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 2020-2021)

Programme Outline: MSc-I Microbiology (SEMESTER I)

Course code	Unit No	Name of the Unit	Credits
SMSMCB101		VIROLOGY AND CELL BIOLOGY-I	4
	1	Bacteriophages	
	2	Plant Viruses	
	3	Plasma membrane, Mitochondria and Chloroplast	
	4	Endomembrane system	
SMSMCB102		GENETICS-I	4
	1	DNA replication and Gene expression	
	2	Recombination, Mutation and Repair	
	3	Regulation of gene expression in bacteria	
	4	Eukaryotic gene regulation and Epigenetics	
SMSMCB103		MICROBIAL BIOCHEMISTRY	4
	1	Aqueous Solutions and Acid-Base Chemistry	
	2	Analytical Biochemistry	
	3	Bioorganic Molecules	
	4	Signaling and stress	
SMSMCB104		MEDICAL MICROBIOLOGY AND IMMUNOLOGY	
	1	Advances in Medical Microbiology part 1	4
	2	Advances in Medical Microbiology part 2	
	3	Immune system and health I	
	4	Immune system and health II	
SMSMCBP1		PRACTICALS	
SMSMCBP101		VIROLOGY AND CELL BIOLOGY-I	2
SMSMCBP102		GENETICS-I	2
SMSMCBP103		MICROBIAL BIOCHEMISTRY	2
SMSMCBP104		MEDICAL MICROBIOLOGY AND IMMUNOLOGY	2

Programme Outline: MSc-I Microbiology (SEMESTER II)

Course code	Unit No	Name of the Unit	Credits
SMSMCB201		VIROLOGY AND CELL BIOLOGY-II	4
	1	Human Viruses	
	2	Emerging and re-emerging viruses, Tumor viruses and Prions	
	3	Cytoskeleton, Cellular reproduction and Development of multicellular organisms	
	4	Signaling, Communication and Programmed cell death in microorganisms	
SMSMCB202		GENETICS-II	4
	1	Mendelian Genetics and Population Genetics	
	2	Evolutionary Genetics, Transposable genetic elements and Cancer	
	3	Techniques used in Genetics	
	4	Bioinformatics and Functional Genomics	
SMSMCB203		MICROBIAL BIOCHEMISTRY	4
	1	Biosynthesis and Molecular Physiology	
	2	Enzymology	
	3	Metabolism of one & two carbon compounds	
	4	Microbial Degradation of xenobiotics	
SMSMCB204		MEDICAL MICROBIOLOGY AND IMMUNOLOGY	
	1	Epidemiology of Infectious Diseases	4
	2	Clinical Research in Medical Microbiology	
	3	Clinical Immunology I	
	4	Clinical Immunology II	
SMSMCBP2		PRACTICALS	
SMSMCBP201		Virology and Cell Biology-II	2
SMSMCBP202		Genetics –II	2
SMSMCBP203		Microbial Biochemistry	2
SMSMCBP204		Medical Microbiology and 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	VIROLOGY AND CELL BIOLOGY-I	
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	50	50
PASSING MARKS	20	20

COURSE OBJECTIVES:

CO 1	To explain and describe the replication and regulation of transcription of bacteriophages.
CO 2	To discuss the life cycle of plant viruses and agents that infect plants such as Viroids.
CO 3	To develop an understanding of cell biology of eukaryotic microorganisms being Microbiology students.
CO 4	To explain cell biology of humans and animals in order to understand the life cycle of human and animal viruses.
CO 5	To facilitate students' understanding of the structure and function of the nuclear envelope, nuclear pore complex and its role in facilitating nucleocytoplasmic exchange.
CO 6	To familiarize students with the structure and role of rough and smooth endoplasmic reticulum, Golgi complex, lysosomes and vacuoles.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to explain replication and regulation of gene expression of different bacteriophages.
CLO 2	The learner will be able to compare different bacteriophages.
CLO 3	The learner will be able to explain the structure, replication and life cycle of specific plant viruses and prevention and control of plant viral infections.
CLO 4	The learner will be able to describe membrane proteins and transport, mitochondrial ETC and ATP synthesis and chloroplast in eukaryotes.

CLO 5	The learner will be able to explain and discuss eukaryotic nuclear pore complex, Endoplasmic reticulum, Golgi complex and vesicle transport, vacuoles of eukaryotic microorganisms such as fungi, yeast (*Saccharomyces cerevisiae*) algae and amoeba.
CLO 6	The learner will be able to apply the knowledge of the cell biology concepts such as endocytosis, clathrin coated vesicles, transport of mRNAs from nucleus to cytoplasm to understand the life cycle of human viruses in semester 2.

UNIT 1	Bacteriophages (15 Lectures)
	Students to revise general properties, structure of bacteriophages and stages in a lytic life cycle of a typical phage
1.1	*E.coli* Phage T7: Genetic organization, regulation of transcription, DNA replication and maturation (03 L)
1.2	*E.coli* Phage φX174: Replication, transcription, packaging (02 L)
1.3	Filamentous DNA phages- M13: Attachment and entry, replication, assembly and release (02 L)
1.4	Single stranded RNA phages MS-2 and Qβ: Genetic organization and life cycle (01L)
1.5	Lambda phage: lytic and lysogenic cycle (05 L)
1.6	Bacteriophage Mu: Properties, Genetic organization and replication (02 L)
UNIT 2	Plant Viruses (15 Lectures)
2.1	Viruses causing plant diseases: History, transmission, symptoms, detection, prevention and control (02 L)
2.2	Structure of plant viruses (01L)
2.3	Life cycles- overview (01L)
2.4	Tobacco Mosaic Virus- Life cycle, host range, transmission, symptoms, diagnosis and control (04 L)
2.5	Citrus Tristeza Virus (01L)
2.6	Applications of plant viruses (01L)
2.7	RNA interference (02 L)

2.8	Plant satellites (01L)
2.9	Viroids (02 L)
UNIT 3	Plasma membrane, Mitochondria and Chloroplast (15 Lectures)
	Students to revise basic properties of cells, different classes of cells and functions of plasma membrane
3.1	Plasma membrane (06 L) a. Chemical composition of membranes- (in brief) i. Membrane lipids (phosphoglycerides, sphingolipids, cholesterol) ii. carbohydrates b. Structure and functions of membrane proteins - i. Integral membrane proteins ii. peripheral membrane proteins iii. lipid anchored membrane proteins c. Membrane lipids and fluidity d. Movement of substances across cell membranes i. Diffusion of substances through membranes Voltage-gated channels, Ligand-gated channels, Mechano-gated channels ii. Facilitated diffusion iii. Active transport
3.2	Mitochondria (06 L) a. Mitochondrial structure and function- membrane and matrix b. Oxidative metabolism in the mitochondrion c. Role of mitochondria in the formation of ATP i. Electron transport ii. types of electron carriers d. Establishment of proton motive force e. Machinery for ATP formation i. Structure of ATP synthase ii. basis of ATP formation, Rotational catalysis f. Peroxisomes
3.3	Chloroplast (03 L) a. Chloroplast structure and function b. Photosynthetic metabolism c. Photosynthetic pigments d. Photosynthetic units and reaction centers i. PSII operations ii. PSI operations

	e. Photophosphorylation
UNIT 4	Endomembrane system (15 Lectures)
4.1	a. Nuclear envelope b. Structure of the Nuclear Pore Complex and its role in Nucleocytoplasmic exchange c. The endoplasmic reticulum d. The smooth endoplasmic reticulum e. Functions of the rough endoplasmic reticulum- synthesis and processing of proteins f. The Golgi complex g. Types of vesicle transport and their functions- Cop II-coated vesicles, Cop I-coated vesicles h. Fungal vacuoles, comparison with lysosomes i. Contractile Vacuoles in algae and amoeba j. Vacuoles in yeast *Saccharomyces cerevisiae* k. Endocytic pathway

REFERENCES

SMSMCB101

1. Freifelder, David. (2004). Molecular Biology, 2nd edn. *Narosa Publishing House.*
2. Russell, Peter J. (2010). iGenetics: A Molecular Approach, 3rd edn. *Pearson.*
3. Shors, Teri. (2009). Understanding viruses, 1st edn. *Jones and Bartlett Publishers.*
4. Hull, Roger. (2013). Plant Virology, 5th edn. *Academic Press.*
5. Mahy, Brian WJ., and Regenmortel, Marc HV Van. (2010). Desk Encyclopedia of General Virology. *Elsevier.*
6. Cann, Alan. (2015). Principles of Molecular Virology, 6th edn. *Academic Press.*
7. Karp, Gerald. (2010). Cell and Molecular Biology, 6th edn. *John Wiley & Sons, Inc*.
8. Klionsky, Daniel J., Herman, Paul K., and EMR, Scott D. (1990). The Fungal Vacuole: Composition, Function and Biogenesis. *American Society for Microbiology.* 0146 (0749):266-292.
9. Li, Sheena Claire., and Kane, Patricia M. (2009). The Yeast Lysosome-like Vacuole: Endpoint and Crossroads. *Biochim Biophys Acta.*1793 (4):650-663.

