SRI VENKATESWARA UNIVERSITY COLLEGE OF SCIENCES

TIRUPATI - 517 502

DEPARTMENT OF VIROLOGY

Two-Year M.Sc., Virology Program

Semester Pattern Syllabus
(Choice Based Credit System)
Academic year 2021-22 onwards
(New Syllabus as per NEP-2020)

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 MicrobiologicalSciences 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 Diseasesin 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.

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 humansand for promoting collaborative linkages with industries and research organizations for knowledge exchange and possible process/product development.
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 lifeto contribute to the welfare of the society and mankind.

S.V. UNIVERSITY, TIRUPATI:: SVU COLLEGE OF SCIENCES
CBCS Pattern (With effect from academic year2021-2022)
M.Sc., VIROLOGY
COURSE PATTERN AND SCHEME OF EXAMINATION
CURRICULAM

SEMESTER -I

Sl. No.	Components of Study	Course Code	Title of the Course	Credit hours /week	No. of Credits	IA Marks	Sem End Exam Marks	Total
1	Core-Theory (Mandatory)	VIR-101	Biological Chemistry	6	4	20	80	100
2	Core-Theory (Mandatory)	VIR-102	Analytical Techniques	6	4	20	80	100
3	*Compulsory Foundation-Theory (Optional)	VIR-103A (Or)	General Microbiology (Or)	6	4	20	80	100
		VIR-103B	Microbial Physiology and Metabolism	6	4	20	80	100
4	*Elective Foundation-Theory (Optional)	VIR-104A (Or)	General Virology (Or)	6	4	20	80	100
		VIR-104B	Enzyme Technology	6	4	20	80	100
5	Practical-I (Core 1 and 3A or 3B)	VR-105A (Or)	Biological Chemistry & General Microbiology (Or)	9	4	-	100	100
		VR-105B	Biological Chemistry & Microbial Physiology and Metabolism	9	4	-	100	100
6	Practical-II (Core 2 and 4A or 4B)	VIR-106A (Or)	Analytical Techniques & General Virology (or)	9	4	-	100	100
		VIR-106B	Analytical Techniques & Enzyme Technology	9	4	-	100	100
Total				****36 T and 36 P**	**24**	**80**	**520**	**600**
7	***Audit Course (Self-Study)	VIR-107	Human and Professional Ethics-I	0	-	100	-	0

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

****36 h T (Theory) and 36 h P (Practicals) for two batches**

*****Marks of audit course are not included for overall grade**

SEMESTER-II

Sl. No.	Components of Study	Course Code	Title of the Course	Credit hours/ week	No. of Credits	IA Marks	Sem End Exam Marks	Total
1	Core-Theory (Mandatory)	VIR-201	Cell BiologyandTissue Culture	6	4	20	80	100
2	Core-Theory (Mandatory)	VIR-202	Microbial Genetics andMolecular Biology	6	4	20	80	100
3	*Compulsory Foundation - Theory (Optional)	VIR-203A (Or)	Recombinant DNA Technology (Or)	6	4	20	80	100
		VIR-203B	Biostatistics and Bioinformatics	6	4	20	80	100
4	*Elective Foundation- Theory (Optional)	VIR-204A (Or)	Immunology (Or)	6	4	20	80	100
		VIR-204B	Food and Environmental Biotechnology	6	4	20	80	100
5	Practical-I (Core 1 and 3A or 3B)	VIR-205A (Or)	Cell Biology and Tissue culture & Recombinant DNA Technology (Or)	9	4	-	100	100
		VIR-205B	Cell Biology and Tissue culture & Biostatistics and Bioinformatics	9	4	-	100	100
6	Practical-II (Core 2 and 4A or 4B)	VIR-206A (Or)	Microbial Genetics and Molecular Biology & Immunology (Or)	9	4	-	100	100
		VIR-206B	Microbial Genetics and Molecular Biology & Food and Environmental Biotechnology	9	4	-	100	100
Total				****36 T and 36 P**	**24**	**80**	**520**	**600**
7	***Audit Course (Self-Study)	VIR-207	Human and Professional Ethics-II	**0**	**-**	**100**	**-**	**-**

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

****36 h T (Theory) and 36 h P (Practicals) for two batches**

*****Marks of audit course are not included for overall grade.**

SEMESTER-III

	Components of Study	Course Code	Title of the Course	Credit hours/ week	No. of Credits	IA Marks	Sem End Exam Marks	Total
1	Core-Theory (Mandatory)	VIR-301	Plant Virology	6	4	20	80	100
2	Core-Theory (Mandatory)	VIR-302	Plant Virus Diseases	6	4	20	80	100
3	*Generic Elective-Theory (Optional)	VIR-303A (Or)	Molecular Virology	6	4	20	80	100
		VIR-303B	Tumor Virology	6	4	20	80	100
4	Practical (Core 1, 2 and 3A or 3B)	VIR-304A (Or)	Plant Virology and Virus Diseases& Molecular Virology	9	4	-	100	100
		VIR-304B	Plant Virology and Virus Diseases& Tumor Virology	9	4	-	100	100
5	Skill Oriented Course (Mandatory)	VIR-305A	Theory- Molecular Techniques	3	2	10	40	50
		VIR-305B	Practical-MolecularTechniques	6	2	-	50	50
6	**Open Elective-Theory (Optional) **(Offered to other departments)**	VIR-306A (Or)	Basic Virology	6	4	20	80	100
		VIR-306B	Agricultural, Animal and Human Viruses	6	4	20	80	100
Total				***39 T and 30 P	**24**	**90**	**510**	**600**
7	****Skill enhancement Add-on Course (Self-Study)	VIR-307	Communicative English and Fundamentals of Computers	-	-	**100**	-	-

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

****Open Elective: Courses offered to students of others disciplines.**

Minimum strength to offer the open elective course is 10 students.

*****39 h T (Theory) and 30 h P (Practicals) for two batches**

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

SEMESTER-IV

	Course Code	Components of Study	Title of the Course	Credit hours/ week	No. of Credits	IA Marks	Sem End Exam Marks	Total
1	Core-Theory (Mandatory)	VIR-401	Animal and Human Virology	6	4	20	80	100
2	Core-Theory (Mandatory)	VIR-402	Animal and Human Virus Diseases	6	4	20	80	100
3	*Generic Elective-Theory (Optional)	VIR-403A (Or)	Applied Virology	6	4	20	80	100
		VIR-403B	Virus-based Biotechnology	6	4	20	80	100
4	*Practical	VIR-404A (Or)	Animal and Human Virology and Virus Diseases& Applied Virology	9	4	-	100	100
		VIR-404B	Animal and Human Virology and Virus Diseases & Virus-based Biotechnology	9	4	-	100	100
5	**Multidisciplinary Course	VIR-405A	Theory-Industrial Biotechnology	3	2	10	40	50
		VIR-405B	Practical- Industrial Biotechnology (Or)	6	2	-	50	50
	**Project work	VIR-405C	Project work related to Virology	-	4	-	100	100
6	***Open Elective-Theory (Optional) **(Offered to other departments)**	VIR-405A (Or)	Clinical Virology	6	4	20	80	100
		VIR-406B	Emerging and Reemerging Viruses	6	4	20	80	100
Total				****39 T and 30 P	**24**	**90**	**510**	**600**
7	*****Skill Enhancement Add-on Course (Self-Study)	VIR-407	Research Aptitude and Entrepreneurship	**-**	**-**	**100**	**-**	**-**

***Among the generic electives, the student shall choose one followed by the relevant practical.**
****Individual student can choose either project work or multidisciplinary course based on their interest.**
*****Open Elective: Courses offered to students of others disciplines. Minimum strength to offer the open elective course is 10 students.**
******39 h T (Theory) and 30 h P (Practicals) for two batches.**
*******The marks of Add-on courses are not included for overall grade.**

M.Sc. VIROLOGY
CBCS Pattern (With effect from the Academic year 2021-2022)

SEMESTER-I

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

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

Course Educational Objectives:

1. To impart analytical knowledge in Biochemistry, to learn the basic concepts of chemical processes of living organisms and the classification, structure, properties and functions of biomolecules of life (carbohydratesand lipids),
2. To learn, the classification, structure, properties and functions of , proteins classification and mechanism of action of enzymes andenzyme kinetics.
3. To learn, the classification, structure, properties and functions of nucleic acids, hormones, growth regulators and importance of vitamins and
4. To learn about the 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 of carbohydrates; outline structure and properties of important mono-, di-, and oligosaccharides and their identification and functions; structure, occurrence and biological importance of structural polysaccharides (cellulose, chitin, agar, pectins, proteoglycans, sialic acids).

Lipids: Building blocks of lipids; classification of lipids; fatty acids - physicochemical properties, separation, distribution in nature, characterization and saponification and iodine number. Nomenclature, outline structures, properties and functions of glycerides, neutral lipids (waxes, fats, oils), phospholipids, sphingolipids and glycolipids; steroids- plant sterol, ergosterol, cholesterol; lipoproteins- classification, composition and importance.

UNIT-II

Amino acids: Classification, structure and physicochemical properties.

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

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

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

UNIT- III

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

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

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

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

UNIT- IV

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

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

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

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

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

CO1: Acquire knowledge on major elements and biomolecules 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 biosynthesis of carbohydrate, lipid, carbohydrates, and proteins. and learn the concepts of bioenergetics and biosynthesis of carbohydrate, lipid, carbohydrates, and proteinsanduse this knowledge to compete for 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) Lehninger, 3rd edition by Nelson and Cox (Worth).
7. NMS Biochemistry 4th edition (1999) Victor L. Davidson and Donald B Sittman.
8. Microbial Physiology (1999), 3rd ed. by A.G. Moat & J.W. Foster, Wiley- Liss.
9. Microbial Physiology and Metabolism. (1995), by D.R. Caldwell. 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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	3	2	1	1	3
CO2	3	3	3	3	2	3	2	2	2	2	1	2
CO3	2	2	2	2	1	3	3	2	2	2	1	-

CO4	**1**	**1**	**1**	**-**	**-**	**3**	**3**	**1**	**2**	**2**	**2**	**-**

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

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

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 microscopic,
2. To understand the approaches involved in chromatographic, centrifugal, and electrophoretic techniques.
3. To learn about various radioisotopes, spectroscopy and cell countingtechniques that are used for characterization of biomolecules and
4. To learn about 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 and diafiltration (tangential flow filtration using membrane cut-offs), membrane filtration and their applications.

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

UNIT-II

Chromatography: Principle, theoryand applications of partition (paper chromatography), adsorption (TLC), column (ion-exchange, gel permeation, affinity); Principle and applications of GLC, HPLC, FPLC, GC/LC-MS and 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 andtypes 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 and surface plasmon resonance.

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

UNIT-IV

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

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

Vital statistics: Death rate and ratio, measures of morbidity measures of mortality.

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:Define 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:Define basic concepts of statistics and apply basic statistical methods to Virology related research experiments involving statistical data.

Learning Recourses and Suggested books:

1. Biomolecular Thermodynamics: From Theory to Application (Foundations of Biochemistry and Biophysics) (2017) 1st Edition, Publisher: CRC Press.
2. Study Guide with Student Solutions Manual and Problems Book for Garrett/Grisham's Biochemistry (2016) Reginald H. Garrett , Charles M. Grisham 6th Edition, Publisher: Cengage Learning.
3. Biochemical Calculations: How to solve Mathematical Problems in General Biochemistry(2010) Irwin H. Segel International Edition Paperback – 1910, 2nd edition, Publisher: Wiley India Private Limited.
4. Analytical techniques in Biochemical and biophysics for macromolecules (2009) AvinashUpadyay, NirmalaneduUpadyay 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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	3	2	1	1	3
CO2	3	3	3	3	2	3	2	2	2	2	1	2
CO3	2	2	2	2	1	3	3	2	2	2		
CO4	1	1	1	1	1	1	3	1	2	1	2	1

VIR-103A: GENERAL MICROBIOLOGY (Optional)
(Compulsory Foundation -Theory)

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

Course Educational Objectives:

1. To learn aboutfundamentals aspects of microbiology including origin, evolution ofmicroorganisms, different groups of microorganisms and their importance, microscopy principles and applications, morphology, and structure of bacteria,
2. To learn about Microbiological media, isolation, cultivation and enumeration methods of microorganisms, microbial growth characteristics, maintenance, and preservation of microbial cultures.

3. To develop knowledge on microbial taxonomy, transport of nutrients in microbes, control strategies of microorganism,

4. To develop knowledge on general characteristics, structure and reproduction of fungi, algae, and protozoan parasites.

UNIT – I

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

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

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

UNIT-II

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

Microbial growth: Definition, microbial growth curve, batch culturing, continuous, synchronous, biphasic culturing, generation time, factors influencing the growth-physical chemical and biological; microbial growth measurement methods.

Maintenance and preservation of microbial cultures: Short term and long term preservation methods; repeated sub-culturing, oil overlay, sterile soil/sand, glycerol-deep freezing, drying methods, freeze-drying (lyophilization), and revival of microbial cultures.

UNIT-III

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

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

UNIT-IV

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

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

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

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

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

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

CO1: Understand the origin, evolution, different groups and importance of microorganisms and learn the types, principles and applications of microscopy, morphology, and structure of bacteria.

CO2: Learn the basic concepts of media preparation, isolation, cultivation, enumeration, growth measurement, maintenance, and preservation methods of microorganisms.

CO3: Explain the general criteria for microbial classification, general characteristics of microorganisms, mechanism of nutrient transport in microbes and strategies used for control of microorganisms.

CO4: Describe the general characteristics, structure, reproduction of important fungi, algae and protozoan parasites.

Learning Resources and Suggested Books:

1. Brock Biology of Microorganisms 16th Edition (2020) Madigan MT, Martinko JM, Dunlap PV, Clark DP Prentice Hall publisher USA.
2. *Foundations in Microbiology*, (10th Edition) (2018)Kathleen Park Talaro and Barry Chess, Tata McGraw, India.
3. Microbiology, 10th Edition (2017) Lansing M Prescott, Donald A Klein, John P Harley, Mc Graw Hill publisher.
4. Microbiology and Parasitology (2016) B. S. Nagoba,Elsevier Health Sciences.
5. Textbook of Microbiology (2016) R. Ananthanarayan,OrientBlacksman 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.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**1**	**1**	**3**
CO2	**3**	**3**	**3**	**3**	**2**	**3**	**2**	**2**	**2**	**2**	**1**	**-**
CO3	**2**	**2**	**2**	**2**	**1**	**3**	**3**	**2**	**2**	**2**	**1**	**2**
CO4	**1**	**1**	**1**	**1**	**2**	**3**	**3**	**1**	**2**	**1**	**1**	**-**

(Or)

VIR-103B: MICROBIAL PHYSIOLOGY AND METABOLISM (Optional)
(Compulsory Foundation - Theory)

Lecture: 6 hours/week	**Internal test Assessment: 20 Marks**

	Seminars and assignments
Tutorial: Textbooks, E-learning resources, study materials, PowerPoint lectures	**Semester End Examination: 80 Marks**
Semester: I	**Credits: 4 Credits**

Course Educational Objectives:

1. To learn about fundamental aspects of nutrition and growth requirements and the mechanism of transport of nutrients in different groups of microorganisms and their importance
2. To learn about microbial growth characteristics metabolism of growth and microbial photosynthesis
3. To develop knowledge on microbial metabolism of Carbohydrates, Aerobic and Anaerobic respiration

4. To develop knowledge on lipid, protein, nucieotide metabolismof microorganisms.

Unit I

Nutrition and growth: Elemental nutrient requirements of microbes; nutritional groups of bacteria; autotrophy-photoautotrophy and bacterial photosynthesis; chemoautotrophy and autotrophic metabolism; heterotrophy- photoheterotrophy and chemoheterotrophy, heterotrophic metabolism in bacteria; nutritional mutants and their use in metabolic studies.

Transport of nutrients in microbes: Structural organization of plasma membrane in relation to transport, types and mechanisms of transport (passive, simple, facilitated, active, chemical modification) with reference to sugars, amino acids and ions; methods for studying of transport, coupling of transport of ions and metabolites to ATP/proton gradient.

Unit II

Microbial Growth: Definition; salient features of growth curve; generation time; specific growth rate; batch and continuous culture; synchronous growth; diauxic growth curve.; factors influencing the microbial growth; measurement of cell numbers; cell mass and metabolic activity; environment and microbial growth.

