SANKALCHAND PATEL UNIVERSITY, VISNAGAR

Faculty of Science and Humanities

Structure, Teaching Scheme and Syllabus of

B.Sc. (Honours and Honours with Research) Biotechnology

Semester 8

as per NEP 2020

Program Code: SC101

With effect from:2023-24

Branch Name:	B.Sc. Biotechnology
Program Code:	SC101
Course Name:	Research Methodology
Course Code:	18-BIM406-4C
Pre-requisite Course:	

Course Objectives:

- To understand Meaning of Research, Objectives of Research, Motivation in Research
- To understand Significance of Research
- To understand Research Problem and Data Collection
- To understand Research planning and Sampling
- To understand Data Analysis and Research Writing

Teaching and Examination Scheme:

Teaching Scheme (Hours per .)				**Evaluation Scheme (Marks)**				
				Theory (Marks)		**Practical (Marks)**		
Lecture (L)	**Tutorial (T)**	**Practical (P)**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total (Marks)**
3	-	2	4	50	25	--	25	100

Subject Contents:

Unit	**Content**	**Lectures**	**Weightage**
1	Research Fundamentals • Meaning of Research, Objectives of Research, Motivation in Research • Basic types of Research: Descriptive, Analytical, Applied, Fundamental, Quantitative, Qualitative, Conceptual, Empirical, Clinical, Laboratory, Historical research, Significance of Research • Research methods vs. methodology, Research and Scientific method • Research process, Criteria of good research, Problems encountered by Researchers in India	15	33%
2	Research Problem and Data Collection • Meaning of Hypothesis and its characteristics, Nature, function and importance of hypothesis, Basic concepts concerning testing of hypothesis, Procedure for Hypothesis testing, • Introduction to research problem, Techniques involved in defining a problem	15	33%

	• Meaning of data and needs for data collection, Methods of primary data collection (Observation, Interviewing, questionnaire, schedule, and other methods • Methods of secondary data collection: Characteristics, Selection of appropriate method, Case study method • Concept of Sampling, Steps in sample design • Types of sampling design: Probability sampling, Nonprobability sampling • Criteria in selecting sampling procedure and Characteristics of good sample • Experimental data collection and data processing: Processing operations, problems in processing, elements of analysis in data processing, software for data processing		
3	Research planning, Data Analysis and Research Writing • Meaning and need for Research design • Features of good research design • Category of research design • Design format for a research proposal • Significance of report writing • Different steps in writing report • General format of research report • Types of reports • Mechanics of report writing • Precautions for writing research reports	15	34%

List of Experiments:

- Abstract writing from the given research paper
- Designing a Questionnaire
- Secondary Data Collection Exercise
- Data Entry and Processing using EXCEL
- Data Classification and Tabulation
- Basic Statistical Analysis in EXCEL
- Literature Review Writing (5-10 research papers)

Textbooks:

- Kothari, C.R.,1985, Research Methodology- Methods and Techniques, New Delhi, Wiley Eastern Limited

Reference Books:

- Das, S.K., 1986, An Introduction to Research, Kolkata, Mukherjee and Company Pvt. Ltd.
- Misra R.P., 1989, Research Methodology: A Handbook, New Delhi, Concept Publishing Company
- Kumar, R., 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2nd.ed.), Singapore,Pearson Education.
- Bhattacharya, D.K., 2006, Research Methodology, (2nd.ed.), New Delhi, Excel Books.
- Panneerselvam R.,2012, Research Methodology, New Delhi, PHI Learning Pvt. Ltd.
- Khan, Irfan Ali, 2008, Fundamentals of Biostatistics, Ukaaz Publications
- Rosner B.A., 2011, Fundamentals of Biostatistics, Cengage Learning
- Katz J.M., 2009, Form Research to Manuscript: A guide to scientific writing, USA, Springer Science
- Saravanavel, P. 1990. Research methodology. Allahabad, Kitab Mahal

List of Open-Source Software/learning website:

- https://archive.nptel.ac.in/courses/109108158/
- https://archive.nptel.ac.in/courses/109103153/
- https://www.youtube.com/watch?v=lqqJ5BmXzB0

Course Learning Outcomes (CLO): On completion of this course, the students will be able to:

