SOPHIA COLLEGE FOR WOMEN (EMPOWERED AUTONOMOUS)

Affiliated to the University of Mumbai

Programme: Science

Microbiology

T.Y.B.Sc. MICROBIOLOGY (Major)

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 FOR MAJOR:

	SEMESTER 5				SEMESTER 6		
TITLE	**Major 7 Genetics**	**Major 8 Microbial Biochemistry- I**	**Major 9 Bioprocess technology- I**		**Major 10 rDNA Technology, Bioinformatics and Virology**	**Major 11 Microbial Biochemistry- II**	**Major 12 Bioprocess technology- II**
TYPE OF COURSE	**DSC**	**DSC**	**DSC**		**DSC**	**DSC**	**DSC**
CREDITS	**4 (3 theory + 1 practical)**	**4 (3 theory + 1 practical)**	**4 (3 theory + 1 practical)**		**4 (3 theory + 1 practical)**	**4 (3 theory + 1 practical)**	**4 (3 theory + 1 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. 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.

SOPHIA COLLEGE FOR WOMEN (EMPOWERED AUTONOMOUS)

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: Sciences **Microbiology Major**	**Semester – 5**
Course Title: Genetics	**Course Code: SMCB357MJ**

COURSE OBJECTIVES:

It aims to

1. explain the molecular details of DNA replication in prokaryotes and eukaryotes.
2. introduce the different types of mutations, mechanism of action of physical, chemical and biological mutagens and detection of mutants.
3. describe the molecular mechanisms of DNA repair processes in prokaryotes.
4. understand classical genetics by learning about model systems, extra chromosomal genetic elements, basics of recombination in bacteria and applications of targeted recombination in gene editing.
5. understand the process of horizontal gene transfer mechanisms in bacteria and analytical skills in solving problems on gene mapping.

COURSE OUTCOMES:

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

1. explain the mechanisms of DNA replication in prokaryotes along with the roles of key enzymes and proteins, the different models of replication based on historical experimental evidence and the types and mechanisms of mutations that can arise during and post the replication process.
2. understand the differences between prokaryotic and eukaryotic DNA replication, the DNA repair mechanisms and analyse the structural and functional significance of transposable elements, plasmids, and integrons in prokaryotic genomes and their implications in antibiotic resistance.
3. analyse the use of bacterial gene transfer mechanisms for applications in gene mapping and the classical and modern genome editing tools.

Theory Lectures per week (1 Lecture is 60 minutes)		**3**	
Total number of Hours in a Semester		**45**	
Credits		**3**	
Evaluation System	**Summative Examination**	**2 Hour**	**50 marks**
	Continuous Assessment	**--**	**50 marks**

UNIT 1 Bacterial DNA replication and damage (1 Credit)	1.1	a. Models of DNA replication (Conservative, dispersive, semi-conservative) b. Meselson-Stahl experiment	**15 Hours**
	1.2	Proteins and enzymes involved in prokaryotic DNA replication (discovery, types, properties, functions and mechanisms of action) a. DNA polymerases b. DNA gyrase and a. DNA ligase	
	1.3	Prokaryotic DNA replication process/ steps a. Initiation b. Elongation (Okazaki's experiment) c. Termination of replication	
	1.4	Mutations a. Types of mutations - Point mutation, Base pair substitution-Transition and Transversion, Missense mutation, Nonsense mutation, Silent mutation, Neutral mutation, Frameshift mutation b. Forward mutation, Reverse mutation (Reversion), Suppressor mutation-intragenic and intergenic. c. Spontaneous mutations - DNA replication errors, Spontaneous chemical changes- Depurination and Deamination d. Induced mutations - i. Physical mutagens – Radiation ii. Chemical mutagens- - Base analogs- 5-bromouracil and 2-aminopurine - Alkylating agents- Mode of action of EMS (MMS and nitrosoguanidine only as examples) iii. Intercalating agents- definition and examples iv. Biological mutagens e. Ames test f. Detection of mutants - Replica plate technique -auxotrophic and antibiotics resistant mutants	
UNIT 2 DNA repair, Extrachromosomal genetics and model systems	2.1	Molecular details of eukaryotic replication a. ORC b. Licensing factors c. Eukaryotic DNA polymerases d. Replicating the ends of the chromosomes- Mechanism of telomerase action e. Comparison of prokaryotic and eukaryotic DNA replication	**15 Hours**

(1 Credit)	2.2	DNA Repair a. Light repair or photoreactivation b. Repair of alkylation damage c. Base excision repair d. Nucleotide excision repair e. Methyl-directed mismatch repair f. SOS repair	
	2.3	Plasmids a. Physical nature b. Detection and isolation of plasmids c. Plasmid incompatibility and Plasmid curing d. Cell to cell transfer of plasmids e. Types of plasmids i. F plasmids ii. Resistance Plasmids iii. Plasmids encoding toxins and other virulence characteristics iv. Col factor v. Degradative plasmids	
	2.4	Transposable Elements in Prokaryotes a. Insertion sequences b. Transposons i. Types ii. Structure and properties iii. Mechanism of transposition iv. Transposon mutagenesis c. Integrons- Structure and significance	
	2.5	Model systems in the study of genetics a. Characteristics of a model organism b. Examples of model organisms used in study (*E. coli, S. cerevisiae, A. thaliana, C. elegans, D. melanogaster, and M. musculus*) c. Examples of studies undertaken using model organisms	
UNIT 3 Recombination and horizontal gene transfer in bacteria (1 Credit)	3.1	Recombination in bacteria a. General/Homologous recombination- Holliday model of recombination b. Site –specific recombination	**15 Hours**
	3.2	Genome editing Principles of Gene editing technologies - a. Homologous recombination b. Zinc-finger nucleases (ZFNs)	

