Shri Rawatpura Sarkar University,

Raipur

Examination Scheme & Syllabus as per Outcome Based Education (OBE) and Choice Based Credit System (CBCS)

for

MASTER OF SCIENCE

In

MICROBIOLOGY

Program Outcomes

On completion of program students will be able to

1. Get ability to apply the process of science by formulating hypotheses and design experiments based on the scientific method.

2. Analyze and interpret results from a variety of microbiological methods.

3. Use quantitative reasoning by using mathematical calculations and graphing skills to solve problems in microbiology.

4. Communicate and collaborate with other disciplines by effectively communicating the fundamental concepts of microbiology in written and oral format.

5. Identify credible scientific sources to interpret and evaluate the evidences

6. Understand the relationship between science and society by recognizing and discussing logical, scientific and ethical issues in microbiology.

7. Prepare and view specimens for examination using light microscopy.

8. Use pure culture and selective techniques to isolate microorganisms. Identify microorganisms (media-based, molecular and serological).

9. Estimate the number of microorganisms in a sample by suitable enumeration technique.

10. Use appropriate microbiological and molecular lab equipment and methods.

11. Practice safe microbiology, using appropriate protective, biosafety and emergency procedures.

12. Document and report on experimental protocols, results and conclusions.

13. Basic knowledge about microbiology, biophysical techniques, biochemistry, cell biology, molecular biology, cancer biology, metabolic disorders etc.

14. To create awareness to become conscious citizens with a sense of responsibility towards their surrounding irrespective of any man made differences.

Shri Rawatpura Sarkar University, Raipur

Faculty of Science

Two Years M. Sc. Programme

Scheme of Teaching and Examination

M. Sc. Second Semester Microbiology

Outcome Based Education (OBE) and Choice Based Credit System (CBCS)

(Effective from the Academic Year 2022-2023)

SN	Course Code	Course Title	Hours/Week			Credits	Maximum Marks			Sem End Exam Duration (Hrs.)
			L	**T**	**P**		Continuous Evaluation	Sem. End Exam	Total	
1.	SMS07201T	Microbiology V: Immunology	4	-	-	4	30	70	100	3
2.	SMS07202T	Microbiology VI: Microbial Physiology and Metabolism	4	-	-	4	30	70	100	3
3.	SMS07203T	Microbiology VII: Microbial Genetics	4	-	-	4	30	70	100	3
4.	SMS07204T	Microbiology VIII: Microbial Enzyme Technology	4	-	-	4	30	70	100	3
5.	SMS07291P	Lab course: III (Combining Microbiology V and VI)	-	-	4	2	15	35	50	5
6.	SMS07292P	Lab Course: IV (Combining Microbiology VII and VIII)	-	-	4	2	15	35	50	5
7.	SMS07222P	Research Project Based on Research Techniques	2	-	-	2	15	35	50	3
TOTAL						**22**			**550**	

Course Title	**IMMUNOLOGY**				
Course Code	**SMSO7201T**				
Course Credits	**L**	**T**	**P**	**TC**	
	4	**-**	**-**	**4**	
Prerequisites	**Studied the detailed course of Microbiology semester II**				
Course Objectives	• To impart through knowledge of Immunology. • To train the students to pursue further education. • To be familiar with Immunological tools.				
Course Contents	**UNIT I** Introduction to immune system – Innate and acquired immunity. Structure and functions of primary and secondary lymphoid organs. Cells involved in immune responses – Lymphoid cells (B-lymphocytes, T-lymphocytes and Null cells), mononuclear cells (phagocytic cells and their killing mechanisms), granulocytic cells (neutrophils, eosinophils and basophils), mast cells and dendritic cell. **UNIT II** Nature of antigen and antibody – Immunogenicity vs antigenicity, factors influencing immunogenicity, epitopes, haptens, adjuvants and mitogens. Classification, fine structure and functions of immunoglobulins, antigenic determinants on immunoglobulins, isotypic, allotypic and ideotypic variants. **UNIT III** Generation of Diversity in Immune system – Clonal selection theory - concept of antigen specific receptor. Organization of immunoglobulin genes: generation of antibody diversity, T-cell receptor diversity. Immune effector Mechanisms – Kinetics of primary and secondary immune responses, complement activation and its biological consequences, cytokines and co-stimulatory molecules: role in immune responses, Antigen processing and presentation. Cell signaling – Role of MAP kinases. **UNIT IV** Major histocompatibility complex (MHC) genes and products – Polymorphism of MHC genes, role of MHC antigens in immune responses, MHC antigens in transplantation. Measurement of antigen–antibody interactions – Agglutination, precipitation and opsonization, gel diffusion (Ouchterlony double immunodiffusion and Mancini's Radial immunodiffusion), immunoblotting, RIA, ELISA and ELISPOT. **UNIT V** Tolerance vs activation of immune system – Immune tolerance, hypersensitivity (Types I, II, III, IV). Disorders of immune system – Autoimmunity, congenital immunodeficiencies, acquired immunodeficiencies.				