CLO	Description	Bloom's Taxonomy Level
CLO1	Define and explain the fundamental concepts of research, including its objectives, types, significance, and the distinction between research methods, methodology, and the scientific method.	1 Remember 2 Understand
CLO2	Explain and apply the research process, including formulation of research problems and hypotheses, and the criteria for conducting good quality research.	2 Understand 3 Apply
CLO3	Describe, apply, and analyze various methods of data collection, including primary and secondary techniques, and evaluate their suitability for different research contexts.	2 Understand 3 Apply 4 Analyze
CLO4	Explain, apply, and analyze sampling methods, sample design, and data processing techniques, including the use of appropriate software tools.	2 Understand 3 Apply 4 Analyze
CLO5	Apply, analyze, and evaluate different research designs and experimental approaches for effective planning and execution of research studies.	3Apply 4 Analyze 5 Evaluate
CLO6	Apply, evaluate, and develop structured research reports and proposals by integrating appropriate writing formats, analytical interpretation, and ethical considerations.	3Apply 5 Evaluate 6 Create

Mapping of CLO s with POs & PSOs

Course Learning Outcomes	Programme Outcomes (POs)																Programme Specific Outcome (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	PSO1	PSO2	PSO3
CLO1	1	2	1	1	1	2			2									1	
CLO2	1	2	1	1	1	2			2										
CLO3	1	2	1	1	1	2			2	2					1			1	
CLO4	1	2	1	1	1	2			2	2					2				
CLO5	3	3	3	3	2	2			2	3			1					2	
CLO6	3	3	3	3	3	2			2	3			2				1		2

3: High, 2: Medium, 1: Low

Faculty of Science and Humanities
B.Sc. (Biotechnology) (Semester -8) In Effect from Academic Year 2023-24

Branch Name:	B.Sc. Biotechnology
Program Code:	SC101
Course Name:	Advances in Biotechnology
Course Code:	18-BIM407-4C
Pre-requisite Course:	Genetics and Molecular Biology

Course Objectives:

- Provide understanding of recent advances in molecular biology and high-throughput technologies in biotechnology.
- Familiarize students with modern diagnostic techniques, including molecular and automated methods.
- Develop knowledge of emerging infectious diseases, antimicrobial resistance, and therapeutic strategies.
- Introduce nanotechnology concepts and their applications in biotechnology and medicine.
- Enhance analytical and application skills for integrating advanced technologies in research and healthcare.

Teaching and Examination Scheme:

Teaching Scheme (Hours per .)				**Evaluation Scheme (Marks)**				
				Theory (Marks)		**Practical (Marks)**		
Lecture (L)	**Tutorial (T)**	**Practical (P)**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total (Marks)**
3	-	2	4	50	25	--	25	100

Subject Contents:

Unit	Content	Lectures	Weightage
1	Molecular Advances in Biotechnology • Overview of recent advances in life sciences. • Biological data and High-throughput technologies • Next generation sequencing (NGS) technologies and applications. • Gene editing technologies: CRISPR-Cas systems and genome engineering. • Artificial Intelligence in Biology: Use of machine learning and AI in biology	**15**	**34%**
2	**Advances in diagnosis** • Overview of clinical laboratory diagnosis • Conventional techniques for diagnosis: Culture techniques, Biochemical tests, Serological tests, Antibiotic Sensitivity Testing, Basics hematology tests • Conventional techniques for diagnosis of mutations: Ames test, Comet Assay (Single-Cell Gel Electrophoresis), Phenotypic Marker Assays in Microorganisms • Molecular Diagnosis of disease: PCR, RT-PCR, real-time PCR, RFLP • Automated diagnostics (MALDI-TOF) Discovering New Pathogens and rapid diagnostics of emerging diseases like COVID-19, Mucormycosis, Swine flu • Overview and Current status of Anti-HIV, Anti Malaria, Anti	**15**	**33%**

	Tuberculosis and Anti-Cancer treatment • Multidrug resistance and Tackling Antimicrobial Resistance (AMR)		
3	**Nanotechnology in Biotechnology** • Overview of Nanotechnology and types of nanoparticles • Methods of synthesis: physical, chemical, and biological (green synthesis) • Nanotechnology in diagnostics (Nanosensors) • Antimicrobial activity of nanoparticles and role in Antimicrobial Resistance • Nano drug delivery systems • Applications in biofilm control, environment, and food biotechnology • Advantages, limitations, and safety concerns	**15**	**33%**

List of Experiments:

