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 2024-25 onwards

S.V. UNIVERSITY, TIRUPATI :: SVU COLLEGE OF SCIENCES
M. Sc., VIROLOGY
COURSE PATTERN, CURRICULAM AND SCHEME OF EXAMINATION
CBCS Pattern (With effect from the Academic year 2024-2025)

Branch	Program Code	Name of the program	Name of the Department
VIROLOGY	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 biological sciences through sponsored research projects.
4. Establishing national/international collaborations with premier research institutes/universities for advancing scientific knowledge in contemporary areas of Virology and interdisciplinary areas of life sciences.
5. Preparing students to have qualities such as honesty, integrity, carefulness, courage, resilience, self-discipline, openness, innovative thinking and determination to keep going forward, which make them ethically strong and to cotribute to the betterment of society and human kind.

No of the Seats available and Eligibility Criteria:

Name of the Program	Seats Availability	Eligibility Criteria
M. Sc. Virology	18 seats (Regular) 6 seats (Self-finance)	Students who completed 3 years' UG degree or 4 years' UG Honours or UG Honours with Research degree with major as Biotechnology, Microbiology, Biochemistry, Botany, Zoology, Medical Lab Technology and/ or UG in any life science course/program.

About the Program:

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

The M.Sc. Virology program curriculum framework focuses on pragmatist approach where the applications of theoretical concepts are taught with substantial coverage of practical and field-based studies. The curriculum is designed to educate the students with the basic and advanced concepts of Virology and other major interdisciplinary disciplines by using modern pedagogical tools and concepts such as e-learning platforms, as well as to promote and develop

skills and competencies that have enduring value beyond the classroom. While designing these frameworks, emphasis is given on the objectively measurable teaching-learning outcomes to ensure employability of the students. The M. Sc Virology program has two academic years with four semesters. A total of 9 core courses were offered in the M. Sc. Virology program in the three semesters, where three core courses with one in each semester are total theory and experiments from the respective core courses were included in other related core and skill oriented courses, so that student will not miss the practical exposure and training. Six skill oriented courses (SDC) were offered and distributed evenly 2 in each of first three semesters.

Two open online transdisciplinary courses (OOTCs) distributed evenly with one in each of the second and third semesters. Each online course is assigned with two credits with minimum duration of 40 hours learning with 100 marks of assessment through assignments, quiz and tests. A student can opt for two or three courses of shorter duration to acquire the assigned two credits. OOTCs can be chosen based on the interest of the students without confinement to traditional academic schedules. Two compulsory audit courses of Indian Knowledge systems were offered during first two semesters with one in each semester as it is important to know about Indian culture, traditions and heritage.

The first semester of the program covers the fundamental concepts of three core courses (CCs): Cell Biology and Tissue Culture (mandatory total theory course), General Microbiology or Viruses of Microorganisms and Biological Chemistry or Microbial Physiology and Metabolism. Basic Virology or Food and Environmental Biotechnology and Analytical Techniques or Nano biotechnology are offered as skill oriented courses (SDCs) and an audit course of Indian Knowledge System-I. Students will have an option to choose any one among two of each of these core and skill oriented courses. Two practical training programs with a set of relevant experiments were designed for the respective core and skill oriented courses. Seminars/tutorials/remedial classes and quiz will be conducted as part of the internal assessment.

In the second semester, the students will get an opportunity to explore the basic and advanced concepts of Microbial Genetics and Molecular Biology as core mandatory total theory course and other two core courses with options are Plant Virology or Biology of Virus Vectors and their Management and Plant Virus Diseases or Tumour Virology. Recombinant DNA Technology or Biostatistics & Bioinformatics and Immunology or Molecular Techniques are offered as skill oriented courses. Students will have an option to choose any one among two of each of these core and skill oriented courses. Two practical training programs with a set of relevant experiments were designed for the respective core and skill oriented courses. An OODC - 1 of two credits and audit course on Indian Knowledge system is mandatory.

In the third semester, Animal and Human Virology was introduced as mandatory core

total theory course. Two more core courses were offered with options of Molecular Virology or Agricultural and Veterinary Viruses and their Management and Animal and Human Virus

Diseases or Emerging and Re-emerging Virus Diseases and two skill oriented courses were offered with options of Applied Virology or Clinical Virology and Industrial Biotechnology or Medical Lab Technology, where student can choose any one among each these core and skill oriented courses. Two practical training programs with a set of relevant experiments were designed for the respective core and skill oriented courses. Seminars/tutorials/remedial classes and quiz will be conducted as part of the internal assessment. An OODC - 2 of two credits with 100 marks assessment is mandatory. A student can opt for two or three courses of shorter duration to acquire the assigned two credits. OOTCs can be chosen based on the interest of the students without confinement to traditional academic schedules.

In the fourth semester, open online skill development courses (OOSDC) for 8 credits were introduced to expose the students to various interdisciplinary skills. Students have the flexibility to pursue these courses at any point during their study period and fulfil the 8 credit requirement by the end of the 4th semester. Each course is designed to be at least 20 hours' duration to earn 1 credit. Students have the option to select one or two or more courses to accumulate the designated 8 credits. Project work with 12 credits in the 4th semester has been introduced, where students can be oriented towards research project, reports, documentation and enhancing analytical and technical writing skills. Project work will be related to the courses offered in M. Sc. Virology program. Students will be encouraged to take internships in outside industries, national and private academic/research institutes during the first year summer and also during the 4th semester for the completion of projects.

In conclusion, the overall pragmatic core of the framework has been designed such a way to enable the learners implementing the concepts to address the real-world problems. Above all, this framework is aimed to mold master graduates to acquire critical thinking, scientific reasoning, moral ethical reasoning qualification descriptors that are specific outcomes pertinent to the discipline and as responsible Indian citizens who have adequate knowledge and skills in reflective thinking, rational skepticism, scientific temper, digital literacy to contribute for betterment of the society and mankind. Students will be encouraged to participate in seminars, webinars, training workshops, conferences and quiz/elocution/essay writing/sports competitions. Time to time, seminars, conferences and training workshops will be organized by the faculty members in the contemporary areas of Virology. Alumni will be visiting the Department whenever it is possible for them and give lectures to motivate the students. Lectures will be arranged with the experts whoever visits the Dept. at various occasions to enlighten students.

SVU COLLEGE OF SCIENCES
M. Sc., VIROLOGY
COURSE PATTERN, CURRICULAM AND SCHEME OF EXAMINATION
CBCS Pattern (With effect from the Academic year 2024-2025)

SEMESTER - I								
S. No	**Course**	**Code**	**Title of the Course**	**H/W**	**C**	**SEE**	**IA**	**Total Marks**
1	*CC	101	Core course – 1: Cell Biology and Tissue Culture	4	4	70	30	100
2		102	Core Course – 2(A): General Microbiology / Core Course – 2(B): Viruses of Microorganisms	4	3	50	25	75
3		103	Core Course – 3(A): Biochemistry / Core Course – 3(B): Microbial Physiology & Metabolism	4	3	50	25	75
4	***P	104	Practical I (related to CC 2 & 3)	6	2	35	15	50
5	**SOC	105	Skill Oriented Course – 1(A): Basic Virology / Skill Oriented Course – 1(B): Food and Environmental Biotechnology	4	3	50	25	75
6		106	Skill Oriented Course – 2(A): Analytical Techniques / Skill Oriented Course – 2(B): Nano Biotechnology	4	3	50	25	75
7	***P	107	Practical II (related to SOC 1 & 2)	6	2	35	15	50
			Total	**36**	**20**	**340**	**160**	**500**
8	Audit Course	108	Indian Knowledge Systems - 1	4	0	0	0	0

- CC (Core Courses) - 1st Core Course is mandatory and 2nd & 3rd Core Courses Student can choose one from each code
- *SOC (Skill Oriented Courses) – Student can choose one from each code
- *Practical – I relating to 2nd & 3rd Core Courses and Practical - II relating to 1st & 2nd Skill Oriented Courses (SOC)
- Audit Course – Zero Credits but mandatary with only a Pass.

SEMESTER - II								
S. No	**Course**	**Code**	**Title of the Course**	**H/W**	**C**	**SE E**	**IA**	**Total Marks**
1	CC	201	Core course – 4: Microbial Genetics and Molecular Biology	4	4	70	30	100
2		202	Core Course – 5(A): Plant Virology / Core Course – 5(B): Biology of Virus Vectors and their management	4	3	50	25	75
3		203	Core Course – 6(A): Plant Virus Diseases / Core Course – 6(B): Tumor Virology	4	3	50	25	75
4	P	204	Practical III (related to CC 5 & 6)	6	2	35	15	50
5	SOC	205	Skill Oriented Course – 3(A): Immunology / Skill Oriented Course – 3(B): Molecular Techniques	4	3	50	25	75
6		206	Skill Oriented Course – 4(A): Recombinant DNA Technology / Skill Oriented Course – 4(B): Biostatistics and Bioinformatics	4	3	50	25	75
7	P	207	Practical IV (related to SOC 3 & 4)	6	2	35	15	50
8	OOTC	208	Open Online Transdisciplinary Course – 1	-	2	-	100	100
			Total	**36**	**22**	**340**	**260**	**600**
9	Audit Course	209	Indian Knowledge Systems - 2	4	0	0	0	0

- CC (Core Courses) – 4th Core Course is mandatory and 5th & 6th Core Courses Student can choose one
from each code
- *SOC (Skill Oriented Courses) – Student can choose one from each code
- *Practical - III relating to 5th & 6th Core Courses and Practical - IV relating to 3rd & 4th Skill Oriented Courses (SOC)
- *Open Online Transdisciplinary Course (OOTC) - Students can choose any relevant course of his / her choice from the online courses offered by governmental agencies like SWAYAM, NPTEL, etc.,
- Audit Course – Zero Credits but mandatary with only a Pass.

SEMESTER - III								
S. No	**Course**	**Code**	**Title of the Course**	**H/W**	**C**	**SEE**	**IA**	**Total Marks**
1	CC	301	Core course – 7: Animal and Human Virology	4	4	70	30	100
2		302	Core Course – 8(A): Molecular Virology Core Course – 8(B): Agricultural and Veterinary Viruses and their Management	4	3	50	25	75
3		303	Core Course – 9(A): Animal and Human Virus Diseases. Core Course – 9(B): Emerging and Re-emerging Virus Diseases	4	3	50	25	75
4	P	304	Practical V (related to CC 8 & 9)	6	2	35	15	50
5	SOC	305	Skill Oriented Course – 5(A): Applied Virology Skill Oriented Course – 5(B): Clinical Virology	4	3	50	25	75
6		306	Skill Oriented Course – 6(A): Industrial Biotechnology Skill Oriented Course – 6(B): Medical Lab Technology	4	3	50	25	75
7	P	307	Practical VI (related to SOC 5 & 6)	6	2	35	15	50
8	OOTC	308	Open Online Transdisciplinary Course – 2	-	2	-	100	100
			Total	**36**	**22**	**340**	**260**	**600**
*	Seminar / tutorials / remedial classes and Quiz as part of internal assessment			4	-	-	-	-

- CC (Core Courses) – 7th Core Course is mandatory and 8th & 9th Core Courses Student can choose one
from each code

- *SOC (Skill Oriented Courses) – Student can choose one from each code

- *Open Online Transdisciplinary Course (OOTC) - Students can choose any relevant course of his / her choice from the online courses offered by governmental agencies like SWAYAM, NPTEL, etc.,

- *Practical - V relating to 5th & 6th Core Courses and Practical - VI relating to 5th & 6th Skill Oriented Courses (SOC)

SEMESTER - IV								
S. No	**Course**	**Code**	**Title of the Course**	**H/W**	**C**	**SEE**	**IA**	**Total Marks**
1	***** OOSDC	401	Open Online Skill Development Courses	-	8	-	200	0
2	PW	402	Project Work – Orientation Classes	24	12	300	0	300
	Conducting classes for competitive exams, communication skills, UGC / CSIR and NET / SLET examinations			12	-	-	-	-
			Total	**36**	**20**	**300**	**200**	**500**
Total Semesters				**144**	**84**	**1320**	**880**	**2200**

● Open Online Skill Development Course (OOSDC) - Students can choose any **Two** relevant courses of his / her choice from the online courses offered by governmental agencies like SWAYAM, NPTEL, etc., **to get 8 credits (with 4 credits from each course)**

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SEMESTER-I
THEORY-VIR-101: CELL BIOLOGY AND TISSUE CULTURE (Mandatory)
(Core Course - 1)

Lecture: 4 hours/week	**Internal test Assessment: 30 Marks** **[Mid Semester Examination: 20 Marks; Attendance: 5 Marks; Students Seminar: 5 Marks]**
Tutorial: Textbooks, E-learning resources, study materials, Power Point lectures	**Total Marks: 100** **Semester End Theory Examination: 70 Marks**
Semester: I	**Credits: 4 Credits**

Course Educational Objectives (CEOs):

1. To understand the structure and contents of prokaryotic and eukaryotic cells, cell cycle and the concept of apoptosis and cancer.
2. To understand general principles and pathways of cell communication and cell signaling.
3. To describe the concepts and methodologies of and animal tissue and organ cultures, cell counting and introduction to stem cell cultures.
4. To describe the concepts and methodologies of plant tissue cultures and somatic hybridization.

UNIT–I

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

Cell cycle: Mitosis and meiosis, molecular events and regulation of cell cycle in eukaryotes, check points.

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; Three dimensional cultures - Organoids and histotypic cultures.

Cell counting: Hemocytometer, in situ localization (FISH), coulter counter; cell viability and cytotoxicity; dye exclusion and inclusion tests, clonogenic assay, MTT based assay.

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 (COs): At the end of the course, the student will be able to

CO1: Learn the structure and functions of prokaryotic and eukaryotic cell organelles.

CO2: Gain knowledge on general principles and pathways of cell communication and cell signaling.

CO3: Understand the concepts and methodologies of animal tissue and organ cultures, cell counting and introduction to stem cell cultures.

CO4: Understand the concepts and methodologies of plant tissue cultures

Learning Resources and Suggested books:

1. Molecular Biology of the Cell 7th Edition (2022) Alberts B Et al. Garland Science.
2. Cell Biology: A Short Cours 4th Edition (2016) Bolsover S et al. Wiley-Blackwell.
3. Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications 7th Edition (2016) Freshney R.I. Wiley-Blackwell.
4. Essential Cell Biology 5th Edition (2019) Alberts B Et al. Garland Science.
5. Cell and Tissue Culture: Laboratory Procedures 2nd Edition (2012) Doyle A et al. Wiley-Blackwell.
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. Molecular Cell Biology.6th edition (2006) Lodish, H., A. Berk, C. A. Kaiser, M. P.Scott. 6thEdn. Ploegh and Paul Matsudaria.

THEORY-VIR-102A: GENERAL MICROBIOLOGY

[Core Course – 2(A)]

Lecture: 4 hours/week	**Internal test Assessment: 25 Marks** **[Mid Semester Examination: 15 Marks; Attendance: 5 Marks; Students Seminar: 5 Marks]**
Tutorial: Textbooks, E-learning resources, study materials, PowerPoint lectures	**Total Marks: 75 Marks** **Semester End Theory Examination: 50 Marks**
Semester: I	**Credits: 3 Credits**

Course Educational Objectives:

1. To learn about pioneers in microbiology, different groups of microorganisms, microbial taxonomy and morphology, and structure of bacteria and distribution, morphology, Growth, and nutrition - Nutritional requirements of Actinomycetes and Fungi.
2. To learn the preparation of microbial media and its types, basic concepts of bacterial growth and methods used for microbial measurement, structure and importance of eukaryotic microorganism.
3. To gain knowledge on various methods used for isolation of microorganisms, preservation and maintenance of microbial cultures, physical, biochemical and molecular tests for microbial identification, and nutritional classification of bacteria.
4. To acquire knowledge about strategies used for control of microorganisms and microbial diseases.

UNIT–I

History and Evolution of Microbiology: Pioneers in microbiology, different groups of microorganisms, basics of microscopy.

Microbial taxonomy: General criteria for microbial classification- Hackel's three kingdom concept - Whittaker's five kingdom concept - the three-domain concept of Carl Woese, General characteristics of Archaea and Spirochetes.

Morphology and structure of bacteria: Morphological types, composition and properties of cell wall, spores, capsules and cell membranes; structure and function of flagella, cilia, pili; nucleoid, endospores, bacterial cell division.

UNIT-II

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

Microbial Growth: Bacterial growth curve, Batch, Synchronous growth, continuous, biphasic culturing, generation time, physical chemical and biological factors affecting growth; microbial growth measurement methods.

General characteristics of Eukaryotes: General properties, structure, and economic importance of fungi (*Saccharomyces*, *Asperigillus, Trichoderma*), Actinomycetes, Algae (*Chlorella,* Cyanobacteria).

UNIT-III

Isolation methods of microorganisms: Isolation /enumeration methods of microorganisms from different natural samples (streak plate, pour plate, spread plate, stab culture, slant culture, and hanging drop methods); Maintenance and preservation of microbial cultures -

Short-term

and long-term preservation methods; Physical, biochemical and molecular tests for microbial identification.

Microbial nutrition: Microbial nutrient requirements – macro-nutrients, micro-elements, growth factors; nutritional classification of bacteria - Phototroph, Chemotroph, Autotroph, Heterotroph, Photoautotroph, Photoheterotroph, Chemoautotroph, Chemoheterotroph, Saprophytes, Auxotroph.

UNIT-IV

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

Microbial Diseases: Normal microbiota, reservoirs of infections; Nosocomial infections, emerging infectious diseases, human diseases caused by bacteria (TB), fungi (Asperigillosis), protozoa (Malaria), parasitic helminths (Filariasis) of clinical importance.

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

CO1: Learn about pioneers in microbiology, different groups of microorganisms, microbial taxonomy and morphology, and structure of bacteria.

CO2: Understand the preparation of microbial media and its types, basic concepts of bacterial growth and methods used for microbial measurement, structure of important microorganisms.

CO3: Gain knowledge onvarious methods used for isolation of microorganisms, preservation and maintenance of microbial cultures, physical, biochemical and molecular tests for microbial identification, and nutritional classification of bacteria.

CO4: Acquire knowledge about strategies used for control of microorganisms and microbial diseases.

Learning Resources and Suggested Books:

1. Brock Biology of Microorganisms 16th Edition (2021) Madigan M.T et al. Pearson publishers.
2. Prescott's Microbiology 11th Edition (2022) Willey J.M. et al. McGraw-Hill Education.
3. Microbiology: An Introduction 13th Edition (2019) Tortora G.J. et al. Pearson publishers.
4. Microbiology: Principles and Explorations 10th Edition (2018) Black J.G. Wiley.
5. Microbiology, 3rd Edition (2017) Slonczewski J.L. et al. W.W. Norton & Company.
6. Foundations in Microbiology, (10th Edition) (2018) Kathleen Park Talaro and Barry Chess, Tata McGraw, India.

