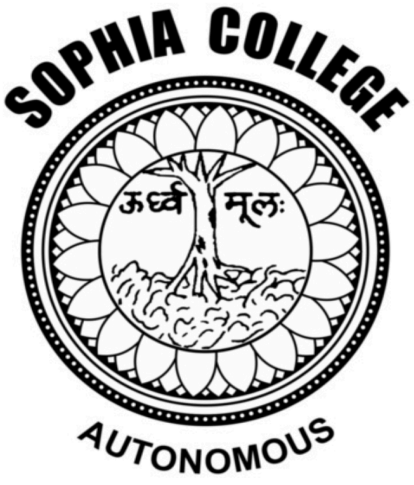

SOPHIA COLLEGE FOR WOMEN (AUTONOMOUS)

Affiliated to the University of Mumbai

Programme: Sciences

M.Sc II Microbiology

Syllabus for the Academic Year 2024-2025

based on the National Education Policy 2020

SOPHIA COLLEGE FOR WOMEN (AUTONOMOUS)

DEPARTMENT OF MICROBIOLOGY

COURSE DETAILS

	SEMESTER III				SEMESTER IV			
TITLE	**Environmental Microbiology-I**	**Medical Microbiology and Immunology-I**	**Enzymology**	**Research Project Proposal**	**Environmental Microbiology-II**	**Medical Microbiology and Immunology-II**	**Pharmaceutical Microbiology**	**Research Project Report**
TYPE OF COURSE	**Mandatory 1**	**Mandatory 2**	**Elective**	**Research Project**	**Mandatory 1**	**Mandatory 2**	**Elective**	**Research Project**
CREDITS	**6**	**6**	**4**	**4**	**6**	**4**	**4**	**6**

Preamble:

The M.Sc program at Sophia College for Women (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 internship 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.

SOPHIA COLLEGE FOR WOMEN (AUTONOMOUS)

PROGRAMME OBJECTIVES

PO 1	To provide a comprehensive in depth understanding of conventional and advanced theoretical concepts and practical skills in microbiology.
PO 2	Inculcate research skills and develop ability to create hypotheses, design experiments, and interpret and document scientific results effectively.
PO 3	Prepare students for employment opportunities in research and industry based on their fields of interest.
PO 4	Enable students to apply microbiological knowledge and skills to understand real-world problems in environmental and industrial contexts.

PROGRAMME SPECIFIC OUTCOMES

PSO 1	Students will gain theoretical and practical knowledge about general microbiology, molecular biology, genetics, cell biology, microbial biochemistry, medical microbiology and immunology.
PSO 2	Students will learn to formulate hypotheses, design experiments, analyze and articulate results using various microbiological methods and consequently be capable of conducting a scientific enquiry.
PSO 3	Students will develop skills essential for employability in the academia, research and industry in the Microbiology and Life Science sector.
PSO 4	Foster a sense of responsibility towards societal issues related to microbiology, including ethical considerations in research.

SOPHIA COLLEGE FOR WOMEN (AUTONOMOUS)

Programme: Sciences MICROBIOLOGY MSC-II	**Semester – III**
Course Title: Environmental Microbiology-I	**Course Code: SMCB635MJ**

COURSE OBJECTIVES

1. Understand theories of origin of life, chemical and cellular evolution.
2. Learn basic principles of microbial ecology and interactions among microbial populations.
3. Understand microbial positive plant interactions like nitrogen fixation, Mycorrhizae and plant pathogen associated diseases
4. Learn marine environment, marine microbial populations and their symbiotic associations
5. Understand sample collection and different physiological and nucleic acid based methods for studying microorganisms in the environment

COURSE OUTCOMES

The learner will be able to:

1. describe the theories of origin of life
2. identify and distinguish the various positive and negative interactions between single and diverse microbial populations
3. explain the mechanisms of nodule formation by nitrogen fixing bacteria, mycorrhizae, and pathogenesis of bacterial and fungal plant diseases
4. recall marine microbial populations and their symbiotic relationships
5. categorize, compare and contrast different methods for studying microorganisms in the environment
6. apply some of the methods in their practicals and project work

Lectures per week (1 Lecture is 60 minutes)		**4**	
Total number of Hours in a Semester		**60**	
Credits		**4**	
Evaluation System	**Semester End Examination**	**2 Hours**	**50 marks**
	Internal Assessment	**--**	**50 marks**

UNIT I Microbial Ecology	**1.1**	**Origin of life, chemical and microbial Evolution** (RNA world hypothesis, cellular evolution, evolution of organelles)	**15 hours**
	1.2	**Microbial Ecology –** Niche, habitat, ecosystem	
	1.3	**Interactions among microbial populations** a. Interactions within a single microbial population- Positive interactions, Negative interactions b. Interactions between diverse microbial populations- Neutralism, Commensalism, Synergism, Mutualism, Competition, Amensalism, Parasitism, Predation	
	1.4	**Succession within microbial communities** a. Autotrophic-Heterotrophic succession b. Examples of successional processes (any one example)	
UNIT II Soil, Plant and Marine Microbiology	**2.1**	**Soil and Plant Microbiology** (Students to revise Litho- Ecosphere and Physical and chemical properties of soils from SYBSc) a. Soil microbial communities b. Interactions with plant roots- Rhizosphere, plant root effects on microbial population, effects of rhizosphere microbial populations on plants, Mycorrhizae- Ectomycorrhizae and Endomycorrhizae c. Nitrogen fixation in nodules- Nitrogen fixing associations between Rhizobia and legumes **d.** Microbial diseases of plants and plant pathogens-bacterial and fungal diseases of plants	**15 hours**
	2.2	**Marine Microbiology** a. Planktonic environment b. Benthic habitat c. Microbial mats d. Brackish water (estuary) e. Physical, chemical and microbial characteristics of marine water f. Marine microbial populations- Bacteria, Fungi, Algae, Protozoa and Viruses	

		g. Symbiotic associations i. Symbioses of microalgae with animals (Nature of dinoflagellate endosymbionts, Corals) ii. Symbioses of chemoautotrophic prokaryotes with animals (Chemoautotrophic endosymbionts in hydrothermal vent animals) iii. Light organ symbioses in fish and invertebrates (Flashlight fishes and anglerfishes)	
UNIT III Environmental sample collection and physiological methods for studying microorganisms in the environment	**3.1**	**Environmental sample collection and processing** a. Soils and Sediment- Sampling strategies and methods for surface soils, Sampling strategies and methods for the subsurface, Sample processing and storage b. Water- Sampling strategies and methods for water, processing water samples for virus analysis, processing water samples for detection of bacteria and protozoan parasites	**15 hours**
	3.2	**Physiological Methods** (Students to revise cultural methods for bacteria, fungi, algae and viruses from SYBSc, and TYBSc) a. Measuring microbial activity in pure culture b. Carbon Respiration i. The application of respiration measurements in environmental microbiology ii. Tracer studies to determine heterotrophic potential iii. Anaerobic respiration as an indicator of microbial activity c. Incorporation of radiolabeled tracers into cellular macromolecules i. Incorporation of thymidine into DNA ii. Incorporation of leucine into protein d. Adenylate energy charge e. Enzyme assays- Dehydrogenase assay f. Stable isotope probing g. Functional genomics and proteomics based approaches	
UNIT IV	**4.1**	**Nucleic acid based methods of analysis**	**15**