Additional references:

1. Watson, James D., Baker, Tania A., Bell, Stephen P., Gann A., Levine, M., Losick., R. (2003). Molecular Biology of the Gene, 5th edn. *Cold Spring Harbor Laboratory Press.*
2. Watson, James D., Baker, Tania A., Bell, Stephen P., Gann A., Levine, M., Losick., R. (2013). Molecular Biology of the Gene, 7th edn. *Pearson.*

3. Lewin, Benjamin. (2004). Genes VIII. *Pearson.*
4. Madigan, M., Martinko, J., Bender, K., Buckley, D., and Stahl, D. (2015). Brock Biology of Microorganisms 14th edn. *Pearson.*
5. Tropp, Burton E. (2007). Molecular Biology Genes to Proteins, 3rd edn. *Jones and Bartlett publishers.*
6. Lodish, Harvey., Berk, Arnold., and Kaiser, Chris A. (2007). Molecular Cell Biology, 6th edn. *W.H. Freeman & Co Ltd.*
7. De Robertis, E.D.P. (2017). Cell and Molecular Biology, 8th edn. *LWW.*
8. Simm, Claudia., Lahner, Brett., Salt, David., LeFurgey, Ann., Ingram, Peter., Yandell, Brian., and Eide, David J. (2007). *Saccharomyces cerevisiae* Vacuole in Zinc Storage and Intracellular Zinc Distribution. *Eukaryotic Cell.* 1535(9778*):*1166-1177.

NAME OF THE COURSE	GENETICS-I

CLASS	MSc- I	
COURSE CODE	SMSMCB102	
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	50	50
PASSING MARKS	20	20

COURSE OBJECTIVES:

CO 1	To explain coordination of DNA replication and septum formation in bacteria.
CO 2	To describe the molecular details of gene expression and its regulation in bacteria and eukaryotes.
CO 3	To discuss recombination at the molecular level in bacteria and eukaryotic microorganisms such as yeast.
CO 4	To explain complementation test and fine structure mapping in bacteriophages.
CO 5	To describe the mechanism of recombination repair mechanisms in *E.coli* and eukaryotes.
CO 6	To familiarize students with regulation of gene expression in eukaryotes at various levels.
CO 7	To introduce the concept of epigenetic regulation and its significance in control of eukaryotic gene expression.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to recall the concepts of molecular genetics.
CLO 2	The learner will be able to explain the role of bacterial proteins in septum formation and segregation of chromosomes and also in partitioning of plasmids.
CLO 3	The learner will be able to describe molecular details of transcription, RNA processing and splicing and translation.
CLO 4	The learner will be able to explain and classify different recombination models.
CLO 5	The learner will be able to compare the role of proteins in recombination in bacteria and eukaryotes including mating type switching in *Saccharomyces cerevisiae*
CLO 6	The learner will be able to explain the complementation test, fine structure mapping and its significance and recombination repair mechanisms in *E.coli* and eukaryotes.
CLO 7	The learner will be able to explain bacterial operons, mutations affecting regulation of gene expression, attenuation, antisense RNA and regulation during sporulation in *Bacillus.*
CLO 8	The learner will gain an understanding of epigenetic modifications and their role in regulating gene expression patterns.

CLO 9	The learners will be able to explain the significance of DNA methylation, histone modifications, and nucleosome remodeling in gene regulation.

UNIT 1	DNA replication and Gene expression (15 Lectures)
1.1	Replication and Genetics of Cell division in bacteria (05 L) a. Replication and cell cycle b. Septum formation in bacteria c. Function of FtsZ, MinCD and MinE d. Partitioning of Chromosomes e. Partitioning of single copy plasmids
1.2	Gene expression (10 L) a. Transcription i. Bacterial Transcription ii. Eukaryotic Transcription b. RNA molecules and processing i. Messenger RNA- Structure, processing, addition of the 5' Cap, addition of the Poly (A) tail, RNA splicing, self splicing introns, introns of T4 bacteriophage, Alternative processing pathways, RNA editing ii. Transfer RNA- Structure of transfer RNA, tRNA gene structure and processing iii. Ribosomal RNA- Structure of the ribosome, rRNA gene structure and processing c. Translation i. The process of translation- The binding of amino acids to transfer RNAs ii. The Initiation, elongation and termination of translation d. The posttranslational modifications of proteins
UNIT 2	Recombination, Mutation and Repair (15 Lectures)
2.1	Recombination (09 L) a. Holliday model b. DSB repair model c. Homologous recombination machines in prokaryotes- RecBCD, RecA, RuvA, RuvB and RuvC d. Homologous recombination in eukaryotes and proteins involved in the same *e.* Mating type switching in *Saccharomyces cerevisiae*

	f. Concept of linkage
2.2	DNA Mutations (03 L) *(Students to revise the entire topic of Mutations from T.Y.B.Sc.)* a. Mutagens- Base analogs (5-bromouracil, 2-aminopurine), Alkylating agents, Intercalating agents b. Complementation test and fine structure mapping
2.3	DNA Repair (03 L) a. Recombination repair in *E. coli* b. NHEJ pathway
UNIT 3	Regulation of gene expression in bacteria (15 Lectures)
3.1	Regulation of gene expression in bacteria (15 L) a. Operons i. The *lac* operon of *E. coli* –Experimental evidence for the regulation of *lac* genes, mutations in the protein-coding genes, mutations affecting the regulation of gene expression, operator mutations- $lacO^c$ mutations, *lacI* gene regulatory mutations, promoter mutations, positive control of the *lac* operon ii. The *ara* operon of *E. coli*: Positive and negative control iii. The *trp* operon of *E. coli*- Attenuation iv. The *hut* operon b. Antisense RNA c. Riboswitches d. Sigma factor switching- Sporulation in *Bacillus subtilis*
UNIT 4	Eukaryotic gene regulation and Epigenetics (15 Lectures)
4.1	Eukaryotic gene regulation (15 L) a. Gene regulation in Eukaryotes- i. Changes in chromatin structure ii. Regulation of transcription factors and activators iii. RNA Processing- Examples- SV40, sex differentiation in Drosophila, Degradation of RNA, RNA interference (briefly) iv. Processes that affect Translation, modification of proteins. b. Epigenetic regulation- i. DNA methylation and demethylation, ii. Histone modifications, Acetylation, phosphorylation, Ubiquitinylation, Poly ADP Ribosylation, iii. Heterochromatin, histone variants, iv. Nucleosome v. Long non-coding RNA, alternate splicing,

	vi. Mammalian development, dosage compensation and genomic imprinting (disorders/ diseases)

REFERENCES:

SMSMCB102

1. Lewin, Benjamin. (2004). Genes VIII. *Pearson*.
2. Lewin, Benjamin. (2007). Genes IX. *Jones and Bartlett publishers.*
3. Pierce, B. (2008). Genetics- a conceptual approach, 3rd edn, *W.H. Freeman and Company.*
4. Watson, James D., Baker, Tania A., Bell, Stephen P., Gann A., Levine, M., Losick., R. (2003). Molecular Biology of the Gene, 5th edn. *Cold Spring Harbor Laboratory Press.*
5. Watson, James D., Baker, Tania A., Bell, Stephen P., Gann A., Levine, M., Losick., R. (2013). Molecular Biology of the Gene, 7th edn. *Pearson.*
6. Stanier, Roger Y., Adelberg, Edward A., and Ingraham, John L. (1976). General Microbiology, 4th edn. *Macmillan.*
7. Russell, Peter J. (2010). iGenetics: A Molecular Approach, 3rd edn. *Pearson.*
8. Gottschalk, Gerhard. (1985). Bacterial Metabolism, 2nd edn. *Springer, New York, NY.*
9. Weaver, Robert F. (2012). Molecular Biology, 5th edn. *McGraw-Hill*.
10. White, David. (2006). The Physiology and Biochemistry of Prokaryotes, 3rd edn. *OUP.*
11. Watson, James D., Caudy Amy A., Myers, Richard M., and Witkowski Jan A. (2007) Recombinant DNA, Genes and Genomics - A short course, 3rd edn. *W.H. Freeman and Company.*
12. Brooker, Robert. (2017). Genetics: Analysis and Principles, 6th edn. *McGraw-Hill Higher Education.*

Additional references:

1. Snustad, Peter D., Simmons, Michael J. (2003). Principles of Genetics, 3rd edn. *John Wiley & Sons, Inc.*
2. Snustad, Peter D., Simmons, Michael J. (2012). Principles of Genetics, 6th edn. *John Wiley & Sons, Inc.*
3. Freifelder, David. (2004). Molecular Biology, 2nd edn. *Narosa Publishing House.*
4. Tamarin, Robert H. (2002). Principles of Genetics, 7th edn. *McGraw-Hill.*
5. Tropp, Burton E. (2007). Molecular Biology Genes to Proteins, 3rd edn. *Jones and Bartlett publishers.*
6. Klug William S., Cummings Michael R. (2000). Concepts of genetics. 6th edn. *Prentice Hall.*
7. Snyder, Larry., Peters, Joseph. E., Henkin, Tina M., and Champness, Wendy. (2013). Molecular Genetics of bacteria, 4th edn. *Wiley-Blackwell.*

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	50	50
PASSING MARKS	20	20

COURSE OBJECTIVES:

CO 1	To explain the chemistry underlying the preparation of solutions, buffers etc.
CO 2	To explore the principles, instrumentation and applications of various methods of purification of macromolecules and learn about their properties using different instrumental techniques.
CO 3	To explain the structure and functions of macromolecules: proteins, carbohydrates and lipids.
CO 4	To inform about the signaling pathways in bacteria under environmental stresses.

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 apply various techniques for purification of macromolecules keeping in mind their advantages and disadvantages. They will describe the different techniques used for their characterization.
CLO 3	The learner will be able to discuss and correlate the structure of the macromolecules with their functions.
CLO 4	The learner will be able to describe the signaling used by bacteria for survival under varying conditions of temperature, oxygen, and availability of nutrients.

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 (02L)
1.2	Bronsted Concept of conjugate acid- conjugate base pairs, ionization of solutions, pH, titration curves (03L)
1.3	Buffers: preparation, action and their use in Biology Henderson-Hasselbalch equation, buffer capacity (03L)
1.4	Polyprotic acids, amphoteric salts, ionic strength of solutions (03L)
1.5	Problem solving under all heads (04L)
UNIT 2	Analytical Biochemistry (15 Lectures)
2.1	Determination of molecular weight, purity, length and volume of organic compounds (02L)
2.2	General methods of extraction: salting out proteins, use of organic solvents (01L)
2.3	Purification using chromatographic techniques (02L)
2.4	Mass determination using Ultracentrifugation and GC- MS (02L)
2.5	Different types of mass spectrometry and surface plasma resonance methods (02L)
2.6	UV/visible, fluorescence, circular dichroism, NMR and ESR spectroscopy (03L)
2.7	Determination of structure using X-ray diffraction and NMR (02L)
2.8	Radiolabeling techniques: Properties of different types of radioisotopes normally used in biology, their detection and measurement; incorporation of radioisotopes in biological tissues and cells, molecular imaging of radioactive material, safety guidelines. (01L)
UNIT 3	Bioorganic Molecules (15 Lectures)
3.1	Amino acids: Classification and stereochemistry, properties, biochemical information from amino acid sequence, derivative, ionization (02L)
3.2	Structure and function of Proteins: Structure of peptide bond, stability of peptide bond, Ramachandran plot (03L)
3.3	Protein structure, factors determining secondary, tertiary structures: amino acid sequence, thermodynamics of folding, role of disulfide bonds, dynamics of globular protein folding, chaperonins, Protein folding diseases: amyloid diseases and prions. (03L)
3.4	Motifs and domains, protein families, protein stability, prediction of secondary and tertiary structure, protein-protein interactions (02L)

3.5	Glycobiology: Carbohydrates, stability of glycosidic bond, glycoconjugates, proteoglycans, glycoproteins, glycolipids, homopolysaccharide folding, functions of oligosaccharides (02 L)
3.6	Lipids: 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 4	Signaling and Stress (15 Lectures)
4.1	Introduction to two-component signaling systems: a. Response by facultative anaerobes to anaerobiosis, nitrate and nitrite, nitrogen and inorganic phosphate supply b. Synthesis of virulence factors in response to temperature, pH, nutrient, osmolarity and quorum sensors, chemotaxis, photoresponses, aerotaxis (05L)
4.2	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 (04L)
4.3	Bacterial response to environmental stress- heat-shock response, repairing damaged DNA, the SOS response, oxidative stress (02L)
4.4	Bacterial development and quorum sensing: Myxobacteria, Caulobacter, bioluminescence, systems similar to LuxR/LuxI in non-luminescent bacteria, Biofilm development (04L)

REFERENCES:

SMSMCB103

1. Nelson, D., & Cox, M., (2005) Lehninger: Principles of Biochemistry, 4th edn., *New York, W.H. Freeman & Co.*
2. Segel, I.R., (2004). Biochemical calculations, 2nd edn. *John Wiley and Sons.*
3. Jayaraman. Lab Manual in biochemistry. *New Age International Publishers.*
4. White, David. (2011). The physiology and biochemistry of prokaryotes, 4th edn, *Oxford University Press.*

Additional references:

1. Zubay. (1998). Principles of Biochemistry, 4th edn.*Wm. C. Brown Publishers.*
2. Mathew, Van Holde and Ahern. (1999). Biochemistry, 3rd edn. *Pearson Education.*
3. N. Price J. Naira. (2009). Exploring proteins: Student's guide to experimental skills and methods. *Oxford University Press.*

NAME OF THE COURSE	MEDICAL MICROBIOLOGY AND 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	50	50
PASSING MARKS	20	20

COURSE OBJECTIVES:

CO 1	To educate students about emerging and re-emerging diseases listed by the World Health Organization in 2015, as well as those prevalent in Asian countries, emphasizing the modes of transmission, pathogenesis, clinical manifestation, laboratory diagnosis, containment procedures, and treatment.
CO 2	To comprehend the mechanism of the inflammation process and the roles played by leukocytes, chemokines, and other mediators, providing insight into the body's immune response to infection and injury.
CO 3	To grasp the biological activity of cytokines, including their structure, receptors, and therapeutic uses, enhancing understanding of cytokine-mediated immune responses and their potential applications in therapy.
CO 4	To explore the immune responses to infectious diseases caused by viruses, bacteria, protozoa, and helminths, enabling students to understand the complexities of host-pathogen interactions and the body's defense mechanisms.
CO 5	To recognize the importance of gut flora in maintaining health and its role in disease processes, providing insights into the interactions between the microbiota and the immune system, and their implications for health and disease.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to comprehend modes of transmission, pathogenesis, clinical manifestation, laboratory diagnosis, containment procedures to prevent unintentional exposure to bio hazardous agents, and treatment of emerging and re-emerging diseases.
CLO 2	The learner will be able to articulate the process of inflammation and identify the key mediators involved in this process.

CLO 3	The learner will be able to describe the role of cytokines in different immune processes, including the cytokine profile of TH1, TH2, and TH17 subsets, and discuss their therapeutic uses.
CLO 4	The learner will be able to explain the innate and adaptive immune responses to infectious diseases caused by viruses, bacteria, protozoa, and helminths.
CLO 5	The learner will be able to elucidate the changes in gut flora with age, the techniques used to study gut flora, and the importance of gut microflora in health and disease.

UNIT 1	Advances in Medical Microbiology part –I (15 Lectures)
1.1	Bacterial Emerging and Re-emerging Diseases (15L) Detailed Study: Common factors of emerging and reemerging diseases and their causes, Etiology, Transmission, Pathogenesis, Clinical manifestation, Lab diagnosis, Prevention and Treatment. a. Listeriosis b. VRE (Vancomycin Resistant Enterococci) c. Leptospirosis d. Drug resistant Tuberculosis e. Conditions caused by *Helicobactor pylori, Campylobacter* and MRSA
UNIT 2	Advances in Medical Microbiology part –2 (15 Lectures)
2.1	Viral Emerging and Re-emerging Diseases (15 L) Detailed Study: Common factors of emerging and reemerging diseases and their causes, Etiology, Transmission, Pathogenesis, Clinical manifestation, Lab diagnosis, Containment procedures to prevent unintentional exposure to biohazardous agents and Treatment. a. SARS b. Chikungunya c. Swine flu d. Zika Virus e. Dengue f. Japanese Encephalitis g. Nipah h. Ebola i. COVID-19
UNIT 3	Immune System and Health I (15 Lectures)
3.1	Immunity to infection Leukocyte migration and inflammation

	a. Lymphocyte Recirculation b. Cell-Adhesion Molecules c. Neutrophil Extravasation d. Lymphocyte Extravasation e. Chemokines—Key Mediators of Inflammation f. Other Mediators of Inflammation g. The Inflammatory Process h. Anti-Inflammatory Agents
3.2	Cytokines a. Properties of Cytokines b. Cytokine Receptors c. Cytokine Antagonists d. Cytokine Secretion by TH1 and TH2 & TH17 Subsets e. Cytokine-Related Diseases f. Therapeutic Uses of Cytokines and Their Receptors g. Cytokines in Hematopoiesis
UNIT 4	Immune system and health II (15 Lectures)
4.1	Adversial strategies during infection a. Immunity to extracellular bacteria b. Immunity to Intracellular bacteria c. Immunity to Viral infection d. Immunity to Fungi e. Immunity to Parasitic infection
4.2	Gut Flora in Health and Disease a. Changes in gut microflora with age b. Techniques for the study of gut microbiome c. The interplay between nutrition on gut flora d. Effects of gut flora on health and well-being e. Manipulation of the gut microbiome

REFERENCES:

SMSMCB104

1. Dugal, Suparna., and Mantri, Jyoti. (2018). Understanding Emerging and Re-emerging Infectious Diseases, First edn. *Himalaya Publishing House.*
2. Ananthanarayan & Paniker. (2009). Textbook of Microbiology, 8th edn. *University press.*
3. Clinics in laboratory medicine, Emerging Infections and their causative agents. September 2004 vol. 24 no. 3.
4. Basic laboratory methods in clinical bacteriology, WHO 2003
5. Godkar, Praful B., Godkar, Darshan P. (2014). Textbook of Medical laboratory technology, 3rd edn, volume 1 & 2. *Bhalani Publishing House.*
6. Pathak, Sulabha., Palan, Urmi. (2011). Immunology – Essential and Fundamental, 3rd edn, *Capital Publishing Company.*
7. Kindt, Thomas J., Goldsby, Richard A., Osborne, Barbara Anne., Kuby, Janis. (2006). Immunology, 6th edn. *W. H. Freeman and company.*
8. Khan, Fahim Halim. (2009). The Elements of Immunology. *Pearson Education.*
9. Tizard, Ian R. (2005). Immunology: An introduction, 4th edn. *Cengage learning.*
10. Janeway, Charles., Travers, Paul., Walport, Mark., Shlomchik, Mark. (2006). Immunobiology: The immune system in health and disease, 6th edn, Garland Science.
11. Sekirov, Inna., Russell, Shannon L., Antunes, L Caetano M., Finlay, Brett B. (2010). Gut Microbiota in Health and Disease. *Physiol Rev.* 90: 859–904.
12. Human microbiota research June 2019 www.nature.com/collections/microbiota-milestone
13. The Human Gut Microbiota, JRC technical reports, EU Science Hub, https://ec.europa.eu/jrc PDF. ISBN 978-92-79-86471-1. ISSN 1831-9424 doi: 10.2760/17381.

Practicals- Semester 1 SMSMCBP1

NAME OF THE COURSE	VIROLOGY AND CELL BIOLOGY-I 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. enumeration of bacteriophages by plaque assay, 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 studying the integrity of cell membranes and isolation of mitochondria and chloroplasts in order to equip them with basic eukaryotic cell biology practical skills

COURSE LEARNING OUTCOMES

CLO 1	The learner will be able to use the plaque assay to enumerate bacteriophages and calculate plaque forming units/ml
CLO 2	The learner will be able to perform one step growth curve experiment
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 assess the integrity of cell membrane using neutral red uptake method
CLO 5	The learner will be able to perform the extraction of mitochondria and chloroplast from eukaryotic cells

Sr. No	Name of the experiment
1	Enumeration of coliphages by plaque assay.
2	Study of one step growth curve of T4 bacteriophage.
3	Study of lysogeny in *E. coli.*
4	Assignment/Activity on plant viruses/ viroids.
5	Study of cell membrane integrity using uptake of neutral red.
6	Isolation of mitochondria from the cell.
7	Isolation of chloroplasts.

