and inorganic phosphorus using qualitative and quantitative tests and to isolate enzymes from plant and animal sources and determine their activity.

2. To acquire hands-on experience in using various analytical tools such as ultrafiltration, electrophoresis, spectroscopy, chromatography and centrifugation techniques for the isolation and characterization of biomolecules isolated from various sources.

List of Practicals:

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 λ max for colored solutions
15. Determination of λ max of DNA & RNA by UV spectrophotometry
16. Separation of lipids by TLC
17. Separation of amino acids by paper chromatography
18. Isolation and partial purification of proteins from leaf tissue (up to dialysis)
19. Separation of leaf or virus proteins by SDS-PAGE
20. Separation of DNA by submarine agarose gel electrophoresis
21. Isolation of chloroplasts by sucrose density gradient centrifugation (demo)
22. Column chromatography (demo).

Course Outcomes: At the end of the course the student will be able to

CO1: Learn to calculate normality, molarity, molecular weight and percentage of chemical substances and qualitative and quantitative estimation of major biomolecules such as proteins, carbohydrates, lipids, and nucleic acids.

CO2: Know how to isolate and check the activity of enzymes from various sources.

CO3: Learn to use ultrafiltration, chromatography, and electrophoresis techniques for isolation and characterization of biomolecules.

CO4: Acquire the skills to use spectroscopic and centrifugal methods for characterization of biomolecules and use the practical knowledge and skills in Biological Chemistry and Analytical Techniques to conduct research or to foster employability in national and international Biotech/Pharma industries/ research or educational institutes and to grab the opportunities for higher education in national and international institutes.

Learning Resources 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. Microbiology Tools & Techniques (2008) Kanika Sharma-Ane books, India.
4. Protein Purification Techniques 2 nd 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.

VR 104- CORE PRACTICAL GENERAL MICROBIOLOGY AND VIROLOGY

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

Course Educational Objectives:

1. To learn the safety measures in handling different types of microorganisms and to practice various methods used for isolation, cultivation, and identification of the microorganisms from different sources and measuring growth parameters at various conditions.

2. To demonstrate the practical skills in isolation of bacteriophages, cultivation of viruses in embryonated eggs and plants, transmission of plant viruses and checking the stability of plant viruses.

List of Practicals:

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.

Course Outcomes: At the end of the course the student will be able to

CO1: Define laboratory safety measures that need to be followed in Virology and Microbiology laboratories and know preparation of media and different sterilization methods.

CO2: Acquire the practical skills to cultivate, stain and characterize different microorganisms and to check their stability under various conditions.

CO3: Learn to isolate bacteriophages from different sources and cultivate viruses in embryonated eggs and plants.

CO4: Demonstrate the mechanical, aphid and graft transmission of plant viruses and methods used to check the stability of viruses and determine the effect of virus infection on plants through chlorophyll estimation and use the practical knowledge and skills in General Microbiology and Virology to conduct research or to foster employability in national and international Biotech/Pharma industries/ research or educational institutes and to grab the opportunities for higher education in national and international institutes.

Learning Resources and Suggested books:

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.

VR-105: GENERAL MICROBIOLOGY AND VIROLOGY
(Compulsory Foundation related to subject)

Lecture: 5 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**

Course Educational Objectives:

1. To acquire the knowledge on origin, evolution, and importance of microorganisms, microbial taxonomy, morphology, and structure of bacteria and cultivation, control strategies of microorganisms and to learn about important microbial diseases and host pathogen interactions.

2. To understand the physical, biochemical, biological, and molecular properties of viruses and isolation, cultivation and purification methods used for viruses, biology of bacteriophages and subviral agents.

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.

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 of systematic bacteriology.
Morphology and structure of bacteria - Morphological types – structure and cell organelles-cell walls of Gram negative - Gram positive bacteria, cell membranes, structure and function of capsule, flagella, cilia, pili, nucleoid and endospores, bacterial cell division.

UNIT-II

Isolation, cultivation, and enumeration methods of microorganisms: Types of media, Isolation /enumeration methods from different natural samples-streak plate, pour plate, spread plate and hanging drop methods; isolation of microorganisms from different natural samples and approaches for obtaining pure cultures.
Microbial growth: Bacterial growth curve, Batch culturing, Continuous, synchronous, biphasic culturing, Physical, chemical and biological factors influencing the growth, Methods of microbial growth measurement, maintenance and preservation methods of microbial cultures, microbial fermentation.
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.
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).

UNIT- III

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.
Transmission of Viruses: Non-vector and Vector mode of transmission of viruses**.**
Bacteriophages: Biology of major RNA (MS_2, Qβ) and DNA (T4, lambda, Øx174, M_{13}) bacteriophages.

UNIT- IV

Isolation, cultivation, and maintenance of viruses: 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). Assay of viruses-Infectivity assay methods (plaque, pock, end point, local / systemic assay of plant viruses), physical (EM), serological (HA, HI, immunofluorescence, ELISA) and chemical (viral protein and nucleic acid based) approaches.
Purification of viruses: Extraction of viruses from tissues, clarification, concentration of viruses in clarified extracts by physical and chemical methods, further purification of viruses by rate zonal / equilibrium density gradient centrifugation, Criteria of virus purity, Quantitation, and preservation of purified virus preparations.

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

Course Outcomes: At the end of the course the student will be able to

CO1: Understand the origin, evolution, classification of microorganisms and learn the morphology and structure of bacteria.

CO2: Learn the basic concepts of isolation, cultivation, enumeration, growth measurement and control methods of microorganisms and explain the major infectious diseases of humans and their management.

CO3: Describe the nature, origin, evolution, classification and nomenclatures of plant, animal and human viruses and understand the structure, morphology, and transmission of viruses.

CO4: Define the methods used for isolation, cultivation and purification of viruses and understand the biology of bacteriophages and subviral agents and use the theorical knowledge on concepts and principles of General Microbiology and Virology to conduct research or to foster employability in national and international Biotech/Pharma industries/ research or educational institutes, to grab the opportunities for higher education in national and international institutes and to compete for the competitive exams such as UGC-CSIR-NET, GATE, APSET and other scientific examinations.

Learning Resources and Suggested books: Microbiology:

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 Blacksman 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.

Suggested books-Virology

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). 2nd ed. A. Cann. Academic Press.
17. Medical Virology. (1994). 4th edition. D.O. White and F.J. Fenner. Academic Press. Plant Virology. (2001). 4th ed. 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). 2nd ed. A. Cann. Academic Press.
20. Virology: (1994). 3rd ed. Frankel Conrat et al, Prentice Hall.

VR-106: HUMAN VALUES AND PROFESSIONAL ETHICS– I (Elective Foundation)

Lecture: 4 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**

Course Educational Objectives:

1. To enable the students to imbibe and internalize the moral and social values and ethical behavior in the personal and Professional lives.

2. To learn the rights and responsibilities and to appreciate the rights of others and to create awareness on religious values and other good acts and facts of life.

UNIT-I

Definition and Nature of Ethics, Its relation to Religion, Politics, Business, Legal, Medical and Environment; Need for 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.

UNIT-V

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

Course Outcomes: At the end of the course the student will be able

CO1: Aware of the moral values and ethical principles ethics for successful personal and professional life.

CO2: Learn the moral values and good behavioral concepts that need to be followed for a better life, learn to respect others, and develop civil sense to act as responsible citizen by developing sufficient knowledge and skills in critical thinking, scientific reasoning, moral ethical reasoning that are pertinent to the discipline

CO3: Acquire the knowledge about the importance of non-violence, truth, righteousness, and other good acts of life and develop commitment.