Nucleic acid methods for studying microorganisms in the environment		a. Extraction of nucleic acids from environmental samples b. Gene probes and probing- Fluorescent in situ hybridization (FISH) c. PCR Fingerprinting d. Metagenomics (Sequencing by synthesis) e. Restriction fragment length polymorphism analysis i. RFLP analysis of whole genomes ii. RFLP analysis of PCR sequences iii. Fluorescent fragment length polymorphism techniques iv. Pulsed field gel electrophoresis v. Advantages and disadvantages of RFLP and PFGE analyses f. Denaturing/temperature gradient gel electrophoresis i. Theory, concept, advantages and disadvantages of DGGE and TGGE g. Reporter genes i. Theory and concept **ii.** Specific reporter gene systems **iii.** Advantages and disadvantages of reporter genes	**hours**

PRACTICAL **Course Title: Environmental Microbiology-I**	**Course Code: SMCB635MJP**

COURSE OUTCOMES

The learner will be able to:

1. analyze, arrange and paraphrase the literature to write reports on bacterial and archaeal diversity by identifying their key characteristics and assessing their ecological significance in various environments.
2. apply analytical techniques to determine organic matter and chloride content in soil samples and evaluate their implications on soil composition.
3. isolate indole acetic acid (IAA)-producing bacteria from rhizospheric soil and evaluate their potential in promoting plant growth and agricultural applications.
4. set-up Winogradsky's column, classify and distinguish different layers of bacteria, examine and correlate the physiological properties and ecological roles of algae, purple and green sulfur bacteria.

5. analyze microbial respiration in soil and synthesize insights on horizontal gene transfer in marine microorganisms by reviewing and evaluating current scientific literature. 6. use tetrazolium reduction assay to determine the active microbial populations in soil

Lectures per week (1 Lecture is 60 minutes)		**2**	
Total number of Hours in a Semester		**60**	
Credits		**2**	
Evaluation System	**Semester End Examination**	**2 Hours**	**50 marks**
	Internal Assessment	**--**	**50 marks**

	1	A detailed report to be written on Bacterial and Archaeal diversity containing important characteristics, examples and pictures of different groups of a. Bacteria- The Deinococci and Nonproteobacteria, Proteobacteria (Alpha, Beta, Gamma, Delta and Epsilon), Low G+C and High G+C Gram Positive bacteria b. Archaebacteria	**30 hours**
	2	Soil analysis- a. To determine the organic matter content of soil b. To determine the chloride content of soil.	
	3	Isolation of indole acetic acid (IAA) producing bacteria from rhizospheric soil and its effect on plant growth	
	4	Study of algae, Purple sulphur and Green sulphur bacteria.	
	5	Student activity- To search and understand a recent review or a research article on horizontal gene transfer in marine microorganisms. Questions on this will be asked in the quiz and viva.	
	6	Measurement of soil microbial respiration using alkali trapping method.	
	7	Dehydrogenase assay-Tetrazolium reduction test.	

SOPHIA COLLEGE FOR WOMEN (AUTONOMOUS)

Programme: Sciences MICROBIOLOGY MSC-II	**Semester – III**
Course Title: Medical Microbiology and Immunology-I	**Course Code: SMCB636MJ**

COURSE OBJECTIVES

1. Understand the concepts of allergy, hypersensitivities, and chronic inflammation.
2. Gain knowledge about the establishment and maintenance of tolerance and autoimmunity.
3. Study the immunology of transplantation, including types of graft rejection, immunosuppressive therapy, and organ transplantation.
4. Explore the immune response to infectious agents, including viruses, bacteria, protozoan diseases, and diseases caused by parasitic worms.
5. Learn about experimental systems and methods used in immunology, such as antibody generation, immunoprecipitation-based techniques, agglutination reactions, and antibody assays.

COURSE OUTCOMES

The learner will be able to:

1. explain the mechanisms of allergy, hypersensitivities, and chronic inflammation.
2. analyze the factors involved in the establishment and maintenance of tolerance and autoimmunity.
3. evaluate the immunological aspects of transplantation, including graft rejection, immunosuppressive therapy, and organ transplantation.
4. critically assess the immune response to infectious agents and the strategies employed by pathogens to evade the host immune system.
5. demonstrate proficiency in experimental systems and methods used in immunology, including antibody generation, immunoprecipitation - based techniques, agglutination reactions, and antibody assays.

Lectures per week (1 Lecture is 60 minutes)		**4**	
Total number of Hours in a Semester		**60**	
Credits		**4**	
Evaluation	**Semester End Examination**	**2 Hours**	**50 marks**

SOPHIA COLLEGE FOR WOMEN (AUTONOMOUS)

System	Internal Assessment	--	50 marks

UNIT I Allergy, Hyper-sensitivities and chronic inflammation	**1.1**	**Allergy: A Type I Hypersensitivity Reaction** a. Basophils, Mast cells and Eosinophils b. Receptors for IgE c. Activation of Mast cells and Basophils d. Biological mediators of Type I reactions e. Clinical consequences of Type I reactions. f. Late phase reaction g. Tests for diagnosis of Type I hypersensitivity h. Therapeutic measures for Type I hypersensitivity	**15 hours**
	1.2	**Antibody Mediated (Type II) Hypersensitivity reactions** b. Drug- induced hypersensitivity reaction c. Transfusion reactions. d. Rhesus antigen incompatibility	
	1.3	**Immune Complex- Mediated (Type III) Hypersensitivity** a. Mechanism of removal of immune complexes from normal individuals. b. Mechanisms of Type III hypersensitivity reactions c. Localized Type III Reactions d. Generalized Type III Reactions	
	1.4	**Delayed- Type (Type IV) Hypersensitivity (DTH)** a. Contact Hypersensitivity. b. Tuberculin Reaction c. Granulomatous Hypersensitivity	
	1.5	**Chronic Inflammation** a. Causes and Implications b. Infectious and Non-Infectious Triggers of Chronic Inflammation c. Chronic Inflammation: Link to Obesity and Systemic Diseases	
UNIT II	**2.1**	**Establishment and maintenance of tolerance**	**15**

Tolerance, Autoimmunity and Transplantation		a. Protection Mechanisms for Self-Antigens: Antigen Sequestration and Central Tolerance b. Central and Peripheral Tolerance Mechanisms in Autoimmune Regulation	**hours**
	2.2	**Autoimmunity** a. Single organ autoimmune disease b. Systemic autoimmune disease c. Animal models of autoimmune disease d. Therapeutic approaches of autoimmune diseases e. Other Strategies f. Role of MHC, Th cells and TCR in autoimmunity	
	2.3	**Transplantation** a. Introduction b. Types of Graft rejection c. Immunosuppressive therapy of allograft rejection d. Immunology of xenogeneic transplantation e. Transplants to privileged sites f. Organ transplantation g. Graft versus host disease (GVHD)	
UNIT III Immune Response to Infectious Agents	**3.1**	**Introduction**	**15 hours**
	3.2	**Immunity to Viruses** a. Innate immune response to viruses b. Viral neutralization by antibody and complement c. T-cell mediated antiviral mechanism	
	3.3	**Virus strategies for the evasion of host immune response**	
	3.4	**Viral infections** a. The influenza virus b. Antigenic drift and antigenic shift c. Immune response to Influenza infection	