1. Culture techniques: Streak plate, Spread plate, Pour plate, Use of selective and differential media
2. Serological tests: Widal, Agglutination
3. Hematological tests: CBC, ESR
4. Antibiotic Sensitivity Testing: Disc diffusion and Broth dilution methods
5. Visit to any diagnostic laboratory for demonstration of RT-PCR
6. Synthesis of Nanoparticles by Physical/Chemical/Biological Methods
7. Characterization of Nanoparticles (Size, Shape, and Surface Properties)
8. Antimicrobial Activity of Nanoparticles (Zone of Inhibition Test)

Text books:

- Madigan, M.T., Martinko, J.M. and Parker, J., 1997. *Brock biology of microorganisms* (Vol. 11, pp. 1- 10). Upper Saddle River, NJ: Prentice hall.
- McNeil, S.E., 2005. Nanotechnology for the biologist. *Journal of leukocyte biology*, *78*(3), pp.585-594.

Reference Books:

- Sandy B. Primrose, Richard Twyman (2004), Genomics : Applications in Human Biology. Wiley and Sons.
- Industrial Pharmaceutical Biotechnology by Heinrich
- Bio safety in Microbiological and Biomedical Laboratories by Richmond
- Drugs: From Discovery to Approval by Rick
- Handbook of Pharmaceutical Biotechnology by Gad
- Biopharmaceuticals Biochemistry and Biotechnology by Walsh
- Pharmaceutical Microbiology, Blackwell scientific Publications by Hugo 12. Molecular Biotechnol by Glick

List of Open Source Software/learning website:

- https://www.youtube.com/watch?v=uMDh74xGiNM

Course Learning Outcomes (CLO): On completion of this course, the students will be able to:

CLO	Description	Bloom's Taxonomy Level
CLO1	Students will be able to describe recent advances in microbiology and life sciences, including high-throughput biological data acquisition and next-generation sequencing technologies, and explain their significance in research and clinical applications.	1 Remember 2 Understand
CLO2	Students will be able to explain the principles and applications of gene editing technologies, including CRISPR-Cas systems and other genome engineering methods, and assess their potential in research and therapeutic intervention	2 Understand 3 Apply
CLO3	Students will be able to evaluate the role of artificial intelligence and machine learning in analyzing biological data, predicting outcomes, and improving diagnostics and research efficiency.	2 Understand 3Apply 4 Analyze
CLO4	Students will be able to compare conventional and molecular diagnostic techniques, including PCR-based methods, automated systems like MALDI-TOF, and rapid pathogen detection approaches, to identify infectious diseases and genetic mutations.	2 Understand 3Apply 4 Analyze
CLO5	Students will be able to analyze current strategies for treatment of infectious diseases (HIV, malaria, tuberculosis, cancer) and discuss the challenges of multidrug resistance and approaches to tackle antimicrobial resistance.	3Apply 4 Analyze 5 Evaluate
CLO6	Students will be able to describe different types of nanoparticles, their synthesis, and their applications in microbial diagnostics, antimicrobial therapies, drug delivery, and biofilm control, while critically evaluating associated advantages, limitations, and safety concerns.	3Apply 5 Evaluate 6 Create

Mapping of CLO s with POs & PSOs

Course Learning Outcomes	Programme Outcomes (POs)																Programme Specific Outcome (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	PSO1	PSO2	PSO3
CLO1	2	3	3		2	2			2	2					1				
CLO2	2	3	3		2	2			2	3					1				
CLO3	3	3	3		3	3			2	3					1			1	
CLO4	3	3	3		3	3			2	3					2				
CLO5	3	3	3		3	3			2	3					2			1	1
CLO6	3	3	3		3	3			3	3					2		2	1	2

3: High, 2: Medium, 1: Low

Branch Name:	B.Sc. Biotechnology
Program Code:	SC101
Course Name:	Pharmaceutical Biotechnology
Course Code:	18-BIM408-4C
Pre-requisite Course:	Fundamentals of biology

Course Objective:

- Develop understanding microorganisms and their role in pharmaceutical sciences, including antimicrobial agents and resistance.
- Provide knowledge of antimicrobial evaluation, infection control, and contamination prevention.
- Familiarize students with clinical use of drugs, antibiotic policies, and challenges of multidrug resistance.
- Introduce principles of pharmaceutical production, including sterilization, GMP, and aseptic practices.
- Enhance understanding of drug discovery, pharmacology, and regulatory frameworks in the pharmaceutical industry.