		c. Transcription activator-like effector nucleases (TALENs) d. Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR)	
	3.3	Genetic analysis of bacteria	
	3.4	Gene transfer mechanisms in bacteria a. Transformation - Introduction and History, Types of transformation in prokaryotes—Natural transformation in *Streptococcus pneumoniae, Haemophilus influenzae,* and *Bacillus subtilis,* Mapping of bacterial genes using transformation, Problems based on transformation. b. Conjugation - Discovery of conjugation in bacteria, Properties of F plasmid/Sex factor, the conjugation machinery, Hfr strains, their formation and mechanism of conjugation, F' factor, origin and behaviour of F' strains, Sexduction, Mapping of bacterial genes using conjugation (Wolman and Jacob experiment), Problems based on conjugation c. Transduction - Introduction and discovery, Generalised transduction, Use of Generalised transduction for mapping genes, Specialised transduction, Problems based on transduction	

SOPHIA COLLEGE FOR WOMEN (EMPOWERED AUTONOMOUS)

PRACTICAL **Course Title: Genetics Practicals**	**Course Code: SMCB357MJP**

COURSE OUTCOMES:

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

1. explain the historical and scientific contributions of key researchers in the discovery of DNA replication mechanisms, including associated proteins and enzymes.
2. analyze the reduction in bacterial population after exposure to UV, plot bacterial survival curve and determine UV exposure time that result in a 90% reduction in bacterial survival.
3. evaluate UV-induced DNA repair mechanisms in bacteria based on primary data obtained using experimental design to determine the number of survivors.
4. design and conduct mutant isolation and characterization experiments using UV mutagenesis and the replica plate technique.
5. interpret the quality of plasmid DNA after extraction using agarose gel electrophoresis.

Lectures per week (1 Lecture is 120 minutes)		**1**	
Total number of Hours in a Semester		**30**	
Credits		**1**	
Evaluation System	**Summative Examination**	**2 Hours**	**50 marks**
	Continuous Assessment	**--**	

	1	**Student activity- Assignment** - Scientists who discovered facts / mechanisms / proteins and enzymes of DNA replication- report	**30 hours**
	2	Study of UV survival curve- a. UV mutagenesis b. Enumeration of survivors after UV exposure c. Plotting of UV survival curve and determination of exposure time leading to 90% reduction	
	3	Study of UV induced DNA repair mechanisms in bacteria- a. Light repair b. Dark repair	
	4	Isolation of antibiotic resistant mutants using UV mutagenesis- 1. Determination of MIC of the antibiotic 2. UV mutagenesis 3. Isolation of mutants by spread plate technique	
	5	Replica plate technique for selection and characterization of mutants- a. Auxotrophs b. Antibiotic resistant mutants.	
	6	Isolation and quantification of plasmid DNA	
	7	Detection of plasmid DNA by agarose gel electrophoresis.	
	8	**Student activity- Assignment-** Applications of Gene editing- case study and report	

SOPHIA COLLEGE FOR WOMEN (EMPOWERED AUTONOMOUS)

Programme: Sciences Microbiology Major	Semester – 5
Course Title: Microbial Biochemistry- I	**Course Code: SMCB358MJ**

COURSE OBJECTIVES:

It aims to

1. introduce the basic concepts of metabolism in microorganisms and identify major catabolic pathways for carbohydrate breakdown.
2. outline the fermentative breakdown of sugars to produce different end products.
3. evaluate the role of electron transport chains in prokaryotes and understand the mechanism of ATP synthesis.
4. explore the degradation and catabolic pathways for lipids and fatty acids.
5. understand the metabolic fate of amino acids and how they contribute to energy production.
6. describe the breakdown pathways of purine and pyrimidine nucleotides and their physiological relevance.

COURSE OUTCOMES:

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

1. compare various pathways of carbohydrate metabolism (e.g., EMP, ED, HMP, TCA, fermentation), their energetics and recognize their amphibolic roles.
2. recall the key enzymes, intermediates, and end products involved in the fermentative pathways of lactic acid bacteria and yeast.
3. recognise components of the electron transport chains and explain the mechanisms of ATP synthesis in prokaryotes and assess the impact of inhibitors on energy production.
4. construct flow charts illustrating catabolic routes of fatty acid breakdown in a stepwise manner.
5. apply knowledge of catabolic processes such as transamination, deamination to predict the fate of amino acids.
6. illustrate the catabolic pathways of purine and pyrimidine nucleotides and associate them with physiological disorders.

Theory Lectures per week (1 Lecture is 60 minutes)		**3**	
Total number of Hours in a Semester		**45**	
Credits		**3**	
Evaluation System	**Summative Examination**	**2 Hour**	**50 marks**
	Continuous Assessment	**--**	**50 marks**

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UNIT 1 Catabolism of carbohydrates in Chemoorganotrophs (1 Credit)	1.1	Introduction to diversity in Microbial Metabolism Basic bioenergetics and Enzyme catalysis	**15 Hours**
	1.2	Catabolism of Carbohydrates a. Utilization of monosaccharides (pathways with structure and enzymes) i. Glycolysis (EMP) ii. HMP Pathway iii. ED pathway iv. TCA cycle v. Anaplerotic reactions vi. Glyoxylate bypass b. Breakdown of oligosaccharides and polysaccharides c. Energetics of Glycolysis, TCA and ED pathway	
	1.3	Fermentative pathways (with structures and enzymes) a. Lactic acid fermentation i. Homofermentation ii. Heterofermentation: Bifidum pathway b. Alcohol fermentation Overview of other modes of fermentation in microorganisms	
UNIT 2 Electron Transport chain and ATP synthesis (1 Credit)	2.1	Biochemical mechanism of generating ATP- Substrate-Level-Phosphorylation, Oxidative Phosphorylation & Photophosphorylation	**15 Hours**
	2.2	Electron transport chain a. Universal Electron acceptors that transfer electrons to ETC. b. Carriers in ETC i. Hydrogen carriers – Flavoproteins, Quinones ii. Electron carriers – Iron Sulphur proteins, Cytochromes Prokaryotic ETC a. Organization of electron carriers in bacteria b. Generalized electron transport pathway in bacteria c. Different terminal oxidases d. Pattern of electron flow in *E. coli* - aerobic and anaerobic	
	2.3	ATP synthesis a. Explanation of terms – Proton motive force, Proton pump, Coupling sites, P:O ratio, Redox potential (definition of Standard reduction potential) b. Free energy released during electron transfer from NADH to O2 c. Structure of bacterial ATP synthase- Rotational catalysis d. Inhibitors of ETC and OP	

		e. ATP hydrolysis in anaerobes for generation of electrochemical energy	
UNIT 3 Catabolism of fatty acids and nitrogenous compounds in Chemoorganotrophs (1 Credit)	3.1	Lipids –Definition, classification & functions Action of lipases on triglycerides /tripalmitate Catabolism of Fatty Acids and PHB a. Oxidation of saturated fatty acid by β oxidation pathway b. Energetics of β oxidation of Palmitic acid	**15 Hours**
	3.2	Catabolism of Nucleotides a. Degradation of purine nucleotides up to uric acid formation b. Salvage pathway for purine and pyrimidine nucleotides	
	3.3	Protein / amino acid catabolism a. Enzymatic degradation of proteins b. General reactions of amino acids catalyzed by i. decarboxylases ii. deaminases iii. transaminases iv. racemases c. Metabolic fate of amino acids - Glucogenic and ketogenic amino acids d. Fermentation of pair of amino acids -Stickland reaction (include enzymes)	

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PRACTICAL Course Title: Microbial Biochemistry- I Practicals	Course Code: SMCB358MJP

COURSE OUTCOMES:

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

1. assess microbial utilization of glucose under aerobic and anaerobic conditions using OF- tests.
2. perform glucose estimation using glucose oxidase-peroxidase reaction
3. demonstrate lactic acid production and differentiate lactic acid bacteria types based on fermentation end products.
4. detect decarboxylase activity and deaminase activity in microbes to study amino acid degradation
5. quantify total protein in biological samples using the Lowry's assay
6. detect and measure proteolytic enzyme activity in microbial cultures
7. identify lipolytic bacteria by qualitative detection of lipase activity
8. conduct assays to measure uric acid levels and understand conditions that lead to higher levels in blood
9. measure activity of redox enzymes like succinate dehydrogenase and understand their function in the mitochondrial electron transport chain.

Lectures per week (1 Lecture is 120 minutes)		**1**	
Total number of Hours in a Semester		**30**	
Credits		**1**	
Evaluation System	**Summative Examination**	**2 Hours**	**50 marks**
	Continuous Assessment	**--**	

	1	Study of oxidative and fermentative utilization of Glucose	**30 hours**
	2	Glucose detection by GOD/POD.	
	3	Isolation of lactic acid bacteria and screening of Homo-Heterofermentative lactic acid bacteria.	
	4	Study of breakdown of amino acids- Lysine decarboxylase activity Phenylalanine deaminase test	
	5	Protein estimation by Lowry's method.	
	6	Qualitative and Quantitative assay of protease	
	7	Qualitative detection of lipase	
	8	Estimation of uric acid	
	9	Oxidoreductase assay/Succinate dehydrogenase activity	

SOPHIA COLLEGE FOR WOMEN (EMPOWERED AUTONOMOUS)

Programme: Sciences Microbiology Major	Semester – 5
Course Title: Bioprocess Technology- I	**Course Code: SMCB359MJ**

COURSE OBJECTIVES:

It aims to

1. outline the basics of Bioprocess technology
2. describe the basic functions of a fermenter and its parts
3. recognize the significance of aseptic operation and containment.
4. explain the basic principles of sterilization, and methods of batch and continuous sterilization of media
5. discuss the principles of filter sterilization, including sterilization of air and exhaust gas.
6. summarize the concept/process of inoculum preparation and monitoring and control of various parameters in a fermentation.
7. describe different methods employed in recovery and purification of industrial products (downstream processing)
8. explain the treatment of industrial effluent - aerobic breakdown of waste, activated sludge and trickling filter and treatment of sludge
9. explore and analyze modern methods of traditional industrial fermentations and compare it with traditional indian fermentations (Indian Knowledge systems)

COURSE OUTCOMES:

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

1. explain the basics of Bioprocess technology, describe the design of fermenters and its process parameters, recall the importance of aseptic conditions and containment during the fermentation, explain methods of heat and filter sterilization, and summarize the process of inoculum preparation and monitoring and control of various parameters.
2. explain and compare the various processes used in the recovery and purification of industrial products and effluent treatment
3. connect upstream processing with downstream processing
4. summarize and analyze various modern traditional industrial fermentations and compare them with the ancient indian fermentations.

