SOPHIA COLLEGE (AUTONOMOUS)

Affiliated to

UNIVERSITY OF MUMBAI

Programme: Microbiology

Programme code: SMSMCB

MSc-I Microbiology

(Choice Based Credit System with effect from the year 2018-2019)

Programme Outline: MSc-I Microbiology (SEMESTER I)

Course code	Unit No	Name of the Unit	Credits
SMSMCB101		CELL BIOLOGY AND VIROLOGY	4
	1	Virology (Bacterial Viruses)	
	2	Virology (Plant Viruses)	
	3	Cell Biology (Membrane Structure & Transport)	
	4	Cell Biology (Respiratory & Photosynthetic Organelle)	
SMSMCB102		MICROBIAL GENETICS	4
	1	Gene expression and regulation	
	2	Replication, recombination, mutation and repair	
	3	Cytoplasmic Inheritance & Chromosomal Rearrangements	
	4	Molecular tools for genetics, Population genetics	
SMSMCB103		MICROBIAL BIOCHEMISTRY	4
	1	Aqueous Solutions and Acid-Base Chemistry	
	2	Bioorganic Molecules	
	3	Metabolism of one & two carbon compounds	
	4	Transfer of biomolecules	
SMSMCB104		MEDICAL MICROBIOLOGY & IMMUNOLOGY	4
	1	Advances in Medical Microbiology: Part I	
	2	Epidemiology of infectious diseases	
	3	Immune System and Health: Part I	
	4	Recent advances in Immunology: Immunobiology	
SMSMCBP1		PRACTICALS	
SMSMCBP101		CELL BIOLOGY AND VIROLOGY	2
SMSMCBP102		MICROBIAL GENETICS	2
SMSMCBP103		MICROBIAL BIOCHEMISTRY	2
SMSMCBP104		MEDICAL MICROBIOLOGY & IMMUNOLOGY	2

Programme Outline: MSc-I Microbiology (SEMESTER II)

Course code	Unit No	Name of the Unit	Credits
SMSMCB201		CELL BIOLOGY AND VIROLOGY	4
	1	Virology (Animal Viruses)	
	2	Virology in relation to human health	
	3	Cell Biology (Cell division and Cell cycle)	
	4	Cell Biology (Cell Communication)	
SMSMCB202		MICROBIAL GENETICS	4
	1	Viral Genetics, Gene transfer	
	2	Transposable Genetic Elements, Genetic basis of Cancer	
	3	Developmental Genetics	
	4	Applications and Ethics of Genetic Technology	
SMSMCB203		MICROBIAL BIOCHEMISTRY	4
	1	Analytical Biochemistry	
	2	Enzymology	
	3	Signaling and Stress	
	4	Microbial degradation	
SMSMCB204		MEDICAL MICROBIOLOGY & IMMUNOLOGY	4
	1	Advances in Medical Microbiology: Part II	
	2	Clinical Research and Modern Diagnostics	
	3	Immune system and Health: Part II	
	4	Challenges in Immune System	
SMSMCBP2		PRACTICALS	
SMSMCBP201		CELL BIOLOGY AND VIROLOGY	2
SMSMCBP202		MICROBIAL GENETICS	2
SMSMCBP203		MICROBIAL BIOCHEMISTRY	2
SMSMCBP204		MEDICAL MICROBIOLOGY & IMMUNOLOGY	2

PREAMBLE:

The M.Sc program at Sophia College (Autonomous) is open to both female and male students. The M.Sc course is an extension of the undergraduate curriculum dealing with all the branches of Microbiology at a considerable depth and blends the upcoming fields as well as advances in the subject. Research is an integral aspect of the curriculum and includes planning and execution of a dissertation. The outcomes of a number of the dissertations have been published in peer reviewed journals. Participation and presentations - both oral and posters in conferences, workshops and research meets is encouraged. Field projects, Educational visits and short-term internships are also included. The students who complete the postgraduate programme in Microbiology are well trained in the subject and find employment in areas like Quality control, Research and Development, Clinical Research, Teaching etc.

Program Objectives

PO1	To provide in depth knowledge to the learners in the conventional and emerging areas of Microbiology.
PO2	To help learners plan and execute research projects.
PO3	To train the learners to communicate the findings of the research projects effectively.
PO4	To create awareness among the learners about regulatory requirements and compliance, IPR and ethics.

PROGRAMME SPECIFIC OUTCOMES

PSO1	The learner will gain and apply knowledge about recent developments in Genetics, Virology, Cell Biology, Microbial Biochemistry, Medical Microbiology and Immunology, Environmental Microbiology, Food and Dairy Microbiology etc in order to solve problems affecting mankind.
PSO2	The learner will acquire knowledge about research methodology, plan and execute experiments using good laboratory practices, and interpret the experimental results effectively.
PSO3	The learner will be able to communicate their findings by virtue of doing poster /oral presentations in conferences/workshops, writing thesis, research papers, reports etc
PSO4	The learners will gain knowledge of regulatory compliance in various fields like clinical research, IPR and ethics by attending value added courses/seminars/webinars etc which may lead to employability.

SEMESTER 1

NAME OF THE COURSE	CELL BIOLOGY AND VIROLOGY	
CLASS	MSc- I	
COURSE CODE	SMSMCB101	
NUMBER OF CREDITS	4	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	40	60
PASSING MARKS	16	24

COURSE OBJECTIVES:

CO 1	To explain and describe the general properties, replication and regulation of transcription of bacteriophages.
CO2	To describe the genetic organization and growth cycles of specific bacteriophages, including T4, T7, Lambda, ϕX174, filamentous DNA and single-stranded RNA phages.
CO 3	To discuss the morphology and transmission of plant viruses and symptoms of viral infection in plants with a focus on Tobacco Mosaic Virus and Citrus Tristeza Virus.
CO 4	To discuss the diagnostic methods used to identify viral infections in plants
CO 5	To develop an understanding of the structure and function of cellular membranes, including membrane transport mechanisms and intracellular compartmentalization.
CO 6	To explain the structure of the respiratory and photosynthetic cellular organelles, such as mitochondria and chloroplasts, and their roles in cellular energy production.
CO 7	To develop an understanding of cytoskeletal elements
CO 8	To justify the significance of different types of microscopes in study of cellular structures.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to explain the general properties, genetic organization. replication and regulation of gene expression of bacteriophages like T4, T7, Lambda,

	ϕX174, and filamentous DNA and single-stranded RNA phages
CLO 2	The learner will be able to explain the morphology, replication, & transmission routes and symptoms, diagnosis and prevention of plant viral infections.
CLO 3	The learner will be able to compare and contrast the life cycles of different types of plant viruses.
CLO 4	The learner will be able to propose control measures for plant viral diseases based on understanding of viral structure and transmission.
CLO 5	The learner will be able to describe the structure and function of cellular membranes, including lipid bilayers, membrane proteins, and membrane transport mechanisms.
CLO 6	The learner will be able to explain the process and the regulation of energy production in mitochondria and chloroplasts.
CLO 7	The learner will be able explain the membrane transport mechanisms.
CLO 8	The learner will be able to describe the common cytoskeletal elements in cells along with their significance
CLO 9	The learner will be able to compare and contrast different eukaryotic organelles.
CLO 10	The learner will be able to apply the knowledge of the cell biology concepts to understand the life cycle of viruses in semester 2.

UNIT 1	Virology (Bacterial Viruses) (15 Lectures)
1.1	Bacteriophages: General properties of phages, properties of phage infected Bacterial cultures, Specificity of Phage Infection (3L)
1.2	*E. coli* Phage T4 : Properties of T4 DNA, Genetic organization, the T4 growth cycle, Replication of T4 DNA (3L)
1.3	*E.coli* Phage T7 and Lambda: Organization of the T7 genes, Growth Cycle, Regulation of transcription of T7 phage. (4L)
1.4	*E.coli* Phage (phi) X174, Filamentous DNA phages, Single stranded RNA phages, Lysogenic cycle. (5L)
UNIT 2	Virology (Plant Viruses) (15 Lectures)

2.1	Plant viruses : Morphology, Transmission of plant viruses, symptoms of plant diseases caused by viruses. (4L)
2.2	Plant virus life cycles, Plant satellite viruses and satellite Nucleic acids (03L)
2.3	TMV, Citrus Tristeza Virus (CTV), : Viral structure, Genome, Host range, Transmission, Symptom and Control. (6L)
2.4	Diagnosis of viral infections in plants (2L)
UNIT 3	Cell Biology (Membrane Structure & transport) (15 Lectures)
3.1	Cell membrane structure: Lipid bilayer, membrane proteins, Spectrins, Glycophorin, Multipass membrane proteins, Bacteriorhodopsin (4L)
3.2	Membrane Transport: Principles of membrane transport, ion channels and electrical properties of membranes. (3L)
3.3	Intracellular Compartments and protein sorting: Compartmentalization of cells, transport of molecules between the nucleus and cytosol, peroxisomes, Endoplasmic reticulum, transport of proteins into mitochondria and chloroplasts (5L)
3.4	Intracellular vesicular traffic: Endocytosis, exocytosis, transport from the ER through the Golgi apparatus (3L)
UNIT 4	Cell Biology (Respiratory & Photosynthetic Organelle)(15 Lectures)
4.1	Mitochondria: Structure, electron-transport chains and proton pump (3L)
4.2	Chloroplasts: Structure, energy capture from sunlight, genetic system (3L)
4.3	Cytoskeleton: Cytoskeletal filaments, Microtubules, Actin regulation, molecular motors, cell behavior. (5L)
4.4	Cell study : Study of cells under the microscope, Phase contrast, Fluorescence microscopy, Confocal microscopy & electron microscopy. (4 L)