CO4: Learn to live peacefully by having knowledge about the important facts of Bhagavad Gita, values hidden in religions, religious tolerance and aware of crime, and punishment theories and develop the ability to practice the concepts and principles of human and professional ethics for personal and professional growth and use for the betterment of society and mankind.
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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
VR-201: CELL AND MOLECULAR BIOLOGY (Core Theory)

Lecture: 5 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**

Course Educational Objectives:

1. To gain understanding of structural and functional organization of prokaryotic and eukaryotic cells, types of cell division and their regulation, cell communication and signaling and to discuss Mendelian laws, prokaryotic and eukaryotic genome organization, extrachromosomal elements and gene transfer and mapping mechanisms in bacteria.

2. To attain knowledge about the processes involved in central dogma viz. replication, transcription, reverse transcription and translation, mechanisms of DNA damage and repair, regulation of gene expression, mutations, and gene silencing mechanisms.

UNIT – I

Prokaryotic and eukaryotic cells: 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 and cytoskeleton.
Cell cycle: Mitosis and meiosis and their regulation, cell death, mechanism of apoptosis and its significance.
Cell Communication and cell signaling–General principles; 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; Secondary messengers – cAMP pathway and role of calcium; Cell-cell interactions – Adhesion junctions, tight junctions, gap junctions; bacterial chemotaxis and quorum sensing.

UNIT-II

Mendelian principles: dominance, segregation and independent assortment.
Genomes - Types and diversity in size, structure and organization of prokaryotic and eukaryotic genomes.
Genes - modern concept of gene- gene structure and architecture, types of genes, Central dogma theory.
Plasmids: Types, properties, replication and curing, significance/importance; Transposons, exploitation of transposable elements in genetics.

Gene transfer mechanisms and gene mapping in bacteria: Transformation, conjugation, transduction, mapping genes by interrupted mating, fine structure analysis of genes, homologous and nonhomologous recombination.

UNIT-III

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.

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 and machinery, formation of initiation complex, transcription activators and repressors, types of RNA polymerases, capping, methylation, elongation and termination, RNA processing, RNA editing, splicing and polyadenylation, regulation of transcription, 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 (activation of amino acids, initiation, elongation, termination) in prokaryotes and eukaryotes; post-translational modification of proteins and their sorting and targeting; regulation of translation; inhibitors of protein biosynthesis.

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* operon; regulation by attenuation- *trp* operon; antitermination- N protein and *Nut* sites in Lambda phage; Organization and regulation of *nif* gene expression in bacteria; *gal* operon in yeast; global regulatory responses- heat shock response, stringent response and regulation by small molecules such as cAMP.

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.

Course Outcomes: At the end of the course the student will be able to

CO1: Distinguish the cellular organization and cell cycle of prokaryotes and eukaryotes, mechanisms of programed cell death and general principles of cell communication and signaling.

CO2: Understand the Mendelian principles and types and structure of prokaryotic and eukaryotic genomes, extrachromosomal elements and discuss the gene transfer and mapping mechanisms in bacteria.

CO3: Discuss the concepts of central dogma and describe the processes and regulation of DNA replication, transcription, translation and mechanisms of DNA damage and repair.

CO4: Compare the levels of regulation of gene expression in prokaryotes and eukaryotes and describe the types, consequences, and importance of mutants in genetic analysis and gene silencing

mechanisms and use the theorical knowledge on concepts and principles of Cell and Molecular Biology to conduct research or to foster employability in national and international Biotech/Pharma industries/ research or educational institutes, to grab the opportunities for higher education in national and international institutes and to compete for the competitive exams such as UGC-CSIR-NET, GATE, APSET and other scientific examinations.

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 Kindersley.
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.

VR-202 : RECOMBINANT DNA TECHNOLOGY (Core Theory)

Lecture: 5 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**

Course Educational Objectives:

1. To learn basic and advanced tools and techniques, approaches and strategies used in gene manipulation in prokaryotic and eukaryotic systems.

2. To understand the strategies used for gene expression in heterologous hosts and applications/implications of genetic engineering in agriculture, medicine, industry, and biology.

UNIT-1

Scope and importance of recombinant DNA technology

Tools for Recombinant DNA Technology: Gene Vectors-Plasmids, bacterophage 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-Biological data bases-GenBank, Swiss port, EMBL, NCBL and PDB; database searching using BLAST and FASTA; Protein structure prediction approaches, sequence analysis using multiple sequence alignment and phylogenic 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 (pRSET-A); **Yeast cell system** – Expression of cloned genes (pPICZ-A); **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 using animal virus-based vectors (e.g., vaccinia), 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.
Applications and implications of recombinant DNA technology in biology, agriculture, medicine, and industry.

Course Outcomes: At the end of the course the student will be able to

CO1: Explain the scope, importance of genetic engineering, basic steps of gene cloning and the role of enzymes, vectors, oligonucleotides, and hosts in gene manipulation.

CO2: Describe the methods used for construction of genomic and cDNA libraries, major techniques (e.g., DNA sequencing, PCR, DNA profiling, nucleic acid hybridization, microarrays, site directed mutagenesis) used in gene manipulations and their applications.

CO3: Discuss the gene cloning strategies and learn the concepts and applications of genomics, proteomics, transcriptomics, and introduction to metagenomics, metabolomics, viromics.

CO4: Understand the basic and advanced concepts of gene expression in prokaryotic and eukaryotic systems, analyze the applications and implications of genetic engineering.

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.

VR-203 CORE PRACTICAL: CELL AND MOLECULAR BIOLOGY & RECOMBINANT DNA TECHNOLOGY

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

Course Educational Objectives:

1. To learn the laboratory safety practices to be followed to set up molecular biology laboratory and to create ribonuclease free environment in the laboratory and to acquire the practical skills in conducting various experiments related to Cell Biology such as identification of stages of mitosis, isolation of cells, DNA and RNA from plant and animal tissues and to practice plasmid curing, replica plate and gradient plate techniques.

2. To acquire practical skills in conducting plasmid isolation, PCR, recovery of DNA, restriction enzyme digestion of DNA, transformation of bacteria with recombinant plasmid DNA, preparation of southern blots and dot-blots and to discuss the problems related to Molecular Biology and Recombinant DNA Technology and to learn the basic bioinformatics tools for DNA analysis.

List of Practicals:

1. Preparation of cytological studies for identification of stages of mitosis using root tips
2. Examination of cells isolated from sheep kidney.
3. Demonstration of chromosomal (structural and numerical) aberrations (theory).
4. Study of polytene chromosomes (theory).
5. Preparation of sucrose density gradients (step and linear).
6. Isolation of microbial DNA and RNA.
7. Curing of plasmids.
8. Replica plating techniques.
9. Isolation of microbial mutants by gradient plate method.
10. Induction of mutations in bacteria by physical / chemical agents by replica plate method.
11. Creating ribonuclease free environment in the laboratory (theory exercise).
12. Preparation of phenol for nucleic acid isolation (theory exercise).
13. Concentration of nucleic acids (theory exercise).
14. Isolation of plasmids from bacteria through alkaline lysis method.
15. Restriction enzyme analysis of plasmids.
16. Recovery of DNA from gels – low melting point agarose extraction of DNA
17. Transformation of bacteria with recombinant plasmid DNA
18. Southern blotting (demo).
19. Preparation of dot-blots for hybridization (demo).
20. Problems related to recombinant DNA technology.
21. Bioinformatic tools: NCBI, PDB search, BLAST-n, BLAST-p, multiple sequence alignment, phylogenetic tree construction (demo and learning exercises)

Course Outcomes: At the end of the course the student will be able to

CO1: Learn the safety practices and precautions to be followed in setting up molecular biology laboratory with ribonuclease free environment.

CO2: Isolate cells, DNA and RNA from plant and animal tissues, demonstrate mitosis, plasmid curing, replica plate and gradient plate methods.

CO3: Acquire practical skills to isolate plasmids, restriction enzyme digestion of DNA, recovey of DNA from gels, transformation of bacteria and demonstrate the southern and dot blot preparation for hybridization.

CO4: Solve the problems related to molecular biology and recombinant DNA technology and learn the basic bioinformatic tools that are important for DNA analysis and use the practical knowledge and skills in Cell and Molecular Biology and Recombinant DNA Technology to conduct research or to foster employability in national and international Biotech/Pharma industries/ research or educational institutes and to grab the opportunities for higher education in national and international institutes.

Learning Resources and Suggested books:

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 Pub.
5. Current Protocols in Molecular Biology, (2000). Ausubel et al.
6. Current Protocols in Molecular Biology, (2000). Ausbel et al.
7. Biotechnology: A Laboratory Course. (1996). 2nd ed. J.M. Becker, et al., Acad. Press.

VR-204: CORE PRACTICAL – IMMUNOLOGY

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

Course Educational Objectives:

1. To determine WBC and RBC counts, blood, and Rh typing and to conduct theory exercises on production, purification and analysis of polyclonal antibodies and identification of primary and secondary lymphoid organs.

2. To perform *in vitro* serological tests such as immunodiffusion, immunoelectrophoresis, ELISA and western blotting.

List of Practicals:

1. Total counting of RBC & WBC
2. Differential count of W.B.C
3. Hemoglobin estimation.
4. Blood typing & Rh determination.
5. Latex agglutination test.
6. Primary & secondary lymphoid organs (theory).
7. Production of polyclonal antibodies- demonstration of different routes of antigen inoculation, bleeding of experimental animals, and collection of serum.
8. Purification of immunoglobulins and analysis.
9. *In vitro* serological tests:
   a) Single & double immunodiffusion tests
   b) Immuno electrophoresis
   c) Counter current & rocket electrophoresis
   d) DAC- ELISA (indirect)
   e) Dot-ELISA
   f) Electroblot immunoassay (EBIA)

Course Outcomes: At the end of the course the student will be able to

CO1: Illustrate basic immunology techniques such as counting of RBC and WBC, estimation of hemoglobin, identification of the blood groups and Rh.

CO2: Identify of primary and secondary lymphoid organs in virtual animal model and production of polyclonal antibodies in rabbit using BSA as antigen, collection, and preservation of serum.

CO3: Demonstrate antigen-antibody interactions by conducting *in vitro* serological tests such as immunodiffusion and immunoelectrophoresis.

CO4: Conduct DAC-ELISA, Dot-ELISA, and western blotting to identify important pathogens based on antigen-antibody interactions and use the practical knowledge and skills in Immunology to conduct research or to foster employability in national and international Biotech/Pharma industries/ research or educational institutes and to grab the opportunities for higher education in national and international institutes.

Learning Resources and Suggested books:

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.

VR-205: IMMUNOLOGY (Compulsory Foundation)

Lecture: 5 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**

Course Educational Objectives:

1. To compare innate and adaptive immunity and to learn about various components of immune system, antigens, antibodies, *in vitro* and *in vivo* antigen and antibody interactions and immune effector mechanisms.

2. To elucidate the mechanism of humoral and cell mediated immune responses, MHCs, hypersensitivity reactions, autoimmune and immunodeficiency disorders, transplantation and transfusion immunology, concepts and applications of conventional and modern vaccines.

UNIT – I

History: Historical perspectives and milestones in immunology.
Cells and Organs of the Immune system: 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, Immuno electrophoresis (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 and autoimmune diseases.
Transfusion Immunology: Blood cell components, blood group systems in human, Rh typing, transfusion reactions, diseases associated with blood transfusion – Hemolytic anemia.
Transplantation Immunology: Transplantation antigens, types of transplants, Graft versus host reactions.
Vaccines: Conventional and modern vaccines and their applications.

Course Outcomes: At the end of the course the student will be able to

CO1: Discuss the history of immunology, types of immunity, cells and organs of immune system and types and properties of antigens.

CO2: Understand the types, structure and biological activities of antibodies, concepts of *in vivo* and *in vitro* antigen-antibody interactions and discuss the properties and functions of cytokines, Toll-like receptors and complement components and activation pathways

CO3: Describe the induction and mechanism of humoral and cell mediated immune responses, interaction between innate and adaptive immune responses through MHCs and antigen presentations and hypersensitivity reactions.

CO4: Learn about the basis of autoimmune and immunodeficiency disorders, basic of transplantation and cancer immunology, concepts, and applications of conventional and modern vaccines and use the theorical knowledge on concepts and principles of Immunology to conduct research or to foster employability in national and international Biotech/Pharma industries/ research or educational institutes, to grab the opportunities for higher education in national and international institutes and to compete for the competitive exams such as UGC-CSIR-NET, GATE, APSET and other scientific examinations.

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.

VR-206: HUMAN VALUES AND PROFESSIONAL ETHICS– II
(Elective Foundation)

Lecture: 5 hours/week	**Internal test Assessment: 20 Marks** **Seminars and assignments**
Tutorial: Tutorial: Textbooks, E-learning resources, study materials, PowerPoint lectures	**Semester End Examination: 80 Marks**
Semester: II	**Credits: 4 Credits**

Course Educational Objectives:

1. To learn the concepts of value education, professional ethics and human values, structure and responsibilities of family system, research ethics, codes of ethics, to inculcate knowledge and exposure on safety and risk and to develop the students to understand right attitudinal and behavioral aspects, moral values and ethics followed by medical and health care professionals and businesspeople.

2. To increase the awareness among students about environment and create attitude towards sustainable lifestyle and discuss the social ethics and ethics of media.

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 Hippocratus 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. Characterics of ethical problems in management, ethical theories, causes of unethical behavior, ethical abuses and work ethics.

UNIT-IV

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

UNIT-V

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.

Course Outcomes: At the end of the course the student will be able to

CO1: Understand the definition of value education, concept of human and family values, components, structure, and responsibilities of family system and acquire reflective thinking, rational skepticism.

CO2: Acquire the knowledge on the moral responsibilities and ethical issues of medical and health care professionals, avoid unethical things, learn ethical issues raised in genetic engineering and new biological technologies.

CO3: Describe the ethical standards in business by understanding ethical theories and maintain work ethics to build trust between businessman and consumer and avoid unethical behavior and ethical abuse and develop scientific temper, digital literacy.

CO4: Learn to practice environmental ethics by taking responsibility to protect environment and ecosystem and understand the importance of maintenance of social ethics and ethics of media and develop the ability to practice the concepts and principles of human and professional ethics for personal and professional growth and use for the betterment of society and mankind.

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: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: 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

VR-301 : PLANT VIROLOGY (Core Theory)

Lecture: 5 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**

Course Educational Objectives:

1. To define the various concepts related to Plant Virology such as plant virus-host interactions with respect to induction of disease and virus movement strategies, plant virus-vector relationships, approaches used for identification and characterization of plant viruses and virus strains

2. To understand the plant virus ecological and epidemiological concepts, approaches used for detection and control of plant viruses and to learn the concepts related to conventional and transgenic virus resistance mechanisms.

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, transgenic plants exploiting viral and non-viral genes; plant quarantine and its role in virus disease control.

Course Outcomes: At the end of the course the student will be able to

CO1: Understand the mechanisms of induction of diseases in plants by viruses, virus-host interactions, and movement strategies.

CO2: Learn the vector and non-vector modes of plant virus transmission, virus-vector relationships and molecular mechanisms involved in vector transmission and biological, physical, serological and molecular approaches used for identification and characterization of the viruses and virus strains.

CO3: Acquire the knowledge on plant virus spread and survival in nature and approaches used to detect plant viruses and diseases.

CO4: Describe the approaches used for the control and management of plant viruses and vectors and strategies used for acquiring plant virus resistance by conventional and transgenic methods and use the theorical knowledge on concepts and principles of Plant Virology to conduct research or to foster employability in national and international Agriculture/Biotech/Pharma industries/ research or educational institutes and to grab the opportunities for higher education in national and international institutes.

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. Dovas, 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. Mc Lean, 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.

VR-302: PLANT VIRUSES AND DISEASES (Core Theory)

Lecture: 5 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**

Course Educational Objectives:

1. To understand the distribution, incidence and impact, symptoms, causal virus characteristics, diagnosis, disease cycle and management of the virus diseases associated with cereals and millets, oil seed, vegetable, and tuber crops.

2. To acquire knowledge on the distribution, incidence and impact, symptoms, causal virus characteristics, diagnosis, disease cycle and management of the virus diseases associated with food legumes, fruit, cash, spice and beverage crops and flowering and foliage ornamentals.

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

UNIT-I

Cereals and millets:

Rice - tungro, dwarf, 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 (tobamo), yellow mosaic/golden yellow mosaic, fern leaf / shoestring; **Chilli** – leaf curl, vein banding and mosaic caused by TMV, CMV and 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 and leaf curl, watermelon mosaic and bud necrosis, and cucumber green mottle mosaic; **Radish** – mosaic. **Carrot** – red leaf, mottley dwarf and thin leaf; **Cabbage and Cauliflower-** turnip mosaic, cauliflower mosaic and turnip yellow mosaic.

Tuber crops: Potato- leaf roll, rugose mosaic, mild mosaic / latent caused PVX, PVM and PVS and potato spindle tuber viriod 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.

Course Outcomes: At the end of the course the student will be able to

CO1: Describe the incidence and impact, symptoms, causal virus characteristics, diagnosis, disease cycle and management of the major virus diseases of cereals, millets, and oil seed crops.

CO2: Learn the incidence and impact, symptoms, causal virus characteristics, diagnosis, disease cycle and management of the major virus diseases of vegetable and tuber crops.

CO3: Acquire the knowledge of incidence and impact, symptoms, causal virus characteristics, diagnosis, disease cycle and management of the major virus diseases of food legumes and fruit crops.

CO4: Discuss the incidence and impact, symptoms, causal virus characteristics, diagnosis, disease cycle and management of the major virus diseases of cash, spice, beverage, flowering and foliage ornamental crops and use the theorical knowledge on major Plant Viruses and Diseases to conduct research or to foster employability in national and international Agriculture/Biotech/Pharma industries/ research or educational institutes and to grab the opportunities for higher education in national and international institutes.

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. Siganoret. INRA editions-France.
9. Viruses of Plants. (1996). By A.A. Brunt et al., CAB International.

10. Virology in the Tropics. (1994). N. Rishi, et al., (editors). Malhotra Publishing House.
11. Control of Plant Virus diseases by Hadidi et al., (1998). American Phytopathological Society, USA. American Phytopathological Society- Monographs on disease of different crops.
12. CMI/AAB Descriptions of Plant Viruses.

VR-303: CORE PRACTICAL: PLANT VIROLOGY AND PLANT VIRUS DISEASES

Lecture: 9 hours/week	**Semester End Examination: 100 Marks**
Tutorial: Textbooks, E-learning resources, study materials	
Semester: III	**Credits: 4 Credits**

Course Educational Objectives:

1. To acquire practical knowledge on identification of symptoms of major viruses on economically important local crop plants, weeds and to determine effect of viruses on plant metabolism and health.

2. To develop practical skills in identification of plant viruses using biological, serological and molecular tests, to preactice plant virus transmission, and to explore local field survey for estimation of plant virus disease incidence and progress.

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

Course Outcomes: At the end of the course the student will be able to

CO1: Identify major virus diseases of local economically important crop plants and weeds through theory exercises, local field surveys, agricultural research station visits.

CO2: Determine and compare the effect of virus on cell size, chloroplast number, total carbohydrates, proteins, and lipids with healthy counterparts.

CO3: Detect unknown viruses through ELISA and PCR and demonstrate plant virus transmission by seed and vegetative propagules.

CO4: Identify local plant virus vectors, determine virus disease incidence and progress curves through local field visits and use the practical knowledge and skills in Plant Virology and Plant Viruses and Diseases to conduct research or to foster employability in national and international Agriculture/Biotech/Pharma industries/ research or educational institutes and to grab the opportunities for higher education in national and international institutes.

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.

VR-304: CORE PRACTICAL: MOLECULAR VIROLOGY (OR) TUMOR VIROLOGY

a) MOLECULAR VIROLOGY

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

Course Educational Objectives:

1. To acquire skills and technologies related to purification of viruses such as propagation of virus cultures on plants, harvesting virus infected leaves, homogenization, clarification, concentration, further purification, final pelleting and to check the quality and quantity of the viruses.

2. To isolate and analyze virus nucleic acids and proteins using agarose gel and polyacrylamide gel electrophoresis, respectively and to determine the effect of physical and chemical agents on inactivation of viruses.

List of Practicals:

1. Purification of viruses by differential centrifugation.
2. Isolation of virus proteins
3. Analysis of virus proteins (SDS-PAGE molecular weight determination)
4. Isolation of virus nucleic acids
5. Analysis of viral nucleic acids (AGE-molecular weight determination)
6. Isolation and analysis of dsRNA from virus infected tissues
7. Study of inactivation of viruses by various physical and chemical agents

Course Outcomes: At the end of the course the student will be able to

CO1: Acquire the skills to use the techniques involving purification of viruses such as maintenance of virus cultures on propagation hosts, clarification using organic solvents and low speed centrifugation, precipitation using sodium chloride or ammonium sulphate or polyethylene glycol or differential centrifugation, preparation of step and linear density gradients, further purification of viruses using sucrose density gradient centrifugation and final pelleting by ultrafiltration or ultracentrifugation and to check the quality and quantity of viruses using spectroscopy or transmission electron microscopy.

CO2: Isolate virus coat proteins and determine its size and molecular weight through SDS-PAGE.

CO3: Isolate virus nucleic acids (dsRNA, RNA and DNA) and determine its size and molecular weight through agarose gel electrophoresis.

CO4: Determine the stability of virus by studying effect of physical and chemical agents on virus inactivation and use the practical knowledge and skills in Molecular Virology to conduct research or to foster employability in national and international Agriculture/Biotech/Pharma industries/ research or educational institutes and to grab the opportunities for higher education in national and international institutes.

Suggested books / manuals:

1. Virology - A Laboratory Manual, 1992. By Burleson, et al., Academic Press.
2. Virology Methods Manual, 1996. B.W.J. Mahy and H.O. Kangro. Academic Press
3. Molecular Virology: A Practical Approach. 1993. Davison and R.M. Elliot. Oxford University Press.
4. Virology Lab Fax. 1993. D.R. Harper. Bioscientific Publication. Academic Press

(OR)

b) TUMOR VIROLOGY

Lecture: 6 hours/week	**Semester End Examination: 100 Marks**
Tutorial: Textbooks, E-learning resources, study materials.	
Semester: III	**Credits: 4 Credits**

Course Educational Objectives:

1. To detect carcinogens and mutagens using standard tests, to observe histopathology of animal viruses associated with tumors and to detect tumor viruses by PCR.