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Theory Lectures per week (1 Lecture is 60 minutes)		**3**	
Total number of Hours in a Semester		**45**	
Credits		**3**	
Evaluation System	**Summative Examination**	**2 Hour**	**50 marks**
	Continuous Assessment	**--**	**50 marks**

UNIT 1 Fermenter Design, Fermentation process considerations and Operations (1 Credit)	1.1	Introduction to Bioprocess technology	**15 Hours**
	1.2	Fermentation Equipments a. Fermenter and its basic functions b. Parts of the mechanically agitated fermenter i. Agitators - disc turbine, vaned disc, variable pitch open turbine, marine propeller, modern agitators ii. Stirrer glands - Stuffing box, mechanical seal, magnetic drives iii. Baffles iv. Aeration system (Sparger) - Porous sparger, Orifice sparger, Nozzle sparger v. Valves - Introduction, Significance, types of valves - Globe valve, Piston valve, Needle valve, Ball valve, Pinch valve, check valves, pressure control valves, safety valves c. Fermenter Body construction - Construction materials used d. Scale of operation - Laboratory, Pilot-scale and Production level	
	1.3	Fermentation process considerations a. Maintenance and Achievement of aseptic conditions and containment during the process, containment guidelines b. Sterilization i. Introduction. ii. Media sterilization - Concept of Del factor, Design of batch sterilization processes, Methods of batch sterilization - industrial cooker, advantages and disadvantages, Design of continuous sterilization processes- Indirect Spiral heat exchangers and Direct steam injector c. Filter sterilization i. Mechanisms ii. Fixed-pore and non-fixed pore filters iii. Filter sterilization of inlet air iv. Sterilization of fermenter exhaust air	

	1.4	Fermentation process operations a. Inoculum preparation b. Monitoring and control- introduction, tabulation of sensors used to monitor different parameters and control mechanisms	
UNIT 2 Downstream processing: Recovery and Purification of products & Effluent treatment (1 Credit)	2.1	Recovery & Purification of fermentation products a. Introduction b. Precipitation c. Filtration i. Filter-aids ii. Batch filters- Plate and frame filters iii. Continuous filters -Rotary vacuum filter d. Centrifugation i. Cell aggregation and flocculation ii. Range of centrifuges – Basket, tubular bowl e. Cell disruption i. Physical mechanical methods- Liquid shear, Solid shear, Agitation with abrasives, freezing-thawing, Ultrasonication. ii. Chemical and Biological methods- Detergents, Osmotic shock, Alkali, Enzyme treatment f. Liquid – Liquid extraction i. Significance of K value ii. Co-current extraction system iii. Counter-current extraction system - Penicillin Recovery and Podbielniak extractor g. Solvent recovery i. Batch distillation ii. Continuous distillation h. Chromatography- Ion exchange chromatography i. Membrane processes i. Ultrafiltration ii. Reverse osmosis j. Drying i. Drum driers ii. Spray driers iii. Freeze drying k. Crystallization l. Whole broth processing - concept and any one example	**15 Hours**
	2.2	Effluent treatment a. Aerobic breakdown of raw wastewater	

		i. Conventional activated sludge and modifications of the same ii. Trickling filter iii. Rotating biological contactors b. Anaerobic breakdown of waste and compressed biogas plant	
UNIT 3 Indian Knowledge systems on fermented beverages and comparison with the modern fermentation methods (1 Credit)	3.1	Ancient India fermented beverages and products a. Soma (Vedic drink) b. Sura (wine/beer) c. Feni (cashew liquor) d. Toddy (palm wine) e. Vinegar f. Leavened bread	**15 Hours**
	3.2	Modern fermented beverages and methods of production a. White wine and red wine -Fermentation and factors affecting wine fermentation, Secondary fermentation, Storage and aging, clarification b. Beer - Malting and enzymatic changes in detail, Brewing process, Cylindroconical vessels, aging and finishing, clarification and packaging c. Alcohol from molasses -Raw materials used for ethanol production, Organisms used for fermentation, Production process - seed preparation, preparation of medium, fermentation and factors affecting fermentation, Recovery by distillation d. Vinegar -Production using Fring's generator, Production using Acetator, Recovery e. Baker's yeast - Outline of production, fed batch fermentation, yeast strains and their properties, Factors important in production, Harvesting of yeast cells, production of compressed and active dry yeast	

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PRACTICAL **Course Title: Bioprocess Technology- I Practicals**	**Course Code: SMCB359MJP**

COURSE OUTCOMES:

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

1. develop skills to sterilize the culture medium
2. grow yeast in an appropriate medium, count the number of yeast cells using a haemocytometer and calculate the volume of the inoculum to be added to a definite volume of fermentation medium.
3. prepare various dilutions of sugar, inoculate yeast and incubate the mixture in order to determine the sugar and alcohol tolerance of yeast and apply the knowledge gained to carrying out alcohol fermentation.
4. carry out hydrolysis of sucrose and estimate the concentration of sugar using Cole's ferricyanide method before and after the fermentation.
5. estimate alcohol content using potassium ferricyanide method and calculate the efficiency of fermentation using the above data as well.

Lectures per week (1 Lecture is 120 minutes)		**1**	
Total number of Hours in a Semester		**30**	
Credits		**1**	
Evaluation System	**Summative Examination**	**2 Hours**	**50 marks**
	Continuous Assessment	**--**	

	1	Student activity- Students will learn to autoclave media for their practicals and will also do filter sterilization of heat labile media.	**30 hours**
	2	Alcohol fermentation a. Preparation and standardization of yeast inoculum for alcohol fermentation. b. Laboratory Alcohol fermentation using jaggery medium, calculation of efficiency of fermentation.	
	3	Determination of alcohol tolerance for yeast.	
	4	Determination of sugar tolerance for yeast.	
	5	Chemical estimation of sugar by Cole's ferricyanide method.	
	6	Chemical estimation of alcohol.	

ASSESSMENT DETAILS:

1. Continuous Assessment (CA): Any two activities / assignment / test of 25 marks each
2. Summative Assessment (SA): Theory exam of 50 marks – Two-hour duration
3. Summative Assessment (SA): Practical exam of 50 marks – Two- hour duration

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SMCB357MJ Genetics

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SMCB359MJ Bioprocess Technology - I

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SOPHIA COLLEGE FOR WOMEN (EMPOWERED AUTONOMOUS)

Programme: Sciences **Microbiology Major**	**Semester – 6**
Course Title: rDNA Technology, Bioinformatics and Virology	**Course Code: SMCB3610MJ**

COURSE OBJECTIVES:

It aims to

1. introduce the tools and techniques used for gene cloning and genetic engineering.
2. explain the applications of rDNA technology.
3. understand the basics of bioinformatics, its importance and how biological data is stored.
4. draw and explain the structure of viruses, classification and their replication cycle.
5. draw and explain the life cycle and gene regulation of bacteriophages.
6. explain the life cycle of human viruses such as Influenza virus and Human Immunodeficiency virus.
7. describe methods for cultivation of viruses and measurement of infectious viruses.
8. discuss the role of viruses in cancer.

COURSE OUTCOMES:

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

1. describe the methods to generate recombinant DNA molecules along with the required tools and enzymes including the applications of rDNA technology.
2. explain the principles and applications of advanced molecular techniques such as PCR and nucleic acid hybridization; describe methods for cultivation and quantification of infectious viruses and demonstrate understanding of bioinformatics, including the use of databases and data retrieval.
3. analyze the replication strategies of various viruses in relation to the Baltimore classification system, including viruses with +ssRNA, -ssRNA genomes and the significance of reverse transcriptase in viral life cycle, and understand the role of viruses in oncogenesis.

Theory Lectures per week (1 Lecture is 60 minutes)		**3**	
Total number of Hours in a Semester		**45**	
Credits		**3**	
Evaluation System	**Summative Examination**	**2 Hour**	**50 marks**
	Continuous Assessment	**--**	**50 marks**

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UNIT 1 Recombinant DNA technology (1 Credit)	1.1	Basic steps in Gene Cloning	**15 Hours**
	1.2	Cutting and joining of DNA molecules a. Restriction and modification systems b. Restriction endonucleases c. DNA ligases	
	1.3	Vectors a. Plasmids pBR322 and pUC19 - features and cloning of genes b. Phage as cloning vectors, cloning genes into phage vector c. Cosmids a. Shuttle vectors b. BACs and YACs	
	1.4	Screening and selection methods for identification and isolation of recombinant cells a. Screening a cDNA library b. Screening a bacteriophage λ library for a specific gene clone c. Identifying genes in libraries by complementation of mutations d. Identifying specific DNA sequences in libraries using heterologous probes and using oligonucleotide probes	
	1.5	Applications of recombinant DNA technology a. Site specific mutagenesis of DNA b. DNA molecular testing for human genetic diseases c. Forensic investigation - DNA typing d. Gene therapy e. Biotechnology- genetic engineering of plants and animals	
UNIT 2 Basic Techniques, Bioinformatics and introductory Virology (1 Credit)	2.1	Basic techniques a. Southern, Northern and Western blotting. b. Autoradiography c. PCR (Basic, Reverse transcriptase and Real time PCR)	**15 Hours**
	2.2	Bioinformatics a. Introduction to Bioinformatics i. Definition, aims, and tasks of Bioinformatics ii. Applications of Bioinformatics b. Biological Databases i. Importance and Role of Databases ii. Types and Classification of Databases -Nucleic Acid Sequence Databases: EMBL, DDBJ, GenBank -Specialized Genomic Databases	

		-Protein Sequence Databases: PIR, SWISS-PROT -Protein Structure Databases: SCOP, CATH, PROSITE c. Introduction to OMICS i. Genomics- Structural, Functional and Comparative Genomics ii. Annotation: Definition and significance iii. Transcriptomics- Overview and significance of transcriptome analysis iv. Proteomics- Definition, Structural and Functional Proteomics d. Emerging OMICS Fields i. Metabolomics: Definition and significance ii. Pharmacogenomics: Understanding the Genetic basis of drug response e. Sequence Alignment and Phylogenetics i. Sequence Alignment -Global vs Local Alignment -Pair wise and multiple sequence alignment -BLAST – Overview ii. Phylogenetic Tree construction - Concepts and applications	
	2.3	Viral architecture a. Capsid - Helical and icosahedral, viral genome and envelope b. Complex viruses c. Giruses (Definition, examples)	
	2.4	Cultivation of viruses a. Cell lines, embryonated eggs and laboratory animals b. Cytopathic effects	
	2.5	Visualization and enumeration of virus particles a. Plaque assay b. Fluorescent focus assay c. Electron microscopy, Comparison of Atomic force microscopy and electron microscopy d. Virus neutralization assays	
UNIT 3 Classification, life cycle of viruses and bacteriophages (1 Credit)	3.1	c. Viral Classification - Baltimore classification scheme	**15 Hours**
	3.2	The viral replication cycle a. Attachment (HIV and Influenza) b. Penetration (HIV and Influenza) c. Uncoating d. Types of viral genome and their replication i. dsDNA ii. ssDNA	