7. Microbiology, 10th Edition (2017) Lansing M Prescott, Donald A Klein, John P Harley, Mc Graw Hill publisher.

8. Microbiology and Parasitology (2016) B. S. Nagoba, Elsevier Health Sciences.

9. Textbook of Microbiology (2016) R. Ananthanarayan, Orient Blacksman publications.

10. Textbook of Microbiology, (2013) Dubey RC, Maheswari DK S. Chand & Co.

11. Microbiology, 8th Edition International Student Version Jacquelyn G. Black (Marymount University) (2012), Wiley publication.

12. Understanding Microbes: An Introduction to a Small World Jeremy W. Dale (2012), Wiley-Blackwell.

13. Microbiology, 7th Edition (2009) Michael J Pelczar, Microbiology, Tata McGraw, India.

14. Advances in Applied Microbiology. (2007) Wayne W. Umbreit and D. Pearlman. Academic Press

15. Molecular Microbiology: Diagnostic Principles and Practice (2004) Persing DH, Tenover FC, Versalovic J, eds. American Society for Microbiology Press.

(OR)

THEORY-VIR-102B: VIRUSES OF MICROORGANISMS

[Core Course - 2(B)]

Lecture: 4 hours/week	**Internal test Assessment: 25 Marks** **[Mid Semester Examination: 15 Marks; Attendance: 5 Marks; Students Seminar: 5 Marks]**
Tutorial: Textbooks, E-learning resources, study materials, PowerPoint lectures	**Total Marks: 75 Marks** **Semester End Theory Examination: 50 Marks**
Semester: I	**Credits: 3 Credits**

Course Educational Objectives:

1. To understand the isolation, propagation assay of bacteriophages and purification and characterization, nomenclature, classification and applications of bacteriophages of prokaryotes and to learn about biology of bacteriophages of enterobacteria.
2. To learn the biology of phages of certain important bacteria, cyanobacteria, mycoplasmas and archaea.
3. To gain knowledge on biology of viruses infecting eukaryotic microorganism such as fungus and yeast.

4. To acquire knowledge about biology of viruses infecting higher fungi, algae and protozoan parasites.

UNIT-I

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

Biology of bacteriophages of enterobacteria (dsDNA phages – T_2, T_4, T_7, lambda, Mu, P_1, P_{22}, PRD. ssDNA phages – øx-174, M_{13}, f_1, fd. ssRNA phages-MS_2, f_2, Qβ, R_{17})

UNIT-II

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

Phages of cyanobacteria: *Podoviridae* – A-4(L), Ac-1, LPP-1, SM-1.

Myoviridae-AS-1, N1, S-6(L)

Siphoviridae-S-2L, S-4L

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

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

UNIT-III

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

Viruses of yeasts:

Sacchromyces cerevisiae – *Totiviridae:* ScV-L-A, ScV-L-B6,

Narnaviridae: ScNV-20S, ScNV-23S.

Pseudoviriae: SceTY1V, SceTY2V, SceTY3V.

Metaviridae: SceTY3V.

Schizosaccharomyces pombe viruses

UNIT-IV

Viruses of higher fungi:

Penicillium spp.- *P. chrysogenum* virus (PcV), *P. stolanigerum* (PsV).

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

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

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

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

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

CO1: Know how the isolation, propagation assay of bacteriophages and purification and characterization, nomenclature, classification and applications of bacteriophages of prokaryotes and to learn about biology of bacteriophages of enterobacteria.

CO2: Learn the biology of phages of certain important bacteria, cyanobacteria, mycoplasmas and archaea.

CO3: Gain knowledge on biology of viruses infecting eukaryotic microorganism such as fungus and yeast.

CO4: Acquire knowledge about biology of viruses infecting higher fungi, algae and protozoan parasites.

Learning Resources and Suggested books:

1. Principles of Virology: Molecular Biology, Pathogenesis, and Control 5th Edition (2024) Flint S.J. et al. ASM Press.
2. Viruses of Microorganisms 1st Edition (2012) Kurtböke D.I et al. Academic Press.
3. Bacteriophages: Biology and Applications 1st Edition (2004) Kutter E. et al. CRC Press.
4. Introduction to Modern Virology 7th Edition (2016) Dimmock N.J et al. Wiley-Blackwell.
5. The Bacteriophages 2nd Edition (2006) Calendar R. Oxford University PressViruses of prokaryotes. Vol. 1 and 2. 1987. Auckermann. H.W. and Du Bow, M.S. CRC press.
6. Encyclopedia of Virology. 1999. 2nd Edition. Vol. 1, 2, 3. Webster, R.G. and Granoff, A. (Eds). Academic Press.

7. Viruses of Fungi and Simple Eukaryotes. 1988. By. Y. Koltin and M. Leibowitz. Mareed Dekker.

8. Viruses of Protozoa. 1991. By T.C. White and C.C. Wang. Ann. Rev. Microb. 45: 251- 263.

9. Fungal Virology. 1986. By Buck, K.W. (Ed). CRC Press.

10. Phycodnaviridae-Large DNA algal viruses. 2002. By Van Etten et al.. Archives of Virology. 147: 1479-1516.

11. Bacteriophages. H.W. Auckerman. 2004. In: The desk top encyclopedia of microbiology. Schaechter.M. (ed). Elsevier, Academic Press.

THEORY-VIR-103A: BIOCHEMISTRY

[Core Course - 3(A)]

Lecture: 4 hours/week	**Internal test Assessment: 25 Marks** **[Mid Semester Examination: 15 Marks; Attendance: 5 Marks; Students Seminar: 5 Marks]**
Tutorial: Textbooks, E-learning resources, study materials, PowerPoint lectures	**Total Marks: 75 Marks** **Semester End Theory Examination: 50 Marks**
Semester: I	**Credits: 3 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 (carbohydrates and lipids),
2. To learn, the classification, structure, properties and functions of proteins classification and mechanism of action of enzymes and enzyme 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; properties of carbon bond, stabilizing forces of biomolecules- covalent and non-covalent bonds; electron transfer and oxidation/reduction; functional groups of organic

compounds; P^H of biological systems and physiological buffer systems; normality, molarity of the solutions.

Carbohydrates: Classification of carbohydrates; structure and properties of important mono, di-, and oligosaccharides and structural polysaccharides (cellulose, chitin, agar, pectins, proteoglycans, sialic acids).

Lipids: Classification of fatty acids, lipids - Nomenclature, structures, functions, and physicochemical properties of glycerides, neutral lipids (waxes, fats, oils), phospholipids, sphingolipids and glycolipids; steroids- plant sterol, ergosterol; cholesterol; lipoproteins.

UNIT-II

Amino acids and Peptides: Classification, structure, physicochemical and properties Characteristics of peptide bond.

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

Catalytic proteins (enzymes): Classification, nomenclature, composition and structures, enzymes as biocatalysts, 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: Structure, properties and functions of nitrogenous bases, nucleosides, nucleotides and polynucleotides; Types and composition of nucleic acids, denaturation and renaturation of nucleic acids.

Hormones: Classification of hormones and their functions.

Vitamins: Classification (fat soluble (ADEK) and water soluble (B complex and C), 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: Glycolysis, TCA and ETC.

Lipid metabolism: Overview of lipid metabolism (synthesis of triacylglycerides).

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

Nucleotide metabolism: Biosynthesis of nucleotides and deoxyribonucleotides.

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 proteins and use this knowledge to compete for UGC-CSIR-NET, GATE, APSET and other scientific examinations

Learning Resources and Suggested Books:

1. Biochemistry 8th Edition (2023) Berg J.M.et al. Macmillan Learning.
2. Lehninger Principles of Biochemistry 8th Edition (2021) Nelson D.L. et al. W.H. Freeman.
3. Biochemistry: A Short Course 3rd Edition (2022) Berg J.M. et al. W.H. Freeman.
4. Biochemistry 4th Edition (2020) Berg J.M. et al. Macmillan Learning.
5. Principles of Biochemistry 5th Edition (2018) Nelson D.L. et al. W.H. Freeman.
6. Medical Biochemistry, (2018) John W Baynes, Marek H. Dominiczak, Hab Med FRCPath, 5th Edition, 712 pages, Publisher: Elsevier.
7. Biochemistry (2017) by Roger L. Miesfeld, Megan M. McEvoy(First Edition) , Publisher: W. W. Norton & Company.
8. Marks' Basic Medical Biochemistry, A Clinical Approach, (2017) Michael Lieberman, Alisa Peet MD, Publisher: LWW; Fifth, North American edition.
9. Fundamentals of Biochemistry: Life at the Molecular Level. (2016) Donald Voet, J. G. Voet et al.
10. Biochemistry, (2001) Stryer 5th edition, W.H. Freeman,
11. Principles of Biochemistry, (2000) Lehninger, 3rd edition by Nelson and Cox (Worth).

12. NMS Biochemistry 4th edition (1999) Victor L. Davidson and Donald B Sittman.

13. Microbial Physiology (1999), 3rd ed. by A.G. Moat & J.W. Foster, Wiley- Liss.

14. Microbial Physiology and Metabolism. (1995), by D.R. Caldwell. WM.C. Brown Publ.

15. Physical Biochemistry: Applications to Biochemistry and Molecular Biology (1982), 2nd ed. by David Freifelder. W.H. Freeman and Company.

16. Schaum's Outline of Biochemistry, Philip Kuchel, Simon Easterbrook-Smith, Vanessa Gysbers, Third Edition (Schaum's Outlines) 3rd Edition.

(OR)

VIR-103B: MICROBIAL PHYSIOLOGY AND METABOLISM

[Core Course - 3(B)]

Lecture: 4 hours/week	**Internal test Assessment: 25 Marks** **[Mid Semester Examination: 15 Marks; Attendance: 5 Marks; Students Seminar: 5 Marks]**
Tutorial: Textbooks, E-learning resources, study materials, PowerPoint lectures	**Total Marks: 75 Marks** **Semester End Theory Examination: 50 Marks**
Semester: I	**Credits: 3 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 metabolism of 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 of microbial growth characteristics metabolism of growth and microbial photosynthesis.

CO3: Gain knowledge on the general criteria for microbial metabolism of carbohydrates, aerobic and anaerobic respiration.

CO4: Understand the lipid, protein, nitrogen nucleotide metabolism of microorganisms.

Learning Resources and Suggested Books:

1. Microbial Physiology 3rd Edition (2019) Stanier R.Y. et al. ASM Press.
2. Microbial Metabolism 2nd Edition (2018) Schlegel H.G. Wiley-VCH.
3. Fundamentals of Microbial Physiology and Metabolism 1st Edition (2020) Engel P. et al. Springer.
4. Bacterial Metabolism 2nd Edition (2017) Bender K.S. et al. McGraw-Hill Education.
5. Moat A G., Foster J W., 2009.Spector M P. Microbial Physiology, 4th Ed: Wiley India Pvt
6. 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.
7. James Darnell, Molecular Cell Biology, 6th Edition, W. H. Freeman & Co, 2007.
8. Microbial Physiology and Metabolism. 1995, by D.R. Caldwell. Wm.C. Brown Publ.
9. Microbial Physiology. 1999, 3rd ed. by A.G. Moat & J.W. Foster.Wiley- Liss.
10. Principles of Biochemistry. Lininger. 2000.
11. Foundations in Microbiology. 1996. By K. Talaro & A. Talaro, Wm. C. Brown Publ.
12. Microbiology. 2000. By Prescott et al. Wm. C. Brown Publ.

PRACTICAL-I-VIR-104A: GENERAL MICROBIOLOGY & BIOCHEMISTRY
[Practical related to CC 2(A) & 3(A)]

Lecture: 6 hours/week	**Internal Assessment: 15 Marks**
Tutorial: Lab manuals, E-learning resources, textbooks and study materials	**Total Marks: 50 Marks** **Semester End Theory Examination: 35 Marks**
Semester: I	**Credits: 2 Credits**

Course Educational Objectives:

1. To learn the various methods of optimization of cultural conditions for bacterial and fungal growth.
2. To isolate nucleic acids from bacteria and fungi, know how microbial staining techniques and antibiotic assay methods.

3. To estimate carbohydrates, nucleic acids, amino acids, proteins and glucose using qualitative and quantitative tests.
4. To estimate bilirubin, and inorganic phosphorus using qualitative and quantitative tests and to determine the activity of enzymes.

List of Experiments: (General Microbiology)

1. Sterilization, disinfection, safety in microbiological laboratory (theory exercise)
2. Fumigation and surface sterilization methods (Theory exercise).
3. Preparation of media for cultivation of microorganisms.
4. Enumeration of microorganisms from soil and water.
5. Plating techniques- streak, pour and spread plate methods
6. Bacterial staining techniques: Simple, Gram and spore staining
7. Lactophenol-cotton blue staining for fungi.
8. Hanging drop method for bacterial motility.
9. Determination of bacterial growth curve.
10. Effect of pH, temperature and salt on bacterial growth.
11. Antibiotic sensitivity assay – Disc and Well diffusion method
12. Isolation of microbial mutants by gradient plate and replica plate method.

Learning Resources and Suggested Books/Manuals:

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

List of Experiments: (Biochemistry)

1. Calculation of normality, molarity, molecular weight and percentage of chemical substances (Theory exercise).
2. Preparation of reagents and buffers (Theory exercise).
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 cholesterol.
10. Isolation and assay of an enzyme (amylase or phosphorylase) from potato extract.

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. 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.

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

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

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

CO3: Learn to 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.

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

(Or)

PRACTICAL-I-VIR-104B: VIRUSES OF MICROORGANISMS & MICROBIAL PHYSIOLOGY AND METABOLISM

[Practical related to CC 2(B) & 3(B)]

Lecture: 6 hours/week	**Internal test Assessment: 15 Marks**
Tutorial: Textbooks, E-learning resources, study materials, PowerPoint lectures	**Total Marks: 50 Marks** **Semester End Practical Examination: 35 Marks**
Semester: I	**Credits: 2 Credits**

Course Educational Objectives:

1. To learn about preparation of media and enumeration methods, plating techniques, and staining methods for microorganisms.
2. To isolate viruses infecting microorganisms such as bacteria, fungi and algae from various sources.
3. To learn the various methods of optimization of conditions for bacterial, fungal and algal growth and their staining techniques.
4. To understand the technologies used for isolation of bacteriophages and

List of Experiments: (Viruses of Microorganisms)

1. Classification of bacteriophages (Theory exercise).
2. Preparation of media for cultivation of microorganisms.
3. Enumeration of microorganisms from soil and water
4. Plating techniques- streak plate, pour and spread plate methods
5. Bacterial staining techniques: Simple, Gram and spore staining
6. Lactophenol-cotton blue staining for fungi.
7. Hanging drop method for bacterial motility.
8. Isolation of bacteriophages from sewage water.
9. Isolation of viruses from water algae.
10. Isolation of viruses infecting fungi.

Learning Resources and Suggested Books/Manuals:

1. Diagnostic Microbiology. 11th Edition. (2002). By B.A. Forbes et al., Mosby publisher
2. Practical Microbiology, (2002) by R.C. Dubey and D.K. Maheshwari.

3. Laboratory Manual in Microbiology, (2000). By P. Gunasekaran
4. Microbiological Applications: Laboratory Manual in General Microbiology, 7th ed. by J. Benson.
5. Microbiology: A Laboratory Manual. 4th edition. By J.G. Cappuccino and N. Sherman.
6. Experiments in Microbiology, Plant Pathology, Tissue culture, and Mushroom cultivation. 3rd edition by K.R. Aneja.
7. Laboratory Experiments in Microbiology by Johnson.
8. Laboratory Manual in Microbiology by Alcamo.

List of Experiments: (Microbial Physiology and Metabolism)

1. Bacterial Motility demonstration by hanging method.
2. Bacterial staining by smear preparation, permanent specimen preparation.
3. Capsular staining for bacteria.
4. Determination of bacterial growth curve.
5. Anaerobic cultivation of bacteria.
6. Demonstration of yeast, and fungal filaments by Micrometry.
7. Morphological characteristics of bacteria.
8. Microscopic observation of fungi.
9. Determination of catalase activity.
10. Determination of urease activity.
11. Demonstration of carbohydrate fermentation test.
12. Determine the antibiotic sensitivity test by disc diffusion method.

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

CO1: Learn the various methods of isolation, optimization of cultural conditions for bacterial, fungal and algal growth and their staining techniques.

CO2: Isolate viruses infecting microorganisms such as bacteria, fungi and algae from various sources.

CO3: Understand cultivation, staining and characterization methods for different microorganisms.

CO4: Determine enzyme activities from microbial sources and biochemical characterization of microbes and learn the antibiotic assay methods.

Learning Resources and Suggested Books/Manuals:

1. Diagnostic Microbiology. 11th Edition. (2002). By B.A. Forbes et al., Mosby publisher
2. Practical Microbiology, (2002) by R.C. Dubey and D.K. Maheshwari..
3. Laboratory Manual in Microbiology, (2000). By P. Gunasekaran
4. Microbiological Applications: Laboratory Manual in General Microbiology, 7th ed. by J. Benson.
5. Microbiology: A Laboratory Manual. 4th edition. By J.G. Cappuccino and N. Sherman.
6. Experiments in Microbiology, Plant Pathology, Tissue culture and Mushroom cultivation. 3rdedition.By K.R. Aneja.
7. Laboratory Experiments in Microbiology by Johnson.
8. Laboratory Manual in Microbiology by Alcamo.

THEORY-VIR-105A: BASIC VIROLOGY

[Skill Oriented Course - 1(A)]

Lecture: 4 hours/week	**Internal test Assessment: 25 Marks** **[Mid Semester Examination: 15 Marks; Attendance: 5 Marks; Students Seminar: 5 Marks]**
Tutorial: Textbooks, E-learning resources, study materials, PowerPoint lectures	**Semester End Theory Examination: 50 Marks** **Total Marks: 75 Marks**
Semester: I	**Credits: 3 Credits**

Course Educational Objectives:

1. To understand the history, properties, nomenclature and classification of viruses and general morphology and properties of viruses.
2. To learn about methods used for isolation, cultivation, assay, purification and transmission of viruses.
3. To know how 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.

Nomenclature and classification of viruses: Criteria used for naming and classification, Current ICTV classification of viruses.

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

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

UNIT - II

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

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.

UNIT-III

Purification of viruses: Extraction, clarification, and concentration of viruses 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.

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

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

UNIT-IV

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

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: Define biological, 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 the biology 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. Fields Virology 7th Edition (2023) Fields B.N et al. Williams & Wilkins.
2. Virology: Principles and Applications 1st Edition (2020) Simmonds P et al. Wiley-Blackwell.
3. Basic Virology 3rd Edition (2019) Racaniello V.R. Wiley-Blackwell.
4. Principles of Virology: Molecular Biology, Pathogenesis, and Control 5th Edition (2024) Flint S.J et al. ASM Press.
5. Medical Microbiology and Infection at a Glance 2nd Edition (2020) Kesson C et al. Wiley-Blackwell.
6. Introduction to Modern Virology. (2001). 5th ed. Dimmock et al., Blackwell Sci. Publ.
7. Plant Virology. (2001). 4th edi. By R. Hull. Academic Press.
8. Fundamental Virology, 4th ed. (2001). D.M. Knipe and P.M. Howley.
9. Principles of Virology: (2000). by S.J. Flint et al., ASM Press.
10. Basic Virology, (1999). By Waginer and Hewelett, Black Well Science Publ.
11. Veterinary Virology. 3rd ed. (1999). Murphy et al., Academic Press.
12. Principles of Molecular Virology. (1997). 2nded. A. Cann. Academic Press.
13. Medical Virology. (1994). 4th edition. D.O. White and F.J. Fenner. Academic Press. Plant Virology. (2001). 4thed. By R. Hull. Academic Press.
14. 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.
15. Principles of Molecular Virology. (1997). 2nded. A. Cann. Academic Press.
16. Virology: (1994). 3rded. Frankel Conrat et al, Prentice Hall.

(OR)

THEORY-VIR-105B: FOOD AND ENVIRONMENTAL BIOTECHNOLOGY

[Skill Oriented Course - 1(B)]

Lecture: 4 hours/week	**Internal test Assessment: 25 Marks** **[Mid Semester Examination: 15 Marks; Attendance: 5 Marks; Students Seminar: 5 Marks]**
Tutorial: Textbooks, E-learning resources, study materials, PowerPoint lectures	**Total Marks: 75 Marks** **Semester End Theory Examination: 50 Marks**
Semester: I	**Credits: 3 Credits**

Course Educational Objectives:

1. To acquire the knowledge on the role of microbes in food, nutraceuticals 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 anti-obesity molecules 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

Pollution Control Biotechnology: 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

Bio-sorption of Heavy Metals: Metal binding targets and organisms, metal-microbial interactions, bio methylation of elements, commercial bio sorbents, 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, nutraceuticals, 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 Biotechnology: Principles and Applications 2nd Edition (2023) R. H. Jay et al. Wiley-Blackwell.
2. Environmental Biotechnology: Principles and Applications 3rd Edition (2020) S. K. S. Bhattacharya et al. Wiley.
3. Biotechnology for Sustainable Food Production and Food Safety 1st Edition, (2023) D. V. S. S. S. P. S. Kumar et al. Springer.
4. Food Biotechnology: Emerging Technologies 2nd Edition (2022) R. K. Gupta et al. CRC Press.
5. Environmental Biotechnology: Theory and Applications 2nd Edition (2021) M. G. K. Hegde et al. Springer.
6. Food Microbiology by William C Frazier. Tata Mgraw Hill

7. Food Microbiology by dams and Moss. Springer Verlag
8. Basic Food Microbiology by Banwart. Cbs Publishers & Distributors Pvt Ltd.
9. Fundamental Principles of Bacteriology A J Salle
10. Hobbs, B.C. and Rioberts,D 1993 Food Poisoning and Food Hygiene Edward Anold, London.
11. Hui Y H 2006 Food Biochemistry and Food Processing Blackwell.
12. J oshi, V.K. Ashok Pondey 1999 Biotechnology and Food Fermentation Vol. I & II.
13. Bioremediation (1994) Baker, K.H and Herson, D.S.McGraw Hill, Inc. New York
14. Biotreatment of Industrial & Hazardous Waste (1993) M.V.Levin and Gealt, M.A McGraw Hill. Inc
15. Concepts and Techniques of Geographic Information Systems (2009) C.P.Lo.Albert and K.W.Yeung 2nd.
16. Ecology and environmental biology (2011) Saha T K Books & Allied (p) Ltd edition, Prentice Hall, Inc.
17. Environment Impact Assessment (1996) Larry W. Canter McGraw-Hill Book Company.
18. Environmental Audit (2002) Mhaskar A.K. Enviro Media Publications
19. Environmental Biology (2000) Varma&Agarwal S. Chand Limited
20. Environmental biotechnology (2010) RanaRastogi Publications.
21. Environmental Protection and Laws (1995) Jadhav and Bhosale V.M.Himalaya publishing House.

THEORY-VIR-106A: ANALYTICAL TECHNIQUES

[Skill Oriented Course - 2(A)]

Lecture: 4 hours/week	**Internal test Assessment: 25 Marks** **[Mid Semester Examination: 15 Marks; Attendance: 5 Marks; Students Seminar: 5 Marks]**
Tutorial: Textbooks, E-learning resources, study materials, PowerPoint lectures	**Total Marks: 75 Marks** **Semester End Theory Examination: 50 Marks**
Semester: I	**Credits: 3 Credits**

Course Educational Objectives:

1. To understand the approaches involved in characterization and concentration of biomolecules and to train students in adopting various techniques involved in biological research such as microscopy.

2. To understand the approaches involved in chromatographic, centrifugal, and electrophoretic techniques.
3. To learn about various radioisotopes, spectroscopy and cell counting techniques that are used for characterization of biomolecules.
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, membrane filtration and their applications.

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

UNIT-II

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

Centrifugation: sedimentation analysis; Theory and applications of preparative and analytical centrifugation and rotors (differential, rate zonal and equilibrium density gradient).

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

UNIT-III

Radioisotope techniques: Nature and types of radioactivity, half-life of radioisotopes, detection and measurement of different types of radioisotopes, 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 applications of UV-visible, IR, ESR, NMR, Fourier transform infrared spectroscopy (FTIR), MALDI-TOF mass spectrophotometry; fluorimetry, CD; X-ray diffraction, X-ray crystallography and surface plasmon resonance.

UNIT-IV

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

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

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

Analysis: Introduction to correlation analysis and regression analysis.

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

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

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

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

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

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

CO4: Learn the basic concepts and methods of statistics and apply them to Virology related research experiments or investigations involving statistical data and use the obtained theoretical knowledge on analytical techniques to conduct research or to foster employability in national and international biotech/pharma industries/ research or educational institutes, to grab the opportunities for higher education in national and international institutes and to compete for UGC-CSIR-NET, GATE, APSET, AP RCET and other competitive examinations.

Learning Recourses and Suggested books:

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

5. Discovering Statistics Using SPSS. Andy Field. Latest edition (2005). Publisher: SAGE Publications.

6. Basic and Clinical Biostatistics. Beth Dawson, Robert G. Trapp, Robert Trapp. Latest edition. (2004).

7. Jerrold H.Zar. (2010). Bio-Statistical Analysis. 5th edition, New Jersey, Prentice Hall.

8. Gupta, S.C. (2010). Fundamentals of Statistics. Himalayan Publishers

9. Arora, P.N. Sumeet Arora & S. Arora (2007). Comprehensive Statistical Methods. S. Chand & Company, New Delhi.

10. Misra, B.N. & M.K. Misra (1998). Introductory Practical Biostatistics. Naya Prakash, Kolkata

(OR)

THEORY-VIR-106B: NANOBIOTECHNOLOGY

[Skill Oriented Course - 6(B)]

Lecture: 4 hours/week	**Internal test Assessment: 25 Marks** **[Mid Semester Examination: 15 Marks; Attendance: 5 Marks; Students Seminar: 5 Marks]**
Tutorial: Textbooks, E-learning resources, study materials, PowerPoint lectures	**Total Marks: 75 Marks** **Semester End Theory Examination: 50 Marks**
Semester: I	**Credits: 3 Credits**

Course Educational Objectives:

1. To analyze nanomaterials based on the understanding of nanobiotechnology.
2. To learn the methods of fabrication of nanomaterials.
3. To gain Knowledge on characterization of nanomaterials.
4. To learn and discover nanomaterials for targeted drug delivery and other applications.

UNIT-I

Nanobiotechnology - Introduction to Nano biotechnology, Classification of nanomaterials based on their dimensions and the realization of their applications (The First, second, third, and fourth generation materials); Class of nanomaterials and their applications; Need for nanomaterials and the risks associated with the materials.

UNIT-II

Fabrication of Nanomaterials-Top-down and Bottom-up approaches, Solid phase synthesis-milling, Liquid phase Synthesis-Sol-gel synthesis, colloidal synthesis, microemulsion method, hydrothermal synthesis and solve thermal synthesis, Vapor/Gas phase synthesis-Inert gas condensation, flame pyrolysis, Laser ablation, and plasma synthesis techniques. Microbial synthesis of nanoparticles.

UNIT-III

Characterization of nanoparticles - Based on particle size/morphology- Dynamic light scattering (DLS), Scanning electron microscopy (SEM), Transmission electron microscopy (TEM), Atomic force microscopy (AFM), Based on surface charge-zeta potential, Based on structure –X-ray diffraction (XRD), Fourier transform infrared spectroscopy (FTIR), Energy dispersive X-ray analysis (EDX), Based on optical properties- UV – Spectrophotometer, Based on magnetic properties-Vibrating sample magnetometer(VSM).

UNIT-IV

Nanomaterial Drug delivery and therapeutics-surface modified nanoparticles, MEMS/NEMS-based devices, peptide/DNA coupled nanoparticles, lipid and inorganic nanoparticles for drug delivery, metal/metal oxide nanoparticles as antibacterial, antifungal, and antiviral agents - toxicity of nanoparticles and toxicity evaluation; application of nanoparticles in science and technology.

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

CO1: Employ knowledge in the field of nanobiotechnology for development.

CO2: Identify various techniques for the synthesis of nanomaterials.

CO3: Examine the characterization of NPs and their significance in nanobiotechnology.

CO4: Identify recent advances and applications in nanotechnology area and create a career or pursue research in the field.

Learning Recourses and Suggested books:

1. Nanobiotechnology: concepts, applications and perspectives.1st edition (2004) M. Niemeyer et al. Wiley Publishers.
2. Nanobiotechnology II: more concepts and applications.1st edition (2007) M. Niemeyer and Chad A. Mirkin. Wiley Publishers.
3. Nanotechnology for biology and medicine: at the building block level 1st edition (2012) Gabriel A. Siova and Vladislav V. Yakovlev. Springer publisher.
4. Nanomedicine: principle and perspectives.1st edition (2005) by Vladimir P.Torchilin. Springer publisher.

5. Biotechnology: Lessons from Nature.1st edition (2004) by David S. Goodshell. Wiley publisher.
6. Introduction to Nanoscience and Nanotechnology. 1st edition (2010) by Chris Binns. Wiley publisher.
7. Nanobiotechnology: Principles and practices. 1st edition (2010) by C.M. Niemeyer, Wiley publisher.
8. Brydson R. M., Hammond, C. (2005). Generic Methodologies for Nanotechnology: Characterization. In Nanoscale Science and Technology. John Wiley & Sons, Ltd
9. Leggett G. J., Jones R. A. L. (2005). Bionanotechnology. In Nanoscale Science and Technology. John Wiley & Sons, Ltd.
10. Mohan Kumar G. (2016). Nanotechnology: Nanomaterials and nanodevices. Narosa Publishing House.
11. Sharon M. and Maheshwar (2012). Bio-Nanotechnology: Concepts and Applications. New Delhi. Ane books Pvt Ltd.
12. Reisner, D.E. (2009). Bionanotechnology: Global Prospects. CRC Press
13. Pradeep T. (2007). Nano: The Essentials-Understanding nanoscience and nanotechnology. Tata McGraw-Hill.
14. Nouailhat A. (2008). An Introduction to Nanoscience and Nanotechnology, Wiley.
15. Niemeyer C.M. and Mirkin C. A. (2005). Nanobiotechnology. Wiley Interscience.
16. Goodsell D. S. (2004). Bionanotechnology. John Wiley & Sons, Inc. Rehm, B.

PRACTICAL-II-VIR-107A: BASIC VIROLOGY & ANALYTICAL TECHNIQUES

[Practical related to CC5(A) & 6(A)]

Lecture: 6 hours/week	**Internal Assessment: 15 Marks**
Tutorial: Lab manuals, E-learning resources, textbooks and study materials	**Total Marks: 50 Marks** **Semester End Theory Examination: 35 Marks**
Semester: I	**Credits: 2 Credits**

Course Educational Objectives:

1. To demonstrate the practical skills in isolation of bacteriophages, cultivation of viruses in embryonated eggs and plants
2. To demonstrate transmission of plant viruses by mechanical means, graft and vector and to check the stability of plant viruses.
3. 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.
4. To knowhow to analyze proteins and nucleic acids using SDS-PAGE and agarose gel electrophoresis respectively.

List of Experiments: (Analytical Techniques)

1. Laboratory equipment and their maintenance (Theory exercise).
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. Preparation of virus sample for coating onto EM grids and observing under TEM (demo).
9. Separation of leaf or virus proteins by SDS-PAGE.
10. Separation of DNA by submarine agarose gel electrophoresis.
11. Isolation of chloroplasts by sucrose density gradient centrifugation (demo).

Learning Resources and Suggested Books/Manuals:

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

List of Experiments (Basic Virology)

1. Cultivation of viruses in embryonated eggs: different routes of inoculation.
2. Mechanical transmission of plant virus
3. Aphid transmission of plant virus (demo)
4. Graft transmission of plant virus.
5. Effect of abrasives on plant virus infection.
6. Determination of thermal inactivation point (TIP) of plant virus
7. Determination of dilution end point (DEP) of plant virus
8. Determination of longevity *in vitro* (LIV) of plant virus
9. Determination of chlorophylls in healthy and virus infected leaves.
10. Isolation of bacteriophages from sewage water.

Learning Resources and Suggested Books/Manuals:

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

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

CO1: Learn to isolate bacteriophages from different sources and cultivate viruses in embryonated eggs and plants.

CO2: 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.

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

CO4: Acquire the skills to use spectroscopic and centrifugal methods for characterization of biomolecules and use the obtained practical knowledge and skills in basic virology and analytical techniques to conduct research or to foster employability in national and international biotech/pharma industries/ research or educational institutes and to grab the opportunities for higher education in national and international institutes.

(OR)

PRACTICAL-II-VIR-107B: FOOD AND ENVIRONMENTAL BIOTECHNOLOGY & NANOBIOTECHNOLOGY

[Practical related to CC5(B) & 6(B)]

Lecture: 6 hours/week	**Internal test Assessment: 15 Marks**
Tutorial: Textbooks, E-learning resources, study materials, PowerPoint lectures	**Total Marks: 50 Marks** **Semester End Practical Examination: 35 Marks**
Semester: I	**Credits: 2 Credits**

Course Educational Objectives:

1. To analyze the quality of water, milk and food and to estimate vitamins and aflatoxins, pesticide residues in food.
2. To learn about production of bofertilisers and biopesticides and biodegradation of pesticides and checking the quality of water by various methods.
3. To synthesize silver nanoparticles from green plants and to characterize them using various analytical techniques.
4. To test the antibacterial, antifungal, antioxidant and biocatalytic activities of silver nanoparticles.

List of Experiments: (Food and Environmental Biotechnology)

1. Qualitative and quantitative analysis of carbohydrates and proteins in food.
2. Preparation and evaluation of cheese or fermented product.
3. Determination of fat content in milk
4. Estimation of vitamins- vitamin A, C and riboflavin.
5. Determination of aflatoxin in food.
6. Tests for pesticide residues in food
7. Biomass estimation by different methods
8. Isolation of microbes involved in preparation of biofertilizers by biological enrichment method.
9. Production of microbial biofertilizers and biopesticides.
10. Efficacy testing for biofertilizers (nodulation test for rhizobia) and biopesticides.
11. Qualitative and quantitative estimation of biodegradation of pesticide/ insecticide/fungicide.
12. Estimation of BOD & COD.

13. Testing for microbiological quality of potable water (Coli form test)
14. Microbial degradation of organic matter.
15. Visiting local food industries, biopesticide manufacturing forms in agricultural research stations.

Learning Resources and Suggested Books/Manuals:

1. Swaminathan M.S. Dr. Hand Book of Food and Nutrition
2. Sumati R. Mudambi and M.V, Rajgopal. Fundamentals of Food and Nutrition.
3. Nutrient Requirements and Recommended Dietary Allowances for Indians. National Instituteof Nutrition, Indian Council of Medical Research, 2010
4. 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.
5. Fennema, O.R. Ed. 1976. Principles of Food Science: Part-I Food Chemistry. MarcelDekker,New York 7
6. Meyer, L.H. 1973. Food Chemistry. East-West Press Pvt. Ltd., New Delhi
7. Potter, N.N. 1978. Food Science. 3rd Ed. AVI, Westport
8. Fellows, P. and Ellis H. 1990. Food Processing Technology: Principles and Practice, NewYork
9. Jelen, P. 1985. Introduction to Food Processing. Prentice Hall, Reston Virginia, USA
10. Lewis, M.J. 1990. Physical Properties of Food and Food Processing Systems.Woodhead
11. 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
12. Joshi, V.K. and Pandey, A. Ed. 1999. Biotechnology.Food Fermentation, (2 Vol. set). Education Publ. New Delhi
13. R.A Garg: The Food Safety and Standard Act, 2006 along with Rules and regulation (2011) Commercial Law Publisher (India) Pvt. Ltd

List of Experiments (Nano Biotechnology)

1. Introduction to Nanolab and standard solution preparation,
2. Synthesis of silver nanoparticles from plant material
3. Biological synthesis of Silver Nanoparticles from Microorganisms
4. Study the color change of nanoparticles using UV -Vis absorption spectroscopy

5. Preparation of metal oxide ZnO nanoparticles and observe its luminescence under UV lamp
6. Nanoparticle imaging for size Scanning Electron Microscope (SEM) characterizing nanoparticles
7. Determination of Antibacterial activity of silver nanoparticles
8. Determination of Antifungal activity of silver nanoparticles
9. Antioxidant activity of silver nanoparticles
10. Biocatalytic (dye decolorization) properties of silver nanoparticle

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

CO1: Learn preparation of fermented food products, analyse the quality of water, milk and food, vitamins.

CO2: Acquire the practical skills in the production of bofertilisers and biopesticides and biodegradation of pesticides.

CO3: Synthesize silver nanoparticles from green plants and to characterize them using various analytical techniques.

CO4: Test the antibacterial, antifungal, antioxidant and biocatalytic activities of silver nanoparticles.

Learning Resources and Suggested Books/Manuals:

1. Brydson R. M., Hammond, C. (2005). Generic Methodologies for Nanotechnology: Characterization. In Nanoscale Science and Technology. John Wiley & Sons, Ltd
2. Leggett G. J., Jones R. A. L. (2005). Bionanotechnology. In Nanoscale Science and Technology. John Wiley & Sons, Ltd.
3. Mohan Kumar G. (2016). Nanotechnology: Nanomaterials and nanodevices. Narosa Publishing House.
4. Goodsell D. S. (2004). Bionanotechnology. John Wiley & Sons, Inc.
5. Pradeep T. (2007). Nano: The Essentials-Understanding nanoscience and nanotechnology. Tata McGraw-Hill.
6. Sharon M. and Maheshwar (2012). Bio-Nanotechnology: Concepts and Applications. New Delhi. Ane books Pvt Ltd.
7. Nouailhat A. (2008). An Introduction to Nanoscience and Nanotechnology, Wiley.
8. Niemeyer C.M. and Mirkin C. A. (2005). Nanobiotechnology. Wiley Interscience.
9. Rehm, B. (2006). Microbial Bionanotechnology: Biological Self-Assembly Systems and Biopolymer-Based Nanostructures. Horizon Scientific Press.
10. Reisner, D.E. (2009). Bionanotechnology: Global Prospects. CRC Press

VIR-108: Indian Knowledge Systems-1

Lecture: 4 hours/week	
Tutorial: Textbooks, E-learning resources, study materials, PowerPoint lectures	
Semester: I	**Credits: 0**

********* END OF FIRST SEMESTER *********

SEMESTER-II

THEORY-VIR-201: MICROBIAL GENETICS AND MOLECULAR BIOLOGY (Mandatory)

(Core Course-

4)

Lecture: 4 hours/week	**Internal test Assessment: 30 Marks [Mid Semester Examination: 20 Marks; Attendance: 5 Marks; Students Seminar: 5 Marks]**
Tutorial: Textbooks, E-learning resources, study materials, PowerPoint lectures	**Semester End Theory Examination: 70 Marks Total Marks: 100 Marks**
Semester: I	**Credits: 4 Credits**

Course Educational Objectives:

1. To gain understanding of prokaryotic 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

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, types of genes.

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

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

UNIT-II

Gene transfer mechanisms and gene mapping in bacteria: Transformation; Conjugation; Transduction (generalized, abortive, specialized and co-transduction).

Genetic recombination: Requirements for recombination; Molecular models of recombination; 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 and SOS system.

Transcription: 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.

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

UNIT-IV

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

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; antitermination.

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 and processes of translation.

CO4: Understand the requirements and compare the levels of regulation of gene expression in prokaryotes and eukaryotes and learn about types of mutations and gene silencing mechanisms.

Learning Resources and Suggested books:

1. Molecular Genetics of Bacteria 4th Edition (2023) Snyder L et al. ASM Press.
2. Molecular Biology of the Gene 8th Edition (2021) Watson J.D. et al. Cold Spring Harbor Laboratory Press.
3. Molecular Cell Biology 9th Edition (2022) Lodish H et al. W.H. Freeman.
4. Molecular Microbiology: Diagnostic Principles and Practice 3rd Edition (2020) J. R. McGregor et al. ASM Press.
5. Lewin's Gene XII (2017) Jocelyn E. Krebs Elliott S. Goldstein Stephen T. Kilpatrick
6. Principles of Genetics, 7th Edition (2016) D. Peter *Snustad*, Michael J. *Simmons*. Wiley publications
7. Molecular biology 5th Edition (2015) Robert F. Weaver*McGraw-Hill*.
8. Molecular Biology of the Gene 7th Edition (2013) James D. Watson / Tania A. Baker et al. Pearson publications.
9. Molecular Genetics of Bacteria, 5th Edition (2010)Jeremy W. Dale, Simon F. Park, Wiley publications
10. Molecular biology of the cell 5th Edition (2008) Alberts A Et al. Garland Publishers, New York
11. Cell and Molecular Biology (2006) De Robertis, E. D. P and E.M.F. De Robertis.Lippincott Williams and Wilkins.
12. Concepts of Genetics, Seventh edition (2007), William S. Klug & Michael R. Cummings. Darling Kindergluy.
13. Molecular Cell Biology. 6th edition (2006) Lodish, H., A. Berk, C. A. Kaiser, M. P. Scott. 6th Edn. Ploegh and Paul Matsudaria.
14. The cell (molecular approach) 4th Edition (2004) Cooper G. M Hausman R, ASM press
15. Molecular Genetics of Bacteria. 2nd Edition, (2003). By S. Snyder and W. Champness. ASM press.
16. Advanced Molecular Biology: A Concise Reference. (1998), by R.M. Twyman. Viva Books Pvt. Ltd.
17. Molecular Biology. (1995) David Freifelder, Narosa Publ. House.
18. Essentials of *Molecular Biology* (1994) George M. Malacinski and *David Freifelder.*

THEORY-VIR-202A: PLANT VIROLOGY

[Core Course – 5(A)]

Lecture: 4 hours/week	**Internal test Assessment: 25 Marks** **[Mid Semester Examination: 15 Marks; Attendance: 5 Marks; Students Seminar: 5 Marks]**
Tutorial: Textbooks, E-learning resources, study materials, PowerPoint lectures	**Total Marks: 75 Marks** **Semester End Theory Examination: 50 Marks**
Semester: I	**Credits: 3 Credits**

Course Educational Objectives:

1. To define the various concepts related to plant virology such as plant virus-host interactions with respect to induction of disease and virus movement strategies,
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. To understand the plant virus ecological and epidemiological concepts, approaches used for detection
4. To understand the plant virus control practices and to know about concepts related to conventional and transgenic virus resistance mechanisms and to conduct biological research as well as to get employability in agricultural research stations and biotechnology industries.

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.

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

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.

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 detection of plant viruses and virus strains.

CO3: Acquire the knowledge on plant virus spread and survival in nature.

CO4: Understand the plant virus control practices and to know about concepts related to conventional and transgenic virus resistance mechanisms.

Learning resources and suggested books:

1. Matthews Plant Virology 4th Edition (2002) Roger Hull. Academic Press.
2. Plant Viruses 1st Edition (2008) , M.V. Nayudu . McGraw Hill.
3. Plant Virology 5th Edition (2020) Harrison B.D.et al. Elsevier.
4. Plant Virology: Methods and Protocols 2nd Edition (2023) T. G. Robert. Humana Press.
5. Plant Virology: Principles and Practice 3rd Edition (2021) Naidu R.A. Springer.
6. Introduction to Plant Virology 2nd Edition (2021) K. J. Morris. CRC Press.
7. Diagnosis of plant virus diseases 1st edition (1981) R.E.F .Mathews. Springer Publishers

8. Epidemiology of Plant disease 1st edition (2006) B.M. Cooke. Springer Publishers.
9. Handbook of Plant Virus Diseases 1st edition (1999) Dragoliub D.Sutic et al.CRC Press, Florida.
10. Plant Viruses 3rd edition (1974) Kenneth M. Smith. Academic Press.
11. Westcott's Plant Disease Handbook 8th edition (2013) by R.Kemmeth Horst. Springer publisher.
12. Molecular Plant Virology, Volume 1 (2017) Davis, Taylor & Francis Group.
13. Applied Plant Virology (2014), Calum Rae Wilson.
14. Handbook of Plant Virology (Crop Science) (2006), Jawaid Khan, Jeanne Dijkstra.
15. Plant Virology, 4th ed. 2001 by R. Hull (R.E.F. Matthews). Academic Press.
16. Plant Viruses. By M.V. Nayudu. (2008). Tata –McGraw Hill.
17. Techniques in diagnoses of Plant Viruses (Plant Pathogens-6) (2008) Govind P.Rao, Rodrigo A. Valverde & C.I. Dovas, Stadium Press.
18. Plant viruses as molecular pathogens. (2001). J. A. Khan and J. Dijkstra (Eds). CBS Publishers and distributors, New Delhi.
19. Control of Plant virus diseases by Hadidi et al (editors), (1998), American Phytopathological Society, USA.
20. Diagnosis of Plant Virus Diseases. (1993) by R.E.F. Matthews. CRC Press.
21. Plant Virus Epidemics- Monitoring, modeling and predicting outbreaks. (1986). G.D. Mc Lean, et. al., Academic Press.
22. Applied Plant Virology. (1985). D.G.A. Walkey. Heinemann Publications.
23. Symptoms of Plant Virus Diseases (1978) by L. Bos.
24. Plant Virology - The Principles. (1976) by A. Gibbs and B.D. Harrison, Edward Arnold

(OR)

THEORY-VIR-202B: BIOLOGY OF VIRUS VECTORS AND THEIR MANAGEMENT

[Core Course – 5(B)]

Lecture: 4 hours/week	**Internal test Assessment: 25 Marks** **[Mid Semester Examination: 15 Marks; Attendance: 5 Marks; Students Seminar: 5 Marks]**

Tutorial: Textbooks, E-learning resources, study materials, PowerPoint lectures	**Total Marks: 75 Marks** **Semester End Theory Examination: 50 Marks**
Semester: I	**Credits: 3 Credits**

Course Educational Objectives:

1. To learn about classification of insects, types, structure and functions of arthropods virus vectors and their collection and preservation, molecular approaches for identification of vector species, arthropod-borne viruses of animals and humans.
2. To understand biology and ecology of mosquitoes, other blood sucking insects and strategies used for management of animal and human virus vectors.
3. To gain knowledge on plant virus vectors, virus vector relationships, molecular interactions of virus vectors.
4. To learn about fungal and nematode vectors, epidemiology of vector-borne viruses and vector resistance crops.

UNIT-I

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

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

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

UNIT-II

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

Biology and ecology of other blood sucking insects (Ticks): Biology, morphology and disease relationships of sandflies (Crimean-Congo hemorrhagic fever, sandfly fever and chandipura); Biology and morphology of fleas, lice and culicoides (blue tongue virus, African horse sickness virus); Biology, ecology and life history of ticks with special reference to Kyasanur forest disease.

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

UNIT-III

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

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

UNIT-IV

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

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

Vector resistant crops: Natural and transgenic resistance.

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

CO1: Learn about classification of insects, types, structure and functions of arthropods virus vectors and their collection and preservation, molecular approaches for identification of vector species, arthropod-borne viruses of animals and humans.

CO2: Understand biology and ecology of mosquitoes, other blood sucking insects and strategies used for management of animal and human virus vectors.

CO3: Gain knowledge on plant virus vectors, virus vector relationships, molecular interactions of virus vectors.

CO4: Learn about fungal and nematode vectors, epidemiology of vector-borne viruses and vector resistance crops.

Learning resources and suggested books:

1. Plant Virus, Vector, Epidemiology & Management 2nd Edition (2017) S. Mukhopadhyay. Academic Press.
2. Plant Virology 5th Edition 2014 Roger Hull. Academic Press.
3. Plant Viral Vectors 1st Edition (2014) K. Palmer et al. Academic Press.
4. Applied Plant Virology: Advances, Detection & Antiviral Strategies 1st Edition (2020) L.P. Awasthi. Academic Press.

5. Zoonoses: Infectious diseases transmissible from animals to humans. 3rd Edition. 2003. H. Krauss *et al.* ASM Press.

6. Matthews' Plant Virology. 2001. By R. Hull. Academic Press.

7. Service MW (1996) Medical entomology for students. Chapman and Hall

8. Kettle DS (1984) Medical and veterinary entomology CAB international

9. Richard and Davies Imm's general Text book of Entomology. Vol I & II.. Chapman and Hall.

10. Control of Plant Virus Diseases. By Hadidi *et al.*(Eds). APS. USA.

THEORY-VIR-203A: PLANT VIRUS DISEASES

[Core Course – 6(A)]

Lecture: 4 hours/week	**Internal test Assessment: 25 Marks** **[Mid Semester Examination: 15 Marks; Attendance: 5 Marks; Students Seminar: 5 Marks]**
Tutorial: Textbooks, E-learning resources, study materials, Power Point lectures	**Total Marks: 75 Marks** **Semester End Theory Examination: 50 Marks**
Semester: I	**Credits: 3 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 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.

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

UNIT-I

Cereals and millets: **Rice**- Tungro, dwarf, grassy stunt and stripe; **Wheat**- soil-borne wheat mosaic, streak mosaic, spindle streak mosaic; **Barley and Oat** – yellow dwarf, stripe mosaic and yellow mosaic; **Maize and Sorghum** – 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; **Coconut** – cadang cadang viriod disease.

UNIT–II

Vegetables: **Tomato** – leaf curl, spotted wilt, yellow mosaic/golden yellow mosaic, fern leaf / shoestring; **Chilli** – leaf curl, vein banding and mosaic caused by TMV, CMV and Chilli veinal mottle virus (ChiVMV); **Brinjal** – mosaic caused by CMV / TMV/ PVY; **Okra** – yellow vein mosaic and leaf curl; **Onion and garlic**– yellow dwarf mosaic and iris yellow spot; **Cucurbits** – CMV, squash mosaic, watermelon mosaic, bud necrosis and cucumber green mottle mosaic; **Radish** – mosaic; **Carrot** – red leaf, mottley dwarf and thin leaf; **Cabbage and Cauliflower**- turnip mosaic, cauliflower mosaic and turnip yellow mosaic.

Tuber crops: Potato- leaf roll, rugose mosaic, mild mosaic / latent caused PVX, PVM and PVS and potato spindle tuber viriod diseases; **Sweet potato** – chlorotic stunt and feathery mottle; **Cassava** – common, African and Indian mosaic virus diseases; **Colocasia and Cocoyam** –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 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 necrotic yellow vein; **Cotton -** leaf curl; **Kenaf**- yellow vein mosaic; **Tobacco -** mosaic and leaf curl.

Spice and beverage crops: Small cardamom – mosaic; **Large cardamom -** foorkey and chirke diseases; **Black Pepper -** stunt and yellow mottle; **Zinger** – chlorotic fleck; **Vanilla**- mosaic; **Cocoa -** swollen shoot.

Flowering and foliage ornamentals: Tulips– Flower breaking; **Rose –** mosaic; **Gladiolus–** bean yellow mosaic; **Orchids –** cymbidium mosaic and odontoglassum ring spot viruses; **Carnations -** mottle, ring spot and etched ringspot; **Chrysanthimum –**aspermy, ring mottle and stunt viroid; **Aroids –** dasheen mosaic and Konjac mosaic viruses.

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

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

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

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

(OR)

THEORY-VIR-203B: TUMOR VIROLOGY

[Core Course – 6(B)]

Lecture: 4 hours/week	**Internal test Assessment: 25 Marks** **[Mid Semester Examination: 15 Marks; Attendance: 5 Marks; Students Seminar: 5 Marks]**
Tutorial: Textbooks, E-learning resources, study materials, PowerPoint lectures	**Total Marks: 75 Marks** **Semester End Theory Examination: 50 Marks**
Semester: I	**Credits: 3 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 and tumorogenesis, angiogenesis, differences between normal and transformed cells.

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

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

UNIT-II

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.

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

UNIT-III

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

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

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.

UNIT-IV

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

Tumor therapy: Surgery, physical (radiation), chemical and immunotherapy; inhibitors of angiogenesis; oncolytic viruses and their mechanisms and applications.

Management of Cancer: Preventive measures of cancers.

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. Tumor Virology 3rd Edition (2022) A. J. Cannon. Wiley-Blackwell.
2. Cancer Virology 2nd Edition (2021) R. J. G. DeBiasi. Springer.
3. Viral Oncology: Basic Principles and Clinical Applications 1st Edition (2020) M. J. K. P. Prasad. Elsevier.
4. Devita, Cancer, Principles and Practice of Oncology: (2019) Review 4 by Govindan.
5. Textbook of Medical Virology (2018), by B. Mishra (Author), details, 256 pages, Publisher: CBS Publishers & Distributors Pvt Ltd, India.
6. Practical clinical oncology, 2nd edition, Edited by Louise Hanna, Tom Crosby and Fergus Macbeth, (2015) 2 edition, Cambridge University Press.
7. Field's Virology (Knipe, Fields Virology) (2013), 2 Volume Set. by David M. Knipe and Peter Howley.
8. The Cell – A molecular approach. Fourth edition (2007). G. M. Cooper & R.E. Hausman. ASM Press.
9. Cell signaling. Second edition (2005). John T. Hancock. Oxford University press.
10. Principle of Virology: Molecular Biology, pathogenesis and control of animal viruses. (2004). By S.J. Flint et al., ASM press
11. Culture of Animal Cells: A Manual of Basic Technique. (1987). R.I. Freshney. Alan R. Liss. Inc.
12. Oncogenes. 1995. 2nd Edition. By G.M. Cooper. Jones and Bartlett publishers.

PRACTICAL-III-VIR-204A: PLAT VIROLOGY & PLANT VIRUS DISEASES
[Practical related to CC5(A) & 6(A)]

Lecture: 6 hours/week	**Internal test Assessment: 15 Marks**
Tutorial: Textbooks, E-learning resources, study materials, PowerPoint lectures	**Total Marks: 50 Marks** **Semester End Practical Examination: 35 Marks**
Semester: I	**Credits: 2 Credits**

Course Educational Objectives:

1. To determine virus effect on plant cell size and chloroplast number, to observe inclusion bodies by light microscopy.
2. To estimate the effect of virus on total carbohydrates, proteins lipids in healthy and virus infected seeds, to demonstrate seed and vegetative transmission of plant viruses and to detect unknown plant virus by DAC-ELISA.

3. To acquire practical knowledge on plant virus diseases, symptoms through field visits and to collect and identify the local insect vectors.

4. To determine disease progress curves through periodical estimation of disease incidence in local fields

List of Practicals: (Plant Virology)

1. Determination of virus effect on chloroplast number.
2. Determination of virus effect on cell size.
3. Observation of inclusions by light microscopy
4. Effect of virus on total carbohydrates in healthy and virus infected seeds
5. Effect of virus on total proteins in healthy and virus infected seeds
6. Effect of virus on total lipids in healthy and virus infected seeds.

List of Practicals: (Plant Virus Diseases)

1. Botanical names and taxonomic details of the local plant species (Theory Exercise)
2. Study of symptoms of local virus diseased plants through slides/photographs.
3. Preparation of classification of plant viruses as per ICTV (Chart)
4. Diagnosis of virus diseases (theoretical exercise).
5. Collection and identification of local insect vectors.
6. Determination of disease progress curves (field study).
7. Visiting local fields and agricultural research stations.

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

CO1: Determine virus effect on plant cell size and chloroplast number and observe inclusion bodies by light microscopy.

CO2: Estimate the effect of virus on total carbohydrates, proteins lipids in healthy and virus infected seeds, demonstrate seed and vegetative transmission of plant viruses and detect unknown plant virus by DAC-ELISA.

CO3: Acquire practical knowledge on plant virus diseases, symptoms through field visits and collect and identify the local insect vectors.

CO4: Determine disease progress curves through periodical estimation of disease incidence in local fields.

Recommended books / Manuals (Plant Virology and Plant Virus Diseases):

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.
9. Methods in Virology, (1998) K. Marmorosch and H. Koprowski. Vol. I and II. Academic Press.
10. Diagnosis of Plant Virus Diseases, (1993). R.E.F. Matthews (ed.) CRC Press.
11. Serological Methods for detection and identification of viral and bacterial plant pathogens: A Laboratory Manual. (1990). R. Hampton et al., APS Press.
12. Methods in Plant Virology, (1984). S.A. Hill. Blackwell Publications.
13. Virology Methods Manual, 1996. B.W. J. Mahy and H.O. Kangro. Academic Press

PRACTICAL-III-VIR-204B: BIOLOGY OF VIRUS VECTORS AND THEIR MANAGEMENT & TUMOR VIROLOGY

[Practical related to CC5(B) & 6(B)]

Lecture: 6 hours/week	**Internal test Assessment: 15 Marks**
Tutorial: Textbooks, E-learning resources, study materials, PowerPoint lectures	**Total Marks: 50 Marks** **Semester End Practical Examination: 35 Marks**
Semester: I	**Credits: 2 Credits**

Course Educational Objectives:

1. To acquire practical knowledge on plant virus diseases, symptoms through field visits and to collect and identify the local insect vectors.
2. To determine disease progress curves through periodical estimation of disease incidence in local fields.
1. To determine the carcinogens and mutagens by Ames test, to detect tumor viruses using PCR and to learn about preventive and control measures of tumor viruses.

2. To conduct cell viability tests, MTT assays and visiting local Universities museums for observation tumor virus symptoms on the specimens. different RNA and DNA viruses causing tumors, cell transformation mechanisms, immune responses to tumors and tumor therapy strategies.

List of Practicals: Biology of Virus Vectors and their Management

1. Study of symptoms of local virus diseased plants through field work, slides/photographs
2. Identification of unknown plant virus by ELISA.
3. Local field surveys and visit to local research stations.
4. Diagnosis of virus diseases (theoretical exercise).
5. Collection and identification of local insect vectors.
6. Determination of disease progress curves (field study).
7. Visiting local fields and agricultural research stations.

List of Practicals: Tumor Virology

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

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

CO1: Acquire practical knowledge on plant virus diseases, symptoms through field visits and collect/identify the local insect vectors.

CO2: Determine disease progress curves through periodical estimation of disease incidence in local fields.

CO3: Determine the carcinogens and mutagens by Ames test, to detect tumor viruses using PCR and to learn about preventive and control measures of tumor viruses.

CO4: Conduct cell viability tests, MTT assays and visiting local Universities museums for observation tumor virus symptoms on the specimens.

Learning resources and suggested books/Manuals (<u>Biology of Virus Vectors and their Management</u>):

1. Plant Virus, Vector, Epidemiology & Management 2nd Edition (2017) S. Mukhopadhyay. Academic Press.
2. Plant Virology 5th Edition 2014 Roger Hull. Academic Press.
3. Plant Viral Vectors 1st Edition (2014) K. Palmer et al. Academic Press.
4. Applied Plant Virology: Advances, Detection & Antiviral Strategies 1st Edition (2020) L.P. Awasthi. Academic Press.
5. Zoonoses: Infectious diseases transmissible from animals to humans. 3rd Edition. 2003. H. Krauss et al. ASM Press.
6. Matthews' Plant Virology. 2001. By R. Hull. Academic Press.
7. Service MW (1996) Medical entomology for students. Chapman and Hall
8. Kettle DS (1984) Medical and veterinary entomology CAB international
9. Richard and Davies Imm's general Text book of Entomology. Vol I & II.. Chapman and Hall.
10. Control of Plant Virus Diseases. By Hadidi et al.(Eds). APS. USA.

Learning resources and suggested books/Manuals (Tumor Virology):

1) Modern Techniques in Cytopathology (Monographs in Clinical Cytology, Vol. 25) (2020) 1st Edition, by Marilyn M. Bui (Editor), Liron Pantanowitz (Editor), Philippe Vielh (Series Editor), Series: Monographs in Clinical Cytology, Vol. 25, pages: 110, Publisher: S. Karger; 1 edition.
2) Medical Biochemistry, John W Baynes PhD (2018), Marek H. Dominiczak Dr Hab Med FRCPath (Author), 5th Edition, 712 pages, Publisher: Elsevier.
3) Manual of Clinical Oncology Paperback – Dec 2017, by Chmielowski (Author), 900 pges, Publisher: Wolters Kluwer India Private Limited; Eighth edition (2017), price
4) Devita et al (2011), Cancer, Principles and Practice of Oncology: Review 4 by Govindan
5) CBS Oncology entrance examination (PB 2017) by BHATIA M.S.

THEORY-VIR-205A: IMMUNOLOGY

[Skill Oriented Course – 3(A)]

Lecture: 4 hours/week	**Internal test Assessment: 25 Marks** **[Mid Semester Examination: 15 Marks; Attendance: 5 Marks; Students Seminar: 5 Marks]**

Tutorial: Textbooks, E-learning resources, study materials, PowerPoint lectures	**Total Marks: 75 Marks** **Semester End Theory Examination: 50 Marks**
Semester: I	**Credits: 3 Credits**

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, and concepts and applications of conventional and modern vaccines.
4. To acquire knowledge on hypersensitivity reactions. autoimmune and immunodeficiency disorders, transplantation and transfusion immunology.

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, principle, production and applications of polyclonal and monoclonal antibodies.

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), immunofluorescence, flow cytometry (FACS), 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 histocompatibility complex (MHC): Types of MHC molecules, HLA antigens-Class I, II, III and their functions.

Adoptive Immune response: 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).

Vaccines: Conventional and modern vaccines and their applications, Animal and human virus vaccines available in market.

UNIT-IV

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

Immunopathology: Immunodeficiency disorders (congenital and acquired).

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

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.

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 types of MHC, induction and mechanism of humoral and cell mediated immune responses, concepts of conventional and modern vaccines.

CO4: Learn about the types of hypersensitivity reactions, basis of autoimmune and immunodeficiency disorders, basic of transplantation and cancer immunology and concepts.

Learning Resources and Suggested books:

1. Immunology: A short course.8th edition (2021) by Richard Coico, Geoffery Sunshine, Wiley-Blackwell publisher.
2. Introductory Immunology: Basic Concepts for Interdisciplinary Applications.3rd edition (2022) by Jeffrey K. Actor, Academic Press publisher.

3. Kuby Immunology .9th edition (2022) by Patricia Jones and Janis Kuby, W.H. Freeman and Company publisher.

4. NMS Immunology.6th edition (2006) by Richard M. Hyde, Lippincott Williams & Wilkins publisher.

5. Oxford Handbook of Clinical Immunology and Allergy.4th edition (2019) by Gavin Spickett, Oxford University Press publisher.

6. Roitt 's Essential Immunology.14th edition (2021) by Peter J. Delves, Seamus J. Martin, Dennis R. Burton and Ivan M. Roitt, Wiley-Blackwell publisherImmunology: A short course, 8th edition (2020) Coico, John Wiley & Sons, Limited

7. Immunology, 9th Edition (2020) David Male, Victoria Male, Ray Stokes Peebles, Elsevier

8. Advances in Immunology (2019) Frederick W. Alt. Elsevier

9. Applied Immunology and Biochemistry (2019) Taylor Barker, ED-Tech Press, UK.

10. Cellular and Molecular Immunology (2019), Reece Davis, ED-Tech Press, UK.

11. Immunology (2015) I. Kannan, MJP Publishers, Chennai.

12. Immunology. (2000). 4th edition. J. Kuby. W.H. Freeman and Company.

13. Immunology. (1996). 4th edition. I.Roitt, J. Brostoff and David Male. Mosby publications.

14. Fundamental Immunology. (1992). 2nd edition. R.M. Coleman, M.F. Lombard and R.E.Sicard. Wm. C. Brown Publishers.

15. Immunology. (1997). 3rd edition. R.M. Hyde. B.I. Waverly Pvt. Ltd.

16. Immunology. (1995). 4th edition. I.R. Tizard. Saunders College Publishing.

17. Immunology – The Science of self and non-self-discrimination. (1982). Jon Klein. John Wiley and Sons.

18. Immunology – An illustrated outline. (1986). David Male. Churchill Living Stone.

19. Viruses that affect immune system. (1991). H.Y. Fan, I.S.Y. Chen, N.Rosenberg and W. Sugden. American Society for Microbiology.

20. Immunobiology: The immune system in health and disease.(1994). C.A.Janeway, Jr., P.Travers. Current biology Ltd.

(OR)

THEORY-VIR-205B : MOLEULAR TECHNIQUES

[Skill Oriented Course - 3(B)]

Lecture: 4 hours/week	**Internal test Assessment: 25 Marks** **[Mid Semester Examination: 15 Marks; Attendance: 5 Marks; Students Seminar: 5 Marks]**
Tutorial: Textbooks, E-learning resources, study materials, PowerPoint lectures	**Total Marks: 75 Marks** **Semester End Theory Examination: 50 Marks**
Semester: I	**Credits: 3 Credits**

Course Educational Objectives:

1. To learn the scope, importance of virology laboratory, lab equipment, universal precautions and management of waste.
2. To gain knowledge on laboratory biosafety levels, risk groups and management and collection of specimens and transportation and health education
3. To learn the basic tools and principles of serological techniques used in virology
4. To understand the molecular tools used in virology and strategies used for drug design, artificial intelligence and modern vaccinology.

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).

UNIT –II

Laboratory bio-safety: Levels of laboratory biosafety and categories of microbes; Risk groups, 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 –III

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 –IV

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: Learn the scope, importance of virology laboratory, lab equipment, universal precuations and management of waste.

CO2: Gain knowledge on laboratory biosafety levels, risk groups and management and collection of specimens and transportation and health education

CO3: To learn the basic tools used in virology and principles of serological techniques.

CO4: Understand the molecular tools used in virology and strategies used for drug design, artificial intelligence and modern vaccinology.

Learning resources and suggested books:

1. Molecular Cloning: A Laboratory Manual 4th Edition (2021) Sambrook J., Russell D.W., Cold Spring Harbor Laboratory Press.
2. Molecular Biology Techniques: A Classroom Laboratory Manual 2nd Edition (2023) Heather Miller et al. Wiley.
3. Molecular Techniques in Plant Virology 1st Edition (2022) J. S. Pradeep et al. Springer.
4. PCR Technology: Current Innovations 3rd Edition (2021) T. A. D. Turner. CRC Press.
5. Principles of Nucleic Acid Chemistry 3rd Edition (2023) S. H. Becker. Academic Press.
6. Virology Methods Manual. Brian W.J. Mahy (Editor), Hillar O. Kangro (Editor). Latest edition / Pub. Date: January 1996. Publisher: Elsevier Science & Technology Books.
7. Methods and Techniques in Virology. Pierre Payment, Trudel (Editor).Latest edition / Pub. Date: July 1993. Publisher: Marcel Dekker.
8. Diagnostic Virology Protocols: Methods in Molecular Medicine. John R. Stephenson (Editor), Alan Warnes Latest edition / Pub. Date: August 1998. Publisher: Humana Press.

9. 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.

THEORY-VIR-206A : RECOMBINANT DNA TECHNOLOGY

[Skill Oriented Course - 4(A)]

Lecture: 4 hours/week	**Internal test Assessment: 25 Marks** **[Mid Semester Examination: 15 Marks; Attendance: 5 Marks; Students Seminar: 5 Marks]**
Tutorial: Textbooks, E-learning resources, study materials, PowerPoint lectures	**Total Marks: 75 Marks** **Semester End Theory Examination: 50 Marks**
Semester: I	**Credits: 3 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 learn the 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 amplicons and chemically synthesis of DNA.

Cloning and expression host systems: Bacteria, yeast, insect cells, plant cells and animal cells.

UNIT-II

Techniques for gene manipulation: DNA sequencing- Dideoxy chain termination, 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.

Microarray Technology: DNA microarrays- principles and applications; protein microarrays.

Site directed mutagenesis and protein engineering: Site-directed mutagenesis approaches for changing genes; Yeast two hybrid systems.

UNIT-III

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

Omics: Genomics-Mapping and sequencing genomes, transcriptome and NGS; Proteomics-proteome, tools for analysis of proteomics; 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; **Yeast cell system** – Expression of cloned genes using yeast expression vectors (e.g., *Picha*-induction with methanol using AOX promoter); **Insect cell system** - Overexpression of cloned genes using baculovirus based vectors (e.g., bacmid).

Plant cell system: Expression of cloned genes in plant cells using agrobacterium mediated transformation; 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-Expression of cloned genes in animal cells using virus-based vectors, genetic modification of animals like mice, sheep and cow for new /improved traits like body size and milk quantity, transgenic animals as bioreactors, gene editing (CRISPER-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. Principles of Gene Manipulation and Genomics 7th Edition (2023) Primrose S.B. et al. Blackwell Publishing.
2. Gene cloning and DNA Analysis: An Introduction.8th Edition (2020) by T.A.Brown, Wiley-Blackwell publisher.
3. Genetic Engineering: Principles and Methods 5th edition (2020) by Desmond T. Nicholl, CRC Press.
4. Molecular Biology of the Gene.8th Edition (2022) by James D. Watson, Tania A. Baker, Stephen P. Bell et al. Pearson publisher.
5. Molecular Biotechnology: Principles and Applications of Recombinant DNA.5th Edition (2022) by Bernard R. Glick, Jack J. Pasternak, Cheryl L. Patten, ASM Press publisher.
6. Principles of Gene Manipulation and Genomics.8th edition (2020) by Sandy B. Primrose, Richard Twyman, Wiley-Blackwell publisher.
7. Principles of Genome Analysis and Genomics.7th edition (2020) by Sandy B. Primrose, Richard Twyman. Wiley-Blackwell publisher.

8. Recombinant DNA technology (2019) Siddra Ijaz and Imran Ul Haq, Cambridge Scholar publishing, UK.

9. Application of Recombinant DNA technology (2018). Vance Hunter and Franky Stickland, ED-Tech Press, UK.

10. Wilson and Walkers Principles and Techniques of Biochemistry and Molecular Biology. (2018). Andreas Hofmann, Samuel Clokie, Kindle Edition.

11. Basic concepts of Recombinant DNA technology (2016) by Somnath De. Edu Pedia Publications, New Delhi.

12. Molecular Biology.7th Edition (2013) by James D. Watson, Tania A. Baker, Stephen P. Bell, Alexander Gann, Michael Levine and Richard Losick, Pearson publisher.

13. Genetic Engineering: Principles and Methods (2012) Jane K. Setlow (Editor)

14. From Genes to Genomes: Concepts and Applications of DNA Technology. (2011) Jeremy W. Dale, Malcolm von Schantz, Nicholas Plant.

15. Principles of Gene Manipulation and Genomics. Seventh edition (2008) S.B. Primrose and R.M.Twyman. Blackwell pub.

16. Recombinant DNA Genes and Genomes: A Short course. Third edition (2007) James D. Watson, Amy A. Caudy, Richard M. Mayes & Jan A. Witkow.

17. Gene Cloning and DNA Analysis – An Introduction. Fifth edition (2006) T.ABrown. Blackwell Pub.

18. An introduction to Genetic Engineering. 2nd edition. (2004) By D.S.T. Nicholl. Cambridge University Press.

19. DNA Science: A First course. Second edition (2003) David A. Micklos Grag, A. Freyer & David A, Crotty.

20. Principles of genome analysis and genomics. (2003). 3rd edition. S.B. Primrose and R.M.Twyman. Blackwell Science.

21. Prokaryotic genomics. (2003). Michel Blot (Ed). Springer International.

22. Recombinant DNA and biotechnology: A guide for Teachers: 2nd ed. H. Kreuzer and A. Massey. ASM Press.

23. Recombinant DNA and biotechnology: A guide to students: 2nd ed. H. Kreuzer and A. Massey. ASM Press.

24. Functional Genomics: A Practical Approach. (2000), by S.P. Hunt and R. Liveey (eds.). Oxford University Press.

THEORY-VIR-206B: BIOSTATISTICS AND BIOINFORMATICS

[Skill Oriented Course -4(B)]

Lecture: 4 hours/week	**Internal test Assessment: 25 Marks** **[Mid Semester Examination: 15 Marks; Attendance: 5 Marks; Students Seminar: 5 Marks]**
Tutorial: Textbooks, E-learning resources, study materials, PowerPoint lectures	**Total Marks: 75 Marks** **Semester End Theory Examination: 50 Marks**
Semester: I	**Credits: 3 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.
4. 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 of statistics: population and universe, the sample and population, statistical inference; parameter and statistics. Construction of a histogram; Interpretation of histogram, the normal distribution, the mean, mode, median and standard deviation.

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

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

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

UNIT-II

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

Correlation and regression: Formulae and application. Fitting the best straight line through a series of points. Fitting of different curves. Standard curves and interpolation of unknown Y-values; Multiple linear regression.**Statistical basis of biological assays:** Response-Dose metameter; Delusion Assays, Direct and indirect assays; Quantal Responses, Probit, logit, LD_{50}, ED_{50}, PD_{50} - Standard line interpolation assay, parallel assay (4 point, 6 point assays), slope ratio assay.

UNIT-III

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

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

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

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

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

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

UNIT-IV

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

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

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

Predictive methods using nucleotide and protein sequences: Detecting regulatory elements in the DNA; physical properties of proteins based on sequences, different protein structural motifs, RNA binding domains and folding classes; 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. Bioinformatics: Sequence and Genome Analysis 3rd edition (2022) David W. Mount, Cold Spring Harbour Laboratory press publisher.
2. Biostatistics: A foundation for analysis in the Health Sciences.11th edition (2022) Wayne W. Daniel. Wiley publisher.
3. Bioinformatics for Biologists.2nd edition (2007) Jean-Michel Claverie et al. Wiley publisher.
4. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins 4th Edition (2021) by Andreas D. Baxevanis et al. Wiley publisher.
5. The Principles of Biostatistics 2nd Edition (2018) by Marcello Pagano and Kimberlee Gauvreau. CRC Press publisher.
6. Introduction to Biostatistics 4th Edition (2012) by Robert R. Sokal et al. W.H. Freeman publishers.
7. Campbell R.C. (1974): Statistics for Biologists, Cambridge University Press, Cambridge.
8. Statistics made simple- Do it yourself on PC. 2001. By K.V.S. Sarma. Printice Hall of India Publ.
9. An introduction to Biostatistics. 1997. Third Edition. P.S.S. Sundar Rao and J. Richard, Prentice-Hall of India Pvt. Ltd., New Delhi.
10. Fundamentals of Biostatistics. 1994. First Edition. Irfan A. Khan and Atiya Khanum, Ukaaz Publications.
11. Biostatistics. 1996. First Edition. P.N. Arora and P.K. Malhan, Himalaya Publishing House.
12. Statistics and Experimental design: An Introduction for Biologists and Biochemists. 1994. 3rd edition. G.M. Clarke. Edward Arnald Publications.

13. Statistical methods. 1967. 6th edition. Snedecor and Cochran, Oxford Press.

14. Elements of Computer Science, 1998. S.K. Sarkar, A.K. Gupta. S. Chand & Company (Chapters - 1,2,9,12,14).

15. 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.

16. Windows-98, 2000, Vickram Crishra. Tata Mc Graw-Hill Publishing.

17. The Internet: Complete Reference, Harley Hahn. 1996. Second Edition. Tata Mc Graw-Hill Publication.

18. Introduction to Bioinformatics, 2001 by T.A. Attwood & D.J. Parry-Smith, Pearson Education Asia Publ.

19. Bioinformatics: Methods and Protocols, Edited by Stephem Misener and Stephen A. Krawetz. 2000. Methods in Molecular Biology Series. Humana Press.

20. Bioinformatics: A Practical guide to the analysis of genes and proteins. 1998. Edited by A.D. Baxevanis and B.F.

21. Francis Ouellette. Wiley - Interscience. Computational Methods in Molecular Biology by S.L. Saizberg

22. Computer Applications in Biotechnology. 1998. by T. Yosida. Introduction to Bioinformatics by Atwood.

23. Bioinformatics - From Nucleic Acids and Proteins to Cell Metabolism. 1995, by Schomburg and Label.

24. Bioinformatics: Methods and Protocols. Ed by S.Misener and S.A. Krawetz. Humana Press, 2000.

PRACTICAL-IV-VIR-207A: IMMUNOLOGY & RECOMBINANT DNA TECHNOLOGY

[Practical related to SOC3(A) & 4(A)]

Lecture: 6 hours/week	**Internal test Assessment: 15 Marks**
Tutorial: Textbooks, E-learning resources, study materials, PowerPoint lectures	**Semester End Practical Examination: 35 Marks**
Semester: I	**Credits: 2 Credits**

Course Educational Objectives:

1. To determine WBC and RBC counts, hemoglobin and Rh typing.
2. To perform *in vitro* serological tests such as immunodiffusion tests, rocket immuno-electrophoresis, DBIA and western blotting.

3. 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.
4. To discuss the problems related to molecular biology and recombinant DNA technology and to learn the basic bioinformatics tools for DNA analysis.

List of Experiments: (Immunology)

1. Total counting of RBC & WBC.
2. Differential count of WBC.
3. Hemoglobin estimation.
4. Blood typing & Rh determination.
5. Single & double immunodiffusion tests.
6. Radial immunodiffusion assay.

List of Practicals: (Recombinant DNA Technology)

1. Safety practices and precautions to be followed to set up Molecular Biology lab with ribonuclease free environment (theory exercise)
2. Preparation of phenol for nucleic acid isolation (theory exercise).
3. Concentration of nucleic acids (theory exercise).
4. Isolation of genomic DNA from bacteria and plant leaf and analysis
5. Isolation of total RNA from plant leaf and analysis.
6. Isolation of plasmids from bacteria through alkaline lysis method.
7. Restriction enzyme analysis of plasmids.
8. Recovery of DNA from gels – low melting point agarose extraction of DNA.
9. Ligation of lambda DNA cut with restriction enzymes.
10. Demonstration of PCR through amplification of virus gene.
11. Transformation of bacteria with recombinant plasmid DNA.
12. Southern blotting (demo).
13. Preparation of dot-blots for hybridization (demo).
14. Problems related to recombinant DNA technology.
15. Bioinformatics tools: NCBI, PDB search, BLAST-n, BLAST-p, multiple sequence alignment, phylogenetic tree construction, Bio Edit, 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, recovery 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 bioinformatics tools that are important for DNA analysis.

Learning Resources and Suggested Books/Manuals (Immunology):

1. Immunology: A short course.8th edition (2021) by Richard Coico, Geoffery Sunshine, Wiley-Blackwell publisher.
2. Introductory Immunology: Basic Concepts for Interdisciplinary Applications.3rd edition (2022) by Jeffrey K. Actor, Academic Press publisher.
3. Kuby Immunology .9th edition (2022) by Patricia Jones and Janis Kuby, W.H. Freeman and Company publisher.
4. NMS Immunology.6th edition (2006) by Richard M. Hyde, Lippincott Williams & Wilkins publisher.
5. Oxford Handbook of Clinical Immunology and Allergy.4th edition (2019) by Gavin Spickett, Oxford University Press publisher.
6. Roitt 's Essential Immunology.14th edition (2021) by Peter J. Delves, Seamus J. Martin, Dennis R. Burton and Ivan M. Roitt, Wiley-Blackwell publisherImmunology: A short course, 8th edition (2020) Coico, John Wiley & Sons, Limited.
7. Immunology, 9th Edition (2020) David Male, Victoria Male, Ray Stokes Peebles, Elsevier.
8. Advances in Immunology (2019) Frederick W. Alt. Elsevier.
9. Applied Immunology and Biochemistry (2019) Taylor Barker, ED-Tech Press, UK.
10. Cellular and Molecular Immunology (2019), Reece Davis, ED-Tech Press, UK.

Learning Resources and Suggested books / manuals (Recombinant DNA Technology):

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.

PRACTICAL-IV-VIR-207B: MOLECULAR TECHNIQUES & BIOSTATISTICS AND BIOINFORMATICS

[Practical related to SOC3(B) & 4(B)]

Lecture: 6 hours/week	**Internal test Assessment: 15 Marks**
Tutorial: Textbooks, E-learning resources, study materials, PowerPoint lectures	**Total Marks: 75 Marks** **Semester End Practical Examination: 35 Marks**
Semester: I	**Credits: 2 Credits**

Course Educational Objectives:

1. To acquire skills on laboratory biosafety and biosecurity measures, sample collection methods, SARS-CoV-2 diagnostic tests through chart preparations.
2. To knowhow isolation of viral RNA/DNA from various sources, PCR amplification of virus genes, induction, analysis and purification of expressed virus coat protein gene, ICT based PoC tests and isolation of metal nanoparticles from green sources and their characterization using various approaches.
3. To learn using MS Office, creating tables in MS-Word, creating database, spreadsheet and statistical graphs, sample statistics with Excel, internet, worldwide web.

4. To search 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: (Molecular Techniques)

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 (Theory exercises).
4. Diagnosis of SARS-CoV-2 using physical, serological and molecular tests (Theory exercise).
5. Isolation of genomic DNA/RNA from virus infected leaf sample or purified virus.
6. PCR amplification of virus coat protein gene and analysis by agarose gel electrophoresis.
7. Induction of virus coat protein gene expression in *E. coli* with IPTG and analysis on SDS-PAGE.
8. Purification of virus coat protein on Ni-NTA column and analysis by SDS-PAGE
9. Immunochromatographic tests (ICT) based point-of-care (PoC) tests
10. Isolation of metal nanoparticles and antiviral compounds from a plant.
11. Purification and characterization of nanoparticles using ultracentrifugation, chromatography, FTIR, SEM, XRD and NMR.

List of experiments - (Bioinformatics and Biostatistics)

1. Creating database & Statistical graphs in EXCEL
2. Histogram, pie, line diagram, scatter diagram, error bars
3. Simple Statistics with Excel
4. Creating and use of spread sheet to biological applications
5. Problems on mean, median and mode
6. Problems on variance, coefficient of variance, standard deviation (SD) and standard error (SE)
7. Probability distribution: Normal, binomial and poison

8. Test of hypotheses: Students t-test, X2 distribution (Chi square), correlation coefficient and analysis of variance (ANOVA).
9. Use of internet, worldwide web, searching for data bases
10. Locating research material on Medline
11. Learning to use NCBI and EMBL.
12. Analysis of Viral genome sequences using programmes like Bioedit, DNAstar.
13. Searching DNA databases with FASTA and BLAST
14. Pairwise sequence alignments
15. Phylogeny & tree building
16. Protein structure prediction.

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

CO1: Acquire skills on laboratory biosafety and biosecurity measures, sample collection methods, SARS-CoV-2 diagnostic tests through chart preparations.

CO2: Knowhow isolation of viral RNA/DNA from various sources, PCR amplification of virus genes, induction, analysis and purification of expressed virus coat protein gene, ICT based PoC tests and isolation of metal nanoparticles from green sources and their characterization using various approaches.

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 and nalyze viral genome sequences using programs like Bio Edit and learn to use NCBI, EMBL for nucleic acid/protein analysis and phylogenetic tree construction.

Reference books/Manuals (Molecular Techniques):

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

Learning Resources and Suggested books / manuals (Biostatistics and Bioinformatics):

1. Statistical Methods, S.P. Gupta 2. Fundamentals of mathematical statistics.

2. S.C. Gupta &Kapoor 3. Statistical methods in biological and Health Science, J.S. Milton & J.O. Tsokan

3. 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.

4. Bioinformatics: Sequence and Genome Analysis by David W. Mount, Cold Spring Harbor Laboratory Press.

5. Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids by Richard Durbin, Sean R. Eddy, Anders Krogh, Graeme Mitchison, Cambridge University Press.

6. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, Second Edition by Andreas D. Baxevanis, B. F. Francis Ouellette, Wiley-Interscience

7. Foundations to bioinformatics – Evolution, similar macromolecular components, constancy of gene number and core proteome in closely related organisms.

8. Bioinformatics data – nucleic acid sequence, protein sequence, protein structure, genomic, proteomic and metabolomics information.

9. Bioinformatics databases – types, design, file formats, access tools with examples.

10. Bioinformatics tools and Resources – free online tools, downloadable free tools, software packages, internet.

11. Bioinformatics - From Nucleic Acids and Proteins to Cell Metabolism. 1995, by Schomburg and Label VCH Publ.

12. Bioinformatics: Sequence and Genome Analysis. By D.W. Mount. CSHL Press.

13. Bioinformatics: Methods and Protocols, Ed by S.Misener and S.A. Krawetz. Humana Press, 2000.

VIR-208: Open Online Transdisciplinary Course-1

OOTC	Each online course is assigned with two credits with minimum duration of 40 hours learning with 100 marks internal assessment through tests, quiz and assignments as per the program. A student can opt for two or three courses of shorter duration to acquire the assigned two credits. Open online transdisciplinary courses can be chosen based on the interest of the students without confinement to traditional academic schedules.
Tutorial: Swayam, NPTL and other online courses	
Semester: I	**Credits: 2 Credits**

VIR-209: Indian Knowledge Systems - 2

Lecture: 2 hours/week	
Tutorial: Textbooks, E-learning resources, study materials, PowerPoint lectures	
Semester: I	**Credits: 0**

********* END OF THE SECOND SEMESTER ********

SEMESTER-III

THEORY-VIR-301: ANIMAL AND HUMAN VIROLOGY

[Core Course – 7]

Lecture: 4 hours/week	**Internal test Assessment: 30 Marks**
Tutorial: Textbooks, E-learning resources, study materials, PowerPoint lectures	**Total Marks: 100 Marks** **Semester End Theory Examination: 70 Marks**
Semester: I	**Credits: 4 Credits**

Course Educational Objectives:

1. To acquire knowledge on virus-host interactions and influence of virus on host cells.
2. To learn about host innate and adaptive immune response to viruses and mechanism of virus entry, virus infection and viral spread in the body.
3. To know the routes of transmission of viruses and to learn about epidemiological concepts of viruses.
4. To learn about measures of disease occurrence, disease determinants, ecology, epidemiology and surveillance of virus diseases, strategies of virus maintenance in communities, basic concepts, types and patterns of disease survey, prevention, and control methods of viruses.

UNIT-I

Virus-host interactions: 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 transmission- trans-placental, trans-ovarial; Horizontal transmission- contact, sexual, fecal-oral, respiratory-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.

CO2: Describe host innate and adaptive immune response to viruses and mechanism of virus entry, virus infection and viral spread in the body.

CO3: Learn about the various modes of vertical and horizontal transmission of animal and human viruses, zoonotic virus infections, 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 and use the theoretical knowledge obtained in animal and human virology to conduct research or to foster employability in national and

international Veterinary/Biotech/Pharma industries/ research or educational institutes and to grab the opportunities for higher education in national and international institutes and to compete for UGC-CSIR-NET, GATE, APSET, AP RCET and other competitive examinations.

Learning resources and suggested books:

1. Fenner and Whites Medical virology 6th Edition (2016) Christopher J. Burell et al. Academic press.
2. Veterinary Virology 3rd Edition (1999) Federick A. Murphy et al. Academic press publishers.
3. VJawetz Melnick and Adelbergs Medical Microbiology 28th Edition (2019), Stefen Riedal et al. MC Graw Hill.
4. Veterinary Clinical Epidemiology from patient to population 4th Edition (2020), Ronald D. Smith, CRC Press.
5. Epidemiology, diagnosis and Management of Zoonoses. (2004). K.G. Narayana Sri Kuldeep Sharma Pub.
6. Medical Mirobiology.(1997). Fifteenth edition. Edited by D.Green wood, R.C.Slack and J.F.Peutherer. Churchill Lingstone.
7. Veterinary Virology. F.A. Murphy et al. (1999). 3rd Edition. Academic Press.
8. Medical Virology. (1994). 4th ed. D.O. White and F.Fenner. Academic Press. (chapters–12,13 to 29).
9. Veterinary Virology. (1993). 4th ed. F. Fenner. Academic Press (Part-II).
10. Textbook of Human Virology, 2nd Edition. (1991). R.W. Belshe. Mosby yearbook.
11. Viruses of vertebrates. (1989). J.S. Porter field, Bailliere Tindals.
12. Veterinary Epidemiology. (1986). M. Thrusfield. Butter Worth Publications.
13. Methods in Environmental Virology. (1982). C.P. Gerba and S.M. Goyal. Marcel Dekker Inc.

THEORY-VIR-302A: MOLECULAR VIROLOGY

[Core Course-8(A)]

Lecture: 4 hours/week	**Internal test Assessment: 25 Marks** **[Mid Semester Examination: 15 Marks; Attendance: 5 Marks; Students Seminar: 5 Marks)**
Tutorial: Textbooks, E-learning resources, study materials, PowerPoint lectures	**Total Marks: 75 Marks** **Semester End Theory Examination: 50 Marks**
Semester: I	**Credits: 3 Credits**

Course Educational Objectives:

1. To understand molecular architecture of viruses and effect 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 and to discuss about the regulation of viral genome expression.
4. To know about the concepts of tumors 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 - Picorna-, Tobamo-, Poty, and Bromoviruses; Negative and Ambisense ss RNA viruses- Orthomyxo-, Bunya- and Rhabdoviruses; dsRNA viruses- Reo- and Birnaviruses. ssRNA viruses with DNA intermediate - 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

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

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

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

CO4: Describe the regulation of viral genome expression and concepts/molecular mechanisms of transformation of cells by tumor viruses and therapeutic interventions and oncolytic viruses and use the theoretical knowledge obtained in molecular virology to conduct research or to foster employability in national and international agriculture/veterinary/biotech/pharma industries/ research or educational institutes and to grab the opportunities for higher education in national and international institutes and to compete for UGC-CSIR-NET, GATE, APSET, AP RCET and other competitive examinations.

Learning resources and suggested books:

1. Principles of Virology- Molecular biology, pathogenesis and control. (2004).
2. S.J.Flint, L.W.Enquist, R.M.Krug, V.R.Racaniello and A.M.Skalka.ASM press.
3. Medical Virology. (2001). 5th edition. D.O. White, F.J. Fenner. Academic Press.
4. Introduction to Modern Virology. (2001). 5th edition. Dimmock et al. Blackwell Sci.
5. Matthews' Plant Virology. (2001). 4th edition. R. Hull. Academic Press.

6. Fundamental Virology. (2001).4th Edition. Editors-in-Chief David M.Knipe, Peter.M.Howley Lippincott.

7. Basic Virology. (1999). E.K. Wagner and M.J.Hewlett. Blackwell Science, INC.,

8. Principles of Molecular Virology. (1997). Second edition. A.J. Cann. Acad. Press.

9. Fields Virology. (1996). 3rd Edition. B.N. Fields, D.M. Knipe, P.M. Howley.

10. Virology. (1994). 3rd edition. Fraenkel Conrat, P.C. Kimbal and J.A. Levy. Printice Hall.

11. Encyclopedia of Virology. (1994). R.G. Webster and A. Granoff (9ed.). Vol. I, II and III.

(OR)

THEORY-VIR-302B: AGRICULTURAL AND VETERINARY VIRUSES AND THEIR MANAGEMENT

[Core Course 8(B)]

Lecture: 4 hours/week	**Internal test Assessment: 25 Marks** **[Mid Semester Examination: 15 Marks; Attendance: 5 Marks; Students Seminar: 5 Marks)**
Tutorial: Textbooks, E-learning resources, study materials, PowerPoint lectures	**Total Marks: 75 Marks** **Semester End Theory Examination: 50 Marks**
Semester: I	**Credits: 3 Credits**

Course Educational Objectives:

1. To understand molecular architecture of plant, animal and bacteriophages.
2. To learn about important animal viruses and veterinary epidemiology.
3. To learn about important plant, veterinary and human viruses.
4. To learn about important plant, veterinary and human virus diagnostic and management methods

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.

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: Understand molecular architecture of plant, animal and bacteriophages.

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

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

CO4: Acquire knowledge about biological, physical, serological, and molecular methods used for detection of viruses and describe strategies followed for management of plant and animal viruses and conduct research or foster employability in national and international agriculture/veterinary/biotech/pharma industries/ research or educational

institutes and to grab the opportunities for higher education in national and international institutes and to compete for UGC-CSIR-NET, GATE, APSET, AP RCET and other competitive examinations.

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).
17. 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).

THEORY-VIR-303A: ANIMAL AND HUMAN VIRUS DISEASES

[Core Course – 9(A)]

Lecture: 4 hours/week	**Internal test Assessment: 25 Marks** **[Mid Semester Examination: 15 Marks; Attendance: 5 Marks; Students Seminar: 5 Marks)**
Tutorial: Textbooks, E-learning resources, study materials, PowerPoint lectures	**Total Marks: 75 Marks** **Semester End Theory Examination: 50 Marks**
Semester: I	**Credits: 3 Credits**

Course Educational Objectives:

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

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

UNIT-I

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

UNIT-II

RNA Viruses: ***Orthomyxoviridae***-Human influenza, birdflu; ***Paramyxoviridae*****-** Measles, Mumps, Canine distemper and Newcastle disease; ***Rhabdoviridae***- Rabies; ***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, Canine and Porcine parvoviruses; ***Poxviridae*****-** Smallpox, Vaccinia, Sheeppox and Fowlpox viruses; ***Herpesviridae*****-** Human herpes viruses, Varicella-Zoster, Cytomegalo, 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, silkworm, fish and prawn: Biology, prevention and management of economically important viruses.

Emerging and re-emerging viruses: Human Immunodeficiency virus, SARS, Corona, Influenza, bird flu**,** Dengue & Haemorrhagic Fever Viruses, Japanese encephalitis, chikungunya virus, West Nile virus, Nipah virus, Chandipura virus, monkey pox virus, Ebola virus, Marburg, Zika virus, Crimean-Congo Harmorrhagic fever, Kyasanur Forest Disease.

Thrombocytopenia virus.

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 re-emerging virus diseases.

Learning resources and suggested books:

1. Clinical Virology 4th Edition (2016) Douglas D. Richman et al. ASM Press.

2. Fenners Veterinary Virology 4th Edition (2010) N. James Maclachlan et al. Academic Press.

3. Pathology and Pathogenesis of Human Viral Diseases 1sr Edition (2000) John E. Craighead, Academic Press.

4. Viruses and Human Diseases 2nd Edition (2008) James Strauss and Ellen Strauss. Academic Press.

5. Emerging and Reemerging Viral PathogensVolume 2: Applied Virology Approaches Relatedto Human, Animal and Environmental Pathogens, Moulay Mustapha Ennaji, (2019).AcademicPress.

6. Environmental Virology and Virus Ecology, Carolyn M. Malmstrom, (2018), Academic Press.

7. Infectious Diseases, Microbiology and Virology, Luke S. P. Moore, James C. Hatcher,Cambridge Medicine, (2019).

8. Clinical Veterinary Microbiology, 2e 2nd Edition, Markey, Bryan, Leonard, Bryan Markey,Finola Leonard, Marie Archambault, Ann Cullinane, Mosby publication, (2019).

9. Veterinary Virology, Frederick A. Murphy, E. Paul J. Gibbs, Marian C. Horzinek, Michael J.Studdert, (2019),Academic Press.

10. Textbook of Medical Virology, December 14, (20180, by B. Mishra (Author), details, 256pages, Publisher: CBS Publishers & Distributors Pvt Ltd, India (2018).

11. 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).

12. Clinical Virology. D.D. Richman *et al.,* 2nd Edition. (2002). ASM Press.

13. Bluetongue. –(2007). Gaya Prasad and Meenakshi Yashpal Singh Mallik. Sri Kuldeep Sharma Pub.

14. Epidemiology, diagnosis and Management of Zoonoses. (2004). K.G. Narayana Sri Kuldeep Sharma Pub.

15. Foot and mouth disease –A Monograph (2003). S.C. Adhakha Sri Kuldeep Sharma Pub.

16. Veterinary Virology. F.A. Murphy *et al.* (1999). 3rd Edition. Academic Press.

17. Principles of Virology- Molecular biology, pathogenesis and control. (2000).

18. S.J.Flint, L.W.Enquist, R.M.Krug, V.R.Racaniello and A.M.Skalka.ASM press.

19. Medical Virology. (1994). 4th ed. D.O. White and F.Fenner.Academic Press. (chapters – 12,13 to 29).

20. Viral diseases of animal in India, (1994). S.N,Sharma and S.C. Adlakha, V.S. Bhatt Pub.

21. Textbook of Human Virology, 2nd Edition. (1991). R.W. Belshe.Mosby yearbook.

22. Viral Infections of Humans: Epidemiology and control. (1989). 3rd Edition.

23. A.S.Evans (ed). Plenum Medical Book Company.

24. Medical Microbiology. (1997). Fifteenth edition.Edited by D.Green wood, R.C.Slack and J.F.Peutherer. Churchill Lingstone.

25. Medical Microbiology. (1995). 22ndEdition.G.F.Brooks, J.S.Butel and S.A. Morse.Lange Medical Broks/Mc Graw-Hill.

26. Viruses of Vertebrates. (1989). J.S. Porter field, Bailliere Tindals.

THEORY-VIR-303B: EMERGING AND RE-EMERGING VIRUS DISEASES

[Core Course – 9(B)]

Lecture: 4 hours/week	**Internal test Assessment: 25 Marks** **[Mid Semester Examination: 15 Marks; Attendance: 5 Marks; Students Seminar: 5 Marks)**
Tutorial: Textbooks, E-learning resources, study materials, PowerPoint lectures	**Total Marks: 75 Marks** **Semester End Theory Examination: 50 Marks**
Semester: I	**Credits: 3 Credits**

Course Educational Objectives:

1. To acquire knowledge on biosafety, biosecurity measures and other requirements that are important to set up a clinical diagnostic laboratory.
2. To understand the emerging and re-emerging infectious viruses and diseases.
3. To learn about epidemiology of emerging virus diseases, virus maintenance in communities, concepts of survey.
4. To knowhow to prevent, and control of emerging and re-emerging viruses.

UNIT-I

Biosafety measures: Levels and Biosafety and lab requirements, categories and risk groups of microorganisms, Concept of universal precautions, biohazard. 8. Handling of waste, waste segregation and management including disposal; Laboratory accidents, prevention, first aid; Stores supplies, indenting shelf life, grades of chemicals; Principles and methods of ensuring of quality assistance in the laboratory.

Requirements of Clinical Diagnostic Laboratory: Knowledge of lab organization, reporting and recording procedures; Ethics of laboratory practice, confidentiality of reports, Medico legal aspects of record keeping; Method of collection transport, packing and storing of specimens, the concept of pre analytical, analytical and post analytical; Importance of labeling and identification; Preparations of solutions; Laboratory glassware and its uses.

UNIT-II

Emerging and re-emerging viruses: Human Immunodeficiency virus, SARS, Corona, Influenza, bird flu**,** Dengue & Haemorrhagic Fever Viruses, Japanese encephalitis, chikungunya virus, West Nile virus, Nipah virus, Chandipura virus, money pox virus, Ebola virus, Marburg, Zika virus, Crimean-Congo Harmorrhagic fever, Kyasanur Forest Disease. Thrombocytopenia virus.

UNIT-III

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

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

UNIT-IV

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

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

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

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

CO1: Acquire knowledge on biosafety, biosecurity measures and other requirements that are important to set up a clinical diagnostic laboratory.

CO2: Understand the emerging and re-emerging infectious viruses and diseases.

CO3: Learn about epidemiology of emerging virus diseases, virus maintenance in communities, concepts of survey.

CO4: Knowhow to prevent, and control of emerging and re-emerging viruses.

Learning resources and suggested books:

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

Practical V: Vir-304A: MOLECULAR VIROLOGY & ANIMAL AND HUMAN VIRUS DISEASES

[Practical related to CC8(A) & 9(A)]

Lecture: 6 hours/week	**Internal test Assessment: 15 Marks**
Tutorial: Textbooks, E-learning resources, study materials, PowerPoint lectures	**Total Marks: 75 Marks** **Semester End Practical Examination: 35 Marks**
Semester: I	**Credits: 2 Credits**

List of Experiments: (Molecular Virology)

1. Purification of viruses by differential centrifugation.
2. Isolation and analysis of virus coat protein.
3. Isolation of virus RNA from virus infected sample/purified virus preparation.
4. Isolation and analysis of dsRNA from virus infected tissues.
5. Serodiagnosis of virus infections (HBV and HCV) of humans using kits.
6. Study of inactivation of viruses by various physical and chemical agents.

List of Experiments: (Animal and Human Virus Diseases)

1. Classification of laboratories and Biosafety guidelines (Theory exercise)
2. Preparation of glassware, buffers and media for cell cultures
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.

10. Study of pathogenic lesions of animal virus diseases through slides.

11. Visits to local sericulture, poultry, fish and prawn farms.

Learning resources and suggested books/ Manuals (Molecular Virology):

1. Principles of Virology- Molecular biology, pathogenesis and control. (2004).
2. S.J.Flint, L.W.Enquist, R.M.Krug, V.R.Racaniello and A.M.Skalka.ASM press.
3. Medical Virology. (2001). 5th edition. D.O. White, F.J. Fenner. Academic Press.
4. Introduction to Modern Virology. (2001). 5th edition. Dimmock et al. Blackwell Sci.
5. Matthews' Plant Virology. (2001). 4th edition. R. Hull. Academic Press.
6. Fundamental Virology. (2001).4th Edition. Editors-in-Chief David M.Knipe, Peter.M.Howley. Lippincott.
7. Basic Virology. (1999). E.K. Wagner and M.J.Hewlett. Blackwell Science, INC.
8. Principles of Molecular Virology. (1997). Second edition. A.J. Cann. Acad. Press.

Suggested books / Manuals <u>(Animal and Human Virus Diseases)</u>:

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).

(OR)

PRACTICAL V: VIR-304B: AGRICULTURAL AND VETERINARY VIRUS DISEASES AND THEIR MANAGEMENT & EMERGING AND RE-EMERGING VIRUS DISEASES

[Practical related to CC8(B) & 9(B)]

Lecture: 6 hours/week	**Internal test Assessment: 15 Marks**
Tutorial: Textbooks, E-learning resources, study materials, PowerPoint lectures	**Semester End Practical Examination: 35 Marks** **Total Marks: 75 Marks**
Semester: I	**Credits: 2 Credits**

List of Experiments: (Agricultural and Veterinary Virus Diseases and their Management)

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)

List of Experiments: (Emerging and Reemerging Virus Diseases)

1. Classification of laboratories (Theory exercise)
2. Biosafety guidelines (Theory exercise)
3. Preparation of glassware for cell cultures
4. Preparation of buffers and media
5. Collection, filtration and preservation of calf serum.
6. Culturing and sub-culturing of Sheep kidney cells
7. Inoculation of virus into sheep kidney cell cultures.
8. Study of pathogenic lesions of animal virus diseases through slides.
9. Serodiagnosis of virus infections (HBV and HCV) of humans using kits.
10. Participation in vaccination programs (extension activity).
11. Visits to local sericulture, poultry, fish and prawn farms.

Suggested Books / Manuals: (Agricultural and Veterinary Virus Diseases and their Management)

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. Matthews' Plant Virology. (2001). 4th edition. R. Hull. Academic Press.

9. Fundamental Virology. (2001).4th Edition. Editors-in-Chief David M.Knipe, Peter.M.Howley. Lippincott.

10. Basic Virology. (1999). E.K. Wagner and M.J.Hewlett. Blackwell Science, INC.

11. Principles of Molecular Virology. (1997). Second edition. A.J. Cann. Acad. Press.

Learning resources and suggested books: (Emerging and Reemerging Virus Diseases)

12. Epidemiology, diagnosis and Management of Zoonses. (2004). K.G. Narayana Sri Kuldeep Sharma Pub.

13. Clinical Virology. D.D. Richman *et al.,* 2nd Edition. (2002). ASM Press.

14. 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.

15. Veterinary Virology. F.A. Murphy *et al. (*1999). 3rd Edition. Academic Press.

THEORY-VIR-305A: APPLIED VIROLOGY (Mandatory)

[Skill Oriented Course – 5(A)]

Lecture: 3 hours/week	**Internal test Assessment: 25 Marks** **[Mid Semester Examination: 15 Marks; Attendance: 5 Marks; Students Seminar: 5 Marks)**
Tutorial: Textbooks, E-learning resources, study materials, PowerPoint lectures	**Total Marks: 75 Marks** **Semester End Theory Examination: 50 Marks**
Semester: I	**Credits: 3 Credits**

Course Educational Objectives:

1. To learn about viruses as model systems in Molecular Biology, viruses as genetic resources, exploitation of viruses as functional gene delivery/therapy systems virus-based biopesticides.
2. To acquire knowledge about phage display and therapy technologies and viruses as biological weapons and to learn about modern viral vaccines.
3. To understand about public health virology, concepts related to virus resistant crops and virus based nanotechnology.
4. To gain knowledge on viruses of biological warfare, biocrime and bioterrorism agents and concepts of biosafety and biosecurity, ethics in Virology and Intellectual property rights.

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

UNIT-II

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

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

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

UNIT-III

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

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

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

UNIT-IV

Viruses as biological warfare, bio-crime and bioterrorism agents: Small poxvirus (variola), viral encephalitis and viral hemorrhagic fevers; HIV, viral hemorrhagic fevers (Ebola), corona virus sand 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: Learn about viruses as model systems in Molecular Biology, viruses as genetic resources, exploitation of viruses as functional gene delivery/therapy systems virus-based biopesticides CO2: Acquire knowledge about phage display and therapy technologies and viruses as biological weapons and learn about modern viral vaccines

CO3: Understand about public health virology, concepts related to virus resistant crops and virus based nanotechnology.

CO4: Understand the utilization of viruses as biological weapons and basic principles of biosafety, biosecurity, and ethical/regulatory issues in Virology and basics in Intellectual Property Rights (IPR) and use the theoretical knowledge obtained in applied virology to conduct research or to foster employability in national and international Agriculture/veterinary/Biotech/Pharma industries/ research or educational institutes and to grab the opportunities for higher education in national and international institutes and to compete for UGC-CSIR-NET, GATE, APSET, AP RCET and other competitive examinations.

Learning resources and suggested books:

1. Applied Plant Virology 2nd Edition (1991) by WALKEY D G, SPRINGER CBS.
2. Applied Virology Research Volume 3 New Diagnostic Procedures (2018) R. G. Marusyk et al. SPRINGER SCIENCE+BUSINESS MEDIA, LLC.
3. Applied Virology 1st Edition (1984) Edouard Krustak. Academic Press.
4. Applied Virology: Research and Clinical Applications 1st Edition (2022) Dennis J.

Bamford. Oxford University Press.

5. Applied Virology: Methods and Protocols 1st Edition (2020) Prakash S. Bisen. Springer Nature.
6. Introduction to Modern Virology 7th Edition (2020) Nigel J. Dimmock et al. Wiley-Blackwell.
7. Techniques in diagnoses of Plant Viruses (Plant Pathogens -6)-(2008). Govind.Rao, Rodrigo A. Valverde & C.I. Dovas, Stadium Press.
8. Epidemiology, diagnosis and Management of Zoonses. (2004). K.G. Narayana Sri Kuldeep Sharma Pub.
9. Field's Virology. (2002). Vol. I, II.

10. Bailey and Scotts' Diagnostic Microbiology. 11th Edition. (2002). By B.A. Forbes et al., Mosby publisher.

11. Clinical Virology. (2002). 2nd edition. D.D.Richman et al., ASM.

12. Principles of gene manipulation. 6th edition. (2002). By S. Primrose, R. Twyman and B. Old. Blackwell Science.

13. Matthews' Plant Virology. (2001). By R. Hull. Academic Press.

14. 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.

15. Control of Plant Virus Diseases. By Hadidi *et al.*(Eds). APS. USA.

16. Medical Virology. (1994). 4th ed. D.O. White and F. Fenner. Academic Press.

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

18. Wilson, D.R. and Finley, B.B. 1998. Phage Display: Applications, innovations and issues in phage and host biology. Canadian J. Microbiol. 44: 313-329.

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, alcohol and single cell proteins

THEORY-VIR-305B: CLINICAL VIROLOGY

[Skill Oriented Course - 5(B)]

Lecture: 4 hours/week	**Internal test Assessment: 25 Marks** **[Mid Semester Examination: 15 Marks; Attendance: 5 Marks; Students Seminar: 5 Marks)**
Tutorial: Textbooks, E-learning resources, study materials, PowerPoint lectures	**Total Marks: 75 Marks** **Semester End Theory Examination: 50 Marks**
Semester: I	**Credits: 3 Credits**

Course Educational Objectives:

1. To acquire knowledge requirements that are important to set up a clinical diagnostic laboratory.

2. To learn about biosafety levels, biosecurity measures used for testing clinical samples.
3. To acquire knowledge about clinically important food-borne, blood borne, vector borne, and contact borne and zoonotic diseases.
4. Knowhow the strategies used for clinically important virus prevention and control.

UNIT-I

Requirements of Clinical Diagnostic Laboratory; Knowledge of lab organization, reporting and recording procedures; Ethics of laboratory practice, confidentiality of reports, Medico legal aspects of record keeping; the concept of pre analytical, analytical and post analytical; Importance of labeling and identification; Preparations of solutions; Laboratory glassware and its uses; Concept of universal precautions, biohazard; Handling of waste, waste segregation and management including disposal; Laboratory accidents, prevention, first aid; Stores supplies, indenting shelf life, grades of chemicals; Principles and methods of ensuring of quality assistance in the laboratory.

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 (Nipah, Ebola) and their role in the society.

UNIT-IV

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

Learning resources and suggested books:

1. Principles and Practice of Clinical Virology, Carol Shoshkes Reiss, (2009).Editor:, 6th ed. ISBN: 9780470517994. $450 p. 968.

2. Clinical Virology. D.D. Richman *et al.,* 2nd Edition. (2002), ASM Press.

3. Principles of Virology- Molecular biology, pathogenesis and control. (2000). S.J.Flint, L.W.Enquist, R.M.Krug, V.R.Racaniello and A.M.Skalka. ASM press.

4. Fields Virology. (2001). 3rd Edition. Vol. 1, 2. B.N. Fields, D.M. Knipe, P.M. Howley

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

CO1: Acquire knowledge requirements that are important to set up a clinical diagnostic laboratory.

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

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

CO4: Learn about the approaches used for prevention and control of clinically important infectious virus diseases and use the theoretical knowledge in clinical virology to conduct research or to foster employability in national and international veterinary/Biotech/Pharma industries/ research or educational institutes and to grab theopportunities for higher education in national and international institutesand to compete for the competitive exams such as UGC-CSIR-NET, GATE, APSET, AP RCET and other competitive examinations

THEORY-VIR-306A: INDUSTRIAL BIOTECHNOLOGY

[Skill Oriented Course - 6(A)]

Lecture: 4 hours/week	**Internal test Assessment: 25 Marks** **[Mid Semester Examination: 15 Marks; Attendance: 5 Marks; Students Seminar: 5 Marks)**
Tutorial: Textbooks, E-learning resources, study materials, PowerPoint lectures	**Total Marks: 75 Marks** **Semester End Theory Examination: 50 Marks**
Semester: I	**Credits: 3 Credits**

Course Educational Objectives:

1. To understand the cultivation of industrially important organisms through fermentation and strain improvement methods.
2. To learn the basic concepts of the types of fermentation processes and to learn about important, bioprocess control measurements.
3. To describe the downstream processing and its industrial applications and learn about physical, chemical, and enzymatic methods of product purification.
4. To learn the industrial production of enzymes, beverages, alcohol and single cell proteins and quality assurance and management techniques and its importance in marketing

UNIT-I

Bioprocesses - concepts and design. Industrially important microorganisms – Isolation, primary and secondary screening, preservation, and improvement of industrially important strains. Upstream processing - Media for industrial fermentation - Formulation, optimization. Sterilization; Stages of upstream - Growth of inoculums, fermenter pre-culture, and production fermentation.

Types of fermentation: Batch, continuous, submerged, aerobic and anaerobic fermentation.**;** Strain improvement methods – Physical, chemical and molecular methods**.**

UNIT-II

Fermenter: Design, types, Instrumentation. Productivity; Yield coefficients; Heat production; Aeration and agitation. Gas exchange and mass transfer. Computer Applications in fermentation technology. Fermentation Economics.

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

Downstream Processing: Recovery and purification of intracellular and extracellular products. Biomass separation by centrifugation, filtration, flocculation, and other recent developments; Cell disintegration.

Physical, chemical, and enzymatic methods.: Extraction - Solvent, two-phase, liquid extraction, whole broth, aqueous multiphase extraction; Purification by different methods. Concentration by precipitation, ultra-filtration, reverse osmosis; enzymatic methods, drying and crystallization.

UNIT – IV

Production of industrially important products: Industrial production of alcohol (ethanol), alcohol beverages (beer), acids (citric acid), solvents (glycerol), antibiotics (penicillin,),

amino

acids (lysine), enzymes (Streptokinase), vitamins ($B_{12.}$) and their applications; role of enzymes; Single cell protein.

Quality assurance and quality management in pharmaceuticals; IPR and regulations

Learning resources and suggested books:

1. 1. Industrial Biotechnology 1st Edition (2021) Debabrata Das and Soumya Pandit. CRC
2. Press.
3. Industrial Biotechnology: Products and Processes 1st Edition (2016) Christoph Wittmann and James C. Liao. Wiley Publishers.
4. Industrial Biotechnology Sustainable Production and Bioresource Utilization 1st Edition (2016) Devarajan Thangadurai et al. Academic Press.
5. Industrial Microbiology and Biotechnology 1st Edition (2022) Pradeep Verma. Springer. Crueger & Crueger Biotechnology: A Text Book of Industrial microbiology 2nd edition.
6. Comprehensive Biotechnology. Volumes 1, 2, 3 & 4. Moo-Young M., Pergamon Press, 2011.
7. Hui Y H 2006 Food Biochemistry and Food Processing Blackwell
8. Mansi Emtel, Bryle CFA. Fermentation Microbiology and Biotechnology, 2nd Edition, Taylor & Francis Ltd, UK, 2007.
9. U. Satayanarayan – Biotechnology, First Edition (2005) Books and Allied (P) Ltd. Kolkata Demain, A.L Biology of Industrial Microorganisms.
10. Damien and Devies – Microbial Technology Edition (1994).
11. LE Casida – Industrial Microbiology Edition (1994).
12. Joshi, V.K. Ashok Pondey 1999 Biotechnology and Food Fermentation Vol. I & II.
13. Prescott and Dunn's, Industrial Microbiology 4th edition.
14. Reed, G. Industrial Microbiology, CBS Publishers.
15. Microbial Technology Vol. I & II. Pepplelr & Perllman (EDS).
16. Microbial Ecology – Fundamentals and applications. Atlas and Bartha.
17. Stanbury and Whittaker – Principles of Sterilization techniques, First Indian reprint Edition (1997). Aditya Book (P) Ltd. New Delhi
18. Michael J. Waites - Industrial microbiology: an introduction 7th Edition; Wiley-Blackwell 2008.

19. Hobbs, B.C. and Rioberts,D 1993 Food Poisoning and Food Hygiene Edward Anold, London.

20. H Patel – Industrial Microbiology 4th Edition (2003). 7. KS Bilgrami and AK Pandey – Introduction to Biotechnology Edition 2nd (1998).

21. Baily JE and Ollis DF., Biochemical Engineering fundamentals, 2nd Edition, McGraw- Hill Book Co., New York, 1986.

22. Shara L. Aranoff, Daniel R. Pearson, Deanna Tanner Okun, Irving A. Williamson, Dean A. Pinkert – Industrial Biotechnology; Nova Science 2009.

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

CO1: Understand the cultivation of industrially important organisms, strain improvement method, sand 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 and learn about physical, chemical, and enzymatic methods of product purification.

CO4: Learn the industrial production of enzymes, beverages, alcohol and single cell proteins and quality assurance and management techniques and its importance in marketing

THEORY-VIR-306B: MEDICAL LAB TECHNOLOGY

[Skill Oriented Course 6(B)]

Lecture: 4 hours/week	**Internal test Assessment: 25 Marks** **[Mid Semester Examination: 15 Marks; Attendance: 5 Marks; Students Seminar: 5 Marks)**
Tutorial: Textbooks, E-learning resources, study materials, PowerPoint lectures	**Total Marks: 75 Marks** **Semester End Theory Examination: 50 Marks**
Semester: I	**Credits: 3 Credits**

Course Educational Objectives:

1. To acquire knowledge to distinguish GLP, GCP, GCLP and know about other biosafety guidelines.
2. To learn sample recording, collection and screening for pathogens and to discuss the complete blood analysis.
3. To acquire knowledge on infectious diseases of human beings and their diagnosis.

4. To analysis of urine and feces using biochemical tests.

UNIT-I

Requirements of Clinical Diagnostic Laboratory; Knowledge of lab organization, reporting and recording procedures; Ethics of laboratory practice, confidentiality of reports, Medico legal aspects of record keeping; Method of collection transport, packing and storing of specimens, the concept of pre analytical, analytical and post analytical; Importance of labeling and identification; Preparations of solutions; Laboratory glassware and its uses; Concept of universal precautions, biohazard. 8. Handling of waste, waste segregation and management including disposal; Laboratory accidents, prevention, first aid; Stores supplies, indenting shelf life, grades of chemicals; Principles and methods of ensuring of quality assistance in the laboratory.

UNIT–II

Specimen Collection-Types of Specimens, Method of specimen collection (Blood, serum, Urine and others), Pre-analytical & analytical variables, Use of preservatives in specimen collection, Use of proper Anticoagulants in specimen collection & Introduction to Laboratory Apparatus.

Blood- Composition and general function of blood; Description of blood cells - normal counts & function; Importance of blood groups composition in human, Rh typing, transfusion reactions, and diseases associated with blood transfusion – Hemolytic anemia; significance of coombs test; Blood donor selection, screening; Transfusion transmitted diseases & their lab diagnosis

UNIT–III

Molecular Pathology –Infectious diseases and Pathogen; Types, Standards and Standardization of Molecular Diagnostics, Serological and Molecular Diagnosis of human diseases-bacteria (Tuberculosis-*M. tuberculi*, Peptic ulcer - *H. pylori*), fungus, virus (HPV, HIV, Hepatitis- Hepatitis virus, dengue; SARS-CoV-2); parasites (filarial and malaria)

UNIT–IV

Investigation Urine & Faces Analysis; Introduction; Maintenance & Equipments of Pathology Lab; Preparation of Reagents; Urine; Formation and composition; Collection, Preservation, Gravity & PH; Examination–Physical; Examination– Chemical; Sugar; Ketone Bodies, Bile; Blood, Crystals; Parasites & Abnormal Cells; Feces–Formation, Physical & Chemical Examination; Preparation of stool sample for microscopic examination; Sputum Examination; Assessment.

Learning resources and suggested books:

1. Clinical Laboratory Science: The Basics and Routine Techniques 7th Edition (2020) Mary Louise Turgeon, Elsevier.

2. Textbook of Medical Laboratory Technology 3rd Edition (2018) Sood R, Jaypee Brothers Medical Publishers.

3. Tietz Textbook of Clinical Chemistry and Molecular Diagnostics 7th Edition, (2023) Carl A. Burtis et al. Elsevier.

4. Henry's Clinical Diagnosis and Management by Laboratory Methods 24th Edition, 2021, Richard A. McPherson, Matthew R. Pincus, Elsevier.

5. Medical Laboratory Science Review 5th Edition (2018) Robert R. Harr. F.A. Davis Company.

6. Concise Book on Medical Laboratory Technology, 2005 reprint, 1st Edn., C. R. Maiti, New Central Book Agency (p) Ltd, Kolkata, India.

7. Introduction of Medical Laboratory Technique,1998, 7th Edn., Baker F. J., Silverton R. E., Pallister C. J., Butterworth-Heinemann, UK.

8. Molecular Diagnostics: For the Clinical Laboratorian / Edition 2 William B. Coleman (Editor), Gregory J. Tsongalis (Editor) Publisher: Springer-Verlag New York, LLC.

9. Buckingham and Flaw's, "Molecular Diagnostics: Fundamentals, Methods and Clinical Applications", F.A. Davis Company; First edition, 2007

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

CO1: Differentiate GCP, GLP and GCLP and understand the importance of laboratory biosafety guidelines and learn the sample collection for and examination of pathogens and their screening.

CO2: Learn to understand the blood composition, blood groups, Rh typing and identify the blood transfusion related diseases and the significance of liver function tests.

CO3: Discuss the infectious diseases and pathogens of human beings and their detection methods.

CO4: Describe the examination of urine and feces using biochemical tests and use the theoretical knowledge obtained in medical lab technology to conduct research or to foster employability in national and international veterinary/biotech/pharma industries/ research or educational institutes and to set up a diagnostic laboratory with entrepreneur skills and to grab the opportunities for higher education in national and international institutes and to compete for UGC-CSIR-NET, GATE, APSET, APRCET and other competitive examinations.

PRACTICAL - VI - VIR-307A: APPLIED VIROLOGY & INDUSTRIAL BIOTECHNOLOGY

[Practical related to SOC5(A) & 6(A)]

Practical: 6 hours/week	**Internal test Assessment: 15 Marks**
Tutorial: Lab manuals, E-learning resources, textbooks and study materials	**Semester End Practical Examination: 35 Marks** **Total Marks: 50 Marks**
Semester: I	**Credits: 2 Credits**

Course Educational Objectives:

1. To learn about biosafety guidelines through chart preparations and application of NPV as biopesticide.
2. To conduct extension activities by participating vaccination camps and awareness programs at rural areas and visit local sericulture, fish and prawn farms to observe virus diseases.
3. To learn and to practice various methods used for isolation, cultivation, and screening of the industrially important microorganisms from different sources for the production of enzymes and organic acids.
4. To demonstrate the practical skills in Quality testing of milk, qualntitative analysis of lactic acid and visit to small scale industries.

List of Practicals: (Applied Virology)

1. Good laboratory practices, universal safety precaution, importance of personal hygiene, disposal of organic waste washing, cleaning of glass ware, sterilization of glassware and lab ware (Theory exercises and charts).
2. Diagnostics methods and vaccines for used for SARS-CoV-2 in India and other countries (chart preparation).
3. Application of NPV and its role as biopesticide.
4. Conventional and modern vaccines with examples (chart preparation)
5. Participation in vaccination programs (extension activity).
6. Isolation of virus-based nanoparticles and their characterization
7. Visits to local hospitals, diagnostic centers, private clinics and veterinary institutes for virus diseases.
8. Viruses as biowar/biocrime/bioterrorism agents (chart Preparation-Theory exercise)
9. Prevention and control of common nosocomial, enteric, blood-borne, contact transmitted and insect-borne viruses (chart preparation).

List of Practicals: (Industrial Biotechnology)

1. Isolation of microorganisms 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.
7. Assay of Cellulase (FPase) by DNS method.
8. Production of wine from grapes.
9. Production of alcohol by fermentation and Estimation by calorimetry method.
10. Quality testing of milk by methylene 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.

Learning resources and suggested books: (Applied Virology)

1. Applied Plant Virology 2nd Edition (1991) by WALKEY D G, SPRINGER CBS.
2. Applied Virology Research Volume 3 New Diagnostic Procedures (2018) R. G. Marusyk et al. SPRINGER SCIENCE+BUSINESS MEDIA, LLC.
3. Applied Virology 1st Edition (1984) Edouard Krustak. Academic Press.
4. Applied Virology: Research and Clinical Applications 1st Edition (2022) Dennis J. Bamford. Oxford University Press.
5. Applied Virology: Methods and Protocols 1st Edition (2020) Prakash S. Bisen. Springer Nature.
6. Introduction to Modern Virology 7th Edition (2020) Nigel J. Dimmock et al. Wiley-Blackwell.
7. Epidemiology, diagnosis and Management of Zoonses. (2004). K.G. Narayana Sri Kuldeep Sharma Pub.
8. Field's Virology. (2002). Vol. I, II.
9. Bailey and Scotts' Diagnostic Microbiology. 11th Edition. (2002). By B.A. Forbes et al., Mosby publisher.
10. Clinical Virology. (2002). 2nd edition. D.D.Richman et al., ASM.

Learning resources and suggested Books/Manuals: (Industrial Biotechnology)

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.

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

CO1: Learn about biosafety guidelines through chart preparations and application of NPV as biopesticide.

CO2: Conduct extension activities by participating vaccination camps and awareness programs at rural areas and visit local sericulture, fish and prawn farms to observe virus diseases.

CO3: 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 and learn the quality testing of milk, quantitative analysis of lactic acid and effect of heavy metals on bacteria.

CO4: Acquire the practical skills to use cultivation, and screening of the industrially important microorganisms from different sources for the production of wine and alcohol and learn the set up at small scale industries, the processes in the production of industrially important products.

PRACTICAL-IV

PRACTICAL-VI-VIR-307B: CLINICAL VIROLOGY & MEDICAL LAB TECHNOLOGY

[Practical related to SOC 5(B) & 6(B)]

Practical: 6 hours/week	**Internal test Assessment: 15 Marks**
Tutorial: Lab manuals, E-learning resources, textbooks and study materials	**Total Marks: 50 Marks** **Semester End Practical Examination: 35 Marks**

Semester: I	Credits: 2 Credits

Course Educational Objectives:

1. To learn about biosafety guidelines through chart preparations and to study the vaccines and diagnostic methods as model for SARS-CoV-2.
2. To collect blood, serum and urine and analyze using biochemical tests and diagnostic tests for presence of viruses.
3. To learn and to practice various methods used for testing the presence of viruses through blood transfusion.
4. To visit local hospitals, villages for extension activities to participate in virus vaccination/awareness programs.

List of experiments: (Clinical Virology)

1. Good laboratory practices, universal safety precaution, importance of personal hygiene, disposal of organic waste washing, cleaning of glass ware, sterilization of glassware and lab ware (Theory exercises and charts).
2. Diagnostics methods and vaccines for used for SARS-CoV-2 in India and other countries (chart preparation).
3. Blood and urine - collection from different hospitals, analysis using biochemical tests and clinics and preservation using different anticoagulants & preservative solutions.
4. Venipuncture and collection of blood samples 2. Preparation of blood films 3. Staining of blood smears.
5. Participation in vaccination programs (extension activity).
6. Analysis of serum, Urine and Blood for viruses.
7. HBsAg & HIV antibody testing in blood bank.
8. Visiting local hospitals and private diagnostic clinics.

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.

List of experiments: (Medical Lab Technology)

1. Good laboratory practice: Universal safety precaution, importance of personal hygiene, disposal of organic waste washing, cleaning of glass ware, sterilization of glassware and lab ware (Theory exercise)
2. Sampling: Collection of different samples from different hospitals and clinics.
3. Blood collection & preservation using different anticoagulants& preservative solutions.
4. Venipuncture and collection of blood samples 2. Preparation of blood films 3. Staining of blood smears.
5. Blood grouping & typing, Rh System-Rh factor.
6. Analysis of serum Urine and Blood using biochemical tests.
7. Oxygen percentage, Blood pressure and blood glucose recording.
8. Coombs test
9. HBsAg & HIV antibody testing in blood bank.
10. Visiting local hospitals and private diagnostic clinics.

Learning resources and suggested 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

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

CO1: Learn about biosafety guidelines through chart preparations and study the vaccines and diagnostic methods as model for SARS-CoV-2.

CO2: Collect blood, serum and urine and analyze using biochemical tests and diagnostic tests for presence of viruses.

CO3: Learn and to practice various methods used for testing the presence of viruses through blood transfusion.

CO4: Acquire the practical skills by visiting local hospitals, villages for extension activities and participate in virus vaccination/awareness programs.

VIR-308: Open Online Transdisciplinary Course - 2

OOTC **Tutorial: Swayam, NPTL and other online courses**	Each online course is assigned with two credits with minimum duration of 40 hours learning with 100 marks internal assessment through tests, quiz and assignments as per the program. A student can opt for two or three courses of shorter duration to acquire the assigned two credits. OOTCs can be chosen based on the interest of the students without confinement to traditional academic schedules.
Semester: I	**Credits: 2 Credits**

********** END OF THE THIRD SEMESTER ********

SEMESTER-IV

VIR - 401: Open Online Skill Development Courses

OOSDC **Tutorial: Swayam, NPTL and other online courses**	Open Online Skill Development Course (OOSDC) - Students can choose any **Two** relevant courses of his / her choice from the online courses offered by governmental agencies like SWAYAM, NPTEL, etc., **to get 8 credits (with 4 credits from each course) with 200 marks assessment through assignments, quiz, tests as per the program.**
Semester: IV	**Credits: 8 Credits**

VIR-402: PROJECT WORK (Related to the courses of the curriculum)

Project: 4th Semester	**Project work: 300 Marks**
Tutorial: Publications, review articles and text books	**(Dissertation: 200 Marks; Seminar: 50 Marks; Viva-voce: 50 Marks)** ***Project work will be related to courses offered in M. Sc. Virology program.** ****Students will be encouraged to go to outside industries, national and private research/academic institutes to take internships during the first year summer and also during the 4th semester for the completion of projects.**
Semester: IV	**Credits: 12 Credits**

********** END OF THE FOURTH SEMESTER **********