	3.5	**Immunity to Bacterial infections** a. First line of defense b. Immune response to extracellular bacteria c. Immune response to intracellular bacteria d. Evasion of host defenses by bacteria	
	3.6	**Bacterial infections** 1. *Corynebacterium diphtheriae.* 2. *Mycobacterium tuberculosis* 3. Lyme disease: *Borrelia burgdorferi*	
	3.7	**Protozoan diseases** a. Malaria b. African sleeping disease c. Leishmaniasis	
	3.8	**Disease caused by parasitic worms** a. Host immune response b. Evasion of immune mechanism by helminths	
UNIT IV Experimental systems and methods-I	**4.1**	**Antibody Generation** a. Production of monoclonal antibodies b. Applications of monoclonal antibodies	**15 hours**
	4.2	**Immunoprecipitation- based techniques** a. Immunoprecipitation Techniques: Solution and Gel Matrix Methods b. Characterizing Cell-Bound Molecules through Immunoprecipitation	
	4.3	**Agglutination Reactions** a. Hemagglutination and Hemagglutination Inhibition Reactions in Virus Detection b. Bacterial Agglutination for Antibody Detection	
	4.4	**Antibody Assays based on Antigen binding to solid phase supports** a. Radioimmunoassay b. ELISA	

		c. ELISPOT assay d. Western blotting	
	4.5	**Microscopic visualization of cells and subcellular structures** a. Enzyme-Conjugated Antibodies in Immunocytochemistry and Immunohistochemistry for Tissue Imaging b. Visualizing Antigen-Antibody Complexes with Gold Beads in Immunoelectron Microscopy	
	4.6	**Immunofluorescence- based imaging techniques** a. Immunofluorescence Microscopy with Fluorescent Antibodies b. Three-Dimensional Imaging with Confocal Microscopy c. Multiphoton Microscopy: A Variant of Confocal Imaging d. In Vivo Immune Response Observation with Intravital Imaging	

PRACTICAL **Course Title: Medical Microbiology and Immunology-I**	**Course Code: SMCB636MJP**

COURSE OUTCOMES

The learner will be able to:

1. analyze and interpret immunological techniques like single radial immunodiffusion, Ouchterlony assay, and hemagglutination to evaluate antigen-antibody interactions and their clinical significance.
2. apply and evaluate cross-matching assays to determine donor-recipient blood compatibility in order to ensure safe blood transfusion.
3. identify pathogenic bacteria, including *Corynebacterium diphtheriae* and *Mycobacterium*, through methods such as isolation, staining, and biochemical testing, and assess their significance in diagnosing associated infections.
4. understand and correlate the application of confocal microscopy to visualize and analyze complex microbial structures for advanced diagnostic purposes.
5. conduct rapid diagnostic tests, such as catalase activity and biochemical inoculations, ensuring precision and adherence to established clinical microbiological protocols.

Lectures per week (1 Lecture is 60 minutes)	**2**

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Total number of Hours in a Semester		**60**	
Credits		**2**	
Evaluation System	**Semester End Examination**	**2 Hours**	**50 marks**
	Internal Assessment	**--**	**50 marks**

	1	Single radial immunodiffusion assay.	**30 hours**
	2	Determine the identity of the antigen using Ouchterlony technique.	
	3	To check the blood compatibility between donor and recipient by cross matching.	
	4	Hemagglutination and hemagglutination inhibition assay.	
	5	Medical diagnosis of *Corynebacterium diphtheriae*- Day 1- Isolation on Loeffler's medium and Potassium tellurite medium. Day 2- Gram staining and metachromatic granule staining using Albert's staining method. Rapid test - catalase. Inoculation in biochemicals.	
	6	Detection of Mycobacterium by Acid fast staining method.	
	7	Pursue a course/internship to achieve hands-on experience in confocal microscopy. Write a report on the same.	

SOPHIA COLLEGE FOR WOMEN (AUTONOMOUS)

Programme: Sciences MICROBIOLOGY MSC-II	**Semester – III**
Course Title: Enzymology	**Course Code: SMCB633E**

COURSE OBJECTIVES

1. Understand the characteristics of enzymes and the role they play in catalyzing reactions.
2. Acquire knowledge about the classification of enzymes.
3. Understand the terms coenzymes, cofactors, and prosthetic groups and their importance.
4. Derive equations and plot graphs for enzyme catalyzed reactions.
5. Gain knowledge about allosteric enzymes.
6. Learn about various parameters that affect the enzyme activity.
7. Gain insight about industrial applications of enzymes.

COURSE OUTCOMES

The learner will be able to:

1. explain the various properties of enzyme like active site, substrate binding and product formation etc
2. classify enzymes on the basis of the reaction catalyzed
3. evaluate the activity of the enzyme under varying pH, temperature and substrate concentration
4. critically study the type of reversible inhibition obtained in the presence of different inhibitors.
5. analyze the action of irreversible inhibitors.
6. apply the knowledge of enzymes for bringing about transformations in various industries.

Lectures per week (1 Lecture is 60 minutes)		**2**	
Total number of Hours in a Semester		**30**	
Credits		**2**	
Evaluation System	**Summative Assessment**	**–**	**-**
	Continuous Assessment	**--**	**50 marks**

UNIT I **Basics of Enzymology**	**1.1**	a. General Characteristics of Enzymes b. Definition and properties of enzymes c. Classification of enzymes based on their activity d. Coenzymes, Cofactors, Prosthetic groups of enzymes and their significance e. Multisubstrate reactions -Ordered, Random, Ping-pong (schematic with example) f. Michaelis-Menten equation and plot, LB equation and plot **g.** Allosteric enzymes - Properties, mechanism of action and their role in regulation of metabolic pathways	**15 hours**
UNIT II **Factors affecting enzyme activity and industrial applications of enzymes**	**2.1**	a. Effect of enzyme concentration, substrate concentration, pH and temperature on enzyme activity b. Inhibitors: Reversible Inhibition of enzymes: Competitive, Non-competitive, Uncompetitive, Mixed inhibition c. Irreversible inhibition of enzymes d. Applications of enzymes in Leather industry, Textile industry, Paper and Pulp industry, Food and Beverage industry, Pharmaceutical industry, Waste water treatment and Biofuel production	**15 hours**

PRACTICAL **Course Title: Enzymology**	**Course Code: SMCB633EP**

COURSE OUTCOMES

The learner will be able to:

1. explain the methods for the production and purification of invertase from *Saccharomyces cerevisiae*.
2. set-up assays to analyze the effects of enzyme concentration, pH, temperature, and inhibitors on enzyme activity and interpret experimental data to understand enzyme functionality.
3. assess the impact of substrate concentration on enzyme activity and calculate Km , Vmax ,the important kinetic parameters that are indicators of enzyme activity.
4. develop experimental protocols to investigate the optimal conditions for enzyme activity.
5. isolate microorganisms capable of producing industrially relevant enzymes.