Microbial metabolism: The concepts of microbial metabolism, primary and secondary metabolism and their significance.

Photosynthesis: Oxygenic, anoxygenic photosynthesis; fixation of CO_2, Calvin cycle - C3 and C4 pathway;chemolithotrophic electron transport systems;methanogenesis;Biolumenescence.

Unit III

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

Aerobic respiration: TCA cycle- intracellular location and reactions of the cycle, amphibolic nature of the cycle, energetics of the cycle; the glyoxalate cycle; mechanisms of substrate-level phosphorylation; respiratory electron transport in mitochondria; mechanism of oxidative phosphorylation.

Anaerobic respiration: Nature of fermentation, the relationship of oxygen to growth and fermentation, biochemical mechanisms of lactic acid, ethanol and acetone fermentations, study of fermentations, relationships between fermentation and energy production; nitrate and sulphate respiration.

UNIT-IV

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

Protein and nitrogen metabolism: Metabolism of amino acids-amino acid biosynthesis and utilization; catabolism of amino acid, transamination, decarboxylation and oxidative deamination; Urea cycle.

Metabolism of nucleotides: Purine and pyrimidine biosynthesis, regulation of purine and pyrimidine biosynthesis,inhibitors of nucleotide synthesis.

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

CO1: Understand the fundamental aspects of nutrition and growth requirements and the mechanism of transport of nutrients in different groups of microorganisms and their importance

CO2: Learn the basic concepts ofmicrobial growth characteristics metabolism of growth and microbial photosynthesis

CO3: Explain the general criteria for microbial metabolism of Carbohydrates, Aerobic and Anaerobic respiration

CO4: Describe the lipid, protein, nucieotide metabolismof microorganisms

Learning Resources and Suggested Books:

1. Doelle H.W. 1969. Bacterial Metabolism.Academic Press.
2. Gottschalk G. 1979. Bacterial Metabolism. Springer Verlag. Moat AG. 1979.
3. Bacterial Physiology and Metabolism. Academic Press.
4. Moat A G., Foster J W., 2009.Spector M P. Microbial Physiology, 4th Ed: Wiley India Pvt
5.Lodish, H., Berk A., Kaiser C. A., Krieger M., Scott M.P., Bretscher A., Ploegh H., and Matsudaira P., Molecular Cell Biology, 6th Edition, Freeman, W. H. and Co., 2008.
6. James Darnell, Molecular Cell Biology, 6th Edition, W. H. Freeman & Co, 2007.
7.Microbial Physiology and Metabolism. 1995, by D.R. Caldwell. Wm.C. Brown Publ.
8.Microbial Physiology. 1999, 3rd ed. by A.G. Moat & J.W. Foster.Wiley- Liss.
9.Principles of Biochemistry. Lehninger. 2000.
10.Foundations in Microbiology. 1996. By K. Talaro& A. Talaro, Wm. C. Brown Publ.
11. Microbiology. 2000. By Prescott et al. Wm. C. Brown Publ.
12.Molecular Cell Biology. 2000 - by Lodish et al.
13.General Microbiology, 1999 by Stanier et al., Macmillan Educational Ltd.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	3	2	1	1	3
CO2	3	3	3	3	2	3	2	2	2	1	1	2
CO3	2	2	2	2	2	3	3	2	2	1	1	2
CO4	1	1	1	-	2	3	3	1	2	2	2	2

VIR-104A: GENERAL VIROLOGY (Optional)
(Elective Foundation-Theory)

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

Course Educational Objectives:

1.To understand the history, properties, nomenclature and classification of viruses and development of virology and

2. To learn about methods used for isolation, cultivation, and purification of viruses.

3..To acquire knowledge about the methods used for quantitation of viruses and major characteristics of important plant and animal virus families and biology and applications of major RNA and DNA viruses of insects,

4. To acquire knowledge about bacteriophages, algal and fungal viruses, subviral agents, importance of viruses in human welfare.

UNIT-I

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

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

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

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

UNIT-II

Laboratory Bio-safety: Principles of bio-safety, biosafety levels, containment facilities, maintenance and handling of laboratory animals and requirements of virology laboratory.

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

Purification of viruses: Extraction of viruses from tissues, clarification, and concentration of viruses in clarified extracts by physical and chemical methods, further purification of viruses by rate zonal / equilibrium density gradient centrifugation, Criteria of virus purity, Quantitation and preservation of purified virus preparations.

UNIT-III

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

Replication: Introduction to virus replication, steps involved in virus replication and general strategies.

Management of viruses: Cultural practices, Sanitation, control of vectors,vaccines, antiviral drugs and chemotherapy.

UNIT-IV

Bacteriophages: Biology of major RNA (MS_2, Qβ) and DNA (T4, lambda, Øx174, M_{13}) bacteriophages, replication of M13, T4 and lambda phages; biology of cyanophages.

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

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

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

CO1: Learn the discovery, nature, origin and evolution of viruses and the physical, biochemical, and biological properties of viruses, criteria used for nomenclature and classification of bacteria, plant and animal viruses.

CO2:Describe the methods used for isolation, cultivation, and purification of viruses and criteria of purity.

CO3: Definebiological, physical, biochemical, and serological methods used for quantitation of viruses, major characteristics of important plant and animal virus families and biology and applications of major RNA and DNA viruses of insects.

CO4: Understand thebiology of major bacteriophages, algal and fungal viruses, subviral agents and importance of viruses in human welfare with suitable examples.

Learning Resources and Suggested Books:

1. Evidence-Based Diagnosis: An Introduction to Clinical Epidemiology 2nd Edition, by Thomas B. Newman, Michael A. Kohn (2020).2 edition, Publisher: Cambridge University Press.
2. Virusphere: From Common Colds to Ebola Epidemics--Why We Need the Viruses That Plague Us (2020). 1st edition, Frank Ryan (Author), Publisher: Prometheus.
3. Guide to Clinical and Diagnostic Virology (2019), (ASM Books) 1st Edition, by ReetiKhare, 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 DiRitaPublisher: LWW; Fifth, North American edition
10. Introduction to Modern Virology. (2001). 5th ed. Dimmock et al., Blackwell Sci. Publ.
11. Plant Virology. (2001). 4th edi. By R. Hull. Academic Press.
12. Fundamental Virology, 4th ed. (2001). D.M. Knipe and P.M. Howley.
13. Principles of Virology: (2000). by S.J. Flint et al., ASM Press.
14. Basic Virology, (1999). By Waginer and Hewelett, Black Well Science Publ.
15. Veterinary Virology. 3rd ed. (1999). Murphy et al., Academic Press.
16. Principles of Molecular Virology. (1997). 2nded. A. Cann. Academic Press.
17. Medical Virology. (1994). 4th edition. D.O. White and F.J. Fenner. Academic Press. Plant Virology. (2001). 4thed. By R. Hull. Academic Press.
18. Field's Virology Vol 1 and 2. B.N. Fields, D.M. Knipe, P.M. Howley, R.M. Chanock, J.L.Melnick, T.P. Monath, B. Roizman, and S.E. Straus, eds.), (2007) 3rd Edition. Lippincott-Raven,Philadelphia, PA.
19. Principles of Molecular Virology. (1997). 2nded. A. Cann. Academic Press.
20. Virology: (1994). 3rded. Frankel Conrat et al, Prentice Hall.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	3	2	1	1	3
CO2	3	3	3	3	2	3	2	2	2	2	1	2
CO3	2	2	1	2	1	3	3	2	2	2	1	-
CO4	1	1	1	1	3	3	3	1	2	1	3	1

(Or)

VIR-104B: ENZYME TECHNOLOGY (Optional)
(Elective Foundation-Theory)

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

Course Educational Objectives:

1.To impart knowledge in Nomenclature and classification; general types properties and Kinetics of Enzymes

2.To learn, the properties and functions of viral enzymes, and mechanism of action of enzymes.

3. To learn, about enzyme immobilization and Biosensors

4.To learn about the Applications of Enzymesin food processing, textile and pharmaceutical industries; Catalytic enzymes

Unit-I

Enzymes: Nomenclature and classification; general types and properties of enzymes.

Kinetics of Enzymes: Enzyme specificity- stereospecificity, reaction specificity, substrate specificity; factors affecting enzyme activity- temperature, pH, time; Michaelis-Menten equation - Analyses of kinetic data-Lineweaver-burk plot; kinetics of single substrate reactions, multisubstrate reactions – mechanisms and kinetics; turnover number; types of inhibition and models -substrate, product; allosteric regulation of enzymes; deactivation kinetics.

Unit-II

Viral enzymes: DNA dependent DNA polymerase, RNA dependent RNA polymerase, protease, ligase, integrase, helicase, primase, reverse transcriptase, Hemagglutinin esterase, Thymidine kinase, neuraminidase, Lysins, polyadenylate polymerase, SARS-CoV replicase complex, vaccinia virus G4 disulfide oxidoreductase; **Proteinases:** 2A proteinase ($2A^{pro}$), 3C proteinase ($3C^{pro}$), 3C-like proteinases, (M^{pro} /$3CL^{pro}$), papain-like proteinases (PL^{pro}: $PL1^{pro}$ and $PL2^{pro}$); Chymotrypsin-like serine proteases, Glycosyltransferases.

Unit-III

Enzyme Immobilization and Biosensors: Physical and chemical techniques for enzyme immobilization – adsorption, matrix entrapment, encapsulation, cross-linking, covalent binding – examples, advantages and disadvantages, design of enzyme electrodes and their application as biosensors in industry, healthcare and environment.

Unit-IV

Applications of Enzymes: Enzymes in industrial processing- Role of cellulases, hemicellulases, lipases, proteases, laccases and pectinases; Enzymes in organic synthesis – esters, amide, peptide; modified and artificial enzymes;enzymes in food processing, textile and pharmaceutical industries; Catalytic enzymes.

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

CO1: Acquire knowledge on Nomenclature and classification; general types properties and Kinetics of Enzymes

CO2: Learn the the properties and functions of viral enzymes, and mechanism of action of enzymes.

CO3: Learn the enzyme immobilization and Biosensors and their applicationsin industry, healthcare and environment.

CO4: Learn the Applications of Enzymesin food processing, textile and pharmaceutical industries; Catalytic enzymes

Learning Resources and Suggested Books/Manuals:

1. Berg.J.M, Tymoczko.J.L, Stryer, L. Biochemistry. 6th ed. Freeman, 2006.
2. Zubay. Biochemistry. 4th ed. William C. Brown Publication, 1998
3. Voet and Voet. Biochemistry.4th edition, John Wiley& sons, 2010.
4. A. Lehningeretal., Principles of Biochemistry, Freeman & company, 2005.
5. L. Stryer, Biochemistry. Freeman & company, 2001.
6. West and Todd., Basic Biochemistry, Oxford and IBH publishing Co. Pvt. Ltd, 2000.
7. Thomas M. Devlin., Text book of Biochemistry with clinical correlations. Wiley-Liss Publications - New York, 1997.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	3	2	1	1	3
CO2	3	3	3	3	2	3	2	2	2	2	1	2
CO3	2	2	2	2	1	3	3	2	2	2	1	2
CO4	1	1	1	1	3	3	3	-	-	1	1	1

PRACTICAL: VIR-105A: BIOLOGICAL CHEMISTRY &GENERAL MICROBIOLOGY

Practicals: 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 determine the activity of enzymes.

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

List of Experiments:

1. Preparation of reagents and buffers
2. Calculation of percentage, molarity and normality of solutions
3. Qualitative tests for identification of carbohydrates
4. Qualitative tests for identification of amino acids
5. Qualitative tests for identification of nucleic acids
6. Estimation of proteins (Lowry method)
7. Estimation of glucose (Anthrone method)
8. Estimation of glycine
9. Estimation of bilirubin
10. Estimation of cholesterol
11. Estimation of inorganic phosphorous
12. Determination of activity of peroxidase and polyphenol oxidase from leaves
13. Isolation and assay of an enzyme (amylase or phosphorylase) from potato extract
14. Sterilization, disinfection, safety in microbiological laboratory(theory)
15. Orientation of instruments - Compound microscope, Autoclave, Incubator cum shaker, Laminar Airflow.

16. Sterilization methods (dry, wet, UV, chemical agents).
17. Preparation of media for cultivation of microorganisms.
18. Enumeration of microorganisms from soil.
19. Enumeration of microorganisms from water
20. Plating techniques- streak plate, pour and spread plate methods
21. Bacterial staining techniques: Simple, Gram and spore staining
22. Lactophenol-cotton blue staining for fungi.
23. Hanging drop method for bacterial motility.
24. Determination of bacterial growth curve.
25. Effect of pH on bacterial growth.
26. Effect of temperature on bacterial growth.
27. Effect of salt concentration on bacterial growth
28. Antibiotic sensitivity assay – Disc and Well diffusion method
29. Isolation of bacteriophages from sewage water

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:Knowhow to isolate and check the activity of enzymes from various sources.

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

CO2:Acquire the practical skills to usecultivation, staining and characterization methods for different microorganisms and to check their stability under various conditions.

Learning Resources and Suggested Books/Manuals:

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

10. Physical Biochemistry: Applications to Biochemistry and Molecular Biology, (1982), 2nd ed. by David Freifelder. W.H. Freeman and Company.
11. Diagnostic Microbiology. 11th Edition. (2002). By B.A. Forbes et al., Mosby publisher
12. Practical Microbiology, (2002) by R.C. Dubey and D.K. Maheshwari.
13. Laboratory Manual in Microbiology, (2000). By P. Gunasekaran
14. Microbiological Applications: Laboratory Manual in General Microbiology, 7th ed. by J. Benson.
15. Microbiology: A Laboratory Manual. 4th edition. By J.G. Cappuccino and N. Sherman.
16. Experiments in Microbiology, Plant Pathology, Tissue culture and Mushroom cultivation. 3rdedition.By K.R. Aneja.
17. Laboratory Experiments in Microbiology by Johnson.
18. Laboratory Manual in Microbiology by Alcamo.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	3	2	1	1	3
CO2	3	3	3	3	2	3	2	2	2	1	-	1
CO3	2	2	2	2	2	3	3	2	2	1	1	3
CO4	1	1	2	2	1	3	3	1	2	2	1	2

(Or)

PRACTICAL: VIR-105B: BIOLOGICAL CHEMISTRY &MICROBIAL PHYSIOLOGY AND METABOLISM

Practicals: 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 determine the activity of enzymes.

2. To learn the various methods of optimization of cultural conditions for bacterial growth and antibiotic assay methods

List of Experiments:

1. Preparation of reagents and buffers
2. Calculation of percentage, molarity and normality of solutions
3. Qualitative tests for identification of carbohydrates

4. Qualitative tests for identification of amino acids
5. Qualitative tests for identification of nucleic acids
6. Estimation of proteins (Lowry method)
7. Estimation of glucose (Anthrone method)
8. Estimation of glycine
9. Estimation of bilirubin
10. Estimation of cholesterol
11. Estimation of inorganic phosphorous
12. Determination of activity of peroxidase and polyphenol oxidase from leaves
13. Isolation and assay of an enzyme (amylase or phosphorylase) from potato extract
14. Microbiological laboratory safety measures (theory)
15. Orientation of instruments - Compound microscope, Autoclave, Incubator cum shaker, Laminar Airflow.
16. Sterilization Methods (dry, wet, UV, chemical agents).
17. Preparation of media for cultivation of microorganisms.
18. Enumeration of microorganisms from soil.
19. Enumeration of microorganisms from water
20. Plating techniques- streak plate, pour and spread plate methods
21. Bacterial staining techniques: Simple, Gram and spore staining
22. Lactophenol-cotton blue staining for fungi.
23. Hanging drop method for bacterial motility.
24. Determination of bacterial growth curve.
25. Effect of pH on bacterial growth.
26. Effect of temperature on bacterial growth.
27. Effect of salt concentration on bacterial growth
28. Antibiotic sensitivity assay – Disc and Well diffusion method
29. Isolation of bacteriophages from sewage water

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:Knowhow to isolate and check the activity of enzymes from various sources.

CO2:Acquire the practical skills to usecultivation, staining and characterization methods for different microorganisms and to check their stability under various conditions.

CO1: Define the various methods of optimization of cultural conditions for bacterial growth and antibiotic assay methods

Learning Resources and Suggested Books/Manuals:

1. Biomolecular Thermodynamics: From Theory to Application (Foundations of Biochemistry and Biophysics) (2017), 1st Edition, Publisher: CRC Press.
2. Study Guide with Student Solutions Manual and Problems Book for Garrett/Grisham's Biochemistry (2016), Reginald H. Garrett , Charles M. Grisham 6th Edition, Publisher: Cengage Learning.