REFERENCES

SMSMCB101

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16. Bray, Dennis. (2000). Cell Movements: From molecules to motility, 2nd edn, *Garland.*

NAME OF THE COURSE	MICROBIAL GENETICS
CLASS	MSc- I

COURSE CODE	SMSMCB102	
NUMBER OF CREDITS	4	
NUMBER OF LECTURES PER WEEK6	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	40	60
PASSING MARKS	16	24

COURSE OBJECTIVES:

CO 1	To describe the molecular details of gene expression and its regulation in bacteria and eukaryotes.
CO 2	To explain coordination of DNA replication and septum formation in bacteria.
CO 3	To discuss recombination at the molecular level in bacteria and eukaryotes.
CO 4	To develop an understanding of mutations at molecular level, how mutations are induced by chemicals and transposable elements and their role in human diseases
CO 5	To describe the mechanism of different repair mechanisms in bacteria and eukaryotes.
CO 6	To explain cytoplasmic inheritance with the help of a few illustrations.
CO 7	To explain chromosomal rearrangements and their effect on gene expression
CO 8	To develop an understanding of concepts and principles associated with population genetics
CO 9	To explain the diverse techniques and molecular tools used in the study of genetics.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to describe molecular details of transcription, RNA processing and translation.
CLO 2	The learner will be able to explain bacterial operons, antisense RNA, riboswitches etc.
CLO 3	The learners will be able to explain the significance of DNA methylation, histone modifications, and nucleosome remodeling in gene regulation.

CLO 4	The learner will be able to explain the role of bacterial proteins in septum formation, segregation of chromosomes and in partitioning of plasmids.
CLO 5	The learner will be able to explain and classify different recombination models and compare the role of proteins in recombination in bacteria and eukaryotes
CLO 6	The learner will be able to explain the molecular basis of mutations, how mutations are induced by chemicals and transposable elements, and justify the role of mutations in human diseases.
CLO 7	The learner will be able to explain and compare different repair mechanisms in bacteria and eukaryotes
CLO 8	The learner will be able to explain cytoplasmic inheritance and chromosomal rearrangements
CLO 9	The learner will be able to compare the techniques and molecular tools used in genetics.
CLO 10	The learner will be able to discuss the principles of population genetics and apply the knowledge to solve problems

UNIT 1	Gene expression and Regulation (15 Lectures)
1.1	Gene Expression (05L) a. Transcription i. Transcription process in prokaryotes ii.Transcription process in eukaryotes b. RNA molecules and processing i. Post transcriptional processing- structure of mRNA, pre mRNA processing, addition of 5'cap, addition of Poly(A) tail, RNA splicing, RNA editing. ii. Small RNA molecules- RNA interference, types, processing & function of microRNAs. c. Translation i. Mechanism of translation- charging of tRNA molecules, initiation, elongation and termination, mRNA surveillance. ii. Post translational modification of proteins

1.2	Regulation of gene expression (10L) a. Control of gene expression in prokaryotes i. Genes & regulatory element ii. Levels of gene regulation iii. DNA binding proteins iv. Antisense RNA molecules v. Riboswitches b. Control of gene expression in eukaryotes i. Regulation through modification of gene structure- DNase I hypersensitivity, histone modifications, chromatin remodeling, DNA methylation. ii. Regulation through transcriptional activators, Coactivators & repressors, enhancers and insulators iii. Regulation through RNA processing & degradation iv. Regulation through RNA interference.
UNIT 2	Replication, recombination, mutation and repair (15 Lectures)
2.1	Regulation of replication (3L) a. Bacterial replication and cell cycle
2.2	Recombination (6L) a. Models for homologous recombination b. Homologous recombination protein machines c. Homologous recombination in eukaryotes d. Mating type switching e. Genetic consequences of the mechanism of Homologous recombination
2.3	Mutation (3L) a. Mutation: Basic features of the process b. Mutations: i. Phenotypic effects ii. Mutations in humans and their effects iii. Conditional lethal mutations c. Molecular basis of mutation (Types, mutations induced by chemicals,

	radiation and transposable genetic elements; expanding trinucleotide repeats and inherited human diseases) d. Screening chemicals for mutagenicity (Ame's test)
2.4	DNA repair mechanisms (3L) a. Types of repair mechanisms i. Direct repair ii. Light dependent repair iii. Excision repair in *E. coli* and mammalian cells iv. Mismatch repair, controlling the direction of mismatch repair v. Base flipping by methylases and glycosylases vi. Recombination repair in *E. coli,* recombination as a mechanism to recover from replication errors vii. SOS repair viii. Conserved repair systems in eukaryotic cells ix. Non-homologous end joining (NHEJ) pathway for repairing double stranded breaks b. Inherited human diseases with defects in DNA repair
UNIT 3	Cytoplasmic Inheritance & Chromosomal rearrangements (15 Lectures)
3.1	Cytoplasmic Inheritance (Organellar Genetics) (10L) a. mt-DNA i. Mitochondrial genome structure ii. Ancestral and derived mitochondrial genome iii. Mitochondrial DNA of Human, yeast and flowering plants iv. Endosymbiotic theory v. Mitochondrial DNA replication, transcription & translation vi. Codon usage in Mitochondria vii. Damage to Mitochondrial DNA and aging. viii. Evolution of Mitochondrial DNA ix. mtDNA analysis for study of evolutionary relationships b. cp DNA

	i. Gene structure and organization ii. General features of replication, transcription and translation of cpDNA iii. Comparison of nuclear, eukaryotic, eubacterial mitochondrial and chloroplast DNA iv. Examples of extranuclear inheritance v. Leaf Variegation vi. Poky mutant of *Neurospora* vii. Yeast petite mutant viii. Human genetic diseases ix. Maps of mtDNA and cp DNA
3.2	Chromosomal Rearrangements and effects on gene expression (5L) a. Amplification and deletion of genes b. Inversions that alter gene expression c. Transpositions that alter gene i. Expression antigenic variation in Trypansomes ii. Mating type switching in yeast iii. Phase variation in *Salmonella*
UNIT 4	Molecular tools for genetics, Population Genetics (15 Lectures)
4.1	Molecular tools for genetics (9L) a. Molecular tools for studying genes and gene activity b. Use of recombinant DNA technology to identify human genes (Huntington's diseases, Cystic fibrosis), molecular diagnosis of human diseases, human gene therapy) c. Labeled tracers (autoradiography, phosphorimaging, liquid scintillation counting, non-radioactive tracers) d. Nucleic acid hybridization (Southern blots, DNA fingerprinting & DNA typing with their forensic applications, Northern blots, in situ hybridization), DNA sequencing (Sanger's chain termination method, Maxam Gilbert's sequencing), Restriction mapping, Site directed mutagenesis

	e. Mapping and quantifying transcripts (S1 mapping, primer extension, run-off transcription) f. Measuring transcription rates in vivo (Nuclear run – on transcription, reporter gene transcription), Assaying DNA – protein interactions (filter binding, gel mobility shift, DNAse and DMS footprinting, knockouts)
4.2	Population genetics (6L) a. Population and gene pool b. Genotypic and Allelic frequencies c. Calculation of Genotypic frequencies and Allelic frequencies for autosomal and X linked loci d. Problems –calculation of allelic and genotypic frequencies e. Hardy-Weinberg Law, genotypic frequencies at HWE f. Implications of the H-W Law g. G. H-W proportions for multiple alleles, h. X-linked alleles i. Testing for H-W proportions and problems j. Genetic ill effects of in-breeding k. Changes in the genetic structure of populations: Mutation, Migration and gene flow, Genetic drift, Natural selection, Simple problems based on the natural forces l. Measuring genetic variation: RFLP, DNA sequencing, Protein electrophoresis

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SMSMCB102

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NAME OF THE COURSE	MICROBIAL BIOCHEMISTRY
CLASS	MSc- I

COURSE CODE	SMSMCB103	
NUMBER OF CREDITS	4	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	40	60
PASSING MARKS	16	24

COURSE OBJECTIVES:

CO 1	To explain the chemistry underlying the preparation of solutions, buffers etc.
CO 2	To explore the structure and functions of proteins, lipids, carbohydrates.
CO 3	To explain the one and two carbon compounds metabolism carried out by microorganisms.
CO 4	To understand the biological membrane and its role in transport of protein and drug transport protein, protein folding and their transport.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to calculate the amount of chemicals required and prepare solutions of specific strength including buffers, they will also be able to calculate pKa and pKb values of an amino acid.
CLO 2	The learner will be able to describe the structure and functions of proteins, lipids and carbohydrates as enzymes, surface molecules, signals, pigments, cofactors etc characterization.
CLO 3	The learner will be able to write the metabolic pathways including the structure of the molecules, role of enzymes/coenzymes involved in the breakdown and synthesis of one and carbon compounds.