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Lectures per week (1 Lecture is 60 minutes)		**2**	
Total number of Hours in a Semester		**60**	
Credits		**2**	
Evaluation System	**Summative Assessment**	**2 Hours**	**50 marks**
	Continuous Assessment	**--**	**–**

	1	Production and isolation of invertase from *Saccharomyces cerevisiae*	**30 hours**
	2	Determination of effect of substrate concentration on enzyme activity (MM kinetics and LB plot)	
	3	Determination of concentration of enzyme on activity	
	4	Determination of effect of pH on enzyme activity	
	5	Determination of effect of temperature on enzyme activity	
	6	Determination of effect of inhibitors enzyme activity (MM kinetics and LB plot)	
	7	Enrichment, Isolation and detection of amylases, pectinases, cellulases and proteases.	

Programme: Sciences MICROBIOLOGY MSC-II	**Semester – III**
Course Title: Research Proposal	**Course Code: SMCB631RP**

SOPHIA COLLEGE FOR WOMEN (AUTONOMOUS)

COURSE OUTCOMES

The learner will be able to:

1. demonstrate a comprehensive understanding of the requirements to carry out a research project including identification of a problem, literature surveys and planning of experiments.
2. understand the areas that require a detailed inquiry in the light of available literature.
3. predict potential outcomes of research findings and provide insights for future investigations.

Hours per week		**8**	
Total number of Hours in a Semester		**120**	
Credits		**4**	
Evaluation System	**Semester End Examination**	**–**	**50 marks**
	Internal Assessment	**--**	**50 marks**

ASSESSMENT DETAILS:

There will be two subheads, namely, Summative Assessment (SA) and Continuous Assessment (CA) of 50 marks each.

1. Mandatory, elective and practical will have **separate heads of passing**.
2. A student needs to secure 40% marks for passing individually in SA and CA.
3. There is no CA for practical.
4. If a student fails, he/she will have to appear for an ATKT examination.
5. Students who have missed the SA for a genuine reason (supported with a document subject to approval by the authorities) will appear for an **Additional SA of 50 marks**. This Additional/ATKT SA will be held after the declaration of the respective semester results and at the discretion of the exam committee.
6. Students will be declared UNSUCCESSFUL, if they score less than 20 marks on 50 marks.
7. Staff will show assessed theory answer papers of SA to students and discuss the rubric of assessment with the students on a day fixed by the PG Exam Committee.
8. There is no reassessment of practical papers.
9. Grievance Redressal Mechanism for addressing grievances related to SA:

Students may apply for Reassessment, Photocopying and Revaluation of the SA answer books after the declaration of results in response to the notice posted by the College Office for the same.

10. Students with learning disability (LD) will be given extra time for SA as per University rules.

B. Continuous Assessment (CA) for Mandatory Courses:

1. CA activities will be planned and conducted by the respective departments.

The departments are required to share the details of the CA activities with the Deputy Controller of PG exam and PG Co-ordinator (VP- Science).

2. Students' CA activity-related scores with assessed papers and feedback on their work (tests, other activities, assignments etc.) must be shared with students.

3. Format of CA: Two CA activities of 25 marks each.

CA 1: Test - 25 marks (Duration for answering the Test: Max. 60 Minutes)

CA 2: Any Activity - 25 marks

5. The minimum score to pass the Course will be 20 marks out of 50 marks.

6. If a student fails to pass (scores less than 20) then, the student will have to appear for 50 marks ATKT - **one IA** Test of 25 marks and **one assignment** of 25 Marks.

C. Continuous Assessment (CA) for Elective Courses:

1. CA activities will be planned and conducted by the respective departments.

The departments are required to share the details of the CA activities with the Deputy Controller of PG exam and PG Co-ordinator (VP- Science).

Format of CA: Two CAs of 25 marks each.

2. DSE - CA score must not be shared with the students (Duration for answering the Test: Max. 60 Minutes)

3. **CA 1: Test - 25 marks subjective type**
   CA 2: Test - 25 marks subjective type

4. The minimum score to pass the Course will be 20 marks out of 50 marks.

5. If a student fails to pass (scores less than 20) then, student will have to appear for 50 marks ATKT - **Two IA** Test of 25 marks each **(Subjective type)**

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D. Evaluation for Common Courses- Research Methodology under NEP:

1. **Only CA is to be conducted for 50 marks**.

CA 1: Test - 25 marks (Duration for answering the Test: Max. 60 Minutes)

CA 2: Any Activity - 25 marks

2. If a student fails to pass (scores less than 20) then, the student will have to appear for 50 marks ATKT-**one IA** Test of 25 marks and **one assignment** of 25 Marks.

3. The minimum score to pass the Course will be 20 marks out of 50 marks.

4. Students' CA activity-related scores with assessed papers and feedback (tests, other activities, assignments etc.) will be shared individually with students.

5. Grievance Redressal Mechanism for addressing grievances related to CAS:

Students will apply in a prescribed format to the respective Vice Principals. The grievance will be

addressed by involving the concerned faculty and the other Exam Committee member/s deputed by the Principal.

E. Evaluation for Common Courses-Research Project (RP) under NEP:

1. Continuous assessment of **50 marks** by the mentor.
2. Summative assessment of **50 marks** by the external examiner.
3. The evaluation pattern decided by the PG examination committee will be followed by all the departments.

REFERENCES:

Mandatory 1 - SMCB635MJ Environmental Microbiology-I

1. Atlas, R. M., & Bartha, R. (1998). *Microbial ecology: Fundamentals and applications* (4th ed.). Pearson Education.
2. Bertrand, J.-C., Caumette, P., Lebaron, P., Matheron, R., Normand, P., & Sime-Ngando, T. (2015). *Environmental microbiology: Fundamentals and applications. Microbial ecology*. Springer.
3. Brooker, R. J. (2012). *Genetics analysis and principles* (4th ed.). McGraw Hill.
4. Madigan, M. T., Bender, K. S., Buckley, D. H., Sattley, W. M., & Stahl, D. A. (2018). *Brock biology of microorganisms* (15th ed.). Pearson.
5. Maier, R. M., Pepper, I. L., & Gerba, C. P. (2009). *Environmental microbiology* (2nd ed.). Academic Press, Elsevier.
6. Munn, C. (2004). *Marine microbiology: Ecology and applications*. Garland Science/BIOS Scientific Publishers.
7. Munn, C. (2011). *Marine microbiology: Ecology and applications* (2nd ed.). Garland Science, Taylor & Francis Group.
8. Russell, P. J. (2010). *iGenetics: A molecular approach* (3rd ed.). Pearson.
9. Willey, J., Sandman, K., & Wood, D. (2019). *Prescott's microbiology* (11th ed.). McGraw Hill.

Mandatory 2 - SMCB636MJ Medical Microbiology and Immunology-I

1. Khan, F. (2006). *The elements of immunology*. Pearson Education India.
2. Owen, J. A., Punt, J., & Stanford, S. A. (2019). *Kuby Immunology* (8th ed.). W. H. Freeman.

ELECTIVE PAPER: SMCB633E Enzymology

1. Conn, P., Stumpf, G., Bruening, R., & Doi, R. (1995). *Outlines of biochemistry* (5th ed.). John Wiley & Sons.
2. Nelson, D. L., & Cox, M. M. (2005). *Lehninger: Principles of biochemistry* (4th ed.). W. H. Freeman & Co.
3. Nelson, D. L., & Cox, M. M. (2013). *Lehninger principles of biochemistry* (6th ed.). W. H. Freeman and Company.
4. Palmer, T. (2004). *Enzymes: Biochemistry, biotechnology, and clinical chemistry*. East West Press Ltd.

SOPHIA COLLEGE FOR WOMEN (AUTONOMOUS)

Programme: Sciences MICROBIOLOGY MSC-II	**Semester – IV**
Course Title: Environmental Microbiology-II	**Course Code: SMCB647MJ**

COURSE OBJECTIVES

1. Explore extremophiles, their diverse adaptations, and survival mechanisms in extreme environments.
2. Investigate the practical applications of extremophilic microorganisms in biotechnology, various industries, and biofuel research.
3. Examine the pivotal roles microorganisms play in sulfur and iron cycles within ecosystems.
4. Enalyze the repercussions of biogeochemical cycles on environmental phenomena like biocorrosion, concrete corrosion, and acid mine drainage.
5. Investigate the significance of biofilm formation in natural settings and explore methods for its regulation.
6. Examine the process of environmental monitoring, emphasizing the contributions of microorganisms.
7. Evaluate the process of eutrophication in aquatic systems, along with techniques for detecting fecal pollution and oil spills in water bodies.
8. Explore methods of bioremediation for treating waste containing chemicals, metals, gases, and oil.
9. Investigate strategies for managing solid waste, including kitchen waste, plastics, and e-waste

COURSE OUTCOMES

The learner will be able to:

1. demonstrate understanding of diverse extreme habitats on Earth and the organisms thriving in such environments.
2. explain the molecular adaptations of extremophilic microorganisms that enable their survival in extreme conditions.
3. recognize the significance of extremophilic microorganisms and their enzymes and other bioproducts in various fields.
4. describe the roles of microorganisms in the sulfur and iron cycles within ecosystems.
5. analyze the environmental consequences of biogeochemical cycles and the involvement of microorganisms in processes like biocorrosion, acid mine drainage, and bioleaching.
6. explain the mechanisms of biofilm formation and methods for its control.

7. describe various environmental monitoring processes to assess pollution levels.
8. discuss eutrophication and oil spills as significant issues in aquatic ecosystems, along with methods for detecting fecal contamination and microbial source tracking.
9. explain different methods of bioremediation and the utilization of microorganisms in waste treatment.
10. Discuss the importance of solid waste management and various methods employed for its effective handling

Lectures per week (1 Lecture is 60 minutes)		**4**	
Total number of Hours in a Semester		**60**	
Credits		**4**	
Evaluation System	**Semester End Examination**	**2 Hours**	**50 marks**
	Internal Assessment	**--**	**50 marks**

UNIT I Extremophiles	**1.1**	**Introduction** **a.** Extreme environments of Thermophiles, Psychrophiles, Acidophiles, Alkaliphiles and Halophiles	**15 hours**
	1.2	Physical and molecular adaptation of Thermophiles, Psychrophiles, Acidophiles, Alkaliphiles and Halophiles	
	1.3	a. Sampling from extreme environments and enrichment culturing methods for isolation of extremophiles. b. Culturing of extremophiles in fermenters	
	1.4	Applications of extremophiles	
UNIT II Impact of Microorganisms on the Environment	**2.1**	**Biogeochemical cycling** a. Sulfur cycle **b.** Iron cycle	**15 hours**
	2.2	**Consequences of Biogeochemical cycles** a. Microbially influenced corrosion (Biocorrosion)	

		i. Metal Corrosion ii. Microbially induced concrete corrosion b. Acid mine drainage and metal recovery, Uranium leaching	
	2.3	**Biofilms** a. The biofilm formation process: attachment, maturation and dispersion to planktonic mode of growth. b. Communication in biofilms: Quorum sensing & other chemical signalling molecules c. Biofilm-related diseases: Cystic fibrosis, Dental plaque, Wounds, Urinary infection, Prosthetic joint infection, Cardiac valve infection. d. Biofilm resistance to antibiotics & host immune system: Limited antibiotic penetration, Horizontal gene transfer, Reduced growth rate, Persister cells, Efflux pumps, EPS matrix protection e. Beneficial biofilms: Application of biofilms in wastewater treatment and microbial leaching of ores. f. Biofouling: health risks and financial losses in the medical, marine and industrial fields. **g.** Biofilm eradication: Methods and commonly used biocides such as surfactants, enzymes, triclosan, chlorhexidine, quaternary ammonium compounds	
	2.4	**Climate change and Combating Greenhouse effect using microbes**	
UNIT III Environmental Monitoring and Water Pollution	**3.1**	**Environmental monitoring** a. Definition of pollution b. Sampling- Land sampling, water sampling and air sampling c. Physical, Chemical and Biological analysis d. Determination of biodegradable organic material e. Monitoring pollution f. Bioindicators g. Biomarkers- Biochemical and genetic indicators h. Toxicity testing using biological material- toxicity testing using plants and algae, Luminescent organisms, Ames test, molecular biology biomarkers	**15 hours**

		i. Biosensors	
	3.2	**Pollution of Aquatic Systems** a. Nature of pollution i. The concept of the self-purification of water as basis for the understanding of pollution ii. Kinds of pollutants iii. Pollution by eutrophication- Algal blooms iv. Biological Indicators of Pollution by Eutrophication b. Pollution of Water with Reference to Human Health i. Microbiological examination of water for fecal contamination- Principle of Indicator organisms, Procedure for the determination of fecal contamination, Methods used in the enumeration of indicator organisms in water, Standard water analysis, Total Maximum Daily Loads and Microbial source tracking in water pollution, Microbial source tracking, Methodologies employed in MST- Molecular, biochemical and chemical methods, Choice of the MST method to use c. Pollution by petroleum in oceans and seas i. Oil spills- Behavior of Oil in an Oil Spill	
UNIT IV Bioremediation and Waste treatment	**4.1**	**Bioremediation** a. Introduction, Synthetic compounds, petrochemical compounds, Inorganic wastes b. Bioremediation strategies- Indigenous microorganisms, stimulation of indigenous microbial growth, Bioaugmentation, use of genetically manipulated organisms, Planned release of genetically engineered microorganisms in the environment and concerns regarding the same. c. Bioremediation techniques in situ- Bioremediation on land, land farming, Bioventing, Biosparging, stimulation d. Bioremediation techniques ex-situ- Composting, biopile process, use of bioreactors, novel technologies e. Bioremediation of metals- Biosorption, extracellular precipitation f. Bioremediation of gasses	**15 hours**

		g. Bioremediation of textile dyes/effluent- types of textile dyes, bioremediation methods, role of bacteria, fungi, yeasts, molds, microbial consortia and biofilms, mechanisms behind bioremediation of textile dyes- (biosorption, biodegradation, mineralization, bioaccumulation), factors affecting degradation, immobilization of bacterial cells, Optimization procedures- Response surface methodology, Environmental concerns- effects on humans and water bodies **h.** Bioremediation of oil spills	
	4.2	**Solid waste management** a. Solid waste management by reduction, collection, recycling and incineration b. Treatment/degradation of kitchen waste, composting, vermicomposting, waste-to-energy technique, landfilling c. Treatment of slaughterhouse/abattoir waste d. Case studies of implementation of ideas- Entrepreneurs e. Management of biomedical waste, plastic and e-waste	

PRACTICAL **Course Title: Environmental Microbiology-II**	**Course Code: SMCB647MJP**

COURSE OUTCOMES

The learner will be able to:

1. enrich, isolate, and analyze thermophiles, halophiles, and alkaliphiles from diverse environments, evaluating their enzymatic activities, including the production of amylase, lipase, cellulase, and xylanase, for industrial and ecological applications.
2. detect and evaluate water pollution in rivers and lakes by estimating chromium levels, pH, BOD, and COD, and by identifying human fecal contamination and antibiotic resistance in *E. coli* isolates, emphasizing environmental health monitoring.
3. assess biofilms using crystal violet assays and analyze the microbial safety of packaged drinking water through compliance with BIS standards, ensuring public health safety.
4. create comprehensive insights into hazardous waste management and domestic and industrial waste treatment by engaging in field visits to pollution control facilities and preparing detailed evaluative

reports.

5. investigate applications of carbon credit systems in mitigating environmental impacts, integrating microbial processes with innovative sustainable practices.

Lectures per week (1 Lecture is 60 minutes)		**2**	
Total number of Hours in a Semester		**30**	
Credits		**2**	
Evaluation System	**Semester End Examination**	**2 Hours**	**50 marks**
	Internal Assessment	**--**	**50 marks**

	1	Enrichment and isolation of thermophiles from soil/ mangrove soil/ compost/ any environment. To determine whether the isolated bacteria are obligate thermophiles. Detection of amylase, lipase, cellulase and xylanase enzymes.	**30 hours**
	2	Enrichment and isolation of halophiles from sea/ mangrove soil. Detection of amyl lipase, cellulase and xylanase enzymes.	
	3	Isolation and characterization of alkaliphiles from soil/ mangrove soil.	
	4	Visualization and study of biofilms using crystal violet assay.	
	5	Detection and monitoring of water pollution in rivers and lakes of Mumbai (any one river and lake from the following- Mithi river, Oshiwara river, Poisar river, Dahisar river, Tulsi lake, Vihar lake)- a. Estimation of Chromium b. Determination of pH, BOD and COD c. Detection of human fecal pollution *(E. coli* and fecal Streptococci) d. Determination of Antibiotic resistance in *E. coli* isolates.	
	6	Student activity- Detection of coliforms and *E.coli* from packaged/bottled drinking water as per BIS standards.	
	7	A report to be written on carbon credit.	

	8	Visit to Maharashtra Pollution Control Board, Central/Regional laboratory OR Common Effluent Treatment Plant, Kopar Khairane, Navi Mumbai to learn treatment of domestic and industrial waste and sludge treatment. A report to be written on this in the journal.	
	9	A detailed report to be written on hazardous waste management. (Minimum 5 references to be included)	

Programme: Sciences MICROBIOLOGY MSC-II	**Semester – IV**
Course Title: Medical Microbiology and Immunology-II	**Course Code: SMCB648MJ**

COURSE OBJECTIVES

1. Understand the fundamental concepts and classification of immunodeficiency disorders, including primary and secondary forms.
2. Identify the molecular and cellular mechanisms underlying primary immunodeficiency disorders.
3. Analyze the role of the complement system in innate and adaptive immunity and its dysfunction in immunodeficiency.
4. Evaluate various treatment modalities available for managing immunodeficiency disorders, considering their mechanisms of action and efficacy.
5. Examine the utility of animal models in studying primary immunodeficiency disorders and translating findings to clinical applications.
6. Explore the relationship between cancer and the immune system, including tumor development, progression, and immune surveillance.
7. Investigate the immune responses elicited by tumors and the mechanisms by which tumors evade immune recognition and destruction.
8. Assess the principles and applications of immunotherapy in cancer treatment, including checkpoint inhibitors, adoptive cell therapy, and cancer vaccines.
9. Examine the comprehensive overview of Covid-19, including its etiology, pathogenesis, epidemiology, clinical manifestations, and treatment options.
10. Discuss the importance of experimental systems and methods in immunology research, including flow cytometry, cell sorting techniques, cell cycle analysis, assays of cell death, biochemical

approaches, and whole animal models.

COURSE OUTCOMES

The learner will be able to:

1. demonstrate a deep understanding of the classification, etiology, and clinical manifestations of primary and secondary immunodeficiency disorders.
2. describe the genetic and molecular basis of primary immunodeficiency disorders and their implications for immune function.
3. explain the role of the complement system in host defense and its dysfunction in immunodeficiency disorders.
4. critically evaluate the effectiveness and limitations of various treatment approaches for immunodeficiency disorders.
5. apply knowledge of animal models to design and interpret experiments related to primary immunodeficiency disorders.
6. analyze the interplay between the immune system and cancer, including the mechanisms of tumor immune evasion.
7. assess the therapeutic potential and challenges of immunotherapy in cancer management.
8. summarize the current understanding of Covid-19, including its epidemiology, clinical features, and therapeutic strategies.
9. utilize experimental techniques such as flow cytometry, cell sorting, and biochemical assays to investigate immune responses and signaling pathways.
10. design and execute experiments using whole animal models to study immunological processes and disease mechanisms.

Lectures per week (1 Lecture is 60 minutes)		**4**	
Total number of Hours in a Semester		**60**	
Credits		**4**	
Evaluation System	**Semester End Examination**	**2 Hours**	**50 marks**
	Internal Assessment	**--**	**50 marks**

UNIT I	**1.1**	**Introduction**	**15**

Immunodeficiency disorders		a. Primary immunodeficiency b. Secondary or acquired immunodeficiency	**hours**
	1.2	**Primary immunodeficiency** a. Lymphoid cell disorders. b. Defects in myeloid lineage	
	1.3	**Defects in the complement system**	
	1.4	**Treatment approaches for immunodeficiency.**	
	1.5	**Animal models of primary immunodeficiency.** a. Nude mice b. SCID mice c. CBA/ N mouse. d. Beige mouse.	
	1.6	**Secondary immunodeficiency and AIDS.** a. The AIDS epidemic. b. The HIV virus. c. HIV's mechanism of immunosuppression. d. Mechanisms of evasion used by HIV e. The course of HIV infection and AIDS. f. Treatment and prevention of AIDS	
UNIT II Cancer and Immune system	**2.1**	**Introduction.** a. Malignant transformation of cells. b. Oncogenes and cancer induction.	**15 hours**
	2.2	**Tumors of the immune system.** a. Tumor antigens. b. Tumor specific antigens. c. Tumor associated antigens	
	2.3	**Immune response to Tumors.** a. T cell mediated immunity.	

		b. NK- cell and macrophage- mediated immunity.	
	2.4	**Evasion of immune response by tumors**.	
	2.5	**Immunotherapy for cancer.** a. Stimulation of active immunity against tumors. b. Non- specific stimulation of the immune system. c. Passive immunotherapy for tumors. d. Adoptive cellular immunotherapy e. Humoral immunotherapy.	
UNIT III Covid-19- A Comprehensive Overview	**3.1**	**Introduction** a. Origins of COVID-19 and early outbreak in Wuhan, China. b. Timeline of major events and developments during the pandemic. c. Emergence and global impact of COVID-19. d. Characteristics of the SARS-CoV-2 virus	**15 hours**
	3.2	**Pathogenesis** a. Viral structure and replication b. Mechanisms of infection and disease progression c. Host immune response and cytokine storm	
	3.3	**Epidemiology** a. Global distribution and transmission patterns b. Risk factors and vulnerable populations c. Surveillance and outbreak management	
	3.4	**Treatment** a. Pharmacological interventions b. Supportive care and management strategies c. Emerging therapies and experimental treatments	
	3.5	**Statistics** a. Global and regional case counts b. Mortality rates and case fatality ratios c. Trends and projections	

	3.6	**Vaccines** a. Development and types of vaccines. b. Vaccination strategies and coverage. c. Efficacy and safety profiles. d. Challenges and vaccine hesitancy. e. Types of Vaccines Invented- i. mRNA Vaccines: 1. BNT162 vaccine by Pfizer and BioNTech 2. mRNA-1273 vaccine by Moderna ii. Viral Vector Vaccines: 1. AZD1222 by AstraZeneca and University of Oxford 2. Sputnik V by the Gamaleya Research Institute, Russia iii. Inactivated Vaccines: 1. CoronaVac by Sinovac 2. BBIBP-CorV by Sinopharm and Beijing Institute of Biological Products, China 3. COVID-19 vaccine by Sinopharm and the Wuhan Institute of Virology, China 4. Covaxin by Bharat Biotech and National Institute of Virology, India 5. Covishield by Serum Institute of India, based on the Oxford-AstraZeneca vaccine iv. Peptide Vaccine: 1. EpiVacCorona by Federal Budgetary Research Institution State Research Center of Virology and Biotechnology, Russia	
UNIT IV Experimental systems and methods-II	**4.1**	**Flow Cytometry.**	**15 hours**
	4.2	**Magnetic activated cell sorting.**	
	4.3	**Cell cycle analysis using -** a. Tritiated (^{3}H) thymidine. b. Colorimetric assays. c. Bromodeoxyuridine-based assays	

		d. Propidium iodine e. Carboxyfluorescein succinimidyl ester.	
	4.4	**Assays of cell death.** a. ^{51}Cr release assay. b. Fluorescently labeled annexin V measures phosphatidylserine on the outer lipid of apoptotic cells. c. The TUNEL assay. d. Caspase assays.	
	4.5	**Biochemical approaches used to elucidate signal transduction pathways.**	
	4.6	**Whole animal experimental systems** a. Federal Guidelines for Animal Research Protection b. Utilizing Inbred Strains to Minimize Experimental Variation c. Investigating Immune Response with Congenic Resistant Strains d. In Vivo Examination of Cell Populations through Adoptive Transfer Experiments e. Engineering Genes in Transgenic Animals f. Gene Modification through Knock-in and Knock-out Technologies g. Tissue-Specific Gene Deletion with the Cre/Lox System	

Programme: Sciences MICROBIOLOGY MSC-II	**Semester – IV**
Course Title: Pharmaceutical Microbiology	**Course Code: SMCB644E**

COURSE OBJECTIVES

1. Understand the basic principles of Quality assurance, Quality Control and GMP in the pharmaceutical industry.
2. Understand the design and structure of pharmaceutical premises, types of contamination and how to control the contamination
3. Learn the principles of personnel management, and personnel hygiene and health in the

pharmaceutical industry.
4. Understand the general principles of documentation in the pharmaceutical industry
5. Understand the importance of sterility in the pharmaceutical industry and methods of sterilization used in the manufacture of pharmaceutical products.
6. Learn Quality Assurance in manufacture of sterile products, clean rooms, changing rooms, sterility testing and pyrogen testing
7. Compare pharmaceutical products with cosmetics and learn antimicrobial preservation efficacy and microbial content testing

COURSE OUTCOMES

The learner will be able to:
1. explain the relationship between Quality assurance, Quality Control and GMP.
2. identify different types of contamination and outline the control measures
3. explain the design, layout and structure of pharmaceutical premises.
4. define the responsibilities of the key personnel involved in the pharmaceutical industry
5. recall the training elements and guidelines to maintain personal hygiene in the industry
6. recognize the importance of documentation in the pharmaceutical industry
7. list the pharmaceutical products that need to be sterile and categorize the different sterilization methods used for the sterilization of the pharmaceutical products
8. explain the quality assurance in the manufacture of sterile pharmaceutical products, functioning of clean rooms
9. explain sterility testing and its importance and apply these skills in testing the sterility of a pharmaceutical product.
10. distinguish between pharmaceutical and cosmetic products.

Lectures per week (1 Lecture is 60 minutes)		**2**	
Total number of Hours in a Semester		**30**	
Credits		**2**	
Evaluation System	**Semester End Examination**	**2 Hours**	**50 marks**
	Internal Assessment	**--**	**50 marks**

UNIT I **Main principles, premises and personnel**	**1.1**	**QA, GMP and QC** a. Quality assurance b. Good manufacturing practices for pharmaceutical products (GMP) c. Quality control and good practices in quality control d. Interrelationship between QA, QC and GMP	**15 hours**
	1.2	**Premises and contamination control** a. Requirements for a pharmaceutical production facility b. Siting and building considerations c. Functional aspects d. Contamination types and sources e. Control of contamination	
	1.3	**Premises: location, design, structure, layout, services, cleaning and disinfection**.	
	1.4	**Personnel** a. Key personnel, responsibilities of heads of the production and quality control departments, joint responsibilities, authorized person, job description b. Training- The need for training in QA and GMP, Costs and benefits of training, the major training elements (background training, GMP training and specific skills training) c. Hygiene and health- the need for personal hygiene, hygiene measures, Tentative guidelines on operator hygiene and health checks	
	1.5	**Documentation: general points**	
UNIT II **Sterility in pharmaceutical products**	**2.1**	**Sterile products: basic concepts and principles** a. Sterility and list of pharmaceutical products which need to be sterile b. Sterilization- fundamental concepts c. Summary/tabulation of all sterilization methods used for the sterilization of different pharmaceutical products	**15 hours**
	2.2	**Assurance of quality in the manufacture of sterile products**	

		a. Sterility assurance b. Clean rooms and clean room standards c. The sterile products manufacturing area or suite d. Changing rooms e. Air supply (Air quality monitoring, frequency of monitoring, standards for clean room monitoring tests) f. The sterile manufacturing area- construction, materials and finishes g. Clothing and changing, instructions to operators on entering and working in clean rooms h. In-process control of sterilization processes i. Sterility testing j. Leaks and leak testing k. Pyrogen or endotoxin testing	
	2.3	**Cosmetics** a. Difference between pharmaceuticals and cosmetics b. Antimicrobial preservation efficacy and microbial content testing (any one method)	

PRACTICAL **Course Title: Pharmaceutical Microbiology**	**Course Code: SMCB644EP**

COURSE OUTCOMES

The learner will be able to:

1. perform and analyze the minimum inhibitory concentration (MIC) of disinfectants such as Lizol and correlate with the efficacy of preservatives to ensure their compliance with pharmaceutical safety standards.
2. perform procedures related to Quality assurance and regulatory compliances of pharmaceutical products such as sterility testing, efficiency testing of HEPA filters in laminar airflow, and verify autoclave sterilization processes using biological indicators.
3. design Standard Operating Procedures (SOPs) based on established references that adhere to Good Manufacturing Practices (GMP).