		iii. ss/dsDNA using an RNA intermediate iv. dsRNA v. positive ssRNA vi. negative ssRNA vii. positive ssRNA using dsDNA as an intermediate e. Assembly f. Maturation g. Release	
	3.3	Bacteriophages a. Life cycle of T4- Adsorption and Penetration, Synthesis of phage nucleic acids and proteins – Virus gene expression and terminal redundancy, Assembly and release of phage particles. b. Regulation of gene expression in lambda phage- Early transcription events, lysogenic pathway, lytic pathway	
	3.4	Viruses in cancer a. Definitions- oncogene, viral oncogene, proto-oncogene, cellular oncogene, tumor suppressor gene, cell transformation, cancer, metastasis b. Characteristics of transformed cells c. Role of viruses in cancer	

SOPHIA COLLEGE FOR WOMEN (EMPOWERED AUTONOMOUS)

PRACTICAL **Course Title: rDNA Technology, Bioinformatics and Virology Practicals**	**Course Code: SMCB3610MJP**

COURSE OUTCOMES:

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

1. isolate genomic DNA from *E. coli* and determine its purity by using UV-visible spectrophotometry.
2. apply restriction digestion technique to lambda phage or any plasmid DNA for cloning purposes.
3. navigate various bioinformatics resources, such as NCBI and EMBL websites, to conduct sequence analysis, including homology searches and phylogenetic analysis.
4. enrich the coliphages from sewage samples, carry out plaque assay in order to enumerate the phages, and calculate MOI.
5. observe animal cell culture in a laboratory setting, and understand the changes that occur under diseased conditions like viral infections/cancers etc.

Lectures per week (1 Lecture is 120 minutes)		**1**	
Total number of Hours in a Semester		**30**	
Credits		**1**	
Evaluation System	**Summative Examination**	**2 Hours**	**50 marks**
	Continuous Assessment	**--**	

	1	Isolation of genomic DNA of *E. coli* and measurement of its concentration by UV-visible spectrophotometer.	**30 hours**
	2	Restriction digestion of lambda phage/ any plasmid DNA(Demonstration)	
	3	Bioinformatics practicals i. Visiting NCBI and EMBL websites and list services available, software tools available and databases maintained. ii. Visiting and exploring various databases a. Using BLAST for sequence analysis. b. Fish out homologs for given specific sequences (Decide sequence of some relevance to their syllabus and related to some biological problem e.g. evolution of a specific protein in bacteria, predicting function of unknown protein from new organism based on its homology). c. Six frame translation of given nucleotide sequence. d. Restriction analysis of given nucleotide sequence. e. Pairwise alignment and multiple alignment of a given protein sequence. f. Formation of a phylogenetic tree.	
	4	Enrichment of coliphages, plaque assay.	
	5	Visit to Animal tissue culture laboratory to observe cultivation of animal cell lines/ monolayer.	

SOPHIA COLLEGE FOR WOMEN (EMPOWERED AUTONOMOUS)

Programme: Sciences Microbiology Major	Semester – 6
Course Title: Microbial Biochemistry-II	**Course Code: SMCB3611MJ**

COURSE OBJECTIVES:

It aims to

1. introduce mechanisms of nutrients transport and regulation of metabolic processes at various levels in a microbial cell.
2. explore the anabolic pathways for biosynthesis of lipids, fatty acids, nucleotides and amino acids.
3. outline catabolism of aliphatic and aromatic hydrocarbons.
4. know the process of energy generation in photosynthetic microorganisms.
5. discuss chemolithotrophy and metabolism of inorganic molecules with special reference to nitrate and sulfate.
6. understand the mechanism of biological nitrogen fixation.

COURSE OUTCOMES:

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

1. analyze various nutrient transport processes and the regulation of metabolic processes at cellular and molecular levels, highlighting feedback mechanisms and control points in different pathways.
2. describe the synthesis of lipids, fatty acids, nucleotides, and amino acids, and draw the key pathways and intermediates involved.
3. compare the light-dependent and light-independent reactions of photosynthesis in prokaryotic and eukaryotic phototrophs through schematic representations.
4. illustrate and compare the major catabolic pathways of aliphatic and aromatic hydrocarbons, and their significance through relevant examples.
5. examine the metabolism of inorganic compounds (nitrate,sulphate) in chemolithotrophs
6. depict the mechanisms of biological nitrogen fixation and summarize the role of different groups of nitrogen-fixing microorganisms.

Theory Lectures per week (1 Lecture is 60 minutes)		**3**	
Total number of Hours in a Semester		**45**	
Credits		**3**	
Evaluation System	**Summative Examination**	**2 Hour**	**50 marks**
	Continuous Assessment	**--**	**50 marks**

SOPHIA COLLEGE FOR WOMEN (EMPOWERED AUTONOMOUS)

UNIT 1 Nutrient Transport and Regulation of Metabolism in Microorganisms (1 Credit)	1.1	Uptake of Nutrients a. Passive transport and facilitated diffusion b. Active transport c. Group Translocation	**15 Hours**
	1.2	Regulation of enzyme activity Definition and major modes of regulation: a. Metabolic channeling b. Regulation of the synthesis of an enzyme DNA binding proteins i. Negative control of transcription: Repression and Induction ii. Positive control of transcription c. Posttranslational Regulation of Enzyme activity i. Allosteric enzymes ii. Feedback inhibition, Isoenzymes iii. Covalent modification of enzymes (example Glutamine synthetase)	
	1.3	Global regulatory mechanisms & catabolite repression Regulation of EMP and TCA cycle - Schematic	
UNIT 2 Catabolic diversity in Microorganisms (1 Credit)	2.1	Chemolithotrophy The Energetics of Chemolithotrophy Sources of Inorganic Electron Donors Biochemistry of a. Hydrogen Oxidation b. Sulfur Oxidation c. Iron Oxidation d. Nitrification, Anammox e. Nitrogen Fixation and Nitrogenase - Nitrogenase properties, Electron Flow in Nitrogen Fixation	**15 Hours**
	2.2	Phototrophy a. Definition of terms in photosynthesis b. Purple photosynthetic bacteria, Green sulphur bacteria, Cyanobacteria (examples) c. Location of photochemical apparatus d. Chlorophylls and Bacteriochlorophylls, Carotenoids and Phycobilins e. Anoxygenic Photosynthesis f. Oxygenic Photosynthesis g. Autotrophic Pathways in Phototrophs, Carboxysomes h. Autotrophy in Green Sulfur Bacteria (reverse citric acid cycle)	
	2.3	Catabolism of aliphatic and aromatic hydrocarbons	

		a. Aerobic degradation of aliphatic hydrocarbons: Role of Monooxygenases and dioxygenases b. Aerobic degradation of aromatic hydrocarbons: Ortho-cleavage (via catechol 1,2-dioxygenase) Meta-cleavage (via catechol 2,3-dioxygenase) c. Overview of anaerobic degradation	
UNIT 3 Essentials of Anabolism in Microorganisms (1 Credit)	3.1	Anabolism of Carbohydrates Synthesis of a. Sugar nucleotides b. Gluconeogenesis (only bacterial) c. Biosynthesis of Peptidoglycan	**15 Hours**
	3.2	Biosynthesis of Fatty acids and lipids a. Biosynthesis of straight chain even carbon saturated fatty acid (palmitic acid) b. Biosynthesis of phosphoglycerides in bacteria c. Biosynthesis of PHB	
	3.3	Biosynthesis of amino acids a. Schematic representation of amino acid families b. Biosynthesis of amino acids of Serine family (Serine, Glycine and Cysteine) Biosynthesis of Nucleotides c. Structure and Role of nucleotides (high energy triphosphates) d. Biosynthesis of purine and pyrimidine nucleotides (only names of intermediates and enzymes to be done, no structures or regulation to be asked in exam)	

SOPHIA COLLEGE FOR WOMEN (EMPOWERED AUTONOMOUS)

PRACTICAL **Course Title: Microbial Biochemistry -II Practicals**	**Course Code: SMCB3611MJP**

COURSE OUTCOMES:

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

1. demonstrate the effect of different types of inhibitors on enzyme activity and interpret results using enzyme kinetics principles.
2. execute the β-galactosidase assay to quantify the enzyme in *E. coli.*
3. study diauxic growth curves to understand the mechanism of catabolite repression in microorganisms.
4. apply enrichment technique to isolate cyanobacteria and quantify photosynthetic rates by assessing the reduction of DCPIP and correlate it with electron transport activity
5. use CAS assay medium to identify bacteria capable of siderophore production.
6. cultivate free-living and symbiotic nitrogen-fixing bacteria.
7. employ enrichment techniques to isolate sulphur oxidizers and understand their role in biogeochemical cycles.
8. detect PHB-producing bacteria using staining methods.
9. isolate indigenous microbes from soil capable of degrading phenol and compare their efficiency for application in bioremediation.

Lectures per week (1 Lecture is 120 minutes)		**1**	
Total number of Hours in a Semester		**30**	
Credits		**1**	
Evaluation System	**Summative Examination**	**2 Hours**	**50 marks**
	Continuous Assessment	**--**	

	1	Effect of inhibitors on enzyme activity (e.g., amylase or invertase)	**30 hours**
	2	β-galactosidase assay	
	3	To study catabolite repression by diauxic growth curve.	
	4	Enrichment of photosynthetic cyanobacteria, Measurement of photosynthetic rate using the Hill reaction (reduction of DCPIP).	
	5	Isolation and detection of siderophore producing bacteria.	
	6	Enrichment of Sulphur oxidizing bacteria	
	7	Isolation and study of Nitrogen fixing bacteria.	
	8	Detection of PHB producing bacteria	
	9	Study of phenol degradation by soil isolates	

SOPHIA COLLEGE FOR WOMEN (EMPOWERED AUTONOMOUS)

Programme: Sciences Microbiology Major	Semester – 6
Course Title: Bioprocess Technology- II	Course Code: SMCB3612MJ

COURSE OBJECTIVES:

It aims to

1. describe traditional industrial fermentations and products such as biofertilizers and bioinsecticides.
2. explain and discuss cultivation of animal cell lines, media for animal cell culture, sterilization of animal cell culture media, design of animal cell culture fermenters, large scale cultivation methods and manufacture of vaccines.
3. describe the principles of quality assurance, quality control, GMP and sterility assurance in the pharmaceutical industry.