Teaching and Examination Scheme:

Teaching Scheme (Hours per .)				Evaluation Scheme (Marks)				
				Theory (Marks)		Practical (Marks)		
Lecture (L)	Tutorial (T)	Practical (P)	Credit	University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	Total (Marks)
3	-	2	4	50	25	--	25	100

Subject Contents:

Unit	Content	Lectures	Weightage
1	**Biology of Microorganisms** • Introduction to Pharmaceutical Biotechnology • Antibiotics: General properties of antibiotics. Antibacterial- β-lactam antibiotics, Amino glycosidic antibiotics, Macrolides, Tetracyclines, Sulfonamides, Polypeptide and glycopeptide, Chloramphenicol. Antifungal- Nystatin, Griseofulvin, Amphotericin, Antiviral Ribavirin, Acyclovir, Ganciclovir, AZT, Antiprotozoal and Anti helminthic agents. Mechanism of action of antibiotics – Bacterial cell wall, Cell membrane, Protein synthesis, Nucleic acid synthesis and antimetabolites- folate antagonism. Resistance- Mechanism of resistance against antibiotics.	**15**	**35%**

2	**Prescribing therapeutics, Contamination and Infection control** • Laboratory evaluation of antimicrobial agents • **Bacterial resistance to antibiotics:** Resistance to β-lactam antibiotics, glycopeptide antibiotics, tetracycline antibiotics, fluoroquinolone antibiotics, chloramphenicol and anti-mycobacterial therapy, Multiple drug resistance, Clinical resistance— MIC values, breakpoints, phenotype and outcome • **Clinical uses of antimicrobial drugs:** Principles of use of antimicrobial drugs, Clinical use, Antibiotic policies • Microbial spoilage, infection risk and contamination control • Chemical disinfectants, antiseptics and preservatives	**15**	35%
3	**Pharmaceutical Production, Drug Discovery and Other practices in Pharmaceutical Industry** • Sterile pharmaceutical products • Principles of good manufacturing practice • Sterilization procedures and sterility assurance • The wider contribution of microbiology to the pharmaceutical sciences • **Drug Discovery and Development**: Drug discovery process, Target Identification, Target Validation, Drug interactions with targets or receptors, preclinical and clinical development of drug, rational drug designing, • Pharmacodynamics, Pharmacokinetics, and Toxicology Regulatory practices of Pharmaceuticals: Brief Introduction to IP, BP, USP, FDA, GMP, GLP, ISO, WHO. • **Factory and hospital hygiene**: Introduction, Control of microbial contamination during manufacture: general aspects, Manufacture of sterile products, Aseptic areas: additional requirements.	**15**	**30%**

List of Experiments:

1. Antibiotic sensitivity assayMicrobial examination of Non-sterile products
2. Sterility testing of different locations of production area and packaging area
3. To check the effect of preservative in different formulations
4. To check the effect of disinfectant

Text books:

- Prescot L.M., Jarley G.P Klein D.A ―Microbiology Latest Edition Mc Graw Hill Company Inc b.
- Rawlins E.A. Bentley's Text Book of Pharmaceutics B ailliere Tindals 24-28 London Latest Edition
- Forbisher ― Fundamentals of Microbiology Philidelphia W.B. Saunders. Latest Edition

Reference Books:

- Hugo and Russell's, Pharmaceutical Microbiology, Wiley India Pvt. Ltd.
- Quality Assurance in Microbiology by Rajesh Bhatia
- Drugs from discovery to approval by Rick Ng, WI LEY-LISS
- Pharmaceutical Microbiology by Ashutosh Kar

- Prescott L.M. Jarley G.P., Klein.D.A. — Microbiology.2nd edition WMC Brown Publishers, Oxford. Latest Edition e.
- War Roitt, Jonathan Brostoff, David male, — Immunology Latest Edition, Mosby-year book Europe Ltd, London.
- Pharmacopoeia of India, Govt of India, Latest Editions.