3. Microbiology Tools & Techniques (2008) Kanika Sharma-Ane books, India.
4. Protein Purification Techniques 2nd ed.-(2001)-Simon Roe-Oxford University Press.
5. Practical Biochemistry: Principles and Techniques (1995), 4th ed. by K. Wilson and J.Walker, Cambridge University Press.
6. Introduction to Practical Biochemistry. (2000). by S.K. Sawhney and Randhir Singh (eds.) Narosa Publ. House
7. Laboratory Manual in Biochemistry, (1996). By J. Jayaraman.
8. Modern Experimental Biochemistry. (1993). 2nd ed. by R.F. Boyer. The Benjamin Cummings Publ. Company.
9. Biochemical Methods for Agricultural Sciences, (1992). By S. Sadasivam and A. Manikam.
10. Physical Biochemistry: Applications to Biochemistry and Molecular Biology, (1982), 2nd ed. by David Freifelder. W.H. Freeman and Company.
11. Diagnostic Microbiology. 11th Edition. (2002). By B.A. Forbes et al., Mosby publisher
12. Practical Microbiology, (2002) by R.C. Dubey and D.K. Maheshwari.
13. Laboratory Manual in Microbiology, (2000). By P. Gunasekaran
14. Microbiological Applications: Laboratory Manual in General Microbiology, 7th ed. by J. Benson.
15. Microbiology: A Laboratory Manual. 4th edition. By J.G. Cappuccino and N. Sherman.
16. Experiments in Microbiology, Plant Pathology, Tissue culture and Mushroom cultivation. 3rdedition.By K.R. Aneja.
17. Laboratory Experiments in Microbiology by Johnson.
18. Laboratory Manual in Microbiology by Alcamo.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	3	-	-	1	3
CO2	3	3	3	3	2	3	2	2	2	2	1	2
CO3	2	2	2	2	2	3	3	2	2	2	1	2
CO4	1	2	1	3	2	3	3	1	2	2	1	1

PRACTICAL:VIR-106A: ANALYTICAL TECHNIQUES & GENERAL VIROLOGY

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

1. 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.

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 Experiments:

1. Laboratory equipment and their maintenance (Theory excercise)
2. Measurement of pH
3. Cell counting by Hemocytometer
4. Determination of λ max for colored solutions
5. Determination of λ max of DNA & RNA by UV spectrophotometry
6. Separation of lipids by TLC
7. Separation of amino acids by paper chromatography
8. Separation of leaf or virus proteins by SDS-PAGE
9. Separation of DNA by submarine agarose gel electrophoresis
10. Isolation of chloroplasts by sucrose density gradient centrifugation (demo)
11. Cultivation of viruses in embryonated eggs: different routes of inoculation.
12. Mechanical transmission of plant virus
13. Aphid transmission of plant virus (demo)
14. Graft transmission of plant virus
15. Determination of thermal inactivation point (TIP) of plant virus
16. Determination of dilution end point (DEP) of plant virus
17. Determination of longevity in vitro (LIV) of plant virus
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:Learn to useultrafiltration, chromatography, and electrophoresis techniquesfor isolation and characterization of biomolecules.
CO2:Acquire the skills to usespectroscopic and centrifugal methods for characterization of biomolecules.
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.

Learning Resources and Suggested Books/Manuals:

1. Biomolecular Thermodynamics: From Theory to Application (Foundations of Biochemistry and Biophysics) (2017), 1st Edition, Publisher: CRC Press.
2. Study Guide with Student Solutions Manual and Problems Book for Garrett/Grisham's Biochemistry (2016), Reginald H. Garrett , Charles M. Grisham 6th Edition, Publisher: Cengage Learning.
3. Microbiology Tools & Techniques (2008) Kanika Sharma-Ane books, India.
4. Protein Purification Techniques 2nd ed.-(2001)-Simon Roe-Oxford University Press.
5. Practical Biochemistry: Principles and Techniques (1995), 4th ed. by K. Wilson and J.Walker, Cambridge University Press.
6. Physical Biochemistry: Applications to Biochemistry and Molecular Biology, (1982), 2nd ed. by David Freifelder. W.H. Freeman and Company.
7. Virology Methods Manual, (1996). B.W.J. Mahy and H.O. Kangro. Academic Press
8. Molecular Virology: A Practical Approach. (1993). Davison and R.M. Elliot. Oxford University Press.

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	3	2	1	2	3
CO2	3	3	3	3	2	3	2	2	2	2	2	-
CO3	2	2	2	2	1	3	3	2	2	2	2	2
CO4	1	2	1	2	1	3	3	1	2	1	1	-

(Or)

PRACTICAL:VIR-106B: ANALYTICAL TECHNIQUES &ENZYME TECHNOLOGY

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

1. 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.

2.To demonstrate the practical skills on quantitative anad qualitative assay of enzymes and their kinetics

List of Experiments:

1. Laboratory equipment and their maintenance (Theory excercise)
2. Measurement of pH
3. Cell counting by Hemocytometer
4. Determination of λ max for colored solutions
5. Determination of λ max of DNA & RNA by UV spectrophotometry

6. Separation of lipids by TLC
7. Separation of amino acids by paper chromatography
8. Separation of leaf or virus proteins by SDS-PAGE
9. Separation of DNA by submarine agarose gel electrophoresis
10. Isolation of chloroplasts by sucrose density gradient centrifugation (demo)
11. Enzyme Kinetics – determination of rate constant
12. Estimation of glucose by Benedict's method
13. Estimation of urea by Diacetyl monoxime method
14. Estimation of urease enzyme in horse gram
15. Estimation of blood sugar
16. Amylase activity from saliva
17. Effect of temperature, pH, time on Enzyme (alkaline phosphatase) activity
18. Determination of acid phosphatase activity

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

CO1:Learn to useultrafiltration, chromatography, and electrophoresis techniquesfor isolation and characterization of biomolecules.

CO2:Acquire the skills to usespectroscopic and centrifugal methods for characterization of biomolecules.

CO3: Learn to estimate the blood sugar, urea. quantitative anad qualitative assay of enzymes and their kinetics

CO4:Knowhow to isolate and check the activity of enzymes from various sources.

Learning Resources and Suggested Books/Manuals:

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

(1982), 2nd ed. by David Freifelder. W.H. Freeman and Company.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	3	3	3	3	3	3	2	1	1
CO2	3	3	3	3	2	3	2	2	2	2	1
CO3	2	2	2	2	1	3	3	2	2	2	2
CO4	1	-	-	3	3	3	3	1	2	1	2

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

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

Course Educational Objectives:

1.To enable the students to imbibe and internalize the moral values and ethical principles

2. To learn ethics moral and social values and ethical behavior in the personal and Professional lives.

3.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.

4. To acquire knowledge about the important facts of Bhagavad Gita, values hidden in religions, religious tolerance and aware of crime, and punishment theories

UNIT-I

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

UNIT-II

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

UNIT-III

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

UNIT-IV

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

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

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 personaland 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 ofcrime, and punishment theories.

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.KavirajKunjanlal, KunjalalBrishagratha, Chowkamba Sanskrit series, Vol I,II and III, Varnasi, Vol I OO, 16-20, 21-32 and 74-77 only.
11. CarakaSamhita: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.

Cours	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO1	PO1	PO1
CO1	3				3	2			3	2		1
CO2	3				3	2			3	2		1
CO3	3				3	2			3	2		1
CO4	3				3	2			3			1

SEMESTER-II

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

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

Course Educational Objectives:

1.To understand the structure and contents of prokaryotic and eukaryotic cells,

2.To understand general principles and pathways of cell communication and cell signaling.

2. To describe the concepts and methodologies of plant tissue cultures.

4.To describe the concepts and methodologies of and animal tissue and organ cultures, cell counting and introduction to stem cell cultures

UNIT – I

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

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

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

UNIT – II

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

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

UNIT – III

Introduction to tissue culture: Principles and types of tissue culture, Culture media - balanced salt solutions; Composition and metabolic functions of media; Defined media and their applications; role of serum and supplements, serum-free media; maintenance of sterility, use of antibiotics, mycoplasma and other contaminations**.**

Animal tissue culture:*In vitro* cultures**-**Primary culture – Mechanical and enzymatic mode of disaggregation, establishment of primary culture; Subculture - Passage number, split ratio, seeding efficiency, criteria for subculture; Cell lines – Definite and continuous cell lines, characterization, authentication, maintenance and preservation of cell lines; Normal*vs*. transformed cells, growth characteristics of transformed cells

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

Three dimensional cultures: Organoids and Histotypic cultures.

UNIT – IV

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

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

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

CO1: Discuss the structure and contents of prokaryotic and eukaryotic cells,
CO2: Discuss general principles and pathways of cell communication and cell signaling.
CO2: Understand theconcepts and methodologies of plant tissue cultures

CO4:Understand theconcepts and methodologies of plant and animal tissue and organ cultures, cell counting and introduction to stem cell cultures.

Learning Resources and Suggested books:

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

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	3	2	1	1	3
CO2	3	3	3	3	2	3	2	2	2	2	-	2
CO3	2	2	2	2	1	3	3	2	2	2	-	2
CO4	1	1	1	1	1	3	3	1	2	2	2	1

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

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

Course Educational Objectives:

1. To gain understanding ofprokaryotic and eukaryotic genome organization, modern concept of genes, plasmids, mobile genetic elements
2. To learn gene transfer and mapping mechanisms in bacteria, genetics of viruses and requirements and mechanism of DNA replication.
3. To attain knowledge about the mechanism of DNA damage and repair, concept of mutations and their importance, processes involved in transcription,
4. To attain knowledge about the mechanism of translation, regulation of gene expression and gene silencing mechanisms.

UNIT-I

Genetic notations, conventions and terminology

Evidences for nucleic acids as information carriers: Genomes- types, diversity in size, structure and organization in viruses, prokaryotes (nucleoid) and eukaryotes (chromosomes, ploidy, chromatin and nucleosomes); Chloroplast and mitochondrial genomes; **Genes -** The modern concept of the genes, gene structure and architecture, types of genes.

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

Mobile genetic elements: Prokaryotes - types and structure of bacterial transposons, and molecular mechanism of transposition; Eukaryotes – types and their structure, and molecular mechanism of transposition; Exploitation of transposable elements in genetics.

UNIT-II

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

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

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

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

UNIT-III

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

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

Translation (Protein biosynthesis) : Genetic code and its elucidation, structure and composition of prokaryotic and eukaryotic ribosomes, structural features of rRNA, mRNA and tRNAs in relation to function, steps in protein biosynthesis in prokaryotes and eukaryotes; post-translational modification of proteins and their sorting and targeting; inhibitors of protein biosynthesis.

UNIT-IV

Regulation of gene expression: An overview on levels of regulation, terminology and operon concepts, enzyme induction and repression; positive and negative regulation in *E. coli*- lac and ara operons; regulation by attenuation- trp operon; antitermination- N protein in lambda phage;Global regulatory responses- heat shock response.

Mutations: Types, causes and consequences of mutations; Mutagens and their mode of action; Isolation and analysis of bacterial / phage mutants; Importance of mutants in genetic analysis.

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

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

CO1: Learn the terminology of molecular genetics, distinguish the prokaryotic and eukaryotic genome organization and describe modern concept of genes, plasmids, and mobile genetic elements.

CO2: Understand the gene transfer and mapping mechanisms in bacteria, genetics of viruses and learn about requirements and mechanism of DNA replication.

CO3: Acquire the knowledge about mechanism of DNA damage and repair, concept of mutations and their importance, requirements, and mechanism of transcription.

CO4: Understand the requirements and processes of translation, compare the levels of regulation of gene expression in prokaryotes and eukaryotesandlearn about gene silencing mechanisms.

Learning Resources and Suggested books:

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	3	2	1	1	3
CO2	3	3	3	3	2	3	2	2	2	2	1	-
CO3	2	2	2	2	1	3	3	2	2	2	1	2
CO4	1	1	2	2	2	3	3	1	2	1	1	-

VIR-203A: RECOMBINANT DNA TECHNOLOGY (Optional)
(Compulsory Foundation-Theory)

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

Course Educational Objectives:

1.To learn the scope, importance of genetic engineering, basic steps of gene cloning and the role of enzymes, vectors, oligonucleotides, and hosts in gene manipulation.
2.To learn basic and advanced tools and techniques, approaches and strategies used in gene manipulation in prokaryotic and eukaryotic systems
3. To learnthe gene cloning strategies and learn the concepts and applications of genomics, proteomics, transcriptomics, and introduction to metagenomics,viromics.
4. 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, bacteriophage vectors, cosmids, yeast vectors, artificial chromosomes (YACs, BACs), Ti plasmid-based vectors,

baculovirus-based vectors, plant and animal virus vectors, shuttle vectors, expression vectors (prokaryotic-e.g., *E. coli* and eukaryotic-e.g., yeast)
Enzymes: DNA and RNA polymerases, Restriction endonucleases, DNA joining enzymes, nucleases and other nucleic acid modifying enzymes.

Oligonucleotides: Linkers, adaptors, homopolymer tails, primers, promoters, Ori, marker genes
Source DNA: Genomic DNA, cDNA, PCR products and chemically synthesized oligonucleotides
Cloning and expression host systems: Bacteria, yeast, insect cells, plants and animal cells.

UNIT-II

Techniques for gene manipulation: DNA sequencing-Chemical, dideoxy chain termination, primer walking, automated DNA sequencing and pyrosequencing methods.
PCR: Principle, factors affecting PCR, different types of PCR and their applications.
DNA profiling: RFLP, AFLP, RAPD and DNA finger printing and their applications.
Nucleic acid blotting and hybridization: Preparation of DNA and RNA probes, hybridization formats and applications of hybridization-based tests.
Microarray Technology:DNA microarrays and chips- principles and applications;protein microarrays and antibody microarrays.
Site directed mutagenesis and protein engineering: Different types of site-directed mutagenesis approaches for changing genes and introduction to protein engineering;Yeast two hybrid systems (protein-protein interactions)

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, tools for proteomicsand analysis of protein expression;Introduction to metagenomics, metabolomics, viromics.

Bioinformatics tools: Glossary,Biological databases-GenBank, Swiss-Prot, UniProt, EMBL, NCBI and PDB; database searching using BLAST and FASTA; Protein structure prediction approaches, sequence analysis using multiple sequence alignment and 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 (e.g., *E. coli*-Insulin); **Yeast cellsystem** – Expression of cloned genes (e.g., *Pichia*: hepatitis B surface antigen (induction with methanol) using AOX promoter); **Insect cell system** - Overexpression of cloned genes using baculovirus based vectors (e.g., bacmid).

Plant cell system: High level expression of cloned genes using agrobacterium mediated transformation and plant virus-based vectors (e.g., CaMV),genetic modification of plants to improve agronomic traits like resistance to herbicides, pests, pathogens, drought, salt; control of fruit ripening and to improve nutritional quality and crop yields, transgenic plants as bioreactors;

Animal cell system-High level expression of cloned genes in CHO cells (Mab production) and using virus-based vectors (e.g., Adenovirus-based vector-Covishield),genetic modification of animals like mice, sheepand cow for new /improved traits like body size and milk quantity, transgenic animals as bioreactors, gene editing (CRISPER-CAS), gene knock out.

Impact of recombinant DNA technology: 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,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 UlHaq, 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.ABrown. 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. MicklosGrag, 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.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	3	2	1	1	3
CO2	3	3	3	3	2	3	2	2	2	2	2	2
CO3	2	2	2	2	1	3	3	2	2	2	2	2
CO4	1	1	1	3	3	3	3	1	2	1	1	1

(Or)

VIR-203B: BIOSTATISTICS AND BIOINFORMATICS (Optional)
(Compulsory Foundation-Theory)

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

Course Educational Objectives:

1. To understand basic concepts of statistics, construction of histogram, normal distribution, mean, median and standard deviation, comparison of means and variances, examples of proportion and count data

2. To learn about analysis of variance, correlation and regression and statistical parameters for biological assays.
3. To learn basics of personal computer and its components, windows operating system, Microsoft office-2000, basics of internet browsing of biological data, computer networking and information networks.

To learn basics of databases and tools, sequence analysis, phylogenetic analysis using bioinformatics tools and predictive methods using nucleotide and protein databases

UNIT-I

Introduction: Definition and applications of statistics in biology: population and universe, the sample and population, statistical inference; parameter and statistics; Construction of a histogram; Interpretation of histogram, the normal distribution; Variables, Random Variables, discrete and Continuous variables, Population sample and random sample; Mean, Mode, Quartiles, Geometric and Harmonic means; Frequency, Frequency distribution; Frequency curve, frequency polygon and histogram.

UNIT-II

Measures of dispersion: Range, Variance, coefficient of variance, SD,SE

Probability distribution: Normal, binomial and poison.

Tests of hypothesis: Students t –test,x2(chi-square)-distribution; Correlation coefficient and analysis of variance ANOVA.

Statistical basis of biological assays: Response-Dose metameter; Delusion Assays, Direct and indirect assays. Quantal Responses,Probit, logit, LD_{50}, ED_{50}, PD_{50} - Standard line interpolation assay, parallel assay (4 point, 6 point assays), slope ratio assay.

UNIT-III

Introduction of Genomic Data and Data Organization: Sequence Data Bank – Introduction to sequence data banks – protein sequence data bank,NBRF-PIR, SWISSPROT, Signal peptide data bank, Nucleic acid sequencedata bank-GenBank, EMBL, nucleotide sequence data bank, AIDS Virus sequence data bank, rRNA data bank. Structural data banks – protein Data Bank (PDB), The Cambridge Structural Database (CSD); Genome data bank – Metabolic pathway data; Microbial and Cellular Data Banks, Introduction to MSDN (Microbial Strain Data Network), Numerical Coding Systems of microbes, Hybridoma Data bank structure, Virus Information System, Cell line information system; other important Data banks in the area of Biotechnology/life sciences/ biodiversity.

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

UNIT-IV

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

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

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

CO1: Understand basic concepts of statistics, construction of histogram, normal distribution, mean, median and standard deviation, comparison of means and variances, examples of proportion and count data.

CO2:Learn the concepts of analysis of variance, correlation and regression and applications of statistical parameters for biological assays.

CO3:Learn basics of personal computer and its components, windows operating system, Microsoft office-2000, basics of internet browsing of biological data, computer networking and information networks.

CO4:Acquire knowledge about databases and tools, sequence analysis, phylogenetic analysis using bioinformatics tools and predictive methods using nucleotide and protein databases

Learning Resources and Suggested books:

1. Biostatistics by Daniel.
2. Campbell R.C. (1974: Statistics for Biologists, Cambridge University Press, Cambridge.
3. Statistics made simple-Do it yourself on PC. 2001. By K.V.S. Sarma. Printice Hall of India Publ.
4. An introduction to Biostatistics. 1997. Third Edition. P.S.S. Sundar Rao and J. Richard, Prentice-Hall of India Pvt. Ltd., New Delhi.
5. Fundamentals of Biostatistics. 1994. First Edition. Irfan A. Khan and Atiya Khanum, Ukaaz Publications.
6. Biostatistics. 1996. First Edition. P.N. Arora and P.K. Malhan, Himalaya Publishing House.
7. Statistics for Biologists. 1980. D.J. Finney.
8. Statistics and Experimental design: An Introduction for Biologists and Biochemists. 1994. 3rd edition. G.M. Clarke. Edward Arnald Publications.
9. Statistical methods. 1967. 6th edition. Snedecor and Cochran, Oxford Press. 1967.
10. Introduction to Bioinformatics, 2001 by T.A. Attwood & D.J. Parry-Smith, Pearson Education Asia Publ.

11. Bioinformatics : Methods and Protocols, Edited by StephemMisener and Stephen A. Krawetz. 2000. Methods in Molecular Biology Series. Humana Press.
12. Bioinformatics : A Practical guide to the analysis of genes and proteins. 1998. Edited by A.D. Baxevanis and B.F.
13. Francis Ouellette. Wiley -Interscience. Computational Methods in Molecular Biology by S.L. Saizberg.
14. Computer Applications in Biotechnology. 1998. by T. Yosida. Introduction to Bioinformatics by Atwood.
15. Bioinformatics - From Nucleic Acids and Proteins to Cell Metabolism. 1995, by Schomburg and Label VCH Publ.
16. Bioinformatics : Sequence and Genome Analysis. By D.W. Mount. CSHL Press.
17. Bioinformatics : Methods and Protocols,. Ed by S.Misener and S.A. Krawetz. Humana Press, 2000.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	3	2	-	-	3
CO2	3	3	3	3	2	3	2	2	2	2	1	2
CO3	2	2	3	3	1	2	2	2	2	2	1	2
CO4	1	1	1	2	2	3	3	1	2	1	2	1

VIR-204A:IMMUNOLOGY (Optional)
(Elective Foundation-Theory)

Course Educational Objectives:

1. To compare innate and adaptive immunity and to learn about various components of immune system,
2. To learn about antigens, antibodies, *in vitro* and *in vivo* antigen and antibody interactions and immune effector mechanisms.
3. To elucidate the mechanism of humoral and cell mediated immune responses, MHCs, hypersensitivity reactions.
4. To acquire knowledge on autoimmune and immunodeficiency disorders, transplantation and transfusion immunology and concepts and applications of conventional and modern vaccines.

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

PowerPoint lectures	
Semester: II	**Credits: 4 Credits**

UNIT-I

History: Historical perspectives and milestones in immunology.

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

Types of immunity: Innate and adaptive immunity.

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

UNIT-II

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

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

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

UNIT-III

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

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).

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

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

UNIT-IV

Immunopathology: Immunodeficiency disorders (congenital and acquired).

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

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

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

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.

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.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	3	2	1	1	3
CO2	3	3	3	3	2	3	2	2	2	2	1	2
CO3	2	2	2	2	1	3	3	2	2	2	1	2
CO4	1	1	1	-	-	3	3	1	2	1	-	1

(OR)

VIR-204B: FOOD AND ENVIRONMENTAL BIOTECHNOLOGY (Optional) (Elective Foundation-Theory)

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

Course Educational Objectives:

1. To acquire the knowledge on the role of microbes in food, neutraceuticals organic foods and functional foods
2. To learn the types of fermentation processes and to learn about Importance of microorganisms in food production; Probiotics and prebiotics Food quality assurance and food laws
3. To understand the Food quality assurance and use of biosensors, biofilters, biofuel cells
4. To learn Biosorption of heavy metals, GEMs and their products, Concept of biosafety

UNIT-I

Microbes in Food industry: Industrial production and preservation of fermented foods; Dairy products – cheeses, yogurt and acidophilus milk; yeast and yeast products: brewer's yeast, baker's yeast, bread making, enzymes used in food industry; edible mushrooms and their cultivation: oyester, Button and Paddy straw mushrooms; medical importance of mushroom products, nutraceuticals, organic foods and functional foods.

UNIT-II

Food technology: Starter culture technology- Importance of microorganisms in food production; Probiotics and prebiotics- Impact on Human health by using milk, milk products and other antiobesitymolecules from microbes, plants and animals; Food additives, food colors and sweeteners- Quality material used in food processing (example organic acid, cellulose and cellulose derivatives); Food quality assurance and food laws- food spoiled by different microorganisms and their control measures, food quality maintained by EFSA (European food safety authority) and FDA (Food and Drug authority).

UNIT-III

Food quality assurance and food laws - Commercial blends of microorganisms and enzymes, immobilized cells and enzymes, biotechnological approaches for recovery of useful products; Microbial techniques for treatment of industrial effluents in pulp and paper, tanning and leather, distillery and dye industries – primary treatment, secondary treatment, aerobic process, treatment by bacteria and fungi and enzymatic treatment; treatment of industrial and other wastes; bio-mining and bioleaching of ores; bioremediation of oil spills; waste water treatment; removal of heavy metals, microbial degradation of pesticides and aromatic compounds; use of biosensors, biofilters, biofuel cells and biochips in industry, healthcare and environment.

UNIT-IV

Biosorption of heavy metals: Metal binding targets and organisms, metal-microbial interactions, biomethylation of elements, commercial biosorbents, metal precipitation, phytoremediation; bio-medical waste management – waste category, waste class and description,treatment and disposal systems,cost of biomedical waste management;

GEMs and their products:Construction and release of GEMs and their applications; GEMs impact on the environment.

Concept of biosafety: Biosafety levels, good microbiological practices, biosafety guidelines, biohazards, biological weapons, bioethical issues, general approval procedures.

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

CO1: Understand the the role of microbes in food ,neutraceuticals organic foods and functional foods

CO2:Learn the Importance of microorganisms in food production; Probiotics and prebiotics Food quality assurance and food laws

CO3:Describe the Food quality assurance and use of biosensors, biofilters, biofuel cells

CO4:Learn the Biosorption of heavy metals, GEMs and their products, Concept of biosafety

Learning Resources and Suggested books / manuals:

1. Food Microbiology by William C Frazier. Tata Mgraw Hill
2. Food Microbiology by dams and Moss. Springer Verlag
3. Basic food microbiology by Banwart. Cbs Publishers & Distributors Pvt Ltd.
4. Principles of Microbiology by Ronald M. Atlas (1995), Amy Mc Cullen
5. Fundamental Principles Of Bacteriology A J Salle
6. Crueger&Crueger Biotechnology: A Text Book of Industrial microbiology 2nd edition.
7. Demain, A.L Biology of Industrial Microorganisms 3
8. Hobbs, B.C. and Rioberts,D 1993 Food Poisoning and Food Hygiene Edward Anold, London.
9. Hui Y H 2006 Food Biochemistry and Food Processing Blackwell.
10. J oshi, V.K. Ashok Pondey 1999 Biotechnology and Food fermentation Vol. I & II.
11. Patel, A.H. Industrial microbiology. Prescott and Dunn's, Industrial Microbiology 4th edution.
12. Reed, G. Industrial Microbiology, CBS Publishers
13. Microbial Technology Vol. I & II. Pepplelr&Perllman (EDS).
14. Microbial Ecology – Fundamentals and applications. Atlas and Bartha
15. Bioremediation (1994) Baker, K.H and Herson, D.S.McGraw Hill, Inc. New York
16. Biotreatment of Industrial & Hazardous Waste (1993) M.V.Levin and Gealt, M.A McGraw Hill. Inc
17. Concepts and Techniques of Geographic Information Systems (2009) C.P.Lo.Albert and K.W.Yeung 2nd.
18. Ecology and environmental biology (2011) Saha T K Books & Allied (p) Ltd edition, Prentice Hall, Inc.
19. Environment Impact Assessment (1996) Larry W. Canter McGraw-Hill Book Company
20. Environmental Audit (2002) Mhaskar A.K. Enviro Media Publications
21. Environmental Biology (2000) Varma&Agarwal S. Chand Limited 16.Environmental biotechnology(2010) RanaRastogi Publications.
22. Environmental Protection and Laws (1995) Jadhav and BhosaleV.M.Himalaya publishing House

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	3	1	1	1	3
CO2	3	3	3	3	2	3	2	2	1	2	1	2
CO3	2	2	2	2	1	3	2	2	2	2	1	2

CO4	**1**	**1**	**1**	**2**	**2**	**3**	**3**	**1**	**2**	**1**	**2**	**1**

PRACTICAL: VIR-205A: CELL BIOLOGY AND TISSUE CULTURE&RECOMBINANT DNA TECHNOLOGY

Course Educational Objectives:

1. To learn laboratory safety practices to be followed to set up molecular biology laboratory and to set up 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.

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

List of Practicals:

1. Preparation of cytological studies for identification of stages of mitosis using onion root tips
2. Examination of cells isolated from sheep kidney.
3. Demonstration of chromosomal (structural and numerical) aberrations (theory exercise).
4. Study of polytene chromosomes (theory exercise).
5. Preparation of sucrose density gradients (step and linear).
6. Safety practices and precautions to be followed to set up Molecular Biology lab with ribonuclease free environment (theory exercise)
7. Preparation of phenol for nucleic acid isolation (theory exercise).
8. Concentration of nucleic acids (theory exercise).
9. Isolation of plasmids from bacteria through alkaline lysis method.
10. Restriction enzyme analysis of plasmids.
11. Recovery of DNA from gels – low melting point agarose extraction of DNA
12. Transformation of bacteria with recombinant plasmid DNA
13. Southern blotting (demo).
14. Preparation of dot-blots for hybridization (demo).
15. Problems related to recombinant DNA technology.

16. Bioinformatics tools: NCBI, PDB search, BLAST-n, BLAST-p, multiple sequence alignment, phylogenetic tree construction, Bioedit, expasy tools (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.

Learning Resources and Suggested books / manuals:

1. Molecular Biology Techniques. A Classroom Laboratory Manual4th 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. Culture of Animal Cells: A Manual of Basic Technique. (1987). R.I. Freshney. Alan R. Liss Inc.
4. Plant tissue culture: Theory and Practice, (1996). S.S. Bhojwani and M.K. Razdan, Elsevier Pub.
5. Methods in Biotechnology. (2001). By Ignacimuthu.
6. Molecular cloning- A laboratory manual. (2001). I, II, III Vols. By Russell and Sambrook. CSH Publs.
7. Current Protocols in Molecular Biology, (2000). Ausubel et al.
8. Current Protocols in Molecular Biology, (2000). Ausbel et al.
9. Biotechnology: A Laboratory Course. (1996). 2nd ed. J.M. Becker, et al., Acad. Press.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	3	2	1	1	3
CO2	3	3	3	3	2	3	1	2	2	2	-	2
CO3	2	2	2	2	1	3	3	2	2	2	1	2
CO4	1	1	1	1	1	3	3	-	2	2	2	1

(Or)

PRACTICAL: VIR-205B: CELL BIOLOGY AND TISSUE CULTURE & BIOSTATISTICS AND BIOINFORMATICS

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 the practical skills in conducting various experiments related to Cell Biology such as isolation of cells, preparation of cell and tissue cultures, isolation of mitochondria, study of chromosomes and identification of stages of mitosis in onion root tips.

2. To learn using MS Office, creating tables in MS-Word, creating database, spreadsheet and statistical graphs, sample statistics with Excel.internet, worldwide web and searching for databases, searching for research material in PubMed, use of bioinformatics tools for the analysis of DNA and to analyze the virus genome using Bio Edit.

List of Practicals:

1. Preparation of cytological studies for identification of stages of mitosis using oni root tips
2. Examination of cells isolated from sheep kidney.
3. Demonstration of chromosomal (structural and numerical) aberrations (theory exercise).
4. Study of polytene chromosomes (theory exercise).
5. Preparation of sucrose density gradients (step and linear).
6. Creating database & Statistical graphs in EXCEL
7. Histogram, pie, line diagram, scatter diagram, error bars
8. Simple Statistics with Excel
9. Creating and use of spread sheet to biological applications
10. Problems on mean, median and mode
11. Problems on variance, coefficient of variance, standard deviation (SD) and stand error (SE)
12. Probability distribution: Normal, binomial and poison
13. Test of hypotheses: Students t-test, X2 distribution (Chi square), correlation coefficient and analysis of variance (ANOVA).
14. Use of internet, worldwide web, searching for data bases
15. Locating research material on Medline
16. Learning to use NCBI and EMBL.
17. Analysis of Viral genome sequences using programmes like Bioedit, DNAstar.
18. Searching DNA databases with FASTA and BLAST
19. Pairwise sequence alignments
20. Phylogeny & tree building
21. Protein structure prediction.

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: Learn how to use MS office and create, edit tables in MS word and to develop knowledge to do simple statistics with Excel, to create statistical graphs and spread sheets in Excel for biological applications

CO4:Use internet, web tools, databases, and search engines for designing, planning, and executing biological research experiments or investigations. Analyze viral genome sequences using programs like Bio Edit and learn to use NCBI, EMBL for nucleic acid/protein analysis and phylogenetic tree construction.

Learning Resources and Suggested books / manuals:

1. Molecular biology of the cell 5th Edition (2008) Alberts A et al. Garland Publishers, New York
2. Cell and Molecular Biology (2006) De Robertis, E. D. P and E.M.F. De Robertis.Lippincott Williams and Wilkins.
3. Molecular Cell Biology.6th edition (2006) Lodish, H., A. Berk, C. A. Kaiser, M. P.Scott. 6thEdn. Ploegh and Paul Matsudaria.
4. Culture of Animal Cells: A Manual of Basic Technique. (1987). R.I. Freshney. Alan R. Liss Inc.
5. Plant tissue culture: Theory and Practice, (1996). S.S. Bhojwani and M.K. Razdan, Elsevier Pub.
6. Statistical Methods, S.P. Gupta 2. Fundamentals of mathematical statistics.
7. S.C. Gupta &Kapoor 3. Statistical methods in biological and Health Science, J.S. Milton & J.O. Tsokan
8. Primrose SB. Principles of Genome Analysis, A guide mapping and sequencing DNA from different organisms. 2nd/Edn. 1998. Blackwell Science, Oxford ISBN 0-632-04983-9.
9. Bioinformatics: Sequence and Genome Analysis by David W. Mount, Cold Spring Harbor Laboratory Press.
10. Biological Sequence Analysis : Probabilistic Models of Proteins and Nucleic Acids by Richard Durbin, Sean R. Eddy, Anders Krogh, Graeme Mitchison, Cambridge University Press.
11. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, Second Edition by Andreas D. Baxevanis, B. F. Francis Ouellette, Wiley-Interscience
12. Foundations to bioinformatics – Evolution, similar macromolecular components, constancy of gene number and core proteome in closely related organisms.
13. Bioinformatics data – nucleic acid sequence, protein sequence, protein structure, genomic, proteomic and metabolomics information.
14. Bioinformatics databases – types, design, file formats, access tools with examples.
15. Bioinformatics tools and Resources – free online tools, downloadable free tools, software packages, internet.
16. Bioinformatics - From Nucleic Acids and Proteins to Cell Metabolism. 1995, by Schomburg and Label VCH Publ.
17. Bioinformatics: Sequence and Genome Analysis. By D.W. Mount. CSHL Press.
18. Bioinformatics: Methods and Protocols,. Ed by S.Misener and S.A. Krawetz. Humana Press, 2000.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	3	2	1	1	3
CO2	3	3	3	3	2	3	2	2	2	2	1	2
CO3	2	2	2	2	1	3	3	2	2	2	1	2
CO4	1	1	1	-	-	3	3	1	2	1	-	1

PRACTICAL: VIR-206A: MICROBIAL GENETICS AND MOLECULAR BIOLOGY & IMMUNOLOGY

Practicals: 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 laboratory safety practices to be followed to set up Cell and Molecular Biology laboratories and to set up ribonuclease free environment in the laboratories and to acquire the practical skills in conducting various experiments related to Cell Biology such as isolation and estimation of DNA and RNA from microbial, plant and animal sources and to practice Ames test, plasmid curing, replica plate and gradient plate techniques.

2.To determine the number of WBC and RBC, estimation of hemoglobin, blood group and Rh typing and to conduct theory exercises on production, purification and analysis of polyclonal antibodies and identification of primary and secondary lymphoid organsvirtuallyand to perform *in vitro* serological tests such as immune diffusion, immune-electrophoresis, ELISA and western blotting.

List of Practicals:

1. Isolation of microbial DNA.
2. Analysis of DNA by spectroscopy and AGE.
3. Isolation of microbial RNA.

4. Analysis of RNA by spectroscopy and formaldehyde denaturing gel electrophoresis.
5. Curing of plasmids.
6. Isolation of microbial mutants by gradient plate method.
7. Induction of mutations in bacteria by physical / chemical agents by replica plate method.
8. Problems related to microbial genetics and molecular biology
9. Primary and secondary lymphoid organs (Theory exercise)
10. Total counting of RBC & WBC
11. Differential count of W.B.C.
12. Hemoglobin estimation.
13. Blood typing & Rh determination.
14. Production of polyclonal antibodies- demonstration of different routes of antigen administration into rabbit (demo)
15. Single & double immunodiffusion tests
16. Radial immunodiffusion assay
17. Rocket immunoelectrophoresis
18. DAC- ELISA (indirect)
19. Dot immunobinding assay (DIBA)
20. Electroblot immunoassay (EBIA)

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 Cell and Molecular Biology laboratory with ribonuclease free environment.

CO2: Isolate and estimate DNA and RNA from microbial, plant and animal tissues and demonstrate curing of plasmids, replica plating techniques, conjugation in bacteria, Ames test, induction of mutations in bacteria by physical/chemical agents, isolation of microbial mutants by gradient plate method.

CO3: Identify of primary and secondary lymphoid organs in virtual animal model and illustrate basic immunology techniques such as counting of RBC and WBC, estimation of hemoglobin, identification of the blood groups and Rh.

CO4: Demonstrate antigen-antibody interactions by conducting *in vitro* serological tests such as immunodiffusion and immune-electrophoresis, DAC-ELISA, Dot-ELISA and western blotting and apply this practical oriented knowledge in Cell Biology and Immunology to foster employability in private industries, higher education in premier institutes

Learning Resources and Suggested books/manuals:

1. Molecular Biology of the Cell, A. Alberts, D. Bray, J. Lewis, M. Raff, K. Robertsand J.D. Watson, (Garland Publishing, New York and London).
2. Molecular Biology, A Comprehensive Introduction to Prokaryotes and Eukaryotes, D. Freifelder (Jones and Bartlett, USA).
3. Recombinant DNA, A Short Course, J.D. Watson, J. Tooze and D.T. Kurtz.(Scientific American Book, W.A. Preemon).

4. Molecular Cloning, Laboratory Manual, Maniatis, E.F. Fritsch and J. Sambrook (Cold Spring Harber Laboratory, New York).
5. Modern Genetics (2nd /Edn, 1984), A.J. Ayala and W. Castra (GoomHelns, London).
6. Techniques in Molecular Biology (1992), J. Walker and W. Castra (GeomHelns, London).
7. Practical Methods in Molecular Biology (1991), R.F. Schecleif and PC. Wensik (SpringerVerlag).
8. Genes V (1994), Benjamin Lewin (Oxford University Press).
9. Immunology: A Laboratory ManualSpiral-bound– November 1, (1994) by Myers.
10. Handbook of Immunology. G.P. Talwar, (1983), Vikas Publishing House, India.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	3	2	1	1	3
CO2	3	3	3	3	2	3	2	2	2	2	1	2
CO3	2	2	2	2	1	3	3	2	2	2	1	2
CO4	1	1	1	-	-	3	3	1	2	1	-	1

(Or)

PRACTICAL: VIR-206B:MICROBIAL GENETICS AND MOLECULAR BIOLOGY & FOOD AND ENVIRONMENTAL BIOTECHNOLOGY

Practicals: 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 laboratory safety practices to be followed to set up Cell and Molecular Biology laboratories and to set up ribonuclease free environment in the laboratories and to acquire the practical skills in conducting various experiments related to Cell Biology such as isolation and estimation of DNA and RNA from microbial, plant and animal sources and to practice Ames test, plasmid curing, replica plate and gradient plate techniques.
2. To analyse the quality of water, milk and food and production of bofertilisers and biopesticides and biodegradation of pesticides

List of Practicals:

1. Isolation of microbial DNA
2. Isolation of microbial RNA
3. Curing of plasmids.

4. Isolation of microbial mutants by gradient plate method.
5. Induction of mutations in bacteria by physical / chemical agents by replica plate method.
6. Problems related to microbial genetics and molecular biology.
7. Qualitative and quantitative analysis of carbohydrates and proteins in food.
8. Preparation and evaluation of cheese or fermented product.
9. Determination of fat content in milk
10. Estimation of vitamins- vitamin A, C and riboflavin.
11. Determination of aflatoxin in food.
12. Tests for pesticidal residues in food
13. Biomass estimation by different methods
14. Isolation of microbes involved in preparation of biofertilizersby biological enrichment method.
15. Production of microbial biofertilizers and biopesticides.
16. Efficacy testing for biofertilizers (nodulation test for rhizobia) and biopesticides.
17. Qualitative and quantitative estimation of biodegradation of pesticide/ insecticide/fungicide.
18. Estimation of BOD & COD
19. Testing for microbiological quality of potable water (Coli form test)
20. Microbial degradation of organic matter.
21. Testing for effect of chemical pesticides on soil microbial respiration 9. Testing for microbial biodegradation of pesticides.
22. Visiting agricultural research stations and forms.

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 Cell and Molecular Biology laboratory with ribonuclease free environment.
CO2: Isolate and estimate DNA and RNA from microbial, plant and animal tissues and demonstrate curing of plasmids.replica plating techniques, conjugation in bacteria, Ames test, induction of mutations in bacteria by physical/chemical agents, isolation of microbial mutants by gradient plate method.
CO3:Learn preparation of fermented food products, analyse the quality of water, milk and food ,vitamins
CO4:Acquire the practical skills in the production of bofertilisers and biopesticides and biodegradation of pesticides

Learning Resources and Suggested books/manuals:

1. Culture of Animal Cells: A Manual of Basic Technique. (1987). R.I. Freshney. Alan R. Liss Inc.
2. Plant tissue culture: Theory and Practice, (1996). S.S. Bhojwani and M.K. Razdan, Elsevier Pub.
3. Swaminathan M.S. Dr. Hand Book of Food and Nutrition
4. Sumati R. Mudambi and M.V, Rajgopal. Fundamentals of Food and Nutrition.
5. Nutrient Requirements and Recommended Dietary Allowances for Indians. National Instituteof Nutrition, Indian Council of Medical Research, 2010

6. Aurand, L.W. and Woods, A.E. 1973. Food Chemistry. AVI, Westport 5. Birch, G.G., Cameron, A.G. and Spencer, M. 1986. Food Science, 3rd Ed. Pergamon Press,New York.
7. Fennema, O.R. Ed. 1976. Principles of Food Science: Part-I Food Chemistry. MarcelDekker,New York 7
8. Meyer, L.H. 1973. Food Chemistry. East-West Press Pvt. Ltd., New Delhi
9. Potter, N.N. 1978. Food Science. 3rd Ed. AVI, Westport
10. Fellows, P. and Ellis H. 1990. Food Processing Technology: Principles and Practice, NewYork
11. Jelen, P. 1985. Introduction to Food Processing. Prentice Hall, Reston Virginia, USA
12. Lewis, M.J. 1990. Physical Properties of Food and Food Processing Systems.Woodhead
13. Stanburry P.P. and Whitaker, A. 1984. Principles of Fermentation Technology.PergamonPress, Oxford UK 13. Rosenthal, I. 1991. Milk and Milk Products. VCH, New York
14. Joshi, V.K. and Pandey, A. Ed. 1999. Biotechnology.Food Fermentation, (2 Vol. set).Education Publ. New Delhi
15. R.A Garg: The Food Safety and Standard Act, 2006 along with Rules and regulation,(2011) Commercial Law Publisher (India) Pvt. Ltd

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	2	3	3	2	1	1	3
CO2	3	3	3	3	2	2	2	2	2	2	-	2
CO3	2	2	2	2	1	3	3	2	2	2	1	2
CO4	1	1	1	2	2	3	3	1	2	2	2	1

VIR 207 - HUMAN VALUES AND PROFESSIONAL ETHICS-II

(Audit Theory Course-Self Study)

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

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
2. To inculcate knowledge and exposure on safety and risk and to expose student to right attitudinal and behavioral aspects,

3. To enable the students to understand the moral values and ethics followed by medical and health care professionals and businesspeople.
4. 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; Characteristics 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.

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:Describe 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: Learn to practice 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.

Learning resources and suggested books:

1. John S Mackenzie: A manual of ethics.
2. "The Ethics of Management" by Larue Tone Hosmer, Richard D. Irwin Inc.
3. "Management Ethics - integrity at work' by Joseph A. Petrick and John F. Quinn, Response Books:NewDelhi.
4. "Ethics in Management" by S.A. Sherlekar, Himalaya Publishing House.
5. Harold H. Titus: Ethics for Today
6. Maitra, S.K: Hindu Ethics
7. William Lilly: Introduction to Ethics
8. Sinha: A Manual of Ethics
9. Manu: Manava Dharma Sastra or the Institute of Manu: Comprising the Indian System of Duties: Religious and Civil (ed.) G.C.Haughton.
10. Susruta Samhita: Tr.KavirajKunjanlal, KunjalalBrishagratha, Chowkamba Sanskrit series, Vol I,II and III, Varnasi, Vol I OO, 16-20, 21-32 and 74-77 only.
11. CarakaSamhita: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

Cours	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO1**	**PO1**	**PO1**
CO1	3				3	2			3	2		1
CO2	3				3	2			3	2		1
CO3	3				3	2			3	2		1
CO4	3				3	2			3			1

SEMESTER-III

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

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

Course Educational Objectives: epidemiological concepts of plant viruses and plant virus management strategies to conduct biological research as well as to get employability in agricultural research stations and biotechnology industries.

1. To define/explain the various concepts related to Plant Virology such as plant virus-host interactions with respect to induction of disease and virus movement strategies,
2. To Learn the vector and non-vector modes of plant virus transmission, virus-vector relationships and molecular mechanisms involved in virus vector interactions
3. Tounderstand the plant virus ecological and epidemiological concepts, approaches used for detection
4. Tounderstand the plant virus controlpractices and to know about 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:Genetic resistance of plants against viruses; generation of transgenic and non-transgenic-mediated virus resistance in plants; 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 induction of plant virus diseases, 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 virus vector interactions and the 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.

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.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	3	2	1	1	3
CO2	3	3	3	3	2	3	2	2	2	2	1	2
CO3	2	2	2	2	1	3	3	2	2	2	1	2
CO4	1	1	1	-	-	3	3	1	2	1	-	1

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

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

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 understand the distribution, incidence and impact, symptoms, causal virus characteristics, diagnosis, disease cycle and management of the virus diseases associated with vegetable and tuber crops

3.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 legume, fruit crops.

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

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 andSorghum** – 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** – cadangcadangviriod 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, CMVandChilliveinal mottle virus (ChiVMV);**Brinjal** – mosaic caused by CMV / TMV/ PVY;**Okra** – yellow vein mosaic and leaf curl;**Onion andgarlic**– yellow dwarf mosaic, latent and iris yellow spot;**Cucurbits** – CMV, squash mosaic, leaf curl, watermelon mosaic, bud necrosis and cucumber green mottle mosaic;**Radish** – mosaic;**Carrot** – red leaf, mottley dwarf and thin leaf;**Cabbage andCauliflower**- 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 mosaicand 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 legume 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

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.Lavakumar 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)- GeorgenAgrios-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.AmericanPhytopathological Society- Monographs on disease of different crops.
12. CMI/AAB Descriptions of Plant Viruses.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	3	2	-	1	3
CO2	3	3	3	3	2	3	2	2	3	2	1	2
CO3	2	2	2	2	3	3	3	2	3	2	1	2
CO4	1	1	1	2	3	3	3	1	-	1	2	1

VIR-303A: MOLECULAR VIROLOGY (Optional)
(GenericElective-Theory)

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

Course Educational Objectives:

1. To understand molecular architecture of viruses and molecular mode of inactivating agents on viruses .
2. To learn about types of viral genomes and steps involved in virus replication and expression and replication of DNA viruses.
3. To acquire knowledge about expression and replication of RNA viruses and subviral agents
4. 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.

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

UNIT-III

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; Eukaryotic viruses - recombination and re-assortment, cross- and multiplicity reactivation, complementation, phenotypic mixing, ploidy, transduction of genes by retroviruses.

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

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

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

CO2: Learn about structure and diversity of viral genomes, general concepts of 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.

Learning resources and suggested books:

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**-**	**1**	**3**
CO2	**3**	**3**	**3**	**3**	**2**	**3**	**2**	**2**	**2**	**2**	**1**	**2**
CO3	**2**	**2**	**2**	**2**	**1**	**3**	**3**	**2**	**2**	**2**	**1**	**2**
CO4	**1**	**1**	**1**	**3**	**3**	**3**	**3**	**1**	**2**	**1**	**-**	**1**

(OR)

VIR-303B: TUMOR VIROLOGY(Optional)
(Generic Elective-Theory)

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

Course Educational Objectives:

1. To understand basic concepts and mechanism of tumors, oncogenes, tumor suppressor genes
2. To acquire knowledge on basic aspects and molecular mechanisms of carcinogenesis and viruses associated with tumors.
3. To learn about different RNA viruses causing tumors, cell transformation mechanisms, immune responses to tumors and tumor therapy strategies.
4. To learn about different DNA viruses causing tumors, cell transformation mechanisms, immune responses to tumors and tumor therapy strategies

UNIT-I

Tumor: Terminology, types of tumors, transformation andtumorogenesis, 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: Molecularmechanisms 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 tumorogenesis;activation of expression of cellular genes by retroviruses; viral genetic information in transformed cells; HepatitisC 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.

Learning resources and suggested books:

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	3	2	1	1	3
CO2	3	3	3	3	2	3	2	2	2	2	1	2
CO3	2	2	2	2	1	3	3	2	2	2	1	2
CO4	1	1	1	3	3	3	3	1	2	1	1	-

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

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

2. To acquire skills and technologies related to purification of viruses such as culture of viruses on propagation harvesting virus infected leaves, homogenization, clarification, concentration, further purification, final pelleting and to check the quality and quantity of the viruses. 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. Study of symptoms of local virus diseased plants through field work, slides/photographs
2. Determination of virus effect on chloroplast number.
3. Determination of virus effect on cell size.
4. Observation of inclusions by light microscopy
5. Effect of virus on total carbohydrates in healthy and virus infected seeds
6. Effect of virus on total proteins in healthy and virus infected seeds
7. Effect of virus on total lipids in healthy and virus infected seeds.
8. Identification of unknown plant virus by ELISA.
9. Local field surveys and visit to local research stations.
10. Diagnosis of virus diseases (theoretical exercise).
11. Collection and identification of local insect vectors.
12. Determination of disease progress curves (field study).
13. Study of seed transmission of viruses
14. Demonstration of transmission of viruses through vegetative propagules.
15. Visiting local fields and agricultural research stations.
16. Purification of viruses by differential centrifugation.
17. Analysis of virus proteins (SDS-PAGE molecular weight determination)

18. Analysis of viral nucleic acids (AGE-molecular weight determination)
19. Isolation and analysis of dsRNA from virus infected tissues
20. 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: Identify major virus diseases of local economically important crop plants and weeds through theory exercises, local field surveys, agricultural research station visits. Determine and compare the effect of virus on cell size, chloroplast number, total carbohydrates, proteins, and lipids with healthy counterparts.

CO2: Detect unknown viruses through ELISA and PCR (theory exercise and practical) and demonstrate plant virus transmission by seed and vegetative propagules. Identify local plant virus vectors, determine virus disease incidence and progress curves through local field visits.

CO2: Acquire the skills to use the techniques involving purification of viruses such as maintenance of virus cultures on propagation hosts, check the quality and quantity of viruses using spectroscopy or transmission electron microscopy. Isolate virus coat proteins and determine its size and molecular weight through SDS-PAGE.

CO4: Isolate virus nucleic acids (dsRNA, RNA and DNA) and determine its size and molecular weight through agarose gel electrophoresis. Determine the stability of virus by studying effect of physical and chemical agents on virus inactivation.

Recommended books / Manuals:

1. Methods in Virology, (1998) K. Marmorosch and H. Koprowski. Vol. I and II. Academic Press.
2. Diagnosis of Plant Virus Diseases, (1993). R.E.F. Matthews (ed.) CRC Press.
3. Serological Methods for detection and identification of viral and bacterial plant pathogens: A Laboratory Manual. (1990). R. Hampton et al., APS Press.
4. Methods in Plant Virology, (1984). S.A. Hill. Blackwell Publications.
5. Virology Methods Manual, 1996. B.W. J. Mahy and H.O. Kangro. Academic Press.
6. Molecular Virology: A Practical Approach. 1993. Davison and R.M. Elliot. Oxford University Press.
7. Virology - A Laboratory Manual, 1992. By Burleson, et al., Academic Press.
8. Virology Lab Fax. 1993. D.R. Harper. Bioscientific Publication. Academic PresS.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	3	2	1	1	3
CO2	3	3	3	3	2	3	2	2	2	2	1	2
CO3	2	2	2	2	1	3	3	2	2	2	1	2

CO4	**1**	**1**	**1**	**-**	**-**	**3**	**3**	**1**	**2**	**1**	**-**	**1**

(OR)

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

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

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

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

List of practicals:

1. Study of symptoms of local virus diseased plants and through field work, slides/photographs
2. Determination of virus effect on chloroplast number.
3. Determination of virus effect on cell size.
4. Observation of inclusions by light microscopy
5. Effect of virus on total carbohydrates in healthy and virus infected seeds
6. Effect of virus on total proteins in healthy and virus infected seeds
7. Effect of virus on total lipids in healthy and virus infected seeds.
8. Identification of unknown plant virus by ELISA.
9. Local field surveys and visit to local research stations.
10. Diagnosis of virus diseases (theoretical exercise).
11. Collection and identification of local insect vectors.
12. Determination of disease progress curves (field study).
13. Study of seed transmission of viruses
14. Demonstration of transmission of viruses through vegetative propagules.
15. Detection of carcinogens and mutagens using Ames test.
16. Histopathology of animal tumor viruses (specimens and slides)
17. Detection of tumor viruses using PCR
18. Observation of specimens (visiting Veterinary University and SVIMS).

19. Cell viability test
20. Cell culture and cultivation of Chicken/bird tumor viruses
21. MTT assay
22. Preventive and control measures of tumor viruses (theory exercises)

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 theoryexercises, local field surveys, agricultural research station visits. Determine and compare the effect of virus on cell size, chloroplast number, total carbohydrates, proteins, and lipids with healthy counterparts.
CO2:Detect unknown viruses through ELISA and PCR (theory exercise and practical) and demonstrate plant virus transmission by seed and vegetative propagules. Identify local plant virus vectors, determine virus disease incidence and progress curves through local field visits.
CO3: Acquire skills to detect carcinogens and mutagens using standard tests such as Ames test. Distinguish transformed and normal cell lines and determine the anticancer property of biologically active compounds.
CO4: Design and execute PCR and other point of care methods using commercial kits for detection of tumor viruses (HCV, HIV). Perform cultivation of poultry tumor viruses in cell cultures and acquiring the knowledge on histopathology of animal tumor viruses.

Learning resources and suggested books:

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	3	2	1	2	3
CO2	3	3	3	3	2	3	2	2	2	3	1	2

CO3	**2**	**2**	**2**	**2**	**1**	**3**	**3**	**2**	**2**	**3**	**1**	**2**
CO4	**1**	**3**	**3**	**2**	**2**	**3**	**3**	**1**	**2**	**1**	**-**	**1**

THEORY-VIR-305A: MOLECULAR TECHNIQUES (Mandatory)
(Skill Development Course)

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

Course Educational Objectives:

1.To learn the scope, importance of virology laboratory, lab equipment and laboratory biosafety
2.To learn basic and advanced tools and techniques, approaches and strategies used in virology.
3. To learnthe advanced moleculartools used in virology and to learn the concepts and applications of genomics, proteomics, transcriptomics, and introduction to metagenomics,viromics.

4. To understand the strategies used for drug design, artificial intelegence and modern vaccinology and applications in medicine.

UNIT-I

Requirements of Virology Laboratory: GCP, GLP GCLP and GDP; Knowledge of lab organization, reporting and recording procedures; Ethics of laboratory practice, confidentiality of reports, Maintenance &Equipments of Virology Lab; Preparation of Reagents; Concept of universal precautions, biohazard, disinfection, sanitation, waste management (Handling of waste, waste segregation and management including disposal).

Laboratory bio-safety: Risk assessment and risk management, laboratory accidents, prevention, first aid; principles and methods of ensuring of quality assistance in the laboratory; types of specimens, method of specimen collection, transport, packing and storing of samples (Blood, serum, urine and others); health education and health communication.

UNIT –II

Basic tools used in Virology: Principles and applications of microscopy, ultrafiltration, dialysis, spectroscopy, electrophoresis, ultracentrifugation, chromatography, autoradiography, western blotting, northern blotting and southern blotting and hybridization, DNA sequencing and PCR; Serological techniques -Principles and applications of virus

neutralization, HA and HI tests, Dot immunobinding assay, ISEM,immunofluorescence, immunohistochemistry and ELISA.

UNIT –III

Advanced Molecular tools used in Virology: Principles and applications of real time PCR, IC-RT-PCR (Immunocapture reverse transcription PCR), LAMP (Loop-mediated isothermal amplification), fluorescence and confocal microscopy, FACS, NMR, CD, 2D and mass spectroscopy, DNA bar coding, microarrays, proteomics,Viromics; Generation of infectious clones using novel methods (e.g., potyvirus-Gibson assembly), Next generation sequencing (NGS); point of care immunodiagnostics; IoT; Artificial Intelligence; biosensors, drug design; modern vaccinology and therapeutics (drugs, interferons, antibody-based therapy); Antivirals-metal nanoparticles and antiviral compounds.

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

CO1: Explain the scope, importance of virology laboratory, lab equipment and laboratory biosafetyhealth education and health communication.

CO2:Describe the basicmethods and advanced tools and techniques, approaches and strategies used in virology, and their principles and applications.

CO3:Discribe the theadvanced molecular tools used in virology and to learn the concepts and applications of genomics, proteomics, transcriptomics, and introduction to metagenomics,viromics.

CO4:Understand the strategies used for drug design, artificial intelegence and modern vaccinology and applications in medicine

Learning resources and suggested books:

1. Virology Methods Manual. Brian W.J. Mahy (Editor), Hillar O. Kangro (Editor). Latest edition / Pub. Date: January 1996. Publisher: Elsevier Science & Technology Books.
2. Methods and Techniques in Virology. Pierre Payment, Trudel (Editor).Latest edition / Pub. Date: July 1993. Publisher: Marcel Dekker.
3. Diagnostic Virology Protocols: Methods in Molecular Medicine. John R. Stephenson (Editor), Alan Warnes Latest edition / Pub. Date: August 1998. Publisher: Humana Press.
4. Diagnostic Procedures for Viral, Rickettsial, and Chlamydial Infections. Edwin H. Lennette (Editor), David A. Lennette, Evelyne T. (Eds.) Lennette, Evelyne T. Lennette (Editor).Latest edition / Pub. Date: January 1995. Publisher: American Public Health Association Publications.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	3	2	1	1	3
CO2	3	3	3	3	2	3	2	2	2	2	1	-

CO3	**2**	**2**	**2**	**2**	**1**	**3**	**3**	**2**	**2**	**2**	**1**	**2**
CO4	**1**	**1**	**1**	**1**	**1**	**3**	**3**	**-**	**2**	**1**	**2**	**1**

PRACTICAL: VIR-305B: MOLECULAR TECHNIQUES
(Skill Development Course)

Practicals: 6 hours/week	**Semester End Examination: 50 Marks**
Tutorial: Textbooks, E-learning resources, study materials, PowerPoint lectures	
Semester: III	**Credits: 2 Credits**

Course Educational Objectives:

1. To classify laboratories based on biosafety levels, 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 ofanimal, human and plant viruses using kit-based point of care tests, preparation, and characterization of virus-based nanoparticles

List of Practicals:

1. Good laboratory practice (GLP), Good clinical practice (GCP), good clinical laboratory practice (GCLP) and good document practices (GDP) (Theory exercises).
2. Universal safety precaution, importance of personal hygiene, disposal of organic waste, washing and cleaning of glass ware, sterilization of glassware and lab ware (Theory exercises).
3. Methods of collection of clinical material for culture-urine, blood, throat swab, faeces, body fluids.
4. Preparation of virus sample for coating onto TEM grids(demo).
5. Transmission electron microscopy (theory exercise, slides, photographs).
6. Diagnosis of SARS-CoV-2 using physical, serological and molecular tests (Theory exercise).
7. Isolation of genomic DNA/RNA from virus infected leaf sample or purified virus
8. PCR amplification of coat protein gene and analysis by agarose gel electrophoresis.
9. Preparation of plasmid, pRSET-A from *E. coli* DH5α and gel analysis.
10. Restriction digestion of vector (gel analysis) and insert with appropriate restriction enzymes
11. Vector and insert ligation.
12. Transformation in *E. coli* DH5α.
13. Plasmid isolation and confirming recombinant by PCR and RE digestion.
14. Transformation of recombinant plasmid in *E.coli* BL21 (DE3)pLys strain.

15. Induction of coat protein with IPTG and analysis on SDS-PAGE.
16. Purification of coat protein on Ni-NTA column and analysis by SDS-PAGE
17. Immunochromatographic tests (ICT) based point-of-care (PoC) tests
18. Immunoblotting/ Western blot assay.
19. Isolation of metal nanoparticles and antiviral compounds from a plant.
20. Purification and characterization of nanoparticles using ultracentrifugation, chromatography, FTIR, SEM, XRD and NMR.

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 Methodsrelated tocollection of clinical material for culture-urine, blood, throat swab, faeces, body fluids
CO3:Acquire practical skills to isolate plasmids from bacteria, restriction enzyme digestion of recombinant plasmid DNA, recovery of DNA from gels, transformation of bacteria and demonstrate the preparation of southern and dot blots for hybridization.

CO4: PCR amplification of coat protein gene and analysis by agarose gel electrophoresisIsolation of metal nanoparticles and antiviral compounds from a plant.Purification and characterization of nanoparticles using ultracentrifugation, chromatography, FTIR, SEM, XRD and NMR.

Reference books/Manuals:

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	3	2	1	1	3
CO2	3	3	3	3	2	3	2	2	2	2	1	2
CO3	2	2	2	2	1	3	3	2	2	2	1	2
CO4	1	1	1	-	-	3	3	1	2	1	-	1

VIR-306A: BAISC VIROLOGY (Optional)
(Open Elective-Theory- Offered to students of other disciplines)

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

Course Educational Objectives:

1.To understand the history, properties, nomenclature and classification of viruses and development of virology and

2. To learn about methods used for isolation, cultivation, and purification of viruses.

3..To acquire knowledge about the methods used for quantitation of viruses and sub viral agents

4. To acquire knowledge about Laboratory Biosafety Management of plant, animal and human viruses

UNIT-I

Introduction to Virology: Origin, evolution and classification 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

Replication: introduction to virus replication, steps involved in replication and general strategies.

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

Purification of viruses: Extraction of viruses from tissues, clarification, and concentration of viruses in clarified extracts by physical and chemical methods, further purification of viruses by rate zonal / equilibrium density gradient centrifugation, Criteria of virus purity, Quantitation and preservation of purified virus preparations.

UNIT-III

Characterization of viruses: Biological, physical, serological and molecular criteria

Virological laboratory methods: Principles and applications of electrophoresis, spectroscopy, ultracentrifugation, chromatography, microscopy, hybridization, DNA Sequencing and PCR.

Subviral agents: Biology of bacteriophages, satellite viruses, sat-RNAs, viroids and prions.

UNIT-IV

Laboratory Biosafety:Principles of laboratory bio-safety, differentiation of pathogens and containment facilities (BSL), Equipment and requirements of virological laboratory.

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

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

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

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

CO1: Learn the discovery, nature, origin and evolution of viruses and the physical, biochemical, and biological properties of viruses, criteria used for nomenclature and classification of bacteria, plant and animal viruses.

CO2:Describe the methods used for isolation, cultivation, and purification of viruses and criteria of purity.

CO3: Definebiological, physical, biochemical, and serological methods used for quantitation of viruses, major characteristicsbacteriophages, algal and fungal viruses, subviral agents.

CO4: Understand the**Laboratory BiosafetyManagement of plant animal and human viruses**.

Learning resources and suggested books:

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	3	2	1	1	3
CO2	3	3	3	3	2	3	2	2	2	2	1	2
CO3	2	2	2	2	1	3	3	2	2	3	1	1
CO4	1	1	1	-	-	3	3	1	2	1	2	1

(OR)

VIR-306B: AGRICULTURAL, ANIMAL AND HUMAN VIRUSES

(Open Elective-Theory-Offered to students of other disciplines)

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

Course Educational Objectives:

1. To acquire knowledge about the origin and evolution of the viruses and properties and cultivation of viruses
2. To learn about important animal viruses and veterinary epidemiology.
3. To learn about important plant and human viruses

To learn about important plant and human virus diagnostic and management methods

UNIT-I

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

UNIT-II

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 tungrovirus, Banana bunchytop virus, sugarcane mosaic virus.

UNIT-III

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

Important animal viruses: Foot and Mouth Disease virus, Bluetongue virus, sheep pox virus, Peste des Petits virus of ruminants, swine fever virus, Infectious Canine distemper virus, infectious bursal disease virus, Sheep pox virus, Newcastle disease virus, Avian influenza virus.

UNIT-III

Important human viruses: Emerging and Zoonotic infections – Zika virus, Chikungunya virus, Nipah virus, Kyasanur forest disease virus, Marburg virus, Ebola virus; Gastrointestinal infections – Rotavirus, Noravirus; Respiratory infections – Influenza virus, coronaviruses, Respiratory syncytial virus; Blood borne viruses – Human Immunodeficiency virus, Hepatitis C virus; Neurological infections – Herpes Simplex virus, Japanese encephalitis virus.

UNIT-IV

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

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

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

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 methodsused for detection of viruses and describe strategies followed for management of plant and animal viruses.

Learning resources and suggested books:

1. Fields Virology, 4th Ed., Vol 2 Ed by David M Knipe, and Peter M Howley Chapters: 24, 28,34, 54, 55, 67 and 68.
2. Gastroenteritis Viruses, Vol. 238. Novartis Foundation Symposium, Mary Estes, Latestedition(2001).
3. Viral Infections of the Gastrointestinal Tract, Vol. 10. Albert Z. Kapikian, Z. Kapikian A. 2nded., rev. and expanded. Latest edition / Pub.(1994).
4. Human Enterovirus Infections, Harley A. Rotbart (Editor), American Society Microbiology, (1995).
5. Viral Gastroenteritis, Edited By U. Desselberger, J. Gray. Elsevier Perspectives InMedicalVirology. 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
10. Medical Virology. Series Editor: Arie J. Zuckerman, Uk Isa K. Mushahwar. (2001).
11. Fields Virology, Volume 2, 4th edition, (2001).
12. Clinical Virology, Second Edition (Richmans Hayden).
13. Hepatitis Viruses (Japan medical research forum).
14. Viral Hepatitis and Liver disease, A.J. Zuckerman.
15. Viral Hepatitis Molecular Biology Diagnosis and Control, By Isa Mushahwar. Elsevier
16. Perspectives In Medical Virology. Series Editor:Arie J. Zuckerman, Isa K. Mushahwar.(2003).
    Krugman's Infectious Diseases of children By Saul Krugman.
18. Zuckerman AJ. ed. Principles and Practice of Clinical Virology.Chichester: John Wiley andSons, (1990). p. ix + 643 p.
19. World Health Organization. Global Measles and Rubella Strategic Plan: 2012-2020.--
20. Geneva: World Health Organization, (2012). p. 42 p.
21. HIV and Aids by Michael A. Palladino, David Wessner. Latest edition / 2005, Benjamin Cummings.
22. HIV Libman, Harvey J. Makadon. Royal Society of Medicine Press Ltd. (2006).

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	3	2	1	1	3
CO2	3	3	3	3	2	3	2	2	3	2	1	2

CO3	**2**	**2**	**3**	**3**	**1**	**3**	**3**	**3**	**3**	**2**	**1**	**2**
CO4	**1**	**1**	**1**	**-**	**1**	**3**	**3**	**1**	**2**	**1**	**1**	**1**

VIR-307: COMMUNICATIVE ENGLISH AND FUNDAMENTALS OF COMPUTERS

(Skill Enhancement Add-on Theory Course-Self Study)

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

Course Educational Objectives:

1. To learn **Oral and Aural Skills**,**Writing Skills**,**Job Skills**and **Soft Skills**
2. To enable the students to understand the **Basics of personal computer and its componentsWindows Operating System-2010 Microsoft Office-**
3. To Learn to practice **MS-Word, MS-Excel, MS-PowerPoint**
4. To increase the awareness **Introduction to InternetE-mailNetworking of Computers and overview of International and Indian networksInformation Networks**

UNIT I

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

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

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

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

UNIT II

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

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

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

UNIT III

MS-Word: Features of MS-Word - MS-Word Window Components - Creating, Editing, Formatting and Printing of Documents – Headers and Footers – Insert/Draw Tables, Table Auto format – Page Borders and Shading – Inserting Symbols, Shapes, Word Art, Page Numbers, Mail Merge.

MS-Excel: Overview of Excel features – Creating a new worksheet, Selecting cells, Entering and editing Text, Numbers, Inserting Rows/Columns –Changing column widths and row heights, Formulae, Referencing cells , Changing font sizes and colors, Insertion of Charts, Auto fill, Sort.

MS-PowerPoint: Features of PowerPoint – Creating a Presentation - Inserting and Deleting Slides in a Presentation – Adding Clip Art/Pictures -Inserting Other Objects, Audio, Video - Resizing and scaling of an Object – Slide Transition – Custom Animation.

UNIT IV

Introduction to Internet: Internet basics, getting onto the internet, e-mail, google drive management (Google documents, Google spread sheets, Google Slides and Google forms), drop box, file transfer protocols, gopher, the world-wide web, types of browsers (Google Chrome, Internet Explorer, Mozilla Firefox), browsing and down loading from sites; Introduction to Social Networking: Twitter, Tumblr, LinkedIn, Facebook, flickr, Skype, yahoo, YouTube, WhatsApp;Learning management systems (Microsoft teams, zoom, webEx, G-meet).

E-mail: Definition of E-mail -advantages and disadvantages –User Ids, passwords,Email addresses, domain names, mailers, message components, message composition, mail Management.

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

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

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

CO1: Acuire the **Oral and Aural Skills**,**Writing Skills**,**Job Skills**and **Soft Skills**
CO2: Understandthe **Basics of personal computer and its componentsWindows Operating System-2010 Microsoft Office-**.

CO3: Learn to practice **MS-Word, MS-Excel, MS-PowerPoint**

CO4:Increase the awareness **Introduction to InternetE-mailNetworking of Computers and overview of International and Indian networksInformation Networks**WWW, HTTP, HTML, URLs, EMB net, NCBI net, Virtual tourism

Learning resources and suggested books:

1. English for Success Suresh Kumar, Cambridge University Press IndiaPvt.Ltd.2010.
2. Communication Skills & Soft Skills - An Integrated Approach, Dorling Kindersley, India Pvt. Ltd. 2013.
3. A. Goel, Computer Fundamentals, Pearson Education, 2010.
4. P. Aksoy, L. DeNardis, Introduction to Information Technology, Cengage Learning, 2006
5. P. K.Sinha, P. Sinha, Fundamentals of Computers, BPB Publishers, 2007.
6. Elements of Computer Science, 1998. S.K. Sarkar, A.K. Gupta. S. Chand & Company (Chapters- 1,2,9,12,14).
7. Microsoft Office. 1997. Stultz. Office 2000 -The Basics and Beyond, 2000. A Lan Neibauer. Tata Mc Graw-Hill Publishing Comp. Part I, II, III, IV, V.
8. Bioinformatics : Methods and Protocols, Edited by StephemMisener and Stephen A. Krawetz. 2000. Methods in Molecular Biology Series. Humana Press.
9. Bioinformatics : A Practical guide to the analysis of genes and proteins. 1998. Edited by A.D. Baxevanis and B.F.
10. Francis Ouellette. Wiley -Interscience. Computational Methods in Molecular Biology by S.L. Saizberg.
11. Computer Applications in Biotechnology. 1998. by T. Yosida. Introduction to Bioinformatics by Atwood.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	3	2	1	1	3
CO2	3	3	3	3	2	3	3	3	2	2	-	2
CO3	2	1	2	2	1	3	3	2	2	2	-	2
CO4	1	1	1	1	1	3	3	1	2	1	1	1

SEMESTER-IV

VIR-401: ANIMAL AND HUMAN VIROLOGY (Mandatory)

(Core Theory-I)

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

Course Educational Objectives:

1. To acquire knowledge on virus-host interactions, host innate and adaptive immune response to viruses, molecular mechanisms of viral pathogenesis,
2. To acquire knowledge on transmission of viruses, mechanism of virus, persistence, infection and spread in the body.
3. To learn the epidemiological concepts and methods of virus diseases, measures of disease occurrence, disease determinants, ecology, epidemiology
4. To learn the 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: Definition and structure of viral receptors (polio, HIV); Cellular interactions—clathrin coated pits, lipid rafts, caveolae, endocytosis and virus uncoating mechanisms; Nuclear localization signals and nuclear pore transit, virus –cytoskeletal interactions, chaperons; Replication sites and their characterization, IRES, replicons, transport of viral proteins; Host cell 'shut off', apoptosis, necrosis, stress response, alteration of signaling pathways, cellular basis of transformation.

Influence of virus on host cells: Host specificity, resistance, interference, cytopathic effects, inclusion bodies, cellular injury associated markers, mechanism of viral persistence and latency—*in vivo* and *in vitro* models (JE, measles and HIV).

UNIT-II

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

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

UNIT-III

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.

Epidemiological concepts of Virus diseases: Definition of terms, types of epidemiological investigations; Disease occurrence **-** Measures of disease occurrence, prevalence, incidence and mapping; disease determinants; host, virus and environmental interactions; Factors affecting virus ecology and epidemiology**.**

UNIT-IV

Virus disease surveillance: Types and methods of public health and infectious virus disease surveillance, establishing surveillance system; Quarantine of viral diseases- International and national; **Surveys:** Basic concepts, types of sampling, vector monitoring.

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

Prevention and Control of viruses: The infection control policy- aseptic techniques, cleaning and disinfection, protective clothing, isolation; Prevention- sanitation, vector control-Various control strategies and environmental management. Control in urban settings, control at aquatic stages, adult population, personal protection, insecticide resistance mechanism and control dynamics;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, molecular mechanisms of viral pathogenesis with respect to polio, rotavirus, and cytomegalovirus.

CO2: Describe the various modes of vertical and horizontal transmission of animal and human viruses, zoonotic virus infections, mechanism of virus persistence, 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 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.

Learning resources and suggested books:

1. Epidemiology, diagnosis and Management of Zoonoses. (2004). K.G. Narayana Sri Kuldeep Sharma Pub.
2. Medical Mirobiology.(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 Inc.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	3	2	1	1	2
CO2	3	3	3	3	2	3	2	2	2	2	1	2
CO3	2	2	2	2	1	3	3	2	3	2	1	2
CO4	1	1	1	-	1	3	3	-	3	1	1	1

VIR-402: ANIMAL AND HUMAN VIRUS DISEASES (Mandatory)

(Core Theory-II)

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

Course Educational Objectives:

1. To describe the etiology, transmission, clinical manifestations, diagnosis, prevention and control of important (+) sense ssRNA viruses infecting animals and humans.
2. To describe the etiology, transmission, clinical manifestations, diagnosis, prevention and control of important (-) sense ssRNA viruses infecting animals and humans
3. To understand the etiology, transmission, clinical manifestations, diagnosis, prevention, and control of important DNA viruses infecting animals and human
4. To learn about the prion diseases, biology, prevention, and management of major viruses of silkworm, poultry, fish and prawn, emerging and reemerging virus diseases.

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

RNA Viruses:

Orthomyxoviridae-Human influenza, birdflu;***Paramyxoviridae-*** Measles, Mumps, Canine distemper, rinderpest, peste des petits ruminants virusandNewcastle 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, SheeppoxandFowlpox 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

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

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

Major viruses of insects: Biology, prevention and management.

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

Emerging and Re-emerging virus diseases: Zika, Nipha, Chikungunya, SARS Coronaviruses, Swineflu, Kyasanur forest disease virus, Marburg virus, WestNilevirus..

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.

Learning resources and suggested books:

1. Emerging and Reemerging Viral PathogensVolume 2: Applied Virology Approaches Relatedto Human, Animal and Environmental Pathogens, Moulay Mustapha Ennaji, (2019).AcademicPress.
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, (20180, by B. Mishra (Author), details, 256pages, Publisher: CBS Publishers & Distributors Pvt Ltd, India (2018).
7. Recent Advances in Animal Virology 1st ed. (2019) Edition, Kindle Edition, by Yashpal SinghMalik (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). 22ndEdition.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. 9eds.) Vol.I, II, Academic Press.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	3	2	1	1	3
CO2	3	3	3	2	2	3	3	2	2	2	1	2
CO3	2	2	2	2	1	3	3	2	2	3	1	2
CO4	1	1	1	1	1	3	3	1	2	1	-	-

VIR-403A: APPLIED VIROLOGY (Optional)

(Generic Elective-Theory)

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

Course Educational Objectives:

1. To learn about the basic concepts, requirements and methods of plant and animal cell and tissuecultures

2.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

4.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

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

Viruses as unique genetic resources: Exploitation of viral genes / sequences in the construction of varied types of gene vectors (cloning, shuttle, expression and transcription) and their applications; virus genes as a source of novel enzymes, gene expression activators and silencers.

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

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

UNIT-II

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

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

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

UNIT-III

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

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

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

UNIT-IV

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

Biosafety and Biosecurity: Laboratory bio-safety, Classification of bio-safety levels and risk groups, containment, Good microbiological practices, Good Laboratory practices (GLP), Disinfection, Decontamination and Sterilization procedures, solid versus liquid waste, safety rules, preparedness and response for the emergency conditions in the laboratory.

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

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.

Learning resources and suggested books:

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	3	2	1	1	3
CO2	3	3	3	3	2	3	2	2	2	3	1	2
CO3	2	2	2	2	1	3	1	2	3	2	1	2
CO4	1	1	2	-	1	3	3	1	2	1	2	1

(OR)

VIR-403B:VIRUS-BASED BIOTECHNOLOGY (Optional)

(Generic Elective-Theory)

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

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,
2. To learn about phage display and phage therapy technologies, virus-based biopesticides and viruses as biological weapons.
3. 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

4.To acquire knowledge about the principles and methodologies of virus resistant cropsand basic principles of biosafety, biosecurity and ethics in Virology

UNIT-I

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

Viruses as unique genetic resources: Exploitation of viral genes / sequences in the construction of varied types of gene vectors (cloning, shuttle, expression and transcription) and their applications; virus genes as a source of novel enzymes, gene expression activators and silencers.

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

UNIT-11

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

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

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

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

UNIT-III

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

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

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

UNIT-IV

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

Biosafety and Biosecurity: Laboratory bio-safety, Classification of bio-safety levels and risk groups, 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, 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 / animalcell 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 and virus-like particles, VNPs 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.

Learning resources and suggested books:

1. Zoonoses: Infectious diseases transmissible from animals to humans. 3rd Edition. (2003). H. Krauss *et al.* ASM Press.
2. Clinical Virology. (2002). 2nd edition. D.D.Richman*et al.,* ASM
3. Matthews' Plant Virology. (2001). By R. Hull. Academic Press.
4. Control of Plant Virus Diseases. By Hadidi*et al.*(Eds). APS. USA.
5. Field's Virology. (2002). Vol. I, II.
6. Bailey and Scotts' Diagnostic Microbiology. 11th Edition. (2002). By B.A. Forbes et al., Mosby publisher.
7. Principles of gene manipulation. 6th edition. (2002). By S. Primrose, R. Twyman and B. Old. Blackwell Science. .
8. Principles of Virology- Molecular biology, pathogenesis and control. (2000). S.J.Flint, L.W.Enquist, R.M.Krug, V.R.Racaniello and A.M. Skalka. ASM press.
9. Medical Virology. (1994). 4th ed. D.O. White and F. Fenner. Academic Press.
10. Veterinary Virology. (1993). 4th ed. F. Fenner*et al.,* Academic Press (Part-II).

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**1**	**1**	**3**
CO2	**3**	**3**	**3**	**3**	**2**	**3**	**2**	**2**	**2**	**2**	**1**	**2**

CO3	**2**	**2**	**2**	**2**	**1**	**2**	**3**	**2**	**3**	**2**	**1**	**-**
CO4	**1**	**1**	**1**	**-**	**1**	**3**	**3**	**1**	**3**	**1**	**1**	**1**

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

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

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

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

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 symptomatology/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.

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 toanalyze 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.

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 ReetiKhare (Author), Publisher: ASM Press; 1 edition (March 19, 2019), 460 pages,Publisher: ASM Press; 1 edition (March 19, 2019).
8. Viruses: Molecular biology, host interactions, and applications to biotechnology. 2018. Paula Tennant, Gustavo Femin and Jerome E Foster. Academic Press.

9. Molecular and Cellular biology of viruses. 2019. Phoebe Lostroh, ISBN 9780815345237.
10. Techniques in diagnoses of Plant Viruses (Plant Pathogens -6)-(2008). Govind.Rao, Rodrigo A. Valverde & C.I. Dovas, Stadium Press.
11. Epidemiology, diagnosis and Management of Zoonses. (2004). K.G. Narayana Sri Kuldeep Sharma Pub.
12. Field's Virology. (2002). Vol. I, II.
13. Bailey and Scotts' Diagnostic Microbiology. 11th Edition. (2002). By B.A. Forbes et al., Mosby publisher.
14. Clinical Virology. (2002). 2nd edition. D.D. Richman et al., ASM
15. Principles of gene manipulation. 6th edition. (2002). By S. Primrose, R. Twyman and B. Old. Blackwell Science.
16. Matthews' Plant Virology. (2001). By R. Hull. Academic Press.
17. Principles of Virology- Molecular biology, pathogenesis, and control. (2000). S.J.Flint, L.W. Enquist, R.M. Krug, V.R. Racaniello and A.M. Skalka. ASM press.
18. Control of Plant Virus Diseases. By Hadidi*et al.* (Eds). APS. USA.
19. Medical Virology. (1994). 4th ed. D.O. White and F. Fenner. Academic Press.
20. Veterinary Virology. (1993). 4th ed. F. Fenner*et al.,* Academic Press (Part-II).

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	3	2	1	1	3
CO2	3	3	3	3	2	3	2	2	2	2	1	2
CO3	2	2	2	2	1	2	2	2	2	2	1	2
CO4	1	1	1	-	-	3	3	1	2	1	1	-

(OR)

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

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

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

1. Classification of laboratories
2. Preparation of glassware for cell cultures
3. Preparation of buffers and media
4. Collection, filtration and preservation of calf serum.
5. Culturing of Sheep kidney cells
6. Culturing of Chicken embryo fibroblast cells.
7. Sub-culturing of Sheep kidney cells.
8. Inoculation of virus into sheep kidney cell cultures.
9. Chicken embryo inoculation techniques.
10. Study of pathogenic lesions of animal virus diseases through slides.
11. Serodiagnosis of virus infections (HBV and HCV) of humans using kits.
12. Participation in vaccination programs (extension activity).
13. Application of NPV and its role as biopesticide.
14. Purification of virus-based nanoparticles using differential centrifugation.
15. Characterization of virus-based nanoparticles.
16. Diagnosis of a plant virus using ELISA.
17. Visits to local sericulture, poultry, fish and prawn farms.
18. Biosafety guidelines (Theory exercise)

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 symptomatology/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.

Suggested Books / Manuals:

21. Diagnostic Microbiology. 11th Edition. (2002). By B.A. Forbes et al., Mosby publisher.

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	3	2	1	1	3
CO2	3	3	3	3	2	3	2	2	2	3	1	2
CO3	2	2	2	2	1	2	3	2	2	3	1	-
CO4	1	1	1	-	-	3	3	1	2	1	1	1

THEORY-VIR-405A: INDUSTRIAL BIOTECHNOLOGY
(Multidisciplinary Course)

Lecture: 6 hours/week	**Internal Assessment: 10 Marks** **Seminars and assignments**
Tutorial: Textbooks, E-learning resources, study materials, PowerPoint presentations by guest lecturers.	**Semester End Examination: 40 Marks**
Semester: IV	**Credits: 2 Credits**

Course Educational Objectives:

1. To acquire the knowledge on cultivation of industrially important organisms **Strain improvement methods**and bioreactors
2. To learn the types of fermentation processes and to learn about important **Bioprocess control measurements**
3. To understand the Downstream processing and its industrial applications
4. To learn industrial production of enzymes, beverages, alchol and single cell proteins

Unit-I

Selection of Microorganisms: Isolation, screening, Preservation and maintenance of industrially important microorganisms; types and source of media for industrial fermentation; buffers-precursors and metabolic regulators and oxygen requirement; Air and Media Sterilization.

Strain improvement methods: Conventional and rDNA methods**.**

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

Unit-II

Fermentation and its types: Solid state and submerged fermentations; Analysis of batch, fed-batch and continuous fermentations, aerobic and anaerobic fermentation, chemostat fermentation.

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

UNIT – III

Down Stream Processing: Cell disruption methods; biomass separation, extraction and purification methods; Quality assurance techniques and its importance in marketing.

UNIT – IV

Applications of Industrial Biotechnology: Industrial production of alcohol (ethanol), alcohol beverages (beer), acids (citric acid), solvents (glycerol), antibiotics (penicillin,), amino acids (lysine), enzymes (amylases), vitamins($B_{12.}$) and their applications;Role of enzymes; Single cell protein.

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

CO1: Understand thecultivation of industrially important organisms **Strain improvement methods**and bioreactors

CO2:Learn the basic concepts of the types of fermentation processes and to learn about important **Bioprocess control measurements**

CO3:Describe the Downstream processing and its industrial applications,Quality assurance techniques and its importance in marketing.

CO4:Learn the industrial production of enzymes, beverages, alchol and single cell proteins

Learning resources and suggested Books:

1. Crueger&Crueger Biotechnology: A Text Book of Industrial microbiology 2nd edition
2. Demain, A.L Biology of Industrial Microorganisms
3. Hobbs, B.C. and Rioberts,D 1993 Food Poisoning and Food Hygiene Edward Anold, London.
4. Hui Y H 2006 Food Biochemistry and Food Processing Blackwell
5. Joshi, V.K. Ashok Pondey 1999 Biotechnology and Food fermentation Vol. I & II.
6. Patel, A.H. Industrial microbiology/
7. Prescott and Dunn's, Industrial Microbiology 4th edution.
8. Reed, G. Industrial Microbiology, CBS Publishers.
9. Microbial Technology Vol. I & II. Pepplelr&Perllman (EDS).
10. Microbial Ecology – Fundamentals and applications. Atlas and Bartha.
11. Stanbury and Whittaker – Principles of Sterilization techniques, First Indian reprint Edition (1997). Aditya Book (P) Ltd. New Delhi
12. Michael J. Waites - Industrial microbiology: an introduction 7th Edition; Wiley-Blackwell 2008.
13. Damien and Devies – Microbial Technology Edition (1994).
14. LE Casida – Industrial Microbiology Edition (1994)
15. H Patel – Industrial Microbiology 4th Edition (2003). 7. KS Bilgrami and AK Pandey – Introduction to Biotechnology Edition 2nd (1998).
16. U Satayanarayan – Biotechnology, First Edition (2005) Books and Allied (P) Ltd. Kolkata.
17. Baily JE and Ollis DF., Biochemical Engineering fundamentals, 2nd Edition, McGraw-Hill Book Co., New York, 1986.
18. Mansi EMTEL, Bryle CFA. Fermentation Microbiology and Biotechnology, 2nd Edition, Taylor & Francis Ltd, UK, 2007.
19. Shara L. Aranoff, Daniel R. Pearson, Deanna Tanner Okun, Irving A. Williamson, Dean A. Pinkert – Industrial Biotechnology; Nova Science 2009.
20. Comprehensive Biotechnology. Volumes 1, 2, 3 & 4.Moo-Young M., Pergamon Press, 2011.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	3	2	1	1	3
CO2	3	3	3	3	2	2	2	2	3	2	1	1
CO3	2	2	2	2	3	2	3	2	3	2	1	2
CO4	1	1	1	-	-	3	3	1	2	1	1	1

PRACTICAL-VIR-405B: INDUSTRIAL BIOTECHNOLOGY
(Multidisciplinary course)

Practical: 6 hours/week	**Semester End Theory Examination : 40 Marks**
Tutorial: Textbooks, E-learning resources, study materials, PowerPoint lectures	

Semester: IV	Credits: 2 Credits

Course Educational Objectives:

1. To learn and to practice variousmethods used for isolation, cultivation, and screening of the industrially important microorganisms from different sources for the production of enzymes and organic acids.

2. To demonstrate the practical skills in Quality testing of milk, qualntitative analysis of lactic acid and visit to small scale industries

List of Practicals

1. Isolation of microorganism from soil and industrial effluents
2. Screening of industrially important Microorganisms (Bacteria and fungi)
3. Production of Citric acid from *Aspergillus niger*
4. Screening of amylase producing microorganisms
5. Screening of cellulase producing fungi from soil
6. Cellulase production from fungi through submerged fermentation
7. Assay of Cellulase (FPase) by DNS method
8. Production of wine from grapes
9. Production of alcohol by fermentation and Estimation by colorimetry method
10. Quality testing of milk by methyline Blue Reduction Test (MBRT)
11. Effect of heavy metals on bacteria
12. Estimation of lactic acid from curd
13. Visit to small scale Bioprocessing industries

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

CO1:Acquire the practical skills to use in cultivation, and screening of the industrially important microorganisms from different sources for the production of enzymes and organic acids.

CO2:Acquire the practical skills to usecultivation, and screening of the industrially important microorganisms from different sources for the production of wineand alcohol.

CO3:Learn theQuality testing of milk, qualntitative analysis of lactic acid andEffect of heavy metals on bacteria.

CO4: visit to small scale industriesto learn the processes in in the production of industrially important products

Learning resources and suggested Books:

1.Christson, J.Harst (1997) Manual of Environmental Microbiology, ASM Press, Washington. DC.

2. De, A.K. (1987) Environmental Chemistry –Wiley Eastern Limited, New Delhi Foster C.F. John Ware D.A. Environmental Biotechnology, Ellis Horwood Limited.

3. Ericksson Ed. (1998) Biotechnology in the pulp and paper industry, Springer.

4.Geetha Bali et al eds (2001) Environmental Biotechnology, ApS Pub.

5. Maheshwari, D. K. et. al., Biotechnological applications of microorganisms, IK . International, New Delhi, 2006

6. Waites, M. J. et. al., Industrial Biotechnology: An Introduction, Blackwell publishing, UK, 2007.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	3	2	1	1	3
CO2	3	3	3	3	2	3	2	3	2	2	1	-
CO3	2	2	2	2	1	3	3	3	2	2	1	2
CO4	1	1	1	-	1	3	3	-	2	1	1	1

(OR)

VIR-405C: PROJECT WORK

Project:6 hours/week	**Dissertation: 60 Marks**
Tutorial: Textbooks, E-learning resources, study materials	**Presentation: 20 Marks** **Viva:20 marks**
Semester: IV	**Credits: 4 Credits**

- Students intended to do project; they need to undertake a project work related to Virology. The project report will be submitted in the form of dissertation duly

certified by the supervisor and Head of the Dept. The project will be presented by the student for evaluation at the end of the semester by external expert.

VIR-406A: CLINICAL VIRIOLOGY
(Open Elective-Theory- Offered to students of other disciplines)

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

Course Educational Objectives:

1. To learn about basic concepts of taxonomy, morphology, transmission, cultivation and replication of viruses and methods used for characterization of viruses,
2. To understand methods used for sample collection, preservation, and detection of viruses and GMP and biosafety practices used in the clinical laboratories.
3. To acquire knowledge about clinically important food-borne, blood borne, vector borne and contact borne and zoonotic diseases and

To learn about the 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, 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 groups, 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 andcharacterization of viruses.

CO2: Learn to collect, preserve the virus samples and detect the viruses by using biological, serological and molecular methods, 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.

Learning resources and suggested books:

1. Principles and Practice of Clinical Virology, Carol Shoshkes Reiss, (2009).Editor:**,** 6th ed. ISBN: 9780470517994. $450 p. 968.
2. Clinical Virology. D.D. Richman *et al.,* 2nd Edition. (2002), ASM Press.
3. Principles of Virology- Molecular biology, pathogenesis and control. (2000). S.J.Flint, L.W.Enquist, R.M.Krug, V.R.Racaniello and A.M.Skalka. ASM press.
4. Fields Virology. (2001). 3rd Edition. Vol. 1, 2. B.N. Fields, D.M. Knipe, P.M. Howley.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	3	2	1	1	3
CO2	3	3	3	3	2	3	2	3	3	2	1	-
CO3	2	2	2	2	1	3	3	2	2	2	1	2
CO4	1	1	1	-	-	3	3	1	2	1	-	1

(OR)

VIR-406B: EMERGING AND REEMERGING VIRUSES(Optional)
(Open Elective-Theory- Offered to students of other disciplines)

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

Course Educational Objectives:

1. To understand the evolution, epidemiology, emergence of infectious and emerging virus diseases, viral zoonotic infections
2. To learn about HIV, SARS, and host defence mechanisms against infectious diseases.
3. To learn about the biology, diagnosis and management of vector-borne emerging infectious viral diseases
4. To understand the impact of environment on virus emergence, control strategies followed for emerging virus diseases and bioterrorism.

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

UNIT-I

Introduction to Virology: Origin, evolution and classification 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: Significance and terminology of virus epidemiology, 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

Emerging and Re-emerging Infectious Viruses: Non-vector borne emerging virus diseases; Human Immunodeficiency virus, SARS, and Influenza.

Vector-borne emerging infectious virus diseases- Dengue & Haemorrhagic fever viruses, Japanese encephalitis virus, Chikungunya virus, West Nile virus, Ebola virus, Nipah, Marburg, Kyasanur forest disease virus, 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, Patterns 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, biology, epidemiology, and emergence of infectious virus diseases, biology of emerging infectious diseases, zoonotic infections
CO2: Learn about the biology, clinical symptoms, epidemiology, diagnosis, and control of viruses causing AIDS and SARS and host defense mechanisms against infectious virus diseases.
CO3:Describe the biology, clinical symptoms, epidemiology, diagnosis, and control of vector borne emerging infectious viral diseases.
CO4:Acquire knowledge on impact of social and environmental change on emergence of viruses, vector control and antiviral therapies, vaccines, public health measures and bioterrorism.

Learning resources and suggested books:

1. Epidemiology, diagnosis and Management of Zoonoses. (2004). K.G. Narayana Sri Kuldeep Sharma Pub.
2. Clinical Virology. D.D. Richman *et al.,* 2nd Edition. (2002). ASM Press.
3. Principles of Virology- Molecular biology, pathogenesis and control. (2000). S.J. Flint, L.W. Enquist, R.M. Krug, V.R. Racaniello and A.M. Skalka. ASM press.
4. Veterinary Virology. F.A. Murphy *et al. (*1999). 3rd Edition. Academic Press.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	3	3	3	3	3	3	1	1	3
CO2	3	3	3	3	2	3	2	2	3	2	1	2
CO3	2	2	2	2	1	3	3	2	3	2	1	2
CO4	1	1	1	-	-	3	3	1	3	1	-	1

VIR-407: RESEARCH APRTITUDE AND ENTERPRENUERSHIP
(Skill Enhancement Add-onTheoryCourse-Self-Study)

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

Course Educational Objectives:

1.To enable the students to imbibeSteps of Research; Methods of Research and communication skills .

2. To learn the **Data Interpretation**Ethical Issues of Data Reporting and for Authenticity.Preparation of research proposal

3.To learn **Information and Communication Technology** (ICT) and Role of Entrepreneurship in Economic Development; Start-ups.

4.To aquireknowledge about the **Idea Generation and Project FormulationInstitutions Supporting and Taxation Benefits**

UNIT-I

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

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

UNIT-II

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

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

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UNIT-III

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

Entrepreneurship: Definition and Concept of entrepreneurship; Entrepreneur Characteristics; Classification of Entrepreneurs; Role of Entrepreneurship in Economic Development; Start-ups.

UNIT-VI

Idea Generation and Project Formulation: Ideas in Entrepreneurships; Sources of New Ideas; Techniques for Generating Ideas; Preparation of Project Report; Contents; Guidelines for Report preparation; Project Appraisal Techniques; Economic Analysis-Financial Analysis; Market Analysis.

Institutions Supporting and Taxation Benefits: Central level Institutions: NABARD; SIDBI, State Level Institutions; DICs; SFC; Government Policy for MSMEs; Tax Incentives and Concessions.

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

CO1:Aware of the Steps of Research; Methods of Research and communication skills .

CO2: Learn the **Data Interpretation**Ethical Issues of Data Reporting and for Authenticity.Preparation of research proposal

CO3: Acquire the knowledge about the importance **Information and Communication Technology** (ICT) and Role of Entrepreneurship in Economic Development; Start-ups.

CO4:Acquire knowledge about the **Idea Generation and Project Formulation,Institutions Supporting and Taxation Benefits**

Learning resources and suggested books:

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

9. Weyrich, L. S., & Harvill, E. T. (2013). Teaching ethical aptitude to graduate student researchers. Accountability in research, 20(1), 5-12.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	3	3	1	1	2
CO2	3	3	3	3	2	3	2	2	3	2	1	-
CO3	2	2	2	2	1	3	1	2	3	2	1	2
CO4	1	1	1	-	-	3	3	1	3	1	-	1