2. To cultivate poultry tumor viruses in cell cultures, to determine the effect of antiviral compounds on transformed cell lines, cell viability assays and to diagnose HCV and HPV using commercial point-of care kit-based tests.

List of Practicals:

1) Detection of carcinogens and mutagens using Ames Test
2) Histopathology of animal tumor viruses (specimens and slides)
3) Detection of tumor viruses using PCR
4) Observation of specimens (visiting Veterinary University and SVIMS).
5) Cell viability test
6) MTT assay
7) Cell culture and cultivation of Chicken/bird tumor viruses
8) Diagnosis of HCV and HPV using commercial kits
9) Preventive and control measures of tumor viruses (theory exercises)

Course Outcomes: At the end of the course the student will be able to

CO1: Acquire skills to detect carcinogens and mutagens using standard tests such as Ames test.

CO2: Distinguish transformed and normal cell lines and determine the anticancer property of biologically active compounds.

CO3: Design and execute PCR and other point of care tests using commercial kits for detection of tumor viruses (HCV, HIV).

CO4: Perform cultivation of poultry tumor viruses in cell cultures and acquire the knowledge on histopathology of animal tumor viruses and develop knowledge on preventive and control measures of tumor viruses through theory exercises and use the practical knowledge and skills in Tumor Virology to conduct research or to foster employability in national and international Agriculture/Biotech/Pharma industries/ research or educational institutes and to grab the opportunities for higher education in national and international institutes.

Suggested books / manuals:

1. Manual of Clinical Oncology Paperback – Dec 2017, by Chmielowski (Author), 900 pges, Publisher: Wolters Kluwer India Private Limited; Eighth edition (2017), price
2. Devita et al (2011), Cancer, Principles and Practice of Oncology: Review 4 by Govindan
3. CBS Oncology entrance examination (PB 2017) by BHATIA M.S. P.

VR-305 : MOLECULAR VIROLOGY (GENERIC ELECTIVE)

Lecture: 5 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**

Course Educational Objectives:

1. To understand molecular architecture of viruses and effect of inactivating agents on viruses and learn about types of viral genomes and steps involved in virus replication and expression and replication of DNA viruses.

2. To acquire knowledge about expression and replication of RNA viruses and subviral agents and to discuss about the regulation of viral genome expression and molecular mechanisms involved in tumor virology.

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 - Qβ, 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.
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.

Course Outcomes: At the end of the course the student will be able

CO1: Acquire knowledge about principles of virus architecture and effect of physical and chemical agents on viruses.

CO2: Know about structure and diversity of viral genomes, general steps involved in replication of viruses and expression and replication of DNA viruses

CO3: Learn about expression and replication of different RNA viruses and subviral agents such as viroids, satellite viruses, defective interfering particles and prions.

CO4: Describe the regulation of viral genome expression and concepts/molecular mechanisms of transformation of cells by tumor viruses and therapeutic interventions and oncolytic viruses and use the theoretical knowledge in Molecular Virology to conduct research or to foster employability in national and international Agriculture/Veterinary/Biotech/Pharma industries/ research or educational institutes and to grab the opportunities for higher education in national and international institutes.

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)

VR-305: TUMOR VIROLOGY (GENERIC ELECTIVE)

Lecture: 5 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**

Course Educational Objectives:

1. To understand basic concepts and mechanism of tumors, oncogenes, tumor suppressor genes and to acquire knowledge on basic aspects and molecular mechanisms of carcinogenesis and viruses associated with tumors.

2. To learn about different RNA and DNA viruses causing tumors, cell transformation mechanisms, immune responses to tumors and tumor therapy strategies.

UNIT-I

Tumor: Terminology, types of tumors, transformation and tumorogenesis, 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 mechanism in carcinogenesis-Translocation, amplification, deletion of oncogenes and consequences.
Viruses associated with tumors: Molecular mechanisms of tissue transformation and tumorogenesis 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.

Course Outcomes: At the end of the course the student will be able to

CO1: Acquire knowledge about the basic aspects of tumors, distinguish normal and transformed cells and describe the role of oncogenes and tumor suppressor genes in causing cancers.

CO2: Understand the role and mechanism of carcinogens in inducing carcinogenesis and molecular viral mechanisms of transformation and tumorigenesis.

CO3: Describe the types of RNA and DNA viruses that are causing tumors and viral mechanisms for cell transformation.

CO4: Learn the concepts and mechanisms of transformation, tumor response to tumors and prophylactic and therapeutic interventions used for management of tumors and use the theoretical knowledge in Tumor Virology to conduct research or to foster employability in national and international Biotech/Pharma industries/ research or educational institutes and to grab the opportunities for higher education in national and international institutes.

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.

VR-306: VETERINARY AND AGRICULTURAL VIRUSES AND THEIR MANAGEMENT (OPEN ELECTIVE)

Lecture: 5 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**

Course Educational Objectives:

1. To acquire knowledge about the origin and evolution, properties and cultivation of the viruses and to learn about important animal viruses and veterinary epidemiology.

2. To learn about important plant and human viruses and their diagnostic and management methods.

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, Blue tongue, 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 bunchy top virus, sugarcane mosaic virus.
Important human viruses: polio, HIV, SARS, human coronavirus, chikungunya, dengue, hepatitis B virus, influenzas virus, Ebola, Marburg.

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 viruses: Sanitation, vector control, vaccines, antiviral drugs, and chemotherapy.

Course Outcomes: At the end of the course the student will be able to

CO1: Describe the origin, evolution, morphology and properties of viruses, cultivation, and transmission of viruses.

CO2: Understand the history, structure, transmission, epidemiology, detection and control of important animal viruses and concepts of veterinary epidemiology.

CO3: Learn about history, structure, transmission, epidemiology, detection, and control of major viruses infecting plants and humans.

CO4: Acquire knowledge about biological, physical, serological, and molecular methods used for detection of viruses and describe strategies followed for management of plant and animal viruses and use the theoretical knowledge on Veterinary and agricultural viruses and their management to conduct research or to foster employability in national and international Agriculture/Veterinary/Biotech/Pharma industries/ research or educational institutes and to grab the opportunities for higher education in national and international institutes.

Suggested books:

1. Epidemiology, diagnosis, and Management of Zoonses. (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.

(OR)

VR-306: EMERGING INTECTIOUS VIRUS DISEASES (OPEN ELECTIVE)

Lecture: 5 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**

Course Educational Objectives:

1. To acquire knowledge about the origin and evolution, properties, and cultivation of viruses and to learn about epidemiology and surveillance of emerging and zoonotic human virus diseases.

2. To understand the vector-borne and non-vector-borne emerging infectious virus diseases and virus maintenance in communities, concepts of survey, prevention, and control of emerging viruses.

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.

Course Outcomes: At the end of the course the student will be able to

CO1: Understand the evolution, general introduction to morphology, cultivation, and transmission of viruses.

CO2: Describe the epidemiology and surveillance of emerging infectious and zoonotic viral diseases.

CO3: List and discuss the important vector-borne and non-vector-borne emerging virus diseases.

CO4: Learn about virus maintenance in communities, surveys and strategies of prevention and control of emerging viruses and bioterrorism and use the theoretical knowledge on Emerging infectious virus diseases to conduct research or to foster employability in national and international Biotech/Pharma industries/ research or educational institutes and to grab the opportunities for higher education in national and international institutes.

Suggested books:

1. Epidemiology, diagnosis and Management of Zoonses. (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.
5. Emerging and transboundary animal viruses (2020). Malik**,** Yashpal Singh, Singh**,** Raj Kumar, Yadav**,** Mahendra Pal. Springer Pub.

SEMESTER-IV

VR-401: ANIMAL AND HUMAN VIROLOGY (CORE THEORY)

Lecture: 5 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**

Course Educational Objectives:

1. To acquire knowledge on virus-host interactions, host innate and adaptive immune response to viruses. transmission of viruses, mechanism of infection and viral spread in the body.

2. To learn the epidemiological concepts of virus diseases, measures of disease occurrence, disease determinants, ecology, epidemiology and surveillance of virus diseases, strategies of virus maintenance in communities, basic concepts, types and patterns of disease survey, prevention, and control methods of viruses.

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.

Course Outcomes: At the end of the course the student will be able to

CO1: Understand the virus host interactions, host defense mechanisms against viruses and innate and adaptive immune responses to viruses.

CO2: Describe the various modes of vertical and horizontal transmission of animal and human viruses, zoonotic virus infections, routes of entry and mechanism of virus spread in the body.

CO3: Learn about the epidemiological concepts of virus diseases, measures of disease occurrence, prevalence, and mapping, determinants of disease, factors affecting virus ecology and epidemiology and biological, serological, and molecular approaches used for detection of animal and human viruses.

CO4: Acquire knowledge on virus disease surveillance, strategies of virus maintenance in communities, principles of virus disease survey, methods of prevention and control of animal and human viruses and use the theoretical knowledge on Animal and Human Virology to conduct research or to foster employability in national and international Veterinary/Biotech/Pharma industries/ research or educational institutes and to grab the opportunities for higher education in national and international institutes.

Suggested books:

1.Epidemiology, diagnosis, and Management of Zoonses. (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 Lingstone.

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

VR-402: ANIMAL AND HUMAN VIRUSES AND DISEASES (CORE THEORY)

Lecture: 5 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**

Course Educational Objectives:

1. To describe the etiology, transmission, clinical manifestations, diagnosis, prevention, and control of important RNA viruses infecting animals and humans.

2. To understand the etiology, transmission, clinical manifestations, diagnosis, prevention, and control of important DNA viruses infecting animals and human and to learn about the prion diseases, biology, prevention, and management of major viruses of silkworm, poultry, fish, prawn, emerging and reemerging virus diseases of humans.

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, bird flu; ***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, Riftvalley 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 rhinotrachitis; ***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 silkworm, poultry, fish, and prawn: Biology, prevention and management.

Emerging and Re-emerging virus diseases: Zika, Nipha, Chikungunya, SARs, coronavirus, Swineflu, west Nile viruses.

Course Outcomes: At the end of the course the student will be able to

CO1: Acquire the knowledge about etiology, transmission, clinical manifestations, diagnosis, prevention, and control of major RNA viruses of *Picornaviridae, Caliciviridae, Coronaviridae, Astroviridae, Matonaviridae, Togaviridae, Flaviridae, Reoviridae* and *Birnaviridae.*

CO2: Learn the etiology, transmission, clinical manifestations, diagnosis, prevention, and control of important RNA viruses of *Orthomyxoviridae, Paramyxoviridae, Rhabdoviridae, Filoviridae, Bunyaviridae, Arenaviridae* and *Retroviridae.*

CO3: Describe the etiology, transmission, clinical manifestations, diagnosis, prevention, and control of important DNA viruses of *Circoviridae, Parvoviridae, Poxviridae, Herpesviridae, Papillomaviridae* and *Adenoviridae*.

CO4: Develop the knowledge about etiology, transmission, clinical manifestations, diagnosis, prevention, and control of important DNA viruses belonging to *Hepadnaviridae, Asfaviridae, Iridoviridae, Polydnaviridae and polyomaviridae* and understand the prion diseases, biology, prevention, and management of major viruses of silkworm, poultry, fish, and prawn, emerging and reemerging virus diseases and use the theoretical knowledge on Animal and Human Viruses and Diseases to conduct research or to foster employability in national and international

Veterinary/Biotech/Pharma industries/ research or educational institutes and to grab the opportunities for higher education in national and international institutes.

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 Zoonses. (2004). K.G. Narayana Sri Kuldeep Sharma Pub.
11. Foot and mouth disease –A monograph. (2003). S.C. Adhakha 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. Viral diseases of animal in India, (1994). S.N,Sharma and S.C. Adlakha, V.S. Bhatt Pub.
16. Textbook of Human Virology, 2nd Edition. (1991). R.W. Belshe. Mosby yearbook.
17. Viral Infections of Humans: Epidemiology and control. (1989). 3rd Edition.
18. A.S.Evans (ed). Plenum Medical Book Company.
19. Medical mirobiology.(1997). Fifteenth edition. Edited by D.Green wood, R.C.Slack and J.F.Peutherer. Churchill Lingstone
20. Medical microbiology. (1995). 22nd Edition. G.F. Brooks, J.S.Butel and S.A. Morse. Lange Medical Broks/Mc Graw-Hill.
21. Viruses of vertebrates. (1989). J.S. Porter field, Bailliere Tindals.
22. Encyclopedia of Virology. (1994). R.G. Webster and Allan Granoff. (eds.) Vol. I, II, Academic Press.

VR-403: CORE PRACTICAL: ANIMAL AND HUMAN VIROLOGY & VIRUS DISEASES

Lecture: 9 hours/week	**Semester End Examination: 100 Marks**

Tutorial: Textbooks, E-learning resources, study materials	
Semester: IV	**Credits: 4 Credits**

Course Educational Objectives:

1. To understand biosafety, biosecurity, and ethical guidelines to handle viruses in the laboratory and to develop skills to maintain, isolate and quantitate viruses in cell lines and to study their cytopathic effects.

2. To acquire the knowledge on detection of animal, human and plant viruses using kit-based point of care tests and to learn the preparation, and characterization of virus-based nanoparticles and to participate in extension activities and field, poultry, agriculture research station and aqua form visits.

List of Practicals:

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 blue tongue virus into sheep kidney cell cultures.
9. Chicken embryo inoculation techniques.
10. Quantal assay of viruses.
11. Study of pathogenic lesions of animal virus diseases through slides.
12. Serodiagnosis of virus infections of humans using kits.
13. Participation in vaccination programs (extension activity).
14. Visits to local poultry, fish, and prawn farms.

Course Outcomes: At the end of the course the student will be able to

CO1: Understand the biosafety, biosecurity, and ethical guidelines to be followed in the molecular virology laboratory.

CO2: Learn the technologies related to preparation of media for cell/tissue cultures, preparation of cell cultures/embryonated eggs for virus cultivation and isolation and quantitation of viruses using differential centrifugation and spectroscopy, respectively.

CO3: Develop skills to test the animal, human and plant viruses using serological and molecular tests and kit-based methods.

CO4: Acquire knowledge on virus-based nanotechnology protocols, virus epidemiology by doing extension activities and visiting field, poultry, agriculture research station and aqua forms and use the practical knowledge and skills in Animal and Human Virology and Virus Diseases to conduct research or to foster employability in national and international Veterinary/Biotech/Pharma industries/ research or educational institutes and to grab the opportunities for higher education in national and international institutes.

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. Gurleson 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).

VR-404: CORE PRACTICAL: APPLIED VIROLOGY

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

Course Educational Objectives:

1.To acquire skills in cultivation of plant, animal, and human viruses in plant/animal cell/tissue cultures/embryonated eggs, their isolation, quantification and to learn the role of NPV as biopesticide, purification of virus-based nanoparticles using differential centrifugation.

2. To develop skills to detect the plant, animal and human viruses using serological and molecular detection tests and to participate in extension and field activities to understand the virus epidemiology.

List of Practicals:

1) Preparation of media for animal cell and tissue cultures.
2) Preparation of cell and tissue cultures.

3) Preparation of media for plant tissue culture
4) Cultivation and isolation of virus from cell culture.
5) Cultivation and isolation of animal virus from embryonated chick egg.
6) Application of NPV and its role as biopesticide.
7) Purification of virus-based nanoparticles using differential centrifugation.
8) Characterization of virus-based Nanoparticles
9) Designing and uses of virus like particles (theory-based exercise)
10) Diagnosis of HIV, HBV and HCV using kits.
11) Diagnosis of PRSV using ELISA.
12) Visits to local poultry, fish, and prawn farms.

Course Outcomes: At the end of the course the student will be able to

CO1: Acquire the skills to prepare the cell cultures and embryonated eggs for cultivation of plant, animal, and human viruses and to isolate and quantitate viruses.

CO2: Learn the methods to detect plant and animal viruses and able to analyze various types of results obtained from serological and molecular viral diagnostic methods.

CO3: Apply the skills acquired to prepare NPV as biopesticides and virus-based nanoparticles and their isolation using analytical methods.

CO4: Participate in extension activities and field, poultry, agriculture research station and aqua form visits and use the practical knowledge and skills in Applied Virology to conduct research or to foster employability in national and international Agriculture/Veterinary/Biotech/Pharma industries/ research or educational institutes and to grab the opportunities for higher education in national and international institutes.

Suggested books / manuals:

1. Viruses: Molecular biology, host interactions, and applications to biotechnology. 2018. Paula Tennant, Gustavo Femin and Jerome E Foster. Academic Press.
2. Molecular and Cellular biology of viruses. 2019. Phoebe Lostroh, ISBN 9780815345237.
3. Techniques in diagnoses of Plant Viruses (Plant Pathogens -6)-(2008). Govind.Rao, Rodrigo A. Valverde & C.I. Dovas, Stadium Press.
4. Epidemiology, diagnosis and Management of Zoonses. (2004). K.G. Narayana Sri Kuldeep Sharma Pub.
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. Clinical Virology. (2002). 2nd edition. D.D. Richman et al., ASM
8. Principles of gene manipulation. 6th edition. (2002). By S. Primrose, R. Twyman and B. Old. Blackwell Science.
9. Matthews' Plant Virology. (2001). By R. Hull. Academic Press.
10. 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.
11. Control of Plant Virus Diseases. By Hadidi *et al.* (Eds). APS. USA.
12. Medical Virology. (1994). 4th ed. D.O. White and F. Fenner. Academic Press.

13. Veterinary Virology. (1993). 4th ed. F. Fenner *et al.*, Academic Press (Part-II).

(OR)

VR-404: CORE PRACTICAL: VIRUS BASED BIOTECHNOLOGY

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

Course Educational Objectives:

1.To acquire skills in cultivation isolation and quantification of plant, animal, and human viruses and to isolate and characterize virus-based nanoparticles for the virus-based nanobiotechnology applications.

2. To develop skills to detect the plant, animal and human viruses using serological and molecular detection tests and to participate in extension and field activities to understand the virus epidemiology.

List of Practicals:

1) Preparation of media for animal cell and tissue cultures.
2) Preparation of cell and tissue cultures.
3) Preparation of media for plant tissue culture
4) Cultivation and isolation of virus from cell culture.
5) Cultivation and isolation of animal virus from embryonated chick egg.
6) Application of NPV and its role as biopesticide.
7) Purification of virus-based nanoparticles using differential centrifugation.
8) Characterization of virus-based Nanoparticles
9) Designing and uses of virus like particles (theory-based exercise)
10) Diagnosis of HIV, HIV, HBV and HCV using kits.
11) Diagnosis of PRSV using ELISA.
12) Visits to local poultry, fish, and prawn farms.

Course Outcomes: At the end of the course the student will be able to

CO1: Acquire the skills to prepare the cell cultures and embryonated eggs for cultivation of viruses and to isolate and quantitate viruses.

CO2: Learn the methods to detect plant and animal viruses and to analyze various types of results obtained from serological and molecular viral diagnostic methods.

CO3: Apply the skills acquired to prepare virus-based nanoparticles and their isolation using analytical methods.

CO4: Participate in extension activities and field, poultry, agriculture research station and aqua form visits and use the practical knowledge and skills in Virus-based Biotechnology to conduct research or to foster employability in national and international Agriculture/Veterinary/Biotech/Pharma industries/ research or educational institutes and to grab the opportunities for higher education in national and international institutes.

Suggested books / manuals:

1. Viruses: Molecular biology, host interactions, and applications to biotechnology. 2018. Paula Tennant, Gustavo Femin and Jerome E Foster. Academic Press.
2. Molecular and Cellular biology of viruses. 2019. Phoebe Lostroh, ISBN 9780815345237.
3. Techniques in diagnoses of Plant Viruses (Plant Pathogens -6)-(2008). Govind.Rao, Rodrigo A. Valverde & C.I. Dovas, Stadium Press.
4. Epidemiology, diagnosis and Management of Zoonses. (2004). K.G. Narayana Sri Kuldeep Sharma Pub.
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. Clinical Virology. (2002). 2nd edition. D.D. Richman et al., ASM
8. Principles of gene manipulation. 6th edition. (2002). By S. Primrose, R. Twyman and B. Old. Blackwell Science.
9. Matthews' Plant Virology. (2001). By R. Hull. Academic Press.
10. 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.
11. Control of Plant Virus Diseases. By Hadidi *et al.* (Eds). APS. USA.
12. Medical Virology. (1994). 4th ed. D.O. White and F. Fenner. Academic Press.
13. Veterinary Virology. (1993). 4th ed. F. Fenner *et al.*, Academic Press (Part-II).

VR-405: a) APPLIED VIROLOGY (GENERIC ELECTIVE)

Lecture: 5 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**

Course Educational Objectives:

1. To learn about the basic concepts, requirements and methods of plant and animal cell and tissue cultures and to acquire knowledge about the production and applications of recombinant DNA technology-based antibodies and vaccines to viruses, production of virus-resistant crops and virus-based biopesticides.

2. To acquire knowledge about common virus infections caused to human beings through vector and non-vector borne modes and basic principles of biosafety, biosecurity, and ethical/regulatory issues in Virology and to understand the concepts of using virus based genetic resources and model systems in molecular biology, phage display and therapy technologies and viruses as biological weapons.

UNIT – I

Cell Culture Methods: Plant tissue culture- Introduction to totipotency of plant cell; Plant tissue culture-Initiation and maintenance of callus and suspension culture, single cell clones, organogenesis, somatic embryogenesis, shoot tip culture, rapid clonal propagation and production of virus-free plants; Cryopreservation and germplasm conservation.

Animal tissue culture- Types of tissues, 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, normal *vs*. transformed cells, growth characteristics of transformed cells, maintenance and preservation of cell lines, stem cells and their significance.

UNIT-II

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, subunits, DNA vaccines, peptides, immunomodulators (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 evaluation.

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.

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-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.

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), basics in Intellectual Property Rights.

UNIT-IV

Viruses as unique genetic resources and 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); 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 (retro-, adeno- and parvoviruses) as functional gene delivery systems (gene therapy); Display of foreign peptides on virion surface and applications.

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

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

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.

Course Outcomes: At the end of the course the student will be able to

CO1: Understand the basic concepts, types, requirements and methodologies of plant/animal cell and tissue cultures used for cultivation of plant and animal viruses.

CO2: Learn the production of recombinant DNA technology-based antibodies and vaccines to viruses and the concepts and methods of production of virus resistant/tolerant crops and virus-based biopesticides.

CO3: Acquire knowledge about common virus infections caused to human beings through vector and non-vector borne modes and basic principles of biosafety, biosecurity, and ethical/regulatory issues in Virology and basics in Intellectual Property Rights (IPR).

CO4: Understand the utilization of viruses as viral genes/sequences as unique genetic resources, novel enzymes, gene expression activators and silencers, gene delivery systems, epitope display platforms and model systems in understanding the replication of nucleic acids and regulation of gene expression strategies and cancer biology, phage display and therapy technologies and viruses as biological weapons and use the theoretical knowledge in Applied Virology to conduct research or to foster employability in national and international Agriculture/veterinary/Biotech/Pharma industries/ research or educational institutes and to grab the opportunities for higher education in national and international institutes.

Suggested books:

1. Viruses: Molecular biology, host interactions, and applications to biotechnology. 2018. Paula Tennant, Gustavo Femin and Jerome E Foster. Academic Press.
2. Molecular and Cellular biology of viruses. 2019. Phoebe Lostroh, ISBN 9780815345237.
3. Techniques in diagnoses of Plant Viruses (Plant Pathogens -6) -(2008). Govind.Rao, Rodrigo A. Valverde & C.I. Dovas, Stadium Press.
4. Epidemiology, diagnosis and Management of Zoonses. (2004). K.G. Narayana Sri Kuldeep Sharma Pub.
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. Clinical Virology. (2002). 2nd edition. D.D. Richman et al., ASM
8. Principles of gene manipulation. 6th edition. (2002). By S. Primrose, R. Twyman and B. Old. Blackwell Science.
9. Matthews' Plant Virology. (2001). By R. Hull. Academic Press.
10. 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.
11. Control of Plant Virus Diseases. By Hadidi *et al.* (Eds). APS. USA.
12. Medical Virology. (1994). 4th ed. D.O. White and F. Fenner. Academic Press.
13. Veterinary Virology. (1993). 4th ed. F. Fenner *et al.*, Academic Press (Part-II).

(OR)

VR-405: B) VIRUS-BASED BIOTECHNOLOGY

Lecture: 5 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**

Course Educational Objectives:

1. To understand the concepts and methods of plant and animal cell and tissue cultures, virus based genetic resources and model systems in molecular biology, phage display and phage therapy technologies, virus-based biopesticides and viruses as biological weapons.

2. To describe the production and applications of recombinant DNA technology-based antibodies to viruses, modern vaccines to viruses, concepts, and applications of virus-based nanotechnologies and to acquire knowledge about the principles and methodologies of virus resistant crops and basic principles of biosafety, biosecurity, and ethics in Virology.

UNIT-I

Tissue culture technology: Types of tissues, 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, normal *vs*. transformed cells, growth characteristics of transformed cells, maintenance and preservation of cell lines, large scale production—suspension cultures, microcarriers, hollow fiber reactors; stem cells and their significance.

Viruses as unique genetic resources and 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); 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 (retro-, adeno- and parvoviruses) as functional gene delivery systems (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.
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 virus.

UNIT-III

Recombinant antibodies: *In vitro* production of rDNA technology-based antibodies (monoclonal antibodies, scFv) to viruses and their applications.
Modern vaccines to viruses: designing of modern vaccines, modern vaccines—recombinant proteins, subunits, 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

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.
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.

Course Outcomes: At the end of the course the student will be able

CO1: Understand the basic concepts, types and methodologies of plant / animal cell and tissue cultures and exploitation of viruses as viral genes/sequences as unique genetic resources, novel enzymes, gene expression activators and silencers, gene delivery systems, epitope display platforms and model systems in understanding the replication of nucleic acids and regulation of gene expression strategies and cancer biology.

CO2: Describe the exploitation of bacteriophages for peptide display and therapy, discuss the virus-based biopesticides and viruses as biological warfare, bio-crime, and bioterrorism agents.

CO3: Learn the concepts and methods of production of recombinant DNA technology-based antibodies and vaccines to viruses and understand the principles and applications of virus-based nanoparticles [virus nanoparticles (VNPs) and virus-like particles, and (VLPs)] in Biotechnology.

CO4: Describe the concepts and methods of production of virus resistant/tolerant crops and guidelines of testing and releasing the transgenic lines in India and learn about biosafety, biosecurity guidelines to be followed to conduct virus-related research and discuss the ethical and regulatory issues in virus-related research and basic concepts of IPR and Indian patenting system and use the theoretical knowledge in Virus-based Biotechnology to conduct research or to foster employability in national and international Agriculture/veterinary/Biotech/Pharma industries/ research or educational institutes and to grab the opportunities for higher education in national and international institutes.

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).

VR-406: CLINICAL VIRIOLOGY (OPEN ELECTIVE)

Lecture: 5 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**

Course Educational Objectives:

1. To learn about basic concepts of taxonomy, morphology, transmission, cultivation and replication of viruses and methods used for sample collection and preservation, characterization and detection of viruses and GMP and biosafety practices used in the clinical laboratories.

2. To acquire knowledge about clinically important food-borne, blood borne, vector borne, and contact borne and zoonotic diseases and strategies used for their prevention and control.

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, virus 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.

Course Outcomes: At the end of the course the student will be able to

CO1: Acquire basic understanding of virus taxonomy and virus properties and learn the concept of transmission, replication, cultivation, and characterization of viruses.

CO2: Learn to collect, preserve the virus samples, and detect the viruses by using biological, serological, and molecular methods and describe good microbiological and laboratory practices used in the clinical laboratories.

CO3: Understand the properties, transmission, pathogenesis, epidemiology, diagnosis, and detection of clinically important virus diseases.

CO4: Learn about the approaches used for prevention and control of clinically important infectious virus diseases and use the theoretical knowledge in Clinical Virology to conduct research or to foster employability in national and international veterinary/Biotech/Pharma industries/ research or educational institutes and to grab the opportunities for higher education in national and international institutes.

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.

(OR)

VR-406: HUMAN VIRUS DISEASES

Lecture: 5 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**

Course Educational Objectives:

1. To understand the clinical course, risk factors, prevention and treatment of enteric viral infections and other viruses causing diarrhea, gastroenteritis, viral encephalitis, respiratory diseases.

2. To learn the clinical course, risk factors, transmission, pathogenesis, prevention and treatment strategies of viruses associated with exanthematous diseases, hemorrhagic fevers, HIV/AIDs and oncogenic viruses.

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, 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

Course Outcomes: At the end of the course the student will be able to

CO1: Understand the clinical symptoms, prevention and treatment strategies of enteric viruses and different hepatitis viruses.

CO2: Understand the clinical symptoms, transmission, spread, laboratory diagnosis of viruses.

CO3: Acquire knowledge about viruses associated with exanthematous diseases and viral hemorrhagic fevers.

CO4: Learn about epidemiology, structure and replication, laboratory diagnosis, prevention and therapeutic interventions of HIV and know about viral oncogenesis and oncogenic viruses and use the theoretical knowledge in Human Virus Diseases to conduct research or to foster employability in national and international veterinary/Biotech/Pharma industries/ research or educational institutes and to grab the opportunities for higher education in national and international institutes.

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. 2nd ed., 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.-- 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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