List of Open Source Software/learning website:

- https://www.youtube.com/watch?v=iy3fjjHPt-U

Course Learning Outcomes (CLO): On completion of this course, the students will be able to:

CLO	Description	Bloom's Taxonomy Level
CLO1	Define and explain the fundamental principles of pharmaceutical microbiology, including the role of microorganisms in drug development, health, and disease.	1 Remember 2 Understand
CLO2	Explain, apply, and analyze the classification, properties, and mechanisms of action of antimicrobial agents, including antibacterial, antifungal, antiviral, antiprotozoal, and antihelminthic drugs.	2 Understand 3 Apply 4 Analyze
CLO3	Apply, analyze, and evaluate antimicrobial resistance mechanisms, including multidrug resistance, and interpret clinical parameters such as MIC values, breakpoints, and therapeutic outcomes in prescribing practices.	3Apply 4 Analyze 5 Evaluate
CLO4	Explain, apply, analyze, and evaluate laboratory methods for antimicrobial testing, infection control strategies, microbial spoilage, and the use of disinfectants, antiseptics, and preservatives in pharmaceutical and healthcare settings.	2 Understand 3Apply 4 Analyze 5 Evaluate
CLO5	Explain, apply, analyze, evaluate, and design pharmaceutical production processes, including sterile product manufacturing, implementation of Good Manufacturing Practices (GMP), sterilization techniques, and sterility assurance systems.	2 Understand 3Apply 4 Analyze 5 Evaluate 6 Create
CLO6	Apply, analyze, evaluate, and design drug discovery and development strategies, including target identification and validation, pharmacodynamics, pharmacokinetics, toxicological evaluation, and regulatory compliance (FDA, WHO, GMP, GLP, ISO) for safe and effective therapeutics.	2 Understand 3Apply 4 Analyze 5 Evaluate 6 Create

Mapping of CLO s with POs & PSOs

Course Learning Outcomes	Programme Outcomes (POs)																Programme Specific Outcome (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	PSO1	PSO2	PSO3
CLO1	1	1				2			1								3	1	1
CLO2	2	2				2			2								3	1	1
CLO3	2	2	1			2			2								3	1	1
CLO4	2	2	1			2			2				1				3	1	1
CLO5	2	2	3			2			2				3				3	1	1
CLO6	3	3	3			2			2				3				1	1	

3: High, 2: Medium, 1: Low

Branch Name:	B.Sc. Biotechnology
Program Code:	SC101
Course Name:	Space Microbiology and Extremophiles
Course Code:	18-MIE402-4C
Pre-requisite Course:	

Course Objectives:

- Understand the scope, aims, and significance of space microbiology, including Martian environment and its analogs (e.g., Antarctica) in astrobiological studies.
- Explain life detection methods and experimental approaches, along with key metabolic indicators of life such as ATP production, phosphate uptake, sulphur metabolism, and photosynthesis.
- Understand the impact of space conditions on microbial life, including changes in astronaut microbial flora and associated health implications.
- Explain the diversity, adaptations, and applications of extremophiles, including alkalophiles, acidophiles, halophiles, barophiles, thermophiles, and methanogens.

Teaching and Examination Scheme:

Teaching Scheme (Hours per .)				**Evaluation Scheme (Marks)**				
				Theory (Marks)		**Practical (Marks)**		
Lecture (L)	**Tutorial (T)**	**Practical (P)**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total (Marks)**
3	-	2	4	50	25	--	25	100

Subject Contents:

Unit	Content	Lectures	Weightage
1	**Space Microbiology** Aims and objectives of Space research Life detection methods. Evidence of metabolism (Gulliver) Evidence of photosynthesis (autotrophic and heterotrophic) • ATP production • Phosphate uptake • Sulphur uptake Martian environment (atmosphere, climate and other details): Antartica as a model for Mars, Search for life on Mars, Viking mission, Viking landers, and Biology box experiment, Gas exchange, Label release and pyrolytic release experiments. Monitoring of astronauts microbial flora: Alterations in the load of medically important microorganisms, changes in mycological autoflora, and changes in bacterial autoflora.	15	33%

2	Introduction to microbial biodiversity: Distribution, Abundance, Ecological Niche, types: Bacterial, Archael and Eucarya **Alkalophiles and Acidophiles** Alkalophiles: Classification, Alkaline environment & Habitats: soda lakes and deserts, calcium, applications Acidophiles: Classification, life at low pH, acid tolerance, applications **Halophiles and Barophiles** **Halophiles** Classification Habitats: Dead Sea, Discovery Basin, Salt Lakes Halophilic Cell walls and Cell Membranes – Purple membrane, compatible solutes Osmoadaptation & Halotolerence Applications of Halophiles and their extremozymes **Barophiles** Classification High-pressure habitats Mechanism of Barophily - Life under extreