SOPHIA COLLEGE FOR WOMEN (EMPOWERED AUTONOMOUS)

Affiliated to the University of Mumbai

Programme: Sciences

Microbiology (Minor)

S.Y.B.Sc. MICROBIOLOGY

Syllabus for the Academic Year 2025-2026 based on the National Education Policy 2020

SOPHIA COLLEGE FOR WOMEN (EMPOWERED AUTONOMOUS)

DEPARTMENT OF MICROBIOLOGY

COURSE DETAILS:

	SEMESTER 3		SEMESTER 4
TITLE	**Minor 3** **Introduction to Microbial Genetics, Bioinformatics and Biotechnology**		**Minor 4** **Microbial Diversity in Extreme Environments**
TYPE OF COURSE - DSC	**MINOR**		**MINOR**
CREDITS	**4** **(2 theory + 2 practical)**		**4** **(2 theory + 2 practical)**

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Preamble:

The department of Microbiology at Sophia College was founded in 1966. Microbiology is the study of life and tentative life forms that cannot be viewed by the unaided eye. The microscopic life encompasses bacteria, protozoa, algae, fungi, and viruses. These organisms impact many aspects of plant, animal and human life and progress.

The Undergraduate curriculum provides fundamental and applied aspects of Microbial life that impacts the rest of the biosphere.

The instructions methodology focuses on providing the fundamental basic information on Microbiology and progressing to the advances. Furthermore, there is emphasis on developing critical and analytical thinking and reasoning skills through problem solving in keeping with the changing times. The courses provide training in Genetics, Biochemistry, Medical Microbiology, Immunology, Bioprocess technology, Food Science and Environmental Science. This interdisciplinary approach helps learners meet the requirements of higher education, research, and industry.

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PROGRAMME OBJECTIVES

PO 1	To introduce the learners to Basic and Applied Microbiology.
PO 2	To build a strong knowledge base in the learner as well as impart sound practical skills in the subject.
PO 3	To provide opportunities for logical thinking, and critical reasoning, such that the learners can handle the demands of higher education, industry and research.
PO 4	To impart soft skills in learners thereby enhancing employability.

PROGRAMME SPECIFIC OUTCOMES

PSO 1	The learners will gain and apply knowledge of Genetics, Virology, Microbial Biochemistry, Medical Microbiology, Immunology, Cell Biology, Bioprocess technology, Environmental Microbiology, Food and Dairy Microbiology, etc to solve problems.
PSO 2	The learners will acquire basic knowledge about scientific methodology, plan and execute experiments using good laboratory practices, and interpret the experimental results effectively.
PSO 3	The students will undertake research projects, internships, visit industries, in order to become ready for higher studies, industry and research.
PSO 4	The students will do value added courses in order to enhance their soft skills and employability.

SOPHIA COLLEGE FOR WOMEN (EMPOWERED AUTONOMOUS)

Programme: Science Microbiology Minor	**Semester – 3**
Course Title: Introduction to Microbial Genetics, Bioinformatics and Biotechnology	**Course Code: SMCB233MN**

COURSE OBJECTIVES:

It aims to:

1. understand the molecular basis of genetic material, DNA and RNA, and the central dogma of molecular biology.
2. analyze the organization of genetic material in prokaryotes and the molecular mechanisms involved in DNA replication.
3. explore bioinformatics tools and applications in genomics and related OMICS technologies
4. introduce the industrial and environmental applications of microbes and recombinant DNA technology.

COURSE OUTCOMES:

At the end of the course, the learner will be able to

1. recall the characteristics of DNA and RNA and the experiments that demonstrated DNA as the genetic material.
2. demonstrate an understanding of bioinformatics and in modern biology, utilizing databases like NCBI, major OMICS technologies and evaluating the application of pharmacogenomics in personalized medicine.
3. demonstrate foundational knowledge of industrial microbial products and its environmental applications in bioremediation, bioenergy and biotechnological production of recombinant insulin.

Theory Lectures per week (1 Lecture is 60 minutes)		**2**	
Total number of Hours in a Semester		**30**	
Credits		**2**	
Evaluation System	**Summative Examination**	**1 hour**	**30 marks**
	Continuous Assessment	**--**	**20 marks**

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UNIT 1 Genetics and Bioinformatics (1 Credit)	1.1	Introduction - Chemical structure of DNA, Organization of prokaryotic chromosome, Nucleoid, plasmids and Transposable elements, Central dogma of molecular biology	**15 Hours**
	1.2	DNA as genetic material - Griffith's experiment, Avery-MacLeod-McCarty experiment and Hershey and Chase experiment	
	1.3	DNA replication a. Mode of replication-semi conservative and bidirectional with evidence b. Enzymes required for replication c. Events at replication fork d. Termination of replication	
	1.4	RNA a. Structure of RNA and types - mRNA, rRNA, tRNA b. RNA as genetic material of viruses- with examples	
	1.5	Introduction to Bioinformatics a. Definition b. OMICS - Genomics, Transcriptomics, Proteomics and Metabolomics c. Pharmacogenomics - variation in responses to drugs d. Databases – Nucleotide - NCBI	
UNIT 2 Microbial Biotechnology (1 credit)	2.1	Industrially important microbial products - a. Antibiotics - Examples of antibiotic producing bacteria b. Vitamins and amino acids c. Enzymes and extremoenzymes with applications	**15 Hours**
	2.2	Alcoholic beverages a. Wine varieties b. Commercial Wine production c. Home brewing	
	2.3	Bioremediation a. Definition and scope of bioremediation b. Bioremediation vs. conventional remediation methods (e.g., incineration, chemical treatment) c. Bioaugmentation and Biostimulation	
	2.4	Bioenergy a. Biofuels b. Generations of Biofuels - examples advantage and disadvantages c. Bioethanol production using corn starch - Flowchart d. Microbial Fuel Cells – Principle	
	2.5	a. Products from genetically engineered microorganism examples b. Recombinant Insulin production	

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PRACTICAL **Course Title: Introduction to Microbial Genetics, Bioinformatics and Biotechnology Practical**	**Course Code: SMCB233MNP**

COURSE OUTCOMES:

At the end of the course, learner will be able to

1. perform nucleic acid extraction and quantification techniques and analyze results to assess the quality and concentration of DNA and RNA.
2. isolate industrially relevant microbes capable of producing antibiotics, amino acids, and enzymes, and design appropriate culture strategies for optimized production.
3. demonstrate understanding of microbial fermentation and biodegradation processes by explaining wine-making steps and evaluating microbial degradation of phenol.
4. use bioinformatics databases such as NCBI to retrieve and analyze nucleotide sequences relevant to microbiological research.
5. effectively communicate molecular biology concepts, such as bacterial transcription and translation, through student-led presentations.

Lectures per week (1 Lecture is 120 minutes)		**2**	
Total number of Hours in a Semester		**60**	
Credits		**2**	
Evaluation System	**Summative Examination**	**3 hours**	**50 marks**
	Continuous Assessment	**--**	

	1	Extraction of genomic DNA from *E. coli*	60 hours
	2	Agarose gel electrophoresis (Demonstration)	
	3	Qualitative detection and Quantitative estimation of DNA	
	4	Qualitative detection and Quantitative estimation of RNA	
	5	Wine making	
	6	Degradation and estimation of Phenol	
	7	Isolation of antibiotic producers	
	8	Isolation of amino acids producers	
	9	Isolation of amylase, protease and lipase producers	
	10	Bioinformatics practicals a. Browsing through NCBI b. Retrieval of a nucleotide sequence from NCBI database	
	11	Student activity- student presentations on Bacterial Transcription and Translation	
	12	Student activity- assignment on Microbial Fuel Cells- Principle and applications (two page report)	

ASSESSMENT DETAILS:

1. Continuous Assessment (CA): Any one activity / assignment / test of 20 marks
2. Summative Assessment (SA): Theory exam of 30 marks – One hour duration
3. Practical exam of 50 marks – Three hours duration

REFERENCES:

SMCB233MN Introduction to Microbial Genetics, Bioinformatics and Biotechnology

1. Madigan, M. T., Martinko, J. M., Dunlap, P. V., Clark, D. P. (2005). Brock Biology of Microorganisms 11th edn, *Benjamin Cummings*
2. Russell, P. J. (2010). iGenetics: A Molecular Approach, 3rd edn. *Pearson.*
3. Rehm, H.-J., & Reed, G. (Eds.). (2000). *Biotechnology: A multi-volume comprehensive treatise (2nd ed., Vol. 11b). Environmental processes II*. Wiley-VCH.
4. Thakur, I. S. (2011). *Environmental biotechnology: Basic concepts and applications* (2nd ed.). I.K. International Publishing House.
5. Weaver, R. F. (2012). Molecular Biology, 5th edn. *McGraw-Hill.*
6. Willey, J. M. & Woolverton, C. J. (2008). Prescott, Harley & Klein's Microbiology 9th edn. Singapore: McGraw Hill International edition.