COURSE OUTCOMES:

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

1. explain and compare the process of various industrial fermentations and products.
2. discuss the preparation and sterilization of animal cell culture media, explain and compare different animal cell culture fermenters, large scale cultivation methods, and manufacture of different types of vaccines
3. recall and explain the basic principles of quality assurance, quality control, GMP and sterility assurance in the pharmaceutical industry including the quality control of vaccines, describe the different types of microbiological assays and apply the same in assaying the concentration of important compounds.

Theory Lectures per week (1 Lecture is 60 minutes)		**3**	
Total number of Hours in a Semester		**45**	
Credits		**3**	
Evaluation System	**Summative Examination**	**2 Hour**	**50 marks**
	Continuous Assessment	**--**	**50 marks**

SOPHIA COLLEGE FOR WOMEN (EMPOWERED AUTONOMOUS)

UNIT 1 Traditional industrial fermentations and products (1 Credit)	1.1	Penicillin and semisynthetic penicillins: a. Introduction b. Penicillin fermentation - inoculum preparation, fermentation, and product recovery c. Semisynthetic penicillins: Examples, production, advantages	**15 Hours**
	1.2	Vitamin B_{12} a. Production by *Propionibacteria* and *Pseudomonas* b. Product recovery	
	1.3	Citric acid a. Production processes- surface and submerged b. Product recovery	
	1.4	Glutamic Acid - Production process and recovery	
	1.5	Fungal amylase production a. Production by solid substrate fermentation (koji process) b. Submerged process c. Product recovery	
	1.6	Production of biofertilizer (*Rhizobium*)	
	1.7	Production of Bioinsecticide - *Bacillus thuringiensis* - briefly	
UNIT 2 Animal cell cultivation and production of vaccines (1 Credit)	2.1	Animal cell cultivation a. Method of cultivating animal cells and establishment of cell lines b. Examples of cell lines c. Animal cell culture media d. Sterilization of animal cell culture media e. Animal cell culture fermenters and Large scale cultivation procedures f. Applications of animal cell culture	**15 Hours**
	2.2	Vaccines a. Production of the bacteria and the bacterial components of bacterial vaccines - fermentation, processing of bacterial harvests (live attenuated vaccine, heat-killed vaccine, subunit vaccine, toxoid vaccine, conjugate) b. Production of the viruses and the viral components of viral vaccines- growth of viruses, processing of viral harvests (live attenuated, inactivated) c. Quality control of vaccines	
UNIT 3 Quality Assurance,	3.1	Quality Assurance, Good manufacturing practices and Quality Control in the Pharmaceutical industry a. Quality Assurance, Good Manufacturing Practices, Quality Control	**15 Hours**

Sterility Assurance and Microbiological Assays (1 Credit)		b. Chemicals & Pharmaceutical production. c. The five variables - Raw materials, In process items, Finished products, Labels and labelling, Packaging materials. d. Documentation e. Control of Microbial contamination during manufacture of a drug f. Manufacture of sterile products g. Clean and Aseptic Area	
	3.2	Sterilization Control and Sterility Assurance a. Bio-burden determinations b. Environmental monitoring c. Sterilization Monitors – Physical, Chemical and Biological indicators d. Sterility Testing	
	3.3	Microbiological assays a. Advantages and Disadvantages b. Bioassay of Antibiotics- Agar diffusion assay (cylinder plate method), turbidimetric assay c. Bioassay of vitamins- Agar diffusion assay (cylinder plate method), turbidimetric assay, titrimetric assay	

SOPHIA COLLEGE FOR WOMEN (EMPOWERED AUTONOMOUS)

PRACTICAL **Course Title: Bioprocess Technology- II Practicals**	**Course Code: SMCB3612MJP**

COURSE OUTCOMES:

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

1. use a chemical method for determination of the concentration of penicillin.
2. cultivate a fungal species using the submerged and surface fermentation methods and compare the amylase production using the DNSA method.
3. isolate nitrogen fixing microorganisms, cultivate them in large numbers and study their effect on the growth of plants using pot experiments
4. check the sterility of injectables using IP protocol.
5. carry out the bioassay for determining the concentration of penicillin and cyanocobalamin using appropriate standard cultures.
6. visit an industry for studying the functions of its various departments.

Lectures per week (1 Lecture is 120 minutes)		**1**	
Total number of Hours in a Semester		**30**	
Credits		**1**	
Evaluation System	**Summative Examination**	**2 Hours**	**50 marks**
	Continuous Assessment	**--**	

	1	Chemical estimation of Penicillin.	**30 hours**
	2	Production of amylase and its detection, shake flask or solid substrate cultivation and estimation (Qualitative).	
	3	Preparation of bacterial biofertilizer.	
	4	Sterility testing of injectables.	
	5	Bioassay of an antibiotic (Ampicillin/ Penicillin/ Amikacin).	
	6	Bioassay of Cyanocobalamin.	
	7	Visit to an industry	

ASSESSMENT DETAILS:

1. Continuous Assessment (CA): Any two activities / assignment / test of 25 marks each
2. Summative Assessment (SA): Theory exam of 50 marks – Two-hour duration
3. Summative Assessment (SA): Practical exam of 50 marks – Two-hour duration

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