4. perform and interpret microbial load testing in pharmaceutical and cosmetic products, evaluating results to ensure compliance with pharmacopeial guidelines and safety requirements.
5. evaluate adherence to Good Control Laboratory Practices (GCLP) procedures and prepare reports.
6. prepare reports to understand the significance of product recalls, self-inspection, audits and training in the pharmaceutical industry

Lectures per week (1 Lecture is 60 minutes)		**2**	
Total number of Hours in a Semester		**60**	
Credits		**2**	
Evaluation System	**Semester End Examination**	**2 Hours**	**50 marks**
	Internal Assessment	**--**	**50 marks**

	1	Determination of MIC of any disinfectant used for cleaning.	**30 hours**
	2	**Activity-** Write a detailed report on training in the pharmaceutical industry (The report should include the following: training elements, the overall learning process and factors influencing the learning process, training objectives, preparation, training room facilities, visual aids, trainers checklist, selection and training of trainers, GMP modules and GMP training course test papers). Students should solve the training test papers. Quality in the Manufacture of Medicines and other Healthcare products by John Sharp is a compulsory reference. At least two more references have to be used.	
	3	**Activity-** a. Critically read Standard Operating Procedures (SOPs) from Quality in the Manufacture of Medicines and other healthcare products , John Sharp and b. Write a SOP on your own on any basic microbiological/analytical process like steam sterilization, UV spectrophotometric analysis etc.	
	4	Monitoring the air quality of a laminar airflow and checking the efficiency	

		of the HEPA filter	
	5	Monitoring of the sterilization process (autoclave) using a biological indicator	
	6	Sterility testing of a pharmaceutical product and reporting (as per Pharmacopoeia).	
	7	Write a detailed report on Good Control Laboratory practice and sampling of starting materials in the pharmaceutical industry: European, US and WHO guidelines.	
	8	Write a short report on product recalls and self-inspection and audits in the pharmaceutical industry	
	9	Determination of Microbial load in cosmetic products.	
	10	Efficacy testing of preservatives.	

Programme: Sciences MICROBIOLOGY MSC-II	**Semester – I**
Course Title: Research Project	**Course Code: SMCB642RP**

COURSE OUTCOMES

The learner will be able to:

1. carry out a research project
2. analyze and interpret results in the light of experimental findings
3. correlate the experimental outcomes with available literature
4. compile a comprehensive report to communicate the research study

Hours per week	**12**
Total number of Hours in a Semester	**180**

SOPHIA COLLEGE FOR WOMEN (AUTONOMOUS)

Credits		6	
Evaluation System	Semester End Examination	–	50 marks
	Internal Assessment	--	50 marks

ASSESSMENT DETAILS:

There will be two subheads, namely, Summative Assessment (SA) and Continuous Assessment (CA) of 50 marks each.

1. Mandatory, elective and practical will have **separate heads of passing**.
2. A student needs to secure 40% marks for passing individually in SA and CA.
3. There is no CA for practical.
4. If a student fails, he/she will have to appear for an ATKT examination.
5. Students who have missed the SA for a genuine reason (supported with a document subject to approval by the authorities) will appear for an **Additional SA of 50 marks**. This Additional/ATKT SA will be held after the declaration of the respective semester results and at the discretion of the exam committee.
6. Students will be declared UNSUCCESSFUL, if they score less than 20 marks on 50 marks.
7. Staff will show assessed theory answer papers of SA to students and discuss the rubric of assessment with the students on a day fixed by the PG Exam Committee.
8. There is no reassessment of practical papers.
9. Grievance Redressal Mechanism for addressing grievances related to SA:

Students may apply for Reassessment, Photocopying and Revaluation of the SA answer books after the declaration of results in response to the notice posted by the College Office for the same.

10. Students with learning disability (LD) will be given extra time for SA as per University rules.

B. Continuous Assessment (CA) for Mandatory Courses:

1. CA activities will be planned and conducted by the respective departments.

The departments are required to share the details of the CA activities with the Deputy Controller of PG exam and PG Co-ordinator (VP- Science).

2. Students' CA activity-related scores with assessed papers and feedback on their work (tests, other activities, assignments etc.) must be shared with students.
3. Format of CA: Two CA activities of 25 marks each.

CA 1: Test - 25 marks (Duration for answering the Test: Max. 60 Minutes)

CA 2: Any Activity - 25 marks

5. The minimum score to pass the Course will be 20 marks out of 50 marks.

6. If a student fails to pass (scores less than 20) then, the student will have to appear for 50 marks ATKT - **one IA** Test of 25 marks and **one assignment** of 25 Marks.

C. Continuous Assessment (CA) for Elective Courses:

1. CA activities will be planned and conducted by the respective departments.

The departments are required to share the details of the CA activities with the Deputy Controller of PG exam and PG Co-ordinator (VP- Science).

Format of CA: Two CAs of 25 marks each.

2. DSE - CA score must not be shared with the students (Duration for answering the Test: Max. 60 Minutes)

3. **CA 1: Test - 25 marks subjective type**

CA 2: Test - 25 marks subjective type

4. The minimum score to pass the Course will be 20 marks out of 50 marks.

5. If a student fails to pass (scores less than 20) then, student will have to appear for 50 marks ATKT - **Two IA** Test of 25 marks each (**Subjective type)**

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D. Evaluation for Common Courses- Research Methodology under NEP:

1. **Only CA is to be conducted for 50 marks**.

CA 1: Test - 25 marks (Duration for answering the Test: Max. 60 Minutes)

CA 2: Any Activity - 25 marks

2. If a student fails to pass (scores less than 20) then, the student will have to appear for 50 marks ATKT-**one IA** Test of 25 marks and **one assignment** of 25 Marks.

3. The minimum score to pass the Course will be 20 marks out of 50 marks.

4. Students' CA activity-related scores with assessed papers and feedback (tests, other activities, assignments etc.) will be shared individually with students.

5. Grievance Redressal Mechanism for addressing grievances related to CAS:

Students will apply in a prescribed format to the respective Vice Principals. The grievance will be addressed by involving the concerned faculty and the other Exam Committee member/s deputed by the Principal.

E. Evaluation for Common Courses-Research Project (RP) under NEP:

1. Continuous assessment of **50 marks** by the mentor.

2. Summative assessment of **50 marks** by the external examiner.

3. The evaluation pattern decided by the PG examination committee will be followed by all the departments.

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Additional Reading

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Mandatory 2 - SMCB648MJ Medical Microbiology and Immunology-II

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Additional reading

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