SOPHIA COLLEGE FOR WOMEN (EMPOWERED AUTONOMOUS)

Programme: Science Microbiology Minor	**Semester – 4**
Course Title: Microbial Diversity in Extreme Environments	**Course Code: SMCB244MN**

COURSE OBJECTIVES:

It aims to:

1. provide a glimpse of the general characteristics of Rickettsia, Chlamydia, Actinomycetes, Archaea and understand their significance.
2. understanding of lower eukaryotic microorganisms—including algae (*Chlamydomonas*), slime molds, yeasts (*Saccharomyces cerevisiae*), and molds (*Rhizopus*)
3. facilitate the identification and knowledge of the characteristics of extremophiles found in various extreme environments.
4. equip students with analytical skills related to the molecular adaptations of extremophiles and their potential applications in biotechnology

COURSE OUTCOMES:

At the end of the course, the learner will be able to

1. describe the characteristics and significance of Rickettsia, Chlamydia, Actinomyces and Archaea
2. identify and describe the morphological and reproductive characteristics of algae, slime molds, yeasts, and molds, and explain their ecological and industrial importance.
3. identify and describe the characteristics of extremophiles found in different extreme environments, including temperature-based, pH-based, and high salt concentration environments.
4. discuss the molecular adaptations of extremophiles and explore their potential applications in various fields such as biotechnology and environmental science

Theory Lectures per week (1 Lecture is 60 minutes)		**2**	
Total number of Hours in a Semester		**30**	
Credits		**2**	
Evaluation System	**Summative Examination**	**1 hour**	**30 marks**
	Continuous Assessment	**--**	**20 marks**

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UNIT 1 Exploring Microbiology (1 Credit)	1.1	a. Introduction to Archaea b. Actinomycetes: General characteristics and Significance.	**15 Hours**
	1.2	Morphological characteristics, Life Cycle, Cultivation, and Significance of: a. Yeast and Molds (*Saccharomyces cerevisiae* and *Rhizopus*) b. Algae (*Chlamydomonas*) c. Slime Molds and Myxomycetes	
	1.3	Viruses: a. Historical highlights, general properties of viruses b. Structure of viruses-capsids, envelopes and genomes. c. Overview of cultivation of viruses. d. Bacteriophages: Lytic cycle, Lysogeny, Structure and Life cycle of T4 phage and lambda phage	
UNIT 2 Extreme Environment (1 credit)	2.1	Microorganisms and environment Ecosystem services and the role played by microorganisms in ecosystems.	**15 Hours**
	2.2	Extremophiles a. Characteristics and examples of the following extreme environments: Temperature based environments- Low and high temperature environments, pH-based environments- Acidic and Alkaline environments, Environments with high salt concentration. b. Morphology, physiology and cultural characteristics of thermophiles, psychrophiles, acidophiles, alkaliphiles and halophiles. c. Molecular adaptations and applications of thermophiles, psychrophiles, acidophiles, alkaliphiles and halophiles.	

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PRACTICAL **Course Title: Microbial Diversity in Extreme Environments Practical**	**Course Code: SMCB244MNP**

COURSE OUTCOMES:

At the end of the course, learner will be able to

1. enrich, isolate, and identify thermophilic and halophilic bacteria, and assess their production of thermostable enzymes such as amylase, protease, lipase, and cellulase.
2. differentiate between a research paper and a review article and critically analyze scientific literature, with a focus on review articles related to extremophiles.
3. isolate, cultivate, and microscopically identify fungi and algae from diverse natural sources using standard microbiological techniques.
4. compare and contrast the key characteristics of algae, protozoa, and fungi through tabulation, demonstrating an understanding of their similarities and differences

Lectures per week (1 Lecture is 120 minutes)		**2**	
Total number of Hours in a Semester		**60**	
Credits		**2**	
Evaluation System	**Summative Examination**	**3 hours**	**50 marks**
	Continuous Assessment	**--**	

	1	Enrichment and isolation of thermophilic bacteria	60 hours
	2	Enrichment and isolation of halophilic bacteria	
	3	Detection of thermostable amylase and protease	
	4	Assignment/Activity- a. To understand the difference between a research paper and a review article b. To search and understand a review article on any extremophile. There will be compulsory questions on this activity in the quiz and the viva.	
	5	Isolation of fungi from air, soil, and decaying/ spoiled materials and microscopic observations of fungal morphology	
	6	Cultivation and microscopy examination of algae from freshwater and marine water samples	
	7	Assignment: Characteristics indicating similarities and differences amongst algae, protozoa and fungi (Tabulation)	
	8	Student activity: Isolation of Psychrophiles from frozen food	

ASSESSMENT DETAILS:

1. Continuous Assessment (CA): Any one activity / assignment / test of 20 marks
2. Summative Assessment (SA): Theory exam of 30 marks – One hour duration
3. Practical exam of 50 marks – Three hours duration

REFERENCES:

SMCB244MN Microbial diversity in extreme environments

1. Willey, J. M. & Woolverton, C. J. (2008). Prescott, Harley & Klein's Microbiology 9th edn. Singapore: McGraw Hill International edition.
2. Pelczar Jr, M. J.; Chan, E.C.S. & Krieg, N. R. (1986). Microbiology 5th edn. New York: Tata McGraw-Hill Education Pvt. Ltd
3. Maier R. M., Pepper I. L. & Gerba C. P., (2010) Environmental Microbiology 2nd edn, *Academic Press, California*