NAME OF THE COURSE	GENETICS-I 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

COURSE OBJECTIVES

CO 1	To provide learners with practical training in running agarose gels and understanding its applications in separating nucleic acids.
CO 2	To familiarize learners with the experimental procedure of studying bacterial conjugation and its role in horizontal gene transfer.
CO 3	To equip learners with skills in analyzing the mutations induced by UV radiation and in selective culturing and identification of streptomycin-resistant mutants
CO 4	To train learners to enrich and isolate auxotrophic mutants using selection and screening methods such as penicillin enrichment and replica plate techniques respectively.
CO 5	To familiarise learners with the principle and significance of the Ames test in assessing the mutagenicity of chemical compounds.

CO 6	To enhance understanding of the utility of colorimetric assays such as the β-galactosidase assay in measuring gene expression and promoter activity.
CO 7	To promote problem-solving skills and apply critical thinking to lac operon-related scenarios.

COURSE LEARNING OUTCOMES

CLO 1	The learner will be able to prepare agarose gels, load DNA samples, run electrophoresis, visualize the separated DNA bands and interpret the gel image to understand the plasmid topology and size.
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 the necessary steps to expose microorganisms to UV radiation for mutagenesis and isolate streptomycin-resistant mutants using selective culturing techniques.
CLO 4	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 5	The learner will be able to understand the experimental procedure to perform the Ames test using bacterial strains.
CLO 6	The learner will be able to perform the β-galactosidase assay and acquire skills in quantifying and analyzing β-galactosidase activity.
CLO 7	The learner will be able to explain the regulation of Lac operon and apply critical as well problem-solving skills to lac operon-related analytical questions.

Sr. No	Name of the experiment
1	Separation of plasmid or genomic DNA using agarose gel electrophoresis.
2	Bacterial conjugation.
3	UV mutagenesis.
4	Penicillin enrichment technique.
5	Ames test.
6	β- galactosidase assay.
7	Problems on *lac* operon.

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
CO2	To acquaint the learner with concept of pKa of amino acids
CO3	To enable the learner to extract , separate, identify and determine the level of unsaturation of fats
CO4	To enable the learner to analyze samples for sugar, fat and polyphenol content
CO5	To familiarize the learner with mechanism of anaerobic respiration, bacterial motility and swarming

COURSE LEARNING OUTCOMES

CLO 1	The learner will become competent in preparation of solutions and buffers of defined strength as per requirement.
CLO 2	The learner will be able to determine the pKa value and molar absorption coefficient of amino acids.
CLO 3	The learner will be able to extract cholesterol, separate fats by chromatography and determine iodine number of 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
CLO 5	The learner will be able to estimate polyphenol concentration in food stuff.
CLO 6	The learner will be able to demonstrate anaerobiosis in *E.coli* , chemotaxis in *Pseudomonas* and effect of parameters on swarming activity of *Proteus* species.

Sr.No	Name of the experiment
1	Preparation of buffers.
2	Determination of pK and pI value for an amino acid.
3	Extraction of total lipids.
4	Isolation of cholesterol and lecithin from egg yolk.
5	Identification of fatty acids and other lipids by TLC.
6	Determination of degree of unsaturation of fats and oils.
7	Isolation of lactose from bovine milk.
8	Estimation of total sugars by phenol-sulphuric acid method.
9	Isolation of glutamic acid from gluten.
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	Adaptation of *E.coli* to anaerobiosis.
14	Chemotaxis of *Pseudomonas.*
15	Effect of temperature and water activity on swarming of *Proteus.*
16	Visit to any centre/research lab for Demonstration of HPLC / GC.

References

Practical:

1. Jayaraman. Laboratory manual in biochemistry. *New Age International Publishers.*
2. Plummer, David T. (1998). An introduction to practical biochemistry, 3rd edn, *Tata McGraw Hill edition.*
3. Beedu, Rao., Deshpande, S. Experimental biochemistry –A student companion. *IK international Pvt. Ltd.*
4. Nigam, A., Ayyagiri, A. Laboratory manual in biochemistry, Immunology and Biotechnology. *Tata McGraw Hill edition.*
5. Primrose, S. B., Wardlaw, A. C. (1982). Source Book of Experiments for the teaching of Microbiology, *Society for General Microbiology Special Publication, Geniza.*
6. White, David., Hegeman, George D. (1997). Microbial Physiology and Biochemistry Laboratory: A quantitative approach, *Oxford University Press Inc.*
7. Wilson, K., Walker, J. (1994). Principles and techniques of practical biochemistry, 4th P edn, *Cambridge University Press*.

NAME OF THE COURSE	MEDICAL MICROBIOLOGY AND 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

COURSE OBJECTIVES

CO 1	To analyze the strategies used by governments to prevent pandemics and evaluate their effectiveness.
CO 2	To evaluate the pathogenesis and microbial causes of communicable diseases caused by Chikungunya, Helicobacter, Leptospirosis, Drug-resistant TB, Campylobacter, MRSA, Swine flu, Zikavirus, Dengue, Nipah, Ebola, Japanese encephalitis, SARS, and COVID-19.
CO 3	To apply the principles of acid-fast staining technique for identifying *M. tuberculosis.*
CO 4	To demonstrate the diagnostic techniques for identifying *Helicobacter pylori* infection such as urea breath test and urease production test on biopsy samples.
CO 5	To use isolation techniques, biochemical tests, and antibiotic susceptibility tests for the diagnosis of VRE.
CO 6	To apply NS1 antigen kit for diagnosing dengue viral infection.
CO 7	To evaluate the principles and application of hemagglutination and hemagglutination inhibition tests for the diagnosis of swine flu-H1N1.
CO 8	To demonstrate the Spirochaete staining technique for the diagnosis of Leptospirosis.
CO 9	To apply the principles of RT-PCR in diagnosing COVID-19 or any other disease.
CO 10	To apply the ELISA as a diagnostic method for most viral infections.

CO 11	To compare and contrast the different tests used to detect resistant *Mycobacteria* such as Bactec MGIT 960 system, Reverse line blot assay, X-pert MTB or RIF assay, and Line Probe assay.
CO 12	To evaluate the significance of phagocytosis and phagocytic index as virulence factors.
CO 13	To demonstrate the techniques for the collection of human blood and separation of mononuclear cells by Ficoll hypaque density gradient centrifugation.
CO 14	To apply Trypan blue as a viability assay for mononuclear cells

COURSE LEARNING OUTCOMES

CLO 1	The learner will be able to gain a comprehensive understanding of the principles and concepts associated with pandemics and the application of bioinformatics in medical sciences.
CLO 2	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 Chikungunya, Helicobacter, Leptospirosis, Drug-resistant TB, among others.
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 tuberculosis.*
CLO 4	The learner will be able to recognize and implement different techniques such as the urea breath test and the test for urease production in biopsy samples for the diagnosis of *Helicobacter pylori.*
CLO 5	The learner will be able to develop expertise in the diagnosis of VRE and other infectious diseases using isolation, biochemical tests, and AST.
CLO 6	The learner will be able to acquire knowledge about the diagnosis of different diseases using NS1 antigen kits for dengue fever.
CLO 7	The learner will be able to gain specialisation in diagnosing Swine flu-H1N1 using hemagglutination & hemagglutination inhibition tests.
CLO 8	The learner will be able to learn how to diagnose Leptospirosis via spirochaete staining.

CLO 9	The learner will be able to develop an understanding of the use of RT-PCR for diagnosing various diseases, including COVID-19.
CLO 10	The learner will be able to gain expertise in using ELISA for diagnosing most viral infections.
CLO 11	The learner will be able to attend an observation session of different techniques for the detection of resistant *Mycobacteria* such as Bactec MGIT 960 system, Reverse line blot assay, X-pert MTB or RIF assay, and Line Probe assay.
CLO 12	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 13	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 14	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	Group project: a) How can governments stop the happening of pandemics? OR b) Application of bioinformatics in medical sciences: Finding a drug suitable for an emerging disease (refer NCBI website).
2	Problem solving exercises in medical microbiology based on diseases caused by- Chikungunya, *Helicobacter*, Leptospirosis, Drug resistant TB, *Campylobacter,* MRSA, Swine flu, Zikavirus, Dengue, Nipah, Ebola or Japanese encephalitis, SARS and COVID-19.
3	Acid fast staining for *M. tuberculosis*.
4	Diagnosis for *Helicobacter pylori:* (Demonstration) Urea breath test and test for urease production in biopsy samples.
5	Diagnosis of VRE: Using isolation, biochemical tests and AST.
6	Diagnosis of dengue: Use of NS1 antigen kit.
7	Diagnosis for Swine flu-H1N1: Hemagglutination & Hemagglutination inhibition test.
8	Diagnosis for Leptospirosis: Spirochaete staining.
9	RT-PCR for diagnosing COVID 19 or any other disease (demonstration).

10	ELISA (Demonstration): A diagnostic method for most viral infections.
11	To observe and write about any one type of test to detect resistant *Mycobacteria*: Bactec MGIT 960 system /Reverse line blot assay/X-pert MTB or RIF assay/Line Probe assay. (Can visit any hospital)
12	Study of virulence factors: a) Phagocytosis b) Phagocytic index
13	Collection of human blood & separation of mononuclear cells by Ficoll hypaque density gradient centrifugation.
14	Trypan blue, mononuclear cells viability assay.

ASSESSMENT DETAILS:

Internal assessment (50 marks)

Part 1: Test (25 marks)

- Students will be given a test from any of the units for 25 marks. The duration of the test will be 50 minutes. (Multiple choice questions- 10 marks, Answer in one word/sentence - 05 marks, Subjective questions - HWY, Justify, Differentiate between, Diagrammatically etc. - 10 marks).

Part 2: Activity (25 marks)

- An activity for 25 marks would be given in the form of a creative learning process. (Powerpoint presentation, Report and Viva, Preparation of study material and viva on the same, any other activity)

Part 3: Test or an Activity (25 marks)

- A Test same as Part 1 or An activity same as Part 3

The best two marks will be considered for the Internal assessment total out of 50

Semester end examination (50 marks)

If Online

- The question paper shall consist of two parts - Part A and B. Part A will consist of 30 marks MCQs (including both 1 and 2 mark MCQs) whereas Part B will consist of 20 marks subjective having 5 mark questions **OR** The question paper will be a 50 mark paper having MCQs of 1 and 2 marks.

If Offline

- The duration of the paper will be two hours.
- There shall be five compulsory questions.
- Q1-4 shall correspond to the four units. Q1-4 shall contain an internal choice (Q1A or Q1A and Q1B or Q1B and so on). Q1-4 shall carry a maximum of 10 marks.
- Q5 shall be from Units 1 to 4. Q5 shall carry a maximum of 10 marks (attempt any 2 of 4)

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	VIROLOGY AND CELL BIOLOGY-II	
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	50	50
PASSING MARKS	20	20

COURSE OBJECTIVES:

CO 1	To explain, discuss and analyze the molecular biology and life cycle of human viruses as per the Baltimore classification scheme.
CO 2	To discuss emergence and re-emergence of viruses, their role in cancer and working with them in the research laboratory.
CO 3	To explain Prions and the genetic experiments performed.
CO 4	To describe the composition of the cytoskeleton in eukaryotes and its importance in cellular structure and function
CO 5	To explain eukaryotic cell cycle, mitosis and meiosis emphasizing more on yeasts *Saccharomyces cerevisiae and mold Neurospora crassa.*
CO 6	To summarize the development of multicellular organisms such as *Drosophila melanogaster.*
CO 7	To explain signalling and communication in eukaryotic microorganisms such as fungi and yeast *Candida albicans* and programmed cell death in bacteria and yeasts.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to explain the replication and life cycle of different viruses, mechanism of retroviruses induce tumors, DNA tumor viruses, oncolytic viruses and Prion only hypothesis.
CLO 2	The learner will be able to compare the life cycle of different viruses.

CLO 3	The learner will be able to explain the structure and functions of Microtubules, Intermediate filaments and Microfilaments.
CLO 4	The learner will be able to explain the cell cycle and checkpoints and their significance, stages of mitosis and meiosis and life cycle of mold *Neurospora crassa.*
CLO 5	The learner will be able to apply the knowledge of cellular reproduction to learn Paper 2 topics such as Mendelian Genetics, Extensions of the same and Cancer.
CLO 6	The learner will be able to recall the development of model organism *Drosophila melanogaster* and role of different genes in its development.
CLO 7	The learner will be able to explain cell signalling and signal transduction, MAP kinase pathway in fungi, Ras signaling in yeast *Candida albicans.*
CLO 8	The learner will be able to explain programmed cell death in *E.coli,* during sporulation in *Bacillus subtilis,* in *Myxococcus xanthus* and programmed cell death and aging in *Saccharomyces cerevisiae.*

UNIT 1	Human Viruses (15 Lectures)
	Students to revise Baltimore classification scheme
	Structure, Replication and Life cycle of following viruses
1.1	Baltimore class 1 viruses a. Poxviruses (Variola major and Vaccinia) (02 L) b. Herpesviruses (02 L)
1.2	Baltimore class 2 viruses- Parvovirus (01L)
1.3	Baltimore class 3 viruses- Rotavirus (02 L)
1.4	Baltimore class 4 viruses- Rhinovirus (02 L)
1.5	Baltimore class 5 viruses a. Rabies virus (01L) b. Measles virus (02 L)
1.6	Baltimore class 6 viruses- Students to revise HIV from T.Y.B.Sc. (Class activity)- (01L)
1.7	Baltimore class 7 viruses- Hepatitis B virus (02 L)
UNIT 2	Emerging and re-emerging viruses, Tumor viruses and Prions (15 Lectures)
2.1	Emerging and reemerging viruses - Factors contributing to emergence and re-emergence, Structure and Life cycle (06 L) a. Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2)

	b. West Nile Virus (WNV) c. Dengue virus
2.2	Tumor viruses (04 L) *Students to revise important definitions related to Cancer and characteristics of transformed cells* a. Molecular mechanisms of virally induced tumor formation by RNA tumor viruses (Retroviruses) b. DNA tumor viruses - Human Papilloma Virus, Adenoviruses, Simian Virus- 40 c. Oncolytic viruses
2.3	Prions (02 L) a. History, case studies b. PRNP gene, Prion only hypothesis c. Biochemical analysis of the prion amino acid sequence d. Genetic Research and experiments with knockout mice
2.4	Working with viruses in the research laboratory (03 L)
UNIT 3	Cytoskeleton, Cellular reproduction and Development of multicellular organisms (15 Lectures)
3.1	Cytoskeleton (08 L) a. Overview of the major functions of the cytoskeleton b. Microtubules i. Structure and composition ii. Microtubule-associated proteins iii. Motor proteins - kinesins, cytoplasmic dynein iv. Microtubule-organizing centers (MTOCs) v. The dynamic properties of microtubules c. Intermediate filaments i. Intermediate filament assembly and disassembly ii. Types and functions d. Microfilaments i. Microfilament assembly and disassembly ii. Myosin: the molecular motor of actin filaments e. Cytoskeletal elements in bacteria
3.2	Cellular Reproduction (05 L) a. The cell cycle b. Control of the cell cycle c. Mitosis d. Meiosis e. Life cycle of mold *Neurospora crassa*
3.3	Development of Multicellular Organisms (02 L)

	a. Genetics of Pattern formation in *Drosophila* i. Egg-polarity genes ii. Segmentation genes iii. Homeotic genes b. Homeobox genes in other organisms
UNIT 4	Signaling, Communication and Programmed cell death in microorganisms (15 Lectures)
4.1	Signaling, communication and programmed cell death in microorganisms (15 L) a. The basic elements of cell signalling systems b. G protein-coupled receptors and signal transduction by them c. MAP Kinase Pathway in fungi *d.* Ras signalling in pathogenic yeast *Candida albicans* e. Communication in Fungi- Messengers- Peptides, alcohols, lipids and volatile compounds f. Programmed cell death in bacteria- *i.* Programmed cell death in *E.coli* ii. Plasmid addiction systems iii. Lysis of the mother cell during sporulation of *Bacillus subtilis* iv. Lysis of vegetative cells in fruiting body formation of *Myxococcus xanthus* g. Programmed cell death and aging in *Saccharomyces cerevisiae*

REFERENCES:

SMSMCB201

1. Shors, Teri. (2009). Understanding viruses, 1st edn. *Jones and Bartlett Publishers.*
2. Wagner, Edward K., Hewlett, Martinez J., Bloom, David C., and Camerini David. (2009). Basic Virology, 3rd edn. *John Wiley and Sons.*
3. Burrell, Christopher., Howard, Colin., and Murphy, Frederick. (2016). Fenner and White's Medical Virology, 5th edn. *Academic Press.*
4. Carter, John., Saunders, Venetia., (2007). Virology Principles and Applications, 1st edn. *Wiley*.
5. Mahy, Brian WJ., and Regenmortel, Marc HV Van. (2010). Desk Encyclopedia of General Virology. *Elsevier.*
6. Dimmock, N. J., Easton, A. J., and Leppard, K. N. (2007). Introduction to Modern Virology, 6th edn. *Blackwell Publishing*.
7. Cann, Alan. (2015). Principles of Molecular Virology, 6th edn. *Academic Press.*
8. Shors, Teri. (2016). Understanding viruses, 3rd edn. *Jones and Bartlett Publishers.*
9. Karp, Gerald. (2010). Cell and Molecular Biology, 6th edn. *John Wiley & Sons, Inc*.
10. White, David. (2006). The Physiology and Biochemistry of Prokaryotes, 3rd edn. *OUP.*

11. Graumann, Peter L. (2007). Cytoskeletal Elements in Bacteria. *Annu. Rev. Microbiol*. 61:589-618.
12. Pierce, B. (2008). Genetics- a conceptual approach, 3rd edn, *W.H. Freeman and company.*
13. Tamarin, Robert H. (2002). Principles of Genetics, 7th edn. *McGraw-Hill.*
14. Russell, Peter J. (2010). iGenetics: A Molecular Approach, 3rd edn. *Pearson.*
15. Cottier, Fabien., and Muhlschlegel, Fritz A. (2011). Communication in Fungi. *International Journal of Microbiology.* Volume 2012, Article ID 351832, 9 pages.
16. Xue, Chaoyang., Hsueh, Yen-Ping and Heitman, Joseph. (2008). Magnificent seven: roles of G protein-coupled receptors in extracellular sensing in fungi. *FEMS Microbiol Rev.* 32(6): 1010–1032.
17. Martínez-Soto, Domingo., Ruiz-Herrera, José. (2017). Functional analysis of the MAPK pathways in fungi. *Revista Iberoamericana de Micología.* 34(4): 192-202.
18. Pentland, Daniel R., Piper-Brown, Elliot., Mühlschlegel, Fritz A., and Gourlay, Campbell W. (2017). Ras signalling in pathogenic yeasts. *Microbial Cell.* Vol 5(2):63-74.
19. Lewis, Kim. (2000). Programmed Death in Bacteria. *Microbiology and molecular biology reviews.* 1092(2172):503-514.
20. Farrugia, Gianluca., and Balzan, Rena. (2012). Oxidative stress and programmed cell death in yeast. *Front. Oncol.*

Additional references:

1. Flint, S.J., Enquist, L.W., Racaniello, V.R., and Skalka, A.M. (2009). Principles of Virology, 3rd edn. Volume I and II. *American Society for Microbiology.*
2. Lewin, Benjamin. (2004). Genes VIII. *Pearson.*
3. Lodish, Harvey., Berk, Arnold., and Kaiser, Chris A. (2007). Molecular Cell Biology, 6th edn. *W.H. Freeman & Co Ltd.*
4. De Robertis, E.D.P. (2017). Cell and Molecular Biology, 8th edn. *LWW.*

NAME OF THE COURSE	GENETICS-II	
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	50	50
PASSING MARKS	20	20

COURSE OBJECTIVES:

CO 1	To discuss Mendelian genetics, principles of inheritance and extensions of and deviations from Mendelian genetics.
CO 2	To develop an understanding of concepts and principles associated with population genetics and evolutionary genetics.
CO 3	To explain the genetic basis of cancer.
CO 4	To describe the transposable genetic elements in prokaryotes and eukaryotes.
CO 5	To explain the diverse techniques used for study of genetics.
CO 6	To discuss basics, applications and scope of bioinformatics.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to recall the Mendelian principles and acquire knowledge of its extensions.
CLO 2	The learner will be able to apply the knowledge to solve problems on Mendelian Genetics
CLO 3	The learner will be able to discuss the principles of population genetics and evolutionary genetics.
CLO 4	The learner will be able to explain the genetic basis of cancer.
CLO 5	The learner will be able to describe the Transposable genetic elements in prokaryotes and eukaryotes.
CLO 6	The learner will be able to compare the techniques used in genetics.
CLO 7	The learner will be able to explain the basics of computational biology and apply the knowledge to solve practical problems.

UNIT 1	Mendelian Genetics and Population Genetics (15 Lectures)

1.1	Mendelian Genetics (03 L) a. Mendel's experimental design b. Monohybrid crosses and Mendel's principle of Segregation i. Branch diagram of monohybrid crosses ii. Use of testcrosses c. Dihybrid crosses and Mendel's principle of Independent Assortment i. Branch diagram of dihybrid crosses d. Trihybrid crosses e. Mendelian genetics in Humans- Pedigree analysis (Only concept, No specific examples of human genetic traits)
1.2	Extensions of and Deviations from Mendelian Genetic Principles (06 L) a. Multiple Alleles b. Modification of dominance relationships i. Incomplete dominance ii. Codominance iii. Molecular explanations c. Essential genes and lethal alleles d. Gene expression and environment e. Epistasis i. Recessive epistasis ii. Dominant epistasis f. Extranuclear Inheritance (non-Mendelian) i. Extranuclear genomes ii. Rules of extranuclear inheritance iii. Examples of extranuclear inheritance
1.3	Population Genetics (06 L) a. Genotypic and allelic frequencies b. Calculation of genotypic and allelic frequencies for autosomal and X linked loci c. Hardy-Weinberg Law and calculation of genotypic frequency at Hardy Weinberg equilibrium d. Factors affecting genotypic and allelic frequencies e. Changes in genetics structure of populations (mutation, migration & gene flow, genetic drift and natural selection) f. Measuring genetic variation
UNIT 2	Evolutionary Genetics, Transposable genetic elements and Cancer (15 Lectures)
2.1	Evolutionary Genetics (04 L) a. Molecular Evolution i. Protein variation

	ii. DNA sequence variation iii. Molecular evolution of HIV in a Florida Dental Practice iv. Patterns of molecular variation v. Molecular clock vi. Evolution of drug resistance in *Mycobacterium tuberculosis*
2.2	Transposable genetic elements (05 L) a. Transposable elements in prokaryotes: An overview b. The medical significance of bacterial transposons c. 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 d. Retrotransposons i. Retrovirus like elements ii. Retroposons e. The genetic and evolutionary significance of transposable elements i. Transposons as mutagens ii. Transposons and genome organization
2.3	Genetic basis of cancer (06 L) a. Cancer- Introduction b. Mutations in different types of genes c. Change in chromosome number and structure, d. Changes in DNA methylation e. Sequential mutations
UNIT 3	Techniques used in Genetics (15 Lectures)
3.1	Techniques used in studying Genetics (15 L) a. Microarrays b. Positional cloning c. RFLP d. Genetic fingerprinting, e. High resolution mapping f. Autoradiography g. Nucleic acid hybridization h. DNA typing with their forensic applications, i. DNA sequencing (Sanger's chain termination method, Pyrosequencing), j. Restriction mapping k. Site directed mutagenesis

	l. Mapping and quantifying transcripts (S1 mapping, primer extension, run-off transcription) m. Measuring transcription rates in vivo (Nuclear run – on transcription, reporter gene transcription), n. Assaying DNA –protein interactions (Filter binding, gel mobility shift, DNase and DMS footprinting.)
UNIT 4	Bioinformatics and Functional Genomics (15 Lectures)
4.1	Bioinformatics (09 L) a. Introduction to bioinformatics, scope and applications b. Databases c. Sequence alignment, dynamic programming: the Needleman and Wunsch Algorithm d. Prediction of genes and annotation methods e. Phylogenetic analysis f. Protein classification and structure prediction g. Structure visualization h. Packages for genomic analysis (EMBOSS) i. Introduction to Linux and Perl
4.2	Functional Genomics (06 L) a. Introduction to Genomics (Structural, Functional and Comparative) b. Genome projects c. Gene disruption knockouts d. Developmental regulation using DNA chips e. CRISPR Cas gene editing with case studies

REFERENCES:

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1. Russell, Peter J. (2010). iGenetics: A Molecular Approach, 3rd edn. *Pearson.*
2. Pierce, B. (2008). Genetics- a conceptual approach, 3rd edn, *W. H. Freeman and Company.*
3. Snustad, Peter D., Simmons, Michael J. (2003). Principles of Genetics, 3rd edn. *John Wiley & Sons, Inc.*
4. Snustad, Peter D., Simmons, Michael J. (2012). Principles of Genetics, 6th edn. *John Wiley & Sons, Inc.*
5. Weaver, Robert F. (2012). Molecular Biology, 5th edn. *McGraw-Hill.*
6. Krane Dan E., Raymer Michael L. (2002). Fundamental Concepts of Bioinformatics, 1st edn. *Benjamin / Cummings.*

7. Attwood Teresa K., Parry-Smith David J. (1999). Introduction to Bioinformatics. 1st edn. *Addison Wesley Longman Limited.*
8. Klug William S., Cummings Michael R. (2000). Concepts of genetics. 6th edn. *Prentice Hall.*

Additional references:

1. Lewin, Benjamin. (2004). Genes VIII. *Pearson.*
2. Lewin, Benjamin. (2007). Genes IX., *Jones and Bartlett publishers.*
3. Snyder, Larry., Peters, Joseph. E., Henkin, Tina M., and Champness, Wendy. (2013). Molecular Genetics of bacteria, 4th edn. *Wiley-Blackwell.*
4. Tamarin, Robert H. (2004). Principles of Genetics, 7th edn. *McGraw-Hill.*

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	50	50
PASSING MARKS	20	20

COURSE OBJECTIVES:

CO 1	To explore the biosynthesis of macromolecules.
CO 2	To categorize the various modes of nitrogen metabolism.
CO 3	To understand the concepts of enzyme kinetics and inhibition.
CO 4	To categorize the regulation of metabolic pathways using enzymes.
CO 5	To understand the metabolism of one and two carbon compounds.
CO 6	To describe the microbial degradation of xenobiotics.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to write metabolic pathways including intermediates, enzymes, cofactors and energetics involved in the biosynthesis of macromolecules.
CLO 2	The learner will be able to write about the mechanism of biological nitrogen fixation, biosynthesis of amino acids and metabolism of nucleic acids.
CLO 3	The learner will be able to schematically and graphically represent the effect of various parameters like concentration of enzyme, substrate concentration, pH, temperature and inhibitors on activity.
CLO 4	The learner will be able to describe the mechanism of metabolic regulation using allosteric enzymes, covalent modification etc.
CLO 5	The learner will be able to write pathways including details of intermediates, enzymes, cofactors involved in the degradation and biosynthesis of one and two carbon compounds.

CLO 6	The learner will be able to write schemes including details of intermediates, enzymes, cofactors involved in order to explain the biodegradation of xenobiotics. They will also comment on the impact of xenobiotics on the environment.

UNIT 1	Biosynthesis & Molecular physiology (15 Lectures)
1.1	Nitrogen metabolism: Biosynthesis of five families of amino acids and histidine, Biosynthesis of purine and pyrimidine bases (04 L)
1.2	Lipid biosynthesis: Synthesis of storage lipids: Fatty acids, triacylglycerols, Synthesis of membrane lipids: Glycerophospholipids, sphingolipids, sterols (02L)
1.3	Vitamins: Fat soluble, water soluble and coenzyme form: functions and biosynthesis (02L)
1.4	Antibiotics: Biosynthesis, mode of action, regulation, genetics, hybrid antibiotics (01L)
1.5	Physiology of autotrophs & anaerobic respiration: autotrophic CO_2 fixation, hydrogen bacteria, methanogens. Nitrifying bacteria, sulphur bacteria, iron bacteria. Synthesis of carbohydrates in plants C_3, C_4 and CAM and bacteria (05L)
1.6	Calvin cycle and its regulation
1.7	Biochemistry of biological nitrogen fixation, properties of nitrogenase and its regulation, Ammonia assimilation with respect to glutamine synthetase, glutamate dehydrogenase, glutamate synthetase, their properties and regulation. (01L)
UNIT 2	Enzymology (15 Lectures)
2.1	Discovery of enzymes, terminology, basic aspects of kinetics of enzyme catalyzed reactions: Michaelis-Menten, Lineweaver-Burk equation derivation and plots. Kinetic parameters used to compare enzyme activities. Problem solving on all subtopics (02L)
2.2	Mechanisms of enzyme catalysis: General acid-base, Covalent and Metal Ion catalysis (05L)
2.3	Example of enzymatic reactions: Chymotrypsin
2.4	Enzyme inhibition -Reversible inhibition: Competitive inhibition, Uncompetitive inhibition, Mixed inhibition -Irreversible inhibition and Suicide inactivators HIV enzyme inhibitors, Nerve gas- catalytic antibodies Problem solving on all subtopics (03L)

2.5	Regulatory enzymes: Allosteric enzymes- General properties, mechanism and kinetics, Two themes of allosteric regulations:-Regulation by covalent modification, -Regulation by multienzyme complexes and multifunctional enzymes (the blood coagulation cascade) (03L)
2.6	Study of Enzyme action using X-ray crystallography, Bioorganic Mechanism of enzyme catalyzed reactions: Stereochemical aspect of inhibition by penicillin (02L)
UNIT 3	Metabolism of one & two carbon compounds (15 Lectures)
	Metabolism of one carbon compounds
3.1	Methylotrophs: Oxidation of methane, methanol, methylamines. Carbon assimilation in methylotrophic bacteria and yeasts. (04L)
3.2	Methanogens: Methanogenesis form H_2, CO_2, CH_3OH, HCOOH, methylamines. Energy coupling and biosynthesis in methanogenic bacteria. (03L)
	Metabolism of two carbon compounds
3.3	Acetate-TCA and Glyoxylate cycle, modified citric acid cycle, Carbon monoxide dehydrogenase pathway and disproportionation to Methane. Ethanol-acetic acid bacteria. (04L)
3.4	Glyoxylate and glycollate-dicarboxylic acid cycle, glycerate Pathway, beta hydroxy aspartate pathway, Oxalate as carbon and energy source (04 L)
UNIT 4	Microbial degradation of Xenobiotics (15 Lectures)
4.1	Degradation of aromatic and alicyclic compounds-important organisms, use of mixed cultures and manipulation of degradative genes, common pathways of aromatic degradation using KEGG Database and LCMS, aerobic and anaerobic degradation of aromatic compounds. (06 L)
4.2	Aromatic and heterocyclic compounds with economical and ecotoxicological significance (phenolic pesticides, phthalic acid esters, lignosulphonates, surfactants, dyes and aromatics released during combustion) (03L)
4.3	Biotransformation of polycyclic aromatic hydrocarbons (PAHs)- Pathway for degradation of Naphthalene, phenanthralene, anthracene, alicyclic and higher aliphatic hydrocarbons, halogenated aliphatics, branched chain alkanes and alkenes. (04L)
4.4	Biochemical mechanisms of pesticide detoxification (02L)

REFERENCES:

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1. Nelson, D., & Cox, M., (1994) Lehninger: Principles of Biochemistry, 4th edn., *CBS publishers and Distributors Pvt. Ltd.*
2. White, D. (2011). The physiology and biochemistry of prokaryotes, 4th edn. *Oxford University Press.*
3. Conn and Stumpf. (2006). Outlines of Biochemistry, 5th edn, *Wiley India Edition.*
4. Pratt-Cornley. (2013). Essential Biochemistry (illustrated), 3rd edn. *Wiley.*
5. Voet D. and Voet J.G. (2011). Principles of Biochemistry, 4th International student edn. .
6. GN Cohen. (2011). Microbial Biochemistry. *Springer.*
7. Gottschalk. (1985). Bacterial metabolism. Springer- Verlag.
8. Rehm, H.J., and Reed G.. (1984). Biotechnology (ed.), Volume 6a. Biotransformations, *Verlag and Chemie.*
9. Doelle H.W. (1975). Introduction to bacterial metabolism. *Academic Press*.
10. Atlas RM and Bartha. (1998). Microbial ecology. *Addison Wesley Longman Inc.*

Additional references:

1. Berg J.M., Tymoczko J.L. and Stryer L. (2012). Biochemistry, 7th edn, *W. H. Freeman and co.*
2. Price N.C. and Stevens L. (1999). Fundamentals of Enzymology, 3rd edn.
3. Segel I.R., (2004). Biochemical calculations, 2nd edn, *John Wiley and Sons.*
4. T. Mckee J. Mckee. (2017). Biochemistry: The Molecular Basis of Life, 6th International edn, Oxford University Press.

NAME OF THE COURSE	MEDICAL MICROBIOLOGY AND 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	50	50
PASSING MARKS	20	20

COURSE OBJECTIVES:

CO 1	To equip students with knowledge of various principles underlying epidemiological studies to understand disease patterns and control strategies effectively.
CO 2	To discuss measures of risk, including mortality and morbidity frequency measures, providing students with a comprehensive understanding of disease burden and impact.
CO 3	To guide students through the various steps involved in public health surveillance to effectively monitor and respond to emerging health threats.
CO 4	To introduce students to clinical research and modern diagnostic methods, equipping them with the necessary skills to conduct and interpret research studies and utilize advanced diagnostic techniques.
CO 5	To elucidate Type I, II, III, and IV hypersensitive reactions as proposed by P. G. H. Gell and R. R. A. Coombs, enhancing students' understanding of immune-mediated responses.
CO 6	To provide insight into the mechanisms underlying organ-specific and systemic autoimmune diseases, enabling students to understand their pathogenesis and clinical manifestations.
CO 7	To explain the principles of transplantation immunology, giving students knowledge of the immune response to transplanted tissues and organs.
CO 8	To discuss primary and secondary immunodeficiency diseases, enabling students to recognize and manage conditions associated with impaired immune function.
CO 9	To explore the malignant transformation of cells and immune evasion mechanisms employed by cancer cells, providing insight into cancer pathogenesis and therapeutic strategies.

CO 10	To develop an understanding of experimental vaccines in developmental stages, acquainting students with ongoing research efforts aimed at preventing infectious diseases and cancer.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to study various epidemiological principles such as herd immunity and methods for controlling epidemics, while also gaining practical experience in developing and explaining the detailed use of Personal Protective Equipment (PPE).
CLO 2	The learner will be able to understand and apply various measures of risks, enabling them to independently perform calculations related to disease burden and risk assessment.
CLO 3	The learner will be able to grasp the details of collecting, analyzing, interpreting, disseminating, and interpreting data in public health surveillance, facilitating effective monitoring and response to health threats.
CLO 4	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 5	The learner will be able to explain the mechanisms underlying type I, II, III, and IV hypersensitivity reactions, deepening their understanding of immune-mediated responses.
CLO 6	The learner will be able to describe the mechanisms and treatment options for organ-specific and systemic autoimmune diseases, enabling them to recognize and manage autoimmune conditions effectively.
CLO 7	The learner will be able to explain the mechanism of graft rejection and the involvement of immune cells, providing insights into transplantation immunology.
CLO 8	The learner will be able to elucidate the mechanisms involved in primary and secondary immunodeficiency diseases and discuss treatment options, enhancing their understanding of immune system disorders.
CLO 9	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 10	The learner will be able to discuss the challenges faced in the development of newer vaccines, gaining insight into the complexities of vaccine development and deployment.

UNIT 1	Epidemiology of Infectious Diseases (15 Lectures)
1.1	Historical aspects-definition
1.2	Descriptive Epidemiology-aims and uses
1.3	Epidemiological Principles a. Herd immunity b. Carrier status c. Co-evolution of host-parasite d. Control of epidemics i. Methods directed against reservoir ii. Methods directed against transmission iii. Pathogen eradication
1.4	Measures of Risk a. Frequency measures b. Morbidity frequency measures c. Mortality frequency measures d. Natality(birth) measures e. Measures of association f. Measures of public health impact
1.5	Public Health Surveillance a. Purpose and characteristics b. Identifying health problems for surveillance c. Collecting data for surveillance d. Analyzing and interpreting data e. Disseminating data and interpretation f. Evaluating and improving surveillance
UNIT 2	Clinical Research and Modern Diagnostics (15 Lectures)
2.1	Introduction to Clinical Research a. What is a clinical trial, history, phases and need? b. Good Clinical practice Guidelines c. Ethical aspects of Clinical Research d. Regulatory Requirements in clinical research e. Clinical Research Methodologies, Statistics and Management f. Case studies
2.2	Modern Diagnostic Methods a. Advances in Molecular and Immunological Techniques b. Microarrays c. Advances in Fluorescence Technology

UNIT 3	Clinical Immunology-I (15 Lectures)
3.1	Hypersensitivity a. Gel and Coombs classification: Type I, II, III and IV hypersensitivity.
3.2	Autoimmune diseases a. Organ Specific Autoimmune Diseases b. Systemic Autoimmune Diseases c. Proposed Mechanisms for Induction of Autoimmunity d. Treatment of Autoimmune Diseases
3.3	Transplantation 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
UNIT 4	Clinical immunology I (15 Lectures)
4.1	Immunodeficiency diseases a. Primary Immunodeficiency b. Defects in the Complement System c. Treatment Approaches for Immunodeficiency d. Secondary Immunodeficiency & AIDS
4.2	Cancer and immune system a. Cancer: Origin & Terminology b. Malignant Transformation of Cells c. Cancer Initiation, Promotion, and Progression d. Tumor Associated Antigens e. Oncogenes & Cancer Induction f. Immune evasion in cancer g. Cancer Immunotherapy
4.3	Experimental vaccines in development a. Challenges faced b. HIV c. T.B. d. Malaria

REFERENCES:
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1. Principles of Epidemiology in Public Health Practice. Third edn, October 2006, updated 2012.U.S. Department of Health and Human Services.
2. Eardley, William et al. (2011). Introduction to Clinical Research, First edn. *Oxford University Press.*
3. Basic Concepts of Microarrays and Potential Applications in Clinical Microbiology. C*lin. Microbiol.Rev* .2009 Oct 22(4)611-633.
4. Recent Advances of Fluorescent Technologies for Drug Discovery and Development. *Curr. Pharm. Des*.2009:15(30):3552-70.
5. Immunological methods for detection and identification of infectious disease and biological warfare agents. *Clin Diagn.Lab. Immunol*. 2003 Jul;10(4):506-513.
6. Recent advances in molecular medicine techniques for the diagnosis, prevention and control of infectious diseases. *European Journal of Clinical Microbiology*. Jan 2013, 32(6).
7. Kindt, Thomas J., Goldsby, Richard A., Osborne, Barbara Anne., Kuby, Janis. (2006). Immunology, 6th edn. *W. H. Freeman and company.*
8. Pathak, Sulabha., Palan, Urmi. (2011). Immunology- Essential & Fundamental, 3rd edn, *Central Publishing Company.*
9. Tizard, Ian R. (2005). Immunology: An introduction, 4th edn. *Cengage learning.*
10. Delves, Peter J., Roitt, Ivan M., Martin, Seamus J., Burton, Dennis R. (2011). Roitt's Essential Immunology, 12th edn, *Wiley- Blackwell.*
11. Khan, Fahim Halim. (2009). The Elements of immunology, *Pearson Education.*
12. Janeway, Charles., Travers, Paul., Walport, Mark., Shlomchik, Mark. (2006). Immunobiology: The immune system in health and disease, 6th edn, Garland Science.

Semester 2 Practicals-SMSMCBP2

NAME OF THE COURSE	VIROLOGY AND CELL BIOLOGY-II 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 show Virology laboratories or Virology related work so that students can correlate the same with the concepts learned in theory
CO 2	To construct/write an assignment on evolution/mutations of any human virus in order to study the emergence and reemergence of viruses and the origin of pandemics
CO 3	To perform Mitosis, Meiosis and describe the morphology of the model organism *Neurospora crassa*
CO 4	To perform experiments to show sporulation and germination in *Bacillus species*
CO 5	To analyze and research video resources on Apoptosis and construct a quiz on the same

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to correlate and recall the experiments done at the Virology Laboratories in the Research Institutes
CLO 2	The learner will be able to do an assignment on Evolution/Mutations of a human virus
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 describe the macroscopic and microscopic characteristics of the mold *Neurospora crassa*
CLO 5	The learner will be able to detect sporulation and germination in *Bacillus species,* and use Haemocytometer to determine the spore count
CLO 6	The learner will be able to analyze and examine the videos on apoptosis and devise a quiz on the same

Sr. No	Name of the experiment
1	Visit to NIRRH or Haffkine research institute.
2	Demonstration - Egg inoculation and cultivating animal virus in embryonated egg.
3	Assignment on 'evolution/mutations of a human virus.'
4	Study of Mitosis.
5	Study of Meiosis.
6	Study of mold *Neurospora crassa.*
7	Sporulation and germination in *Bacillus subtilis.*
8	Student activity- Students will watch at least three videos on Apoptosis and construct a quiz based on the above.

NAME OF THE COURSE	GENETICS-II 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 develop critical thinking and problem solving skills on Mendelian Genetics, Population Genetics and Restriction mapping

CO 2	To perform DNA transformation and plasmid curing in order to develop molecular biology practical skills to operate these basic steps
CO 3	To design primers for amplifying the genes
CO 4	To perform Bioinformatics practicals online in order to develop computational biology skills and apply the different softwares and tools
CO 5	Students will choose and do any online course in Genetics or a workshop on Molecular Biology or Genetics in an institute or a one-week internship in a research laboratory doing work on Genetics

COURSE LEARNING OUTCOMES

CLO 1	The learner will be able to analyze, classify and solve problems on Mendelian Genetics, Population Genetics and Restriction mapping
CLO 2	The learner will be able to perform DNA transformation and plasmid curing experiments and apply these experiments in molecular biology research in future
CLO 3	The learner will be able to design primers to carry out the amplification of genes using Polymerase chain reaction
CLO 4	The learner will be able to apply the tools and softwares of Bioinformatics in computational biology research
CLO 5	The learner will be able to do a workshop or an online course in Molecular Biology or Genetics or an internship in a research institute and apply the knowledge.

Sr. No	Name of the experiment
1	Problems on Mendelian genetics.
2	Problems on Population genetics.
3	DNA Transformation.
4	Curing of plasmids.
5	Problems on restriction mapping.
6	Design of primer & PCR.
7	Bioinformatics practicals.
8	Online course related to any aspect of Genetics **OR** Workshop on Molecular Biology/Genetics in an institute **OR** One-week internship in a research laboratory doing research on Genetics.

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 enable the learner to isolate microorganisms capable of using one C compounds
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 enrich and isolate methylotrophic bacteria
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	Enrichment, isolation and identification of *Methylobacterium.*
2	Purification of an extracellular enzyme (β-amylase) by salting out and dialysis.
3	Enzyme kinetics- effect of enzyme, substrate concentration, pH, temperature and inhibitors on enzyme activity.
4	Demonstration of proteolytic activity.
5	Determination of glucose isomerase present in *Bacillus sp.*
6	Microbial degradation of polycyclic aromatic Hydrocarbons (PAHs) - enrichment, isolation and screening of bacteria.
7	PAH degradation studies.
8	Student Activity Student will present a research paper on microbial degradation of any one Xenobiotic compound highlighting the pathway, optimization and profiling of analyte.

NAME OF THE COURSE	MEDICAL MICROBIOLOGY AND 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 develop an appreciation for the role of Personal Protective Equipment (PPE) in healthcare settings.
CO 2	To demonstrate the ability to gather and interpret data on the epidemiology of diseases, using appropriate methodologies and criteria.
CO 3	To critically evaluate the use of clinical trials in healthcare research.
CO 4	To gain hands-on experience in exploring Microarrays and Advances in Fluorescence Technology through educational visits.
CO 5	To analyze and solve problems related to mortality and morbidity frequency measures.
CO 6	To acquire knowledge of the technique of Immunoelectrophoresis of human serum.
CO 7	To evaluate the concepts and techniques involved in Major and Minor cross matching of blood.
CO 8	To demonstrate the ability to determine ABO & Rh antibody titers and understand the implications.
CO 9	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.

COURSE LEARNING OUTCOMES

CLO 1	The learner will be able to understand the importance and proper use of personal protective equipment (PPE) through a group activity.
CLO 2	The learner will be able to interpret epidemiological data and criteria for diseases through a case study and assignment.
CLO 3	The learner will be able to create an assignment on clinical trials and demonstrate knowledge of clinical trial procedures and concepts.
CLO 4	The learner will be able to gain practical knowledge and exposure to Microarrays or Advances in Fluorescence Technology through an educational visit.
CLO 5	The learner will be able to analyze mortality and morbidity frequency measures and understand their significance in public health.

CLO 6	The learner will be able to apply immunoelectrophoresis technique for separating and identifying protein components in human serum.
CLO 7	The learner will be able to distinguish between major and minor cross-matching of blood and its importance in blood transfusion.
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 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.

Sr. No	Name of the experiment
1	Group activity: Preparation and detailed explanation of the use of Personal Protective Equipment (PPE).
2	Case study for epidemiology of any diseases included in Sem I (Theory), students have to collect data and interpret. This can be done from Net or approaching NGOs like “SEHAT”. Collection of data, criteria, methodology etc. Assignment to be submitted.
3	Students will have to submit an assignment on a clinical trial.
4	Educational visit to see either Microarrays or Advances in Fluorescence Technology (can go to Reliance Life Sciences Centre).
5	Problems on mortality/morbidity frequency measures.
6	Immunoelectrophoresis of human serum.
7	Major and Minor cross matching of blood.
8	Determination of ABO & Rh antibody titers.
9	SRID: For detection of immune deficiency and Complement deficiency.

ASSESSMENT DETAILS:

Internal assessment (50 marks)

Part 1: Test (25 marks)

- Students will be given a test from any of the units for 25 marks. The duration of the test will be 50 minutes. (Multiple choice questions- 10 marks, Answer in one word/sentence - 05 marks, Subjective questions- HWY, Justify, Differentiate between, Diagrammatically etc. - 10 marks).

Part 2: Activity (25 marks)

- An activity for 25 marks would be given in the form of a creative learning process. (Powerpoint presentation, Report and Viva, Preparation of study material and viva on the same, any other activity)

Part 3: Test or an Activity (25 marks)

- A Test same as Part 1 or An activity same as Part 3

The best two marks will be considered for the Internal assessment total out of 50

Semester end examination (50 marks)

If Online

- The question paper shall consist of two parts - Part A and B. Part A will consist of 30 marks MCQs (including both 1 and 2 mark MCQs) whereas Part B will consist of 20 marks subjective having 5 mark questions **OR** The question paper will be a 50 mark paper having MCQs of 1 and 2 marks.

If Offline

- The duration of the paper will be two hours.
- There shall be five compulsory questions.
- Q1-4 shall correspond to the four units. Q1-4 shall contain an internal choice (Q1A or Q1A and Q1B or Q1B and so on). Q1-4 shall carry a maximum of 10 marks.
- Q5 shall be from Units 1 to 4. Q5 shall carry a maximum of 10 marks (attempt any 2 of 4)

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.