Course Outcomes	1. Understanding of the fundamentals of Immunology and key principles of it. 2. Awareness of the major issues at the forefront of the discipline. 3. Ability to dissect a problem in to its key features. 4. Explain the mechanism of immunological responses. 5. Apply the principles of cellular ontogeny and the gene rearrangements to understand the novel and complex immune system.
Text Books	**Text Books:** 1. Immunology: Kubey 2. Immunology: A short Course; Eli Benjamin, Richard Coico 3. Fundamentals of Immunology: William Paul
References Books	**Reference Books:** 1. Essentials of Immunology (6th Edition): Ivan Riot- Blackwell Scientific Publications, Oxford, 1988. 2. Antibodies- A laboratory Manual: Harlow and David Lane (1988), Old Spring harbor Laboratory. 3. Immunology: Roitt, Brostoff and Male 4. Immunology: C.A. Janeway and Paul Travers. 5. Immunology: Weir, D.M. 1992. Immunological techniques: I. R. Tizard, Immunology, An Introduction, 1995, 4th edition – Saunder's.

Course Title	**MICROBIOLOGY VI: MICROBIAL PHYSIOLOGY AND METABOLISM**				
Course Code	**SMS07202T**				
Course Credits	**L**	**T**	**P**	**TC**	
	4	**-**	**-**	**4**	
Prerequisites	**Basic Knowledge of Microbiology**				
Course Objectives	To develop understanding about microbial metabolism, growth and energy generation. • Gain knowledge of various fermentation pathways, microbial communication and energetics. • Familiarize students with concepts of nitrogen and phosphate assimilation, electron transport chain and transfer of genetic information among microbial communities.				
Course Contents	**UNIT I** Microbial growth: mathematical expression of growth, growth measurement, efficient growth curve, synchronous growth and continuous culture, effect of environmental factors on microbial growth, nutrients diffusion, active transport, group translocation, solutes,				

	temperature, oxygen relations. **UNIT II** Photosynthetic microorganisms, brief account of photosynthetic pigments, Oxygenic and anoxygenic photosynthesis, cyclic and non-cyclic photophosphorylation, fixation of CO_2 - Calvin cycle -C3 & C4 pathway. Chemolithotrophy: sulphur, iron, hydrogen, nitrogen oxidations; Methanogenesis - luminescence. Electron transport. **UNIT III** Aerobic respiration, EMP, ED and HMP pathway. TCA cycle- amphibolic reactions. Glyoxalate cycle. Mechanisms of substrate – level and oxidative phosphorylation. Respiratory electron transport in mitochondria and bacteria. Anaerobic respirations: Introduction, sulphate, nitrate, carbonate respirations and their ecological significance. ETC in some anaerobic bacteria. Catalase, SOD, Pasteur Effect. Fermentation. **UNIT IV** Lipid metabolism – Biosynthesis of glycerols, phospholipids and glycolipids. Oxidation of saturated and unsaturated fatty acids. Microbial metabolism of aromatic and aliphatic hydrocarbons, Nucleotide metabolism – Biosynthesis of purine and pyrimidine nucleotides-salvage and *de novo* pathways. **UNIT V** Protein metabolism: Biosynthetic pathways of amino acids and their regulation with emphasis on tryptophane and histidine. Porphyrine biosynthesis; catabolism of aminoacids (transaminaton, deamination). Degradation of proteins- proteases, exo & endo peptidases.
Course outcomes	After going through this unit, students will be able to: 1. Master aseptic techniques and be able to perform routine culture handling tasks safely and effectively 2. Comprehend the various methods for identification of unknown microorganisms 3. Understand the microbial transport systems and the modes and mechanisms of energy conservation in microbial metabolism – Autotrophy and heterotrophy • Know the various Physical and Chemical growth requirements of bacteria and get equipped with various methods of bacterial growth measurement. • Apply the knowledge to understand the microbial physiology to identify the micro organisms.
Text Books	**Text Books** 1. Microbial Physiology and Metabolism: D.R. Caldwell. 2. Microbiology: Lansing M. Prescott, John P. Harley and Donald A. Klein 3. Microbiology-Essentials and applications: Larry McKane and Judy Kandel. 4. Microbial Physiology: A.G. Moat and J.W. Foster.
Reference books	**Reference books** 1. Microbiology: M.J. Pelczar (Jr), E.C.S. Chan and N.R. Kreig. 2. Fundamental principles of Bacteriology: A. J. Salle.

	3. The Physiology and Biochemistry of Prokaryotes: D. White. **4.** Microbial Physiology: S. Ram Reddy and S. M. Reddy

Course Title	**MICROBIOLOGY VII: MICROBIAL GENETICS**				
Course Code	**SMS07203T**				
Course Credits	**L**	**T**	**P**	**TC**	
	4	**-**	**-**	**4**	
Prerequisites	**Basic Knowledge of Microbiology**				
Course Objectives	• Understanding of fundamental concepts in microbial genetics. • Insight into genetic methods used to investigate interesting biological problems. • Insight into current, exciting topics in microbial genetics and related fields. • Experience in reading and evaluating scientific articles. • 5) Understanding of how microbial genetics has advanced science and society.				
Course Contents	**UNIT I** Nucleic Acids: Structure, physical and chemical properties of DNA and RNA, extrachromosomal DNA- profile, function and evolution. **UNIT II** DNA replication, damage and repair, spontaneous and induced mutation, reversion of mutation. **UNIT III** Transposition: Structure of transposons, replicative and non-replicative transposition, transposon mutagenesis. Bacterial conjugation: F Factor, Hfr Transfer, Gene mapping; Transduction: Generalized and specialized transduction. **UNIT IV** Genetic recombination; Molecular models and mechanism, Gene conversion. Gene expression and regulation: Operons and regulons, repression and activation of Lacoperon, feed back inhibition and regulation of virulence genes in pathogenic bacteria. Signal transduction in microbes. **UNIT V** Genetic Engineering: Introduction, vectors, restriction enzymes, cloning of restriction fragments, DNA ligase, insertion of DNA in to vector, detection of recombinant molecules, Applications of genetic engineering: Restriction mapping, site directed mutagenesis, production of proteins from cloned genes, and some other applications.				
Course	• On completion of the course, the student should be able to:				

Outcomes	1.Explain the processes behind mutations and other genetic changes 2.Identify and distinguish genetic regulatory mechanisms at different levels 3.Solve theoretical and practical problems in genetic analysis particularly concerning genetic mapping and strain construction 4.Identify genes and mutations in non-annotated sequence data from databases by means of relevant bioinformatics programs 5.Plan basic experiments in microbial genetics concerned with clarifying phenotypes and their relationship with the genotype 6.Use common methods in microbial genetics
Text Books	**Text Books** 1. Text book of Microbiology: Pelczar, Creig and Chan 2. Text book of Microbiology: Pawar and Daginwalla. Vol I & II 3. General Microbiology: Stanier *et al*.,
Reference Books	**Reference books** 1. Microbial genetics: Maylor, Cronan and Freifelder 2. Microbiology: Presscott *et al*., 3. Microbiology: Talaro & Talaro

Course Title	**MICROBIOLOGY VIII: MICROBIAL ENZYME TECHNOLOGY**				
Course Code	**SMS07204T**				
Course Credits	**L**	**T**	**P**	**TC**	
	4	**-**	**-**	**4**	
Prerequisites	**Basic Knowledge of Microbiology**				
Course Objectives	This course provides the theory and knowledge relevant to the enzymology principles including fundamental properties of enzymes, enzyme catalytic mechanisms and enzyme kinetics. Techniques employed in enzymes purification and characterization are also emphasized in this course.				
Course Contents	**UNIT I** Enzymes from microbial sources, large scale production of enzymes, recovery of enzymes, enzyme purification methods - enzyme precipitation, separation by chromatography, enzyme reactors. **UNIT II**				

	Immobilized enzymes: Physical and chemical methods of immobilization, immobilization supports, kinetics of immobilized enzymes. Enzyme catalysis in apolar medium, reverse micellar entrapment of enzymes and its applications. **UNIT III** Application of enzymes: synthesis of chemicals using enzymes, food technology and medicine. Enzymes in diagnostic assays. **UNIT IV** Enzyme electrodes, immunoenzyme techniques. Commercial products of microbes: Antibiotics, biopolymers, biosensors, biopesticides, Production of biofuels. **UNIT V** Microbial toxins: Types, biochemical and molecular basis of toxin production, implications. Genetically engineered microbes, anti-HIV, anticancer, antifungal, antiplasmodial, anti-inflammatory compounds.
Course Outcomes	1. Distinguish the fundamentals of enzyme properties, nomenclatures, characteristics and mechanisms 2. Apply biochemical calculation for enzyme kinetics 3. Compare methods for production, purification, characterization and immobilization of enzymes 4. Discuss various application of enzymes that can benefit human life 5. Discover the current and future trends of applying enzyme technology for the commercialization purpose of biotechnological products. 6. Plot graphs based on kinetics data
Practical Books	**Practical Books** 1. Industrial Microbiology: Casida, L E. 2. Industrial Microbiology: Patel, A. H. 3. Industrial Microbiology: Miller, B. M. and Litsky. 4. Industrial Microbiology: Prescott and Dunn. 5. Microbial Technology: Peppler, J. H. and Perlman, D.
Reference Books	**Reference books** 1. Biochemistry of Industrial Microorganisms: Rainbow and Rose 2. Economic Microbiology Vol. I-V: Rose. 3. Microbial Enzymes and Biotechnology: Fogarty W. M. and Kelly, C. T. 4. Comprehensive Biotechnology All volumes Ed. Murray Moo-Yong. 5. Biotechnology (A text book of industrial Microbiology) Ed. Cruger & Cruger. **6.** Advances in Applied Microbiology Ed. Perlman Series of volumes.

Course Title	**LAB COURSE: III (COMBINING MICROBIOLOGY VI AND VII)**				
Course Code	**SMS07291P**				
Course Credits	**L**	**T**	**P**	**TC**	
	4	**-**	**-**	**4**	
Prerequisites	**Basic Laboratory Knowledge of Given Theory**				
Course Objectives	To understand the microbial growth kinetics and understanding different physiological phenomenon • To deliver hands-on experience of various enzymatic assays and determination of kinetic parameters • To give basic understanding of microbial genetic manipulations • To understand working of different laboratory equipments used in microbiological laboratories				
Course Contents	1. Agglutination reaction. 2. Radial Immunodiffusion. 3. ELISA. 4. Purification of IgG from the serum by ammonium sulphate, acetone precipitation and dialysis. 5. SDS-PAGE of denatured protein samples and determination of molecular weight of unknown proteins. 6. Poly Acrylamide Gel Electrophoresis of native proteins. 7. Western Blotting of proteins. 8. Antibiotic sensitivity test of blood and urine culture. 9. VDRL test. 10. HBs-AG test. 11. Determination of growth curve and generation time. 12. Estimation of microbial enzymes-amylase, invertase, protease, celllulase, lipase, catalase and phosphatase. 13. Iodine number of fatty acids. 14. Estimation of protein by Lowry's method. 15. Effect of different concentrations of heavy metal on bacterial growth.				

Course Outcomes	Develop capability to quantify enzymes and determine kinetic parameters along with microbial genetic modification strategies 1. Develop capability to perform different gene transfer methods in microbes 2. Hand on training of the general equipments used in microbiology laboratory 3. Comprehend the major spectrophotometric and titrimetric approaches of quantification in biological and environmental samples.
Practical Book	**Text Books** 1. K.R Aneja 2. A handbook of practical microbiology
Reference Books	**Reference books** 1. Immunology: Roitt, Brostoff and Male 2. Immunology: C.A. Janeway and Paul Travers. 3. Microbial Physiology and Metabolism: D.R. Caldwell. 4. Microbial Physiology: A.G. Moat and J.W. Foster. 5. Microbiology: M.J. Pelczar (Jr), E.C.S. Chan and N.R. Kreig. **6.** Fundamental principles of Bacteriology: A. J. Salle.

Course Title	**LAB COURSE: IV (COMBINING MICROBIOLOGY VIII AND IX)**				
Course Code	**SMS07292P**				
Course Credits	**L**	**T**	**P**	**TC**	
	4	**-**	**-**	**4**	
Prerequisites	**Basic Laboratory Knowledge of Given Theory**				
Course Objectives	• To understand the microbial growth kinetics and understanding different genomic phenomenon • To understand working of different laboratory equipments used in microbiological laboratories.				
Course Contents	• Isolation of Genomic DNA from Bacteria species • Isolation of Plasmid DNA.				

	• Molecular size determination of DNA. • Restriction digestion and ligation of DNA. • Determination of K_m and V_{max}.
Course Outcomes	• Develop capability to quantify enzymes and determine kinetic parameters along with microbial genetic modification strategies • Develop capability to perform different gene transfer methods in microbes • Hand on training of the general equipments used in microbiology laboratory
Practical Books	Practical Book .Practical microbiology D.K.Maheshwari K.R Aneja
Reference Books	**Reference books** 1. Microbial genetics: Maylor, Cronan and Freifelder 2. Microbiology: Presscott *et al.*, 3. Microbiology: Talaro & Talaro **4.** Biochemistry of Industrial Microorganisms: Rainbow and Rose

Course Title	**Research Project Based on Research Techniques**				
Course Code	**SMS07222P**				
Course Credits	**L**	**T**	**P**	**TC**	
	2			**2**	
Prerequisites	Theoretical knowledge of Bioanalytical techniques				
Course Objectives	• To impart knowledge of research techniques. • Become familiar with other research based techniques and tools.				
Course Contents	**Unit-I:** Phase-contrast and fluorescent microscopes. Electron microscopy: SEM and TEM. **Unit-II:** Atomic absorption spectroscopy, ESR and NMR spectroscopy. Mass spectroscopy (LC-MS, GC-MS). Fluorescent spectroscopy. **Unit-III:** HPLC, FPLC and Affinity chromatography **Unit-IV:** Polyacrylamide gel electrophoresis (native and SDS), Immunoelectrophoresis, DNA finger printing and ELISA.				

	Unit-V: GM counter, Scintillation counter, Flow cytometry.
Course Outcomes	• Provide scientific understanding of analytical techniques and detail interpretation of results. • Technical writing and presentation skills.
Practical Books	1. Biochemical Techniques theory and practice : White R 2. Analytical Chemistry: Christion G. D. 3. Nuclear Magnetic Resonance: Williams
Reference Books	1. A Biologist Guide to Principle and Techniques: Willson K. and Gounding K.H.