CLO 4	The learner will be able to describe the the mechanism and significance of protein export, drug export and folding of proteins and their export

UNIT 1	Aqueous Solutions and Acid-Base Chemistry (15 Lectures)
1.1	Various units of expressing and inter-converting concentration of solutions: molarity, moles, normality, osmolarity, molality, mole fraction (05L)
1.2	Bronsted Concept of conjugate acid- conjugate base pairs, ionization of solutions, pH, titration curves, Buffers: preparation, action and their use in Biology (05L)
1.3	Henderson-Hasselbalch equation, buffer capacity, Polyprotic acids, amphoteric salts, ionic strengths (05L)
1.4	Problem solving under all heads
UNIT 2	Bioorganic Molecules (15 Lectures)
2.1	Amino acids: Classification and stereochemistry, biochemical information form amino acid sequence, derivative, ionization (02L)
2.2	Structure and function of a. Proteins: Structure of peptide bond, stability of formation of peptide bond, Ramchamndran plot, protein structure, factors determining secondary , tertiary structures: amino acid sequence, thermodynamics of folding, role of disulfide bonds, dynamics of globular protein folding, chaperonins and prions motifs and domains, protein families, protein stability prediction of secondary and tertiary structure, protein-protein interactions (07L) b. Glycobiology: Carbohydrates, stability of glycosidic bond, glycoconjugates, proteoglycans, glycoproteins, glycolipids, homopolysaccharide folding, functions of oligosaccharides (03L) c. Lipids: Lipid classification, structure of lipids in

	membranes- glycerolipids, ether lipids, galactolipids, sulfolipids, lipids in archaebacteria, sphingolipids, terpenes, isoprenoids, Functions of lipids- signals, cofactors, pigments (03L)
UNIT 3	Metabolism of One and Two Carbon Compounds (15 Lectures)
3.1	Metabolism of one carbon compounds: a. Methylotrophs: Oxidation of methane, methanol, methylamines and carbon assimilation in methylotrophic bacteria and yeasts (03L) b. Methanogens: Methanogenesis form H_2, CO_2, CH_3OH, HCOOH, methylamines, energy coupling and biosynthesis in methanogenic bacteria (02L) c. Acetogens: autotrophic pathway of acetate synthesis and CO_2 fixation, (02L) d. Carboxidotrophs: Biochemistry of chemolithoautotrophic metabolism (02L) e. Cynogens and cynotrophs: cynogenesis and cynide degradation (02L)
3.2	Metabolism of two- carbon compounds a. Acetate-TCA and Glyoxylate cycle, modified citric acid cycle, carbon monoxide dehydrogenase pathway and disproportionation to methane (01L) b. Ethanol- acetic acid bacteria (01L) c. Glyoxylate and glycollate- dicarboxylic acid cycle, glycerate pathway, beta hydroxy aspartate pathway (01L) d. Oxalate- as carbon and energy source (01L)
UNIT 4	Transfer of Biomolecules (15 Lectures)
4.1	Protein transport: extracellular protein secretion, drug export system (05L)
4.2	Biological membranes and transport (05L)
4.3	Folding of periplasmic proteins, translocation of folded proteins (05L)

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NAME OF THE COURSE	MEDICAL MICROBIOLOGY & IMMUNOLOGY	
CLASS	MSc- I	
COURSE CODE	SMSMCB104	
NUMBER OF CREDITS	4	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	40	60
PASSING MARKS	16	24

COURSE OBJECTIVES:

CO 1	To educate students about emerging diseases, emphasizing the modes of transmission, pathogenesis, clinical manifestation, laboratory diagnosis, prophylaxis, and treatment.
CO 2	To describe and discuss the principles of epidemiology.
CO 3	To develop an understanding of the immune responses to infectious diseases like AIDS, Influenza, Diphtheria, Tuberculosis and TSEs and evasion of the immune system by the microorganisms
CO 4	To explain and discuss physiological and immunological barriers, Phagocytic cells, lymphocytes, and inflammation process as an innate immune response.
CO 5	To describe the diversity of Immunoglobulins, organization of the immunoglobulin genes and DNA rearrangements.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to explain and compare the modes of transmission, pathogenesis, clinical manifestation, laboratory diagnosis, prophylaxis and treatment of various emerging diseases.
CLO 2	The learner will be able to recall and discuss the principles of epidemiology and justify the significance of public health surveillance
CLO 3	The learner will be able to explain the immune response to various infectious diseases caused by viruses, bacteria, and unconventional infectious agents and evasion of the immune system by them.

CLO 4	The learner will be able to explain the process of inflammation and identify the key mediators involved in the process
CLO 5	The learner will be able to discuss the role of immune cells such as phagocytes, lymphocytes and also distinguish between them.
CLO 6	The learner will be able to explain and summarize the diversity of immunoglobulins, organization of the immunoglobulin genes and DNA arrangements.

UNIT 1	Advances in Medical Microbiology (15 Lectures)
1.1	Emerging Diseases :- Detailed Study of following infections including Etiology, Transmission, Pathogenesis, Clinical Manifestations, Lab. diagnosis, Prophylaxis, and Treatment:-- a. AIDS b. MOTT (mycobacteria other than TB) c. Legionellosis d. Chickungunya e. Cholera caused by *V.cholerae* O139 f. Conditions caused by *Helicobactor pylori* g. SARS.
UNIT 2	Epidemiology of Infectious Diseases(15 Lectures)
2.1	Historical aspects-definition
2.2	Descriptive Epidemiology-aims and uses
2.3	Host parasite interactions in the cause of diseases
2.4	Epidemiological principles in prevention and control of Diseases
2.5	Measures of risks : frequency measures, morbidity frequency measures, mortality frequency measures, natality(birth) measures, measures of association, measures of public health impact.
2.6	Public health surveillance: purpose and characteristics, identifying health problems for surveillance, collecting data for surveillance, analyzing and interpreting data, disseminating data and interpretation, evaluating and

	improving surveillance.
UNIT 3	Immune System and Health part 1(15 Lectures)
3.1	Immune response to infectious diseases:-- a. Immune response to Prions b. Immune response to viral infections - HIV/AIDS-HIV and the immune system-Influenza Avian H5N1. c. Immune response to Bacterial diseases - Difference in the Immune response to extracellular and intracellular bacteria: Diphtheria, Tuberculosis d. Microbial ways of evading the immune system.
UNIT 4	Recent advances in immunology: Immunobiology (15 Lectures)
4.1	Recent advances in Innate immunity including receptors involved and signaling system. Physiological & immunological barriers.
4.2	The cellular players :Phagocytic cells, Lymphocytic cells, DCs.
4.3	The innate immune response: Inflammation, Acute Phase Reaction
4.4	Molecular basis of diversity of immunoglobulin molecules.
4.5	Multigene organization of Ig genes.
4.6	Variable-Region Gene Rearrangements.
4.7	Mechanism of Variable-Region DNA Rearrangements.
4.8	Generation of antibody diversity.
4.9	Manipulations of the immune response.

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SMSMCB104

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Practicals- Semester 1 SMSMCBP1

NAME OF THE COURSE	CELL BIOLOGY AND VIROLOGY PRACTICAL	
CLASS	MSc-I	
COURSE CODE	SMSMCBP101	
NUMBER OF CREDITS	2	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	-	50
PASSING MARKS	-	20

COURSE OBJECTIVES

CO 1	To train students in Virology practicals i.e. purification of bacteriophages from sewage and enumeration by plaque assay, phage typing, one step growth curve and studying lysogeny in order to develop their practical skills
CO 2	To train students in Cell Biology experiments such as purification of lysozyme, preparation of protoplast, isolation of mitochondria and chloroplasts, and study of cell structure using microscopy in order to equip them with basic eukaryotic cell biology practical skills

COURSE LEARNING OUTCOMES

CLO 1	The learner will be able to purify bacteriophages from the sewage and use the plaque assay to enumerate them and calculate plaque forming units/ml
CLO 2	The learner will be able to perform phage typing and one step growth curve experiments
CLO 3	The learner will be able to apply the fundamentals and concepts of lysogeny for other bacteriophages

CLO 4	The learner will be able to purify lysozyme from egg white and prepare protoplast
CLO 5	The learner will be able to perform the extraction of mitochondria and chloroplast from eukaryotic cells
CLO 6	The learner will be able to analyze cell structure using phase contrast, confocal and fluorescence microscopy

Sr. No	Name of the experiment
1	Isolation and Purification of coliphages from sewage
2	Phage Typing of *E. coli and Salmonella* strains.
3	Study of One Step Growth Curve of Lambda phage / T4 Phage.
4	Study of Lysogeny in *E. coli.*
5	Assignment on Virology – Research Paper.
6	Isolation of Lysozyme from egg white. .
7	Preparation of protoplast using Lysozyme.
8	Writing a Research proposal.
9	Study of cell cytology using Phase contrast Microscopy. Demonstration
10	Study of Cell structure using Confocal Microscopy. Demonstration
11	Study of Cell structure using Fluorescence Microscopy. Demonstration
12	Isolation of Chloroplasts.
13	Isolation of Mitochondria from the cell

COURSE OBJECTIVES

CO 1	To enhance understanding of the utility of colorimetric assays such as the β-galactosidase assay in measuring gene expression and promoter activity

NAME OF THE COURSE	MICROBIAL GENETICS PRACTICAL	
CLASS	MSc-I	
COURSE CODE	SMSMCBP102	
NUMBER OF CREDITS	2	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	-	50
PASSING MARKS	-	20

CO 2	To equip learners with skills in analyzing the mutations induced by UV radiation and acridine orange and in selective culturing and identification of streptomycin-resistant mutants
CO 3	To train learners to enrich and isolate auxotrophic mutants using selection and screening methods such as penicillin enrichment and replica plate techniques respectively.
CO 4	To familiarise learners with the principle and significance of the Ames test in assessing the mutagenicity of chemical compounds.
CO 5	To demonstrate learners hybridization techniques such as Northern and Southern blotting
CO 6	To develop critical thinking and problem solving skills on Population Genetics and Restriction mapping
CO 7	To design primers for amplifying the genes
CO 8	To provide learners with practical training in running acrylamide gels and understanding its applications in separating proteins

COURSE LEARNING OUTCOMES

CLO 1	The learner will be able to perform the β-galactosidase assay and acquire skills in quantifying and analyzing β-galactosidase activity.

CLO 2	The learner will be able to perform the necessary steps to expose microorganisms to UV radiation and acridine orange for mutagenesis and isolate streptomycin-resistant mutants using selective culturing techniques.
CLO 3	The learner will be able to enrich and isolate auxotrophic mutants using penicillin enrichment and replica plate techniques and determine the proportion of auxotrophic mutants
CLO 4	The learner will be able to understand the experimental procedure to perform the Ames test using bacterial strains.
CLO 5	The learner will be able to recall Northern and Southern blotting techniques and interpret the data.
CLO 6	The learner will be able to analyze, classify and solve problems on Population Genetics and Restriction mapping
CLO 7	The learner will be able to design primers to carry out the amplification of genes using Polymerase chain reaction
CLO 8	The learner will be able to prepare acrylamide gels, load protein samples, run electrophoresis, visualize the separated protein bands and interpret the gel image to understand the protein purification and size

Sr. No	Name of the experiment
1	β galactosidase assay
2	UV mutagenesis
3	Acridine orange mutagenesis
4	Isolation of mutants by Replica plate technique
5	Penicillin enrichment technique
6	Ames test
7	Southern hybridization technique [Demonstration]
8	Northern Blotting technique [Demonstration]
9	Restriction mapping
10	Design of primer & PCR

11	Protein electrophoresis
12	Problems on population genetics

NAME OF THE COURSE	MICROBIAL BIOCHEMISTRY PRACTICAL	
CLASS	MSc-I	
COURSE CODE	SMSMCBP103	
NUMBER OF CREDITS	2	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	-	50
PASSING MARKS	-	20

COURSE OBJECTIVES

CO 1	To familiarize the learner with preparation and working of buffers
CO 2	To acquaint the learner with concept of pKa of amino acids
CO 3	To enable the learner to extract , separate, identify and determine the level of unsaturation of fats
CO 4	To enable the learner to analyze samples for sugar, fat and polyphenol content
CO 5	To enable the learner to isolate microorganisms capable of using one C compounds

COURSE LEARNING OUTCOMES

Sr. No	Name of the experiment	
1	Preparation of buffers	CLO 1 The learner will become competent in preparation of solutions and buffers of defined strength as per requirement.
2	Determination of pK and PI value for an amino acid	CLO 2 The learner will be able to determine the pKa value and molar absorption coefficient of amino acids
3	Extraction of total lipids	
4	Isolation of cholesterol and lecithin from egg yolk	CLO 3 The learner will be able to extract cholesterol, separate fats by chromatography and determine iodine number of oils
5	Identification of fatty acids and other lipids by TLC	
6	Determination of degree of unsaturation of fats and oils	CLO 4 The learner will be able to isolate lactose and detect it using osazone test as well as estimate total sugar content by phenol sulphuric acid method
7	Isolation of lactose from bovine milk	
8	Estimation of total sugars by phenol sulphuric acid method	CLO 5 The learner will be able to estimate polyphenol concentration in food stuff.
9	Isolation of glutamic acid form gluten	CLO 6 The learner will be able to enrich and isolate methylotrophic bacteria
10	Determination of molar absorption coefficient (ε) of l-tyrosine	
11	Determination of the isoelectric point of the given protein	
12	Estimation of polyphenols/ tannins by Folin- Denis method	
13	Enrichment, isolation and identification of *Methylobacterium*	
14	Diffusion studies of molecules across sheep RBCs	
15	Preparation of liposomes	

COURSE OBJECTIVES

CO 1	To solve problems on diseases caused by HIV, Chikungunya, *Helicobacter*, *Vibrio cholerae* O139.

NAME OF THE COURSE	MEDICAL MICROBIOLOGY & IMMUNOLOGY PRACTICAL	
CLASS	MSc-I	
COURSE CODE	SMSMCBP104	
NUMBER OF CREDITS	2	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	-	50
PASSING MARKS	-	20

CO 2	To demonstrate the diagnosis of HIV: CD4 lymphocyte count and ELISA.
CO 3	To apply the principles of acid-fast staining technique for identifying *Mycobacterium* other than tuberculosis.
CO 4	To demonstrate the diagnostic techniques for Chikungunya
CO 5	To complete the diagnosis of *Vibrio cholerae* by isolating on selective media and identifying with the help of biochemical tests.
CO 6	To identify *Vibrio cholerae O139* by serological means
CO 7	To demonstrate the diagnostic techniques for identifying *Helicobacter pylori* infection
CO 8	To evaluate the significance of phagocytosis and phagocytic index as virulence factors.
CO 9	To demonstrate the techniques for the collection of human blood and separation of mononuclear cells by Ficoll hypaque density gradient centrifugation.
CO 10	To apply Trypan blue as a viability assay for mononuclear cells

COURSE LEARNING OUTCOMES

CLO 1	The learner will be able to develop problem-solving skills in medical microbiology with a particular focus on diagnosing, treating, and preventing diseases caused by microorganisms such as HIV, Chikungunya, *Helicobacter,* and *Vibrio cholerae O139*
CLO 2	The learner will be able to recall and interpret the methods used to diagnose an HIV infection.
CLO 3	The learner will be able to understand the principles behind Acid-fast staining and differentiate between different diseases using this technique, especially for *Mycobacterium* other than tuberculosis
CLO 4	The learner will be able to recall and interpret the methods used for the diagnosis of Chikungunya
CLO 5	The learner will be able to isolate *Vibrio cholerae* on selective media such as TCBS agar, identify using biochemical tests and complete the diagnosis
CLO 6	The learner will be able to identify *Vibrio cholerae O139* using serological method
CLO 7	The learner will be able to recognize and implement different techniques for the diagnosis of *Helicobacter pylori.*
CLO 8	The learner will be able to develop insight into the different virulence factors, including Phagocytosis and Phagocytic index that play a role in the pathogenesis of diseases.
CLO 9	The learner will be able to learn about the process of collecting human blood, and separation of mononuclear cells by Ficoll Hypaque density gradient centrifugation technique.
CLO 10	The learner will be able to acquire knowledge about conducting the Trypan blue mononuclear cells viability assay to determine the vitality of the cells.

Sr. No	Name of the experiment

1	Problem solving exercises in medical microbiology based on diseases caused by- HIV, MOTT, Chikungunya, *Helicobacter, Vibrio cholerae O139.*
2	Diagnosis for HIV a. CD4 lymphocyte count for AIDS b. ELISA for AIDS,
3	Diagnosis for MOTT a. Acid fast staining for MOTT
4	Mono-Spot Test for diagnosis of Chikungunya (Demonstration expt.)
5	Diagnosis for *Vibrio cholerae* O139 - Cholera red test, String test, Oxidase test, Biochemical tests, & isolation on TCBS medium for identification of *Vibrio cholerae O139.*
6	Serological diagnosis for *Vibrio cholerae* O139 using specific monotypic antisera
7	Diagnosis for *Helicobacter pylori*- HPSA *(Helicobacter pylori)* detection from stool sample. (Demonstration experiment) (kit method)
8	Study of virulence factors-Phagocytosis & Phagocytic index
9	Collection of human blood & separation of mononuclear cells by Ficoll hypaque density gradient centrifugation,
10	Counting of viable cells by trypan blue.

For internal assessment: Case study for epidemiology of the diseases included in unit I (Theory)- students have to collect data and interpret. This can be done from Net or approaching NGOs "SEHAT". Collection of data, criteria, methodology etc. Assignment to be submitted.

ASSESSMENT DETAILS:

Internal assessment (40 marks)

Part 1: Test (20 marks)

- Students will be given a written test from any of the units for 20 marks. The duration of the test will be 50 minutes. (Multiple choice questions- 05 marks, Answer in one word/sentence - 05 marks, Subjective questions- HWY, Justify, Differentiate between, Diagrammatically etc. - 10 marks).

Part 2: Activity (15 marks)

- An activity for 15 marks would be given in the form of a creative learning process. (Powerpoint presentation, Report, Preparation of study material, any other activity)

Part 3: Active Participation (05 marks)

Semester end examination (60 marks)

The duration of the paper will be two and a half hours.

- There shall be five compulsory questions
- Q1-4 shall correspond to the four units. Q1-4 shall contain an internal choice (attempt any 2 of 3). Q1-4 shall carry a maximum of 12 marks.
- Q5 shall be from Units 1 to 4 and consist of objective type questions.. Q5 shall carry a maximum of 12 marks (attempt any 4 of 6 for Part A and B and any 2 of 3 for Part C)

Practical Assessment

- The duration of the practical exam will be three days.
- There will be 50 marks practical per paper.
- To appear in the practical exam, students must bring a properly certified journal.

SEMESTER 2

NAME OF THE COURSE	CELL BIOLOGY AND VIROLOGY	
CLASS	MSc- I	
COURSE CODE	SMSMCB201	
NUMBER OF CREDITS	4	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	40	60
PASSING MARKS	16	24

COURSE OBJECTIVES:

CO 1	To explain the classification, clinical features, viral life cycle, genetic variability, pathogenesis and treatment strategies for viral infections in animals and humans.
CO 2	To discuss emergence and re-emergence of viruses and the factors leading to their emergence and reemergence
CO 3	To explain the role of viruses in the development of cancer.
CO 4	To explain unconventional infectious agents such as Prions and Viroids
CO 5	To explain eukaryotic cell cycle, mitosis, meiosis and sex determination in mammals
CO 6	To develop an understanding of the mechanism and significance of programmed cell death in eukaryotes.
CO 7	To discuss the function of cell junctions and cell adhesion.
CO 8	To summarize the development of multicellular organisms such as *Drosophila melanogaster and Caenorhabditis elegans*
CO 9	To explain signalling and communication in eukaryotes.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to explain and compare the replication, life cycle and clinical features of different animal and human viruses.
CLO 2	The learner will be able to explain the emergence and reemergence of viruses
CLO 3	The learner will be able to justify the role of viruses in cancer
CLO 4	The learner will be able to explain prions and viroids and compare them with conventional viral infections..
CLO 5	The learner will be able to explain the eukaryotic cell cycle and differentiate between mitosis and meiosis.
CLO 6	The learner will be able to explain the mechanism of apoptosis in eukaryotes.
CLO 7	The learner will be able to recall the function of cell junctions and cell adhesion.
CLO 8	The learner will be able to explain and summarize the development of model organisms *Drosophila melanogaster* and *Caenorhabditis elegans.*
CLO 9	The learner will be able to explain the cell signaling and signal transduction and justify its importance.

UNIT 1	Virology (Animal Viruses) (15 Lectures)
1.1	Animal Viruses : Influenza viruses : Classification, Clinical features, replication, genetic variation, Treatment and Surveillance (4L)
1.2	Rabies virus, epidemiology, Pathogenesis, Immunity, Management of human rabies, Viral life cycle, genetic variation. (3L)
1.3	Pox virus ; Clinical features, Structure of virus, replication, Vaccinia, orthopox virus, variola virus. (4L)
1.4	Herpes Virus : Clinical signs and symptoms, varicella Zoster virus, Epstein-Barr virus, Cytomegalovirus, Life cycle, laboratory diagnosis, treatment (4L)
UNIT 2	Virology in relation to Human Health (15 Lectures)
2.1	Human Immunodeficiency Virus : transmission, epidemiology, life cycle, prevention, Diagnosis.(4L)
2.2	Hepatitis Virus : Clinical features, epidemiology, Laboratory diagnosis, life

	cycle, Genetic diversity, prevention (3L)
2.3	New reemerging viruses, Evolution and adaptation, ecological factors, climate variability, human factors- social behavior, exposure to zoonotic diseases, human movement (4L)
2.4	Prions and Viroids, - CJD, BSE, Viruses and Cancer –retrovirus, DNA tumor virus, adenovirus, HCC (4L)
UNIT 3	Cell Biology (Cell Division & Cell Cycle)(15 Lectures)
3.1	Mechanism of cell division : M-phase, Mitosis, Cytokines (3L)
3.2	Cell cycle and Programmed cell death : Control system, intracellular control of cell cycle events, Apoptosis, extracellular control of cell growth and apoptosis (5L)
3.3	Cell Junctions and cell adhesion : Anchoring, adherence junctions, Desmosomes, Gap junctions, cell-cell adhesion, Cadherins (3L)
3.4	Development of multicellular organisms: Animal cell development, *Caenorhabditis elegans*, Drosophila signaling genes, gradient of nuclear gene regulatory protein, Dpp and Sog set up, Neural development (4L)
UNIT 4	Cell Biology (Cell Communication)(15 Lectures)
4.1	Germ cells and fertilization, Meiosis, sex determination in mammals, eggs, sperm, fertilization (4L)
4.2	Cell communication : Extracellular signal molecules, nitric oxide gas signal, classes of cell-surface receptor proteins (5L)
4.3	Signaling through enzyme linked cell surface receptors : Docking sites, Ras , MAP kinase, Pl-3 kinase, TGF (3L)
4.4	Signaling in plants : Serine / Threonine kinases, role of ethylene, Phytochromes (3L)

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NAME OF THE COURSE	MICROBIAL GENETICS	
CLASS	MSc- I	
COURSE CODE	SMSMCB202	
NUMBER OF CREDITS	4	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	40	60
PASSING MARKS	16	24

COURSE OBJECTIVES:

CO 1	To develop an understanding of viral genetics, recombination in bacteriophages, fine structure mapping and deletion mapping.
CO 2	To explain the mechanisms of gene transfer and genetic exchange in bacteria: Transformation, Conjugation and Transduction.
CO 3	To describe the transposable genetic elements in prokaryotes and eukaryotes.
CO 4	To explain the genetic basis of cancer.
CO 5	To summarize the genetics of development of model organisms such as *Drosophila, C. elegans and Arabidopsis.*
CO 6	To explain techniques such as RFLP, Positional cloning and FISH for mapping of the human genes at the molecular level.
CO 7	To develop an understanding of diagnosis and treatment of human genetic disorders
CO 8	To discuss the applications of recombinant DNA technology along with its social, ethical and legal issues.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to explain the mechanisms of recombination in bacteriophages, fine structure mapping and deletion mapping.
CLO 2	The learner will be able to explain and compare the gene transfer mechanisms such as Transformation, Conjugation and Transduction.
CLO 3	The learner will be able to describe the Transposable genetic elements in prokaryotes and eukaryotes.
CLO 4	The learner will be able to explain the genetic basis of cancer.
CLO 5	The learner will be able to summarize the genetics of development of model organisms such as *Drosophila, C. elegans and Arabidopsis.*

CLO 6	The learner will be able to explain and compare the techniques used for mapping of human genes
CLO 7	The learner will be able to describe the techniques used for the diagnosis of human genetic disorders and treatment of genetic disorders using gene therapy.
CLO 8	The learner will be able to justify the applications of recombinant DNA technology like production of insulin, transgenic plants and animals.
CLO 9	The learner will be able to discuss the social ethical and legal issues of recombinant DNA technology

UNIT 1	Viral genetics, gene transfer (15 Lectures)
1.1	Viral genetics (05L) a. Mapping the Bacteriophage genome. i. Phage phenotypes ii. Genetic recombination in phages iii. Genetic fine structure mapping iv. Deletion mapping b. Genes within genes : Bacteriophage Φ X174 c. Constructing phage vectors- phage display vectors, suicide vectors, combining phage vectors and transposons
1.2	Gene Transfer (10L) a. Drug resistance and gene transfer in bacteria. b. Genetic exchange in Bacteria – An overview c. Mutant phenotypes in bacteria d. Basic test for transformation, conjugation and transduction e. Transformation: i. The transforming principle ii. Natural competency iii. Process of natural transformation- *Bacillus subtilis* (in detail) iv. Overview of transformation in *Streptococcus pneumoniae & Haemophilus influenzae* *v.* Artificial transformation vi. Transformation and gene mapping f. Conjugation:

	i. Discovery of conjugation ii. F factors and R factors iii. The conjugation machinery and transfer of DNA iv. F^+ X F^- mating v. Hfr formation and conjugation vi. Formation of F primes and transfer from one cell to another vii. Genetic uses of F' viii. Gene mapping using Hfr crosses and 50% rule. ix. Mapping closely linked genes x. Mobilization of nonconjugable plasmids by Conjugation from prokaryotes to eukaryotes g. Transduction: i. Discovery ii.Generalized transduction iii. P1 as model of generalized transduction iv. Specialized transduction- λ phage as model system v. LFT & HFT lysate- Making merodiploids with specialized transducing phage, Moving mutations from plasmids to specialized transducing phage to chromosome
UNIT 2	Transposable genetic elements, genetic basis of cancer (15 Lectures)
2.1	Transposable genetic elements (6L) a. Transposable Elements in Prokaryotes : An Overview, The medical Significance of Bacterial Transposons b. Transposable Elements in Eukaryotes i. Ac and Ds Elements in Maize ii. P Elements and Hybrid Dysgenesis in Drosophila iii. Mariner, an Ancient and Widespread Transposon c. Retrotransposons i. Retrovirus like Elements ii. Retroposons d. The Genetic and Evolutionary Significance of Transposable Elements i. Transposons and Genome Organization ii. Transposons and Mutation

	iii. Rearrangement of Immunoglobulin Genes iv. Evolutionary Issues Concerning Transposable Elements
2.2	Genetic basis of cancer (9L) a. A Common Killer b. Cancer: A Genetics Disease i. The Many Forms of Cancer ii. Cancer and the Cell Cycle iii. A Genetics Basis for Cancer c. Oncogenes i. Tumor-Inducing Retroviruses and Viral Oncogenes ii. Cellular Homologs of Viral Oncogenes: The Proto-Oncogenes iii. Mutant Cellular Oncogenes and Cancer iv. Chromosome Rearrangement and Cancer d. Tumor Suppressor Genes i. Inherited Cancers and Knudson's Two-Hit Hypothesis ii. Cellular Roles of Tumor Suppressor Proteins e. Genetic Pathways to Cancer
UNIT 3	Developmental genetics (15 Lectures)
3.1	Developmental genetics (5L) a. Cloning Experiments b. The Genetics of Pattern Formation in Drosophila c. Homeobox Genes in other Organisms d. The Genetics of Flower Development in Arabidopsis e. Programmed Cell Death in Development f. Evo-Devo: The Study of Evolution and Development
3.2	The genetic control of animal development (10L) a. Stem Cell Therapy: A Brave New World? b. The Process of Development in Animals i. Oogenesis and fertilization ii. The Embryonic Cleavage Divisions and Blastula Formation iii. Gastrulation and Morphogenesis

	c. Genetic Analysis of Development in Model Organisms i. Drosophila as a Model Organism ii. Caenorhabditis as a model organism d. Genetic Analysis of Development Pathways i. Sex Determination in Drosophila ii. Sex Determination in Caenorhabditis e. Molecular Analysis of Genes Involved in Development f. Maternal Gene Activity in Development i. Maternal-Effect Genes ii. Determination of the Dorsal-Ventral and Anterior-Posterior Axes in Drosophila Embryos g. Zygotic Gene Activity in Development i. Body Segmentation ii. Specification of Cell Types iii. Organ Formation
UNIT 4	Applications and ethics of genetic technology (15 Lectures)
4.1	Mapping Human Genes at the Molecular Level a. RFLPs as Genetic Markers b. Linkage Analysis Using RFLPs c. Positional Cloning: The Gene for Neurofibromatosis d. The Candidate Gene Approach: The Gene for Marfan Syndrome e. Fluorescent in Situ Hybridization (FISH) Gene Mapping
4.2	Genetic Disorders: Diagnosis and Screening a. Prenatal Genotyping for Mutations in the β- Globin Gene b. Prenatal Diagnosis of sickle-Cell Anemia c. Single Nucleotide Polymorphisms and Genetic Screening d. DNA Microarrays and Genetic Screening e. Genetic Testing and Ethical Dilemmas
4.3	Treating Disorders with Gene Therapy a. Gene Therapy for Severe Combined Immunodeficiency (SCID) b. Problems and Failures in Gene Therapy c. The Future of Gene Therapy: New Vectors and Target-Cell Strategies d. Ethical Issues and Gene Therapy
4.4	DNA Fingerprints

	a. Minisatellites (VNTRs) and Microsatellites (STRs) b. Forensic Applications of DNA Fingerprints
4.5	Genome Projects Use Recombinant DNA technology a. The Human Genome Project: An overview b. The Ethical, Legal, and Social Implications (ELSI) Program c. After the Genome Projects
4.6	Biotechnology is an Outgrowth of Recombinant DNA Technology a. Insulin Production by Bacteria b. Transgenic Animal Hosts and Pharmaceutical Products c. Transgenic Crop Plants and Herbicide Resistance
4.7	Marshaling recombinant DNA technology to fight AIDS

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NAME OF THE COURSE	MICROBIAL BIOCHEMISTRY	
CLASS	MSc- I	
COURSE CODE	SMSMCB203	
NUMBER OF CREDITS	4	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	40	60
PASSING MARKS	16	24

COURSE OBJECTIVES:

CO 1	To explore the various methods of protein purification.
CO 2	To understand the concepts of enzyme kinetics and inhibition.
CO 3	To analyze the signaling that takes place under stress in microorganisms.
CO 4	To describe the microbial degradation of alicyclic, aromatic compounds and biotransformation of pesticides.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to describe and differentiate between salt precipitation, dialysis, ultrafiltration, ultra centrifugation, molecular sieve chromatography, ion exchange chromatography, affinity chromatography, and electrophoresis techniques as methods of protein purification. they will also be able to calculate the specific activity for the same.
CLO 2	The learner will be able to elaborate and graphically explain the effect of enzyme, substrate concentration, pH, temperature and inhibitors on the activity of the enzymes. they will also be able to describe the mechanism and importance of regulation of metabolic pathways.

CLO 3	The learner will be able to discuss the mechanism of signaling that occurs in microorganisms under the stressful conditions that is high or low pH, temperature, oxygen levels and nutrients and the strategies employed to overcome these.
CLO 4	the learner will be able to write pathways / schemes in order to explain the catabolism of aliphatic, alicyclic and aromatic compounds including the structures of intermediates, enzymes catalyzing the reactions, role of coenzymes etc. They will also be able to explain the breakdown of pesticides leading to their detoxification.

UNIT 1	Analytical Biochemistry (15 Lectures)
1.1	Determination of molecular weights, purity, length and volume of organic compounds (02L)
1.2	Extraction, purification, application and analysis of proteins, carbohydrates and lipids. (06L) a. General methods of extraction: salting out, use of organic solvents b. purification: chromatographic techniques c. mass determination: ultracentrifuge, GC-MS d. structure determination: X-ray diffraction e. location: Confocal spectroscopy
1.3	Methods of analysis: a. Proteins (02L) b. Carbohydrates (02L) c. Lipids (02L) d. Other organic compounds (01L) (problem solving under all heads)
UNIT 2	Enzymology (15 Lectures)
2.1	Enzyme kinetics: (05L) a. Discovery of enzymes b. Enzyme terminology

	c. Basic aspects of chemical kinetics d. Kinetics of enzyme catalyzed reactions e. Enzyme inhibition (reversible and irreversible) f. Specific examples – effect of pH on enzyme activity (Fumarase) g. Enzyme action by X-ray crystallography h. Nerve gas and its significance i. HIV enzyme inhibitors and drug design (Problems solving)
2.2	Enzyme regulation (05L) a. Phosphofructokinase as allosteric enzyme b. General properties of allosteric enzymes c. Two themes of allosteric regulations d. Regulation by covalent modification e. Regulation by multienzyme complexes and multifunctional enzymes f. Specific example- the blood coagulation cascade (problem solving)
2.3	Mechanisms of enzyme catalysis (05L): a. Five themes that occur in discussing enzymatic reactions b. Detailed mechanisms of enzyme catalysis for example- serine proteases, ribonucleases, triose phosphate isomerase, lysozyme, lactate and alcohol dehydrogenases c. catalytic antibodies (Problem solving)
UNIT 3	Signaling and Stress (15 Lectures)
3.1	Introduction to two-component signaling systems (05L): a. Response by facultative anaerobes to anaerobiosis, nitrate and nitrite, nitrogen supply, inorganic phosphate supply b. Effect of oxygen and light on the expression of photosynthetic genes in purple photosynthetic bacteria, response to osmotic pressure and temperature, response to potassium ion and external osmolarity, response to carbon sources

	c. Bacterial response to environmental stress- heat-shock response, repairing damaged DNA, the SOS response, oxidative stress
3.2	Synthesis of virulence factors in response to temperature, pH, nutrient, osmolarity and quorum sensors, chemotaxis, photoresponses, aerotaxis, (05L)
3.3	Bacterial development and quorum sensing : Myxobacteria, Caulobacter, bioluminescence, systems similar to LuxR/LuxI in non luminescent bacteria, biofilms. (05L)
UNIT 4	Microbial degradation (15 Lectures)
4.1	Degradation of aromatic and alycyclic compounds (06L) a. Important organisms b. Use of mixed cultures and manipulation of degradative genes c. Common pathways of aromatic degradation d. Aerobic and anaerobic degradation of aromatic compounds e. Aromatic and heterocyclic compounds with economical and ecotoxicological significance (phenolic pesticides, phthalic acid esters, lignosulphonates, surfactants, dyes and aromatics released during combustion.)
4.2	Biotransformation of polycyclic aromatic hydrocarbons(PAHs)- Naphthalene, phenanthroline, anthracene, alycyclic and higher aliphatic hydrocarbons, halogenated aliphatics, branched chain alkanes and alkenes (06L)
4.3	Biochemical mechanisms of pesticide detoxification (03L)

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SMSMCB203

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NAME OF THE COURSE	MEDICAL MICROBIOLOGY & IMMUNOLOGY	
CLASS	MSc- I	
COURSE CODE	SMSMCB204	
NUMBER OF CREDITS	4	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	40	60
PASSING MARKS	16	24

COURSE OBJECTIVES:

CO 1	To educate students about emerging diseases, emphasizing the modes of transmission, pathogenesis, clinical manifestation, laboratory diagnosis, prophylaxis, and treatment.
CO 2	To develop an understanding of clinical research and modern diagnostic methods, and necessary skills to conduct and interpret research studies
CO 3	To explain immune tolerance, and autoimmune diseases
CO 4	To explain the principles of transplantation immunology, giving students knowledge of the immune response to transplanted tissues and organs.
CO 5	To discuss the malignant transformation of cells and immune evasion mechanisms employed by cancer cells, providing insight into cancer pathogenesis and therapeutic strategies.
CO 6	To discuss the challenges faced in the development of vaccines for some of the diseases
CO 7	To discuss primary and secondary immunodeficiency diseases, enabling students to recognize and manage conditions associated with impaired immune function.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to explain and compare the modes of transmission, pathogenesis, clinical manifestation, laboratory diagnosis, prophylaxis and treatment of various emerging diseases.
CLO 2	The learner will be able to recall clinical research trials and gain exposure to modern diagnostic methods like microarrays, enhancing their understanding of research methodologies and diagnostic techniques.
CLO 3	The learner will be able to describe immune tolerance and the mechanisms and treatment options for organ-specific and systemic autoimmune diseases
CLO 4	The learner will be able to explain the mechanism of graft rejection and the involvement of immune cells, providing insights into transplantation immunology
CLO 5	The learner will be able to recall the processes of cancer initiation, promotion, and progression, as well as the role of cancer immunotherapy, contributing to their knowledge of cancer biology and treatment strategies.
CLO 6	The learner will be able to discuss the challenges faced in the development of vaccines, gaining insight into the complexities of vaccine development and deployment.
CLO 7	The learner will be able to explain and compare the mechanisms involved in primary and secondary immunodeficiency diseases and discuss treatment options, enhancing their understanding of immune system disorders.

UNIT 1	Advances in medical microbiology (15 Lectures)
1.1	Emerging Diseases :- Detailed Study of following infections including Etiology, Transmission, Pathogenesis, Clinical Manifestations, Lab. diagnosis, Prophylaxis, and Treatment. a. Dengue b. Listeriosis c. VRE (Vancomycin Resistant enterococci) d. Leptospirosis e. Hepatitis non A

	f. Swine flu g. Conditions caused by Campylobacter h. Prions
UNIT 2	Clinical Research (15 Lectures)
2.1	Introduction to Clinical Research. a. Good Clinical practice Guidelines b. Ethical aspects of Clinical Research c. Regulatory Requirements in clinical research d. Clinical Research Methodologies and Management e. Clinical Data Management and Statistics in Clinical Research.
2.2	Modern Diagnostic Methods: a. Advances in Molecular and Immunological Techniques b. Microarrays c. Advances in Fluorescence Technology.
UNIT 3	Immune System and Health: Part II(15 Lectures)
3.1	Recent advances in immune tolerance a. Central Tolerance b. Peripheral Tolerance c. Tolerance Induction d. T-cell Tolerance e. B-cell Tolerance f. Incomplete Tolerance g. Duration of Tolerance
3.2	Recent advances in autoimmunity a. Interplaying Factors b. Triggering Factors c. Mechanisms of Damage d. Organ Specific Autoimmune Diseases e. Systemic Autoimmune Diseases

	f. Animal Models for Autoimmune Diseases g. Proposed Mechanisms for Induction of Autoimmunity h. Treatment of Autoimmune Diseases
3.3	Transplantation & Transfusion Immunology a. Antigens Involved in Graft Rejection b. Allorecognition c. Graft Rejection-Role of APC's & Effector Cells d. Graft v/s Host Diseases e. Immunosuppressive Therapies f. Blood Transfusion:-- i. ABO & Rh Blood Groups ii. Potential Transfusion Hazards iii. Transfusion Alternatives
3.4	Cancer immunology. a. Cancer: Origin & Terminology b. Malignant Transformation of Cells c. Oncogenes & Cancer Induction d. Tumors of the Immune System e. Tumor Antigens f. Tumor Evasion of the Immune System g. Cancer Immunotherapy
UNIT 4	Challenges in Immune System(15 Lectures)
4.1	Recent advances in vaccines a. Challenges faced b. HIV c. Measles d. T.B.
4.2	Immunodeficiency diseases a. Primary Immunodeficiency

	b. Defects in the Complement System c. Treatment Approaches for Immunodeficiency d. Animal Models of Primary Immunodeficiency e. Secondary Immunodeficiency & AIDS
4.3	Adversarial strategies to overcome immune response a. Microbial strategies in relation to the immune response b. Inflammation Revisited c. Protective Response Against Bacteria d. The Habitat of Intracellular Bacteria e. Immunity to Fungi f. Immunity to Parasitic Infection

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SMSMCB204

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Semester 2 Practicals-SMSMCBP2

NAME OF THE COURSE	CELL BIOLOGY AND VIROLOGY PRACTICAL	
CLASS	MSc-I	
COURSE CODE	SMSMCBP201	
NUMBER OF CREDITS	2	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	-	50
PASSING MARKS	-	20

COURSE OBJECTIVES

CO 1	To arrange a visit to a research institute such as National Institute for Research in Reproductive and Child Health (NIRRH) or Haffkine Institute to demonstrate inoculation of an embryonated egg and cultivation of an animal virus in the same.
CO 2	To cultivate macrophage cell lines and determine the cell viability
CO 3	To perform Mitosis, and Meiosis
CO 4	To estimate nitric oxide produced by macrophages
CO 5	To perform an experiment to study phagocytosis in order to understand the function of the phagocytic cells
CO 6	To determine the integrity of cell membranes via neutral red uptake method
CO 7	To improve soft-skills and research writing by writing a research paper on techniques used to study cell cycle, reviewing articles on cell-cell communication and preparing an assignment on epidemiology and transmission of animal viruses

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to correlate and recall the inoculation of an embryonated egg and cultivation of an animal virus
CLO 2	The learner will be able to cultivate macrophage cell lines and determine the cell viability
CLO 3	The learner will be able to identify and distinguish between the different steps of Mitosis and Meiosis
CLO 4	The learner will be able to perform an experiment to estimate nitric oxide produced by macrophages
CLO 5	The learner will be able to demonstrate and identify phagocytosis
CLO 6	The learner will be able to detect the integrity of cell membrane using neutral red uptake method
CLO 7	The learner will be able to develop research writing skills, write a research paper on techniques used to study cell cycle, review articles on cell-cell communication and prepare an assignment on epidemiology and transmission of an animal virus.

Sr. No	Name of the experiment
1	Egg inoculation and cultivating animal virus in embryonated eggs. Demonstration.
2	Cultivation of macrophage cell lines and study of cell viability.
3	Study of Mitosis.
4	Study of Meiosis.
5	Estimation of NO (Nitric Oxide) produced by Macrophages.
6	Study of Phagocytosis using bacterial culture / yeast cells.
7	Study of Cell membrane integrity using uptake of neutral red.
8	Writing Research Paper –w.r.t. Techniques used to study cell cycle.
9	Review on Cell – Cell communication.
10	Assignment on Animal viruses – Epidemiology, Transmission.
11	Presentation of Assignment – Cell Biology.

NAME OF THE COURSE	MICROBIAL GENETICS PRACTICAL	
CLASS	MSc-I	
COURSE CODE	SMSMCBP202	
NUMBER OF CREDITS	2	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	-	50
PASSING MARKS	-	20

COURSE OBJECTIVES

CO 1	To perform DNA transformation and plasmid curing in order to develop molecular biology practical skills to operate these basic steps
CO 2	To familiarize learners with the experimental procedure of studying bacterial conjugation and its role in horizontal gene transfer.
CO 3	To perform transduction and understand the role of bacteriophages in the same
CO 4	To identify phage nucleic acids and isolate host range mutants
CO 5	To develop an understanding of transposable elements
CO 6	To develop critical thinking and problem solving skills on gene transfer mechanisms and viral genetics
CO 7	To arrange a visit to Advanced Centre for treatment, research and education in cancer (ACTREC) to understand cancer genetics

COURSE LEARNING OUTCOMES

CLO 1	The learner will be able to perform DNA transformation and plasmid curing experiments and apply these experiments in molecular biology research in future.

CLO 2	The learner will be able to perform experimental procedures to study bacterial conjugation and analyze the order of the gene transfer.
CLO 3	The learner will be able to perform transduction and justify the significance of the bacteriophages in the process.
CLO 4	The learner will be able to perform virology based experiments such as isolation of host range mutants and identification of phage nucleic acids.
CLO 5	The learner will be able to develop an understanding of and analyze transposable elements
CLO 6	The learner will be able to analyze, and solve problems on gene transfer mechanisms and viral genetics
CLO 7	The learner will be able to connect the practical aspects of cancer genetics observed during the ACTREC visit with theory

Sr. No	Name of the experiment
1	Transformation.
2	Conjugation, zygotic induction.
3	Transduction.
4	Identification of phage nucleic acid.
5	Curing of plasmids.
6	Study of transposable elements.
7	Isolation of host range mutants.
8	Problems on gene transfer mechanisms.
9	Problems on viral genetics.
10	Cancer genetics- visit to ACTREC.

NAME OF THE COURSE	MICROBIAL BIOCHEMISTRY PRACTICAL	
CLASS	MSc-I	
COURSE CODE	SMSMCBP203	
NUMBER OF CREDITS	2	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	-	50
PASSING MARKS	-	20

COURSE OBJECTIVES

CO 1	To familiarize the learner with performing enzyme assays.
CO2	To acquaint the learner with concept of optimum pH, temperature and types of inhibitors
CO3	To familiarize the learner with mechanism of anaerobic respiration, bacterial motility and swarming
CO4	To enable the learner to study microorganisms degrading xenobiotics.

COURSE LEARNING OUTCOMES

CLO 1	The learner will become competent in extracting, purifying and performing assay of enzyme amylase.
CLO 2	The learner will be able to determine the optimum parameters for maximum activity of amylase and identify various type of inhibitors
CLO 3	The learner will be able to demonstrate anaerobiosis in *E. coli* , chemotaxis in *Pseudomonas* and effect of parameters on swarming activity of *Proteus* species.
CLO 4	The learner will be able to study microorganisms capable of degrading polycyclic aromatic hydrocarbons
CLO 5	The learner will be able to demonstrate protease activity.

Sr. No	Name of the experiment
1	Differential extraction with buffers.
2	Purification strategy.
3	Purification and concentration by precipitation- by decrease of pH, decrease in ionic strength, salting out, organic solvents, organic polymers, denaturation.
4	Aqueous- two phase partitioning.
5	Purification of an extracellular enzyme (β- amylase) by salting out and dialysis.
6	Enzyme kinetics- Effect of enzyme concentration, substrate concentration, pH, temperature and inhibitors on enzyme activity.
7	Demonstration of proteolytic activity.
8	Determination of glucose isomerase present intracellularly in *Bacillus sp.*
9	Adaptation of *E. coli* to anaerobiosis.
10	Chemotaxis of *Pseudomonas.*
11	Effect of temperature and water activity on swarming of *Proteus.*
12	Different bacteriolytic response associated with addition of lysozyme and salt.
13	Microbial degradation of polycyclic aromatic hydrocarbons (PAHs)- enrichment, isolation and screening of bacteria.
14	PAH degradation studies.
15	Plasmid curing and determination of chemotaxis by drop assay method.

NAME OF THE COURSE	MEDICAL MICROBIOLOGY & IMMUNOLOGY PRACTICAL	
CLASS	MSc-I	
COURSE CODE	SMSMCBP204	
NUMBER OF CREDITS	2	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	-	50
PASSING MARKS	-	20

COURSE OBJECTIVES

CO 1	To solve problems on diseases with specific emphasis on the diagnosis
CO 2	To apply a kit method (TULIP) for diagnosing dengue viral infection.
CO 3	To use isolation techniques, biochemical tests, and antibiotic susceptibility tests for the diagnosis of VRE.
CO 4	To demonstrate the Spirochaete staining technique for the diagnosis of Leptospirosis.
CO 5	To demonstrate the diagnosis of Hepatitis Non-A via ELISA
CO 6	To evaluate the principles and application of hemagglutination and hemagglutination inhibition tests for the diagnosis of swine flu-H1N1.
CO 7	To acquire knowledge of the technique of Immunoelectrophoresis of human serum.
CO 8	To demonstrate the ability to determine ABO & Rh antibody titers and understand the implications.
CO 9	To evaluate the concepts and techniques involved in Major and Minor cross matching of blood.
CO 10	To develop an understanding of how the SRID technique is used in quality control to check purity and quantify the antigen used in vaccine preparation.
CO 11	To critically evaluate the use of clinical trials in healthcare research in the form of an assignment

COURSE LEARNING OUTCOMES

CLO 1	The learner will be able to develop problem-solving skills in medical microbiology with a particular focus on the diagnosis of a disease.
CLO 2	The learner will be able to acquire knowledge about the diagnosis of dengue fever using the kit (TULIP).
CLO 3	The learner will be able to develop expertise in the diagnosis of VRE and other infectious diseases using isolation, biochemical tests, and AST.
CLO 4	The learner will be able to learn how to diagnose Leptospirosis via spirochaete staining.
CLO 5	The learner will be able to recall the diagnosis of Hepatitis Non-A via ELISA
CLO 6	The learner will be able to gain specialisation in diagnosing Swine flu-H1N1 using hemagglutination & hemagglutination inhibition tests.
CLO 7	The learner will be able to apply immunoelectrophoresis technique for separating and identifying protein components in human serum.
CLO 8	The learner will be able to determine the antibody titers of ABO and Rh in blood and how it can impact transfusions and other medical procedures.
CLO 9	The learner will be able to distinguish between major and minor cross-matching of blood and its importance in blood transfusion.
CLO 10	The learner will be able to apply the SRID technique to validate the purity and accurately quantify the antigen concentration in vaccine production, detect immune deficiency and complement deficiency, identify specific antibodies, and determine the presence of antigens and antibodies in biological samples.
CLO 11	The learner will be able to create an assignment on clinical trials and demonstrate knowledge of clinical trial procedures and concepts.

Sr. No	Name of the experiment
1	Problem solving exercises in medical microbiology with appropriate tests for the diagnosis of diseases.
2	Rapid identification for Dengue virus (IgM & IgG) kit method “TULIP” Immunochromatography (Demonstration Experiment)

3	Diagnosis for VRE: Isolation using Bile Esculin agar, PYR test.
4	Diagnosis for VRE: AST.
5	Diagnosis for VRE: MIC using High Comb MIC Test.
6	Diagnosis for Leptospirosis: Spirochaete staining.
7	Diagnosis for Hepatitis Non- A: ELISA.
8	Diagnosis for Swine flu-H1N1:Hemagglutination & Hemagglutination inhibition test.
9	Immunoelectrophoresis of proteins – Human serum
10	Determination of ABO & Rh – Antibody titre
11	Major & Minor cross matching of blood.
12	SRID: For detection of immune deficiency and Complement deficiency.
13	Students will have to submit an assignment on clinical trials.

ASSESSMENT DETAILS:

Internal assessment (40 marks)

Part 1: Test (20 marks)

- Students will be given a written test from any of the units for 20 marks. The duration of the test will be 50 minutes. (Multiple choice questions- 05 marks, Answer in one word/sentence - 05 marks, Subjective questions- HWY, Justify, Differentiate between, Diagrammatically etc. - 10 marks).

Part 2: Activity (15 marks)

- An activity for 15 marks would be given in the form of a creative learning process. (Powerpoint presentation, Report, Preparation of study material, any other activity)

Part 3: Active Participation (05 marks)

Semester end examination (60 marks)

The duration of the paper will be two and a half hours.

- There shall be five compulsory questions
- Q1-4 shall correspond to the four units. Q1-4 shall contain an internal choice (attempt any 2 of 3). Q1-4 shall carry a maximum of 12 marks.
- Q5 shall be from Units 1 to 4 and consist of objective type questions.. Q5 shall carry a maximum of 12 marks (attempt any 4 of 6 for Part A and B and any 2 of 3 for Part C)

Practical Assessment

- The duration of the practical exam will be three days.
- There will be 50 marks practical per paper.
- To appear in the practical exam, students must bring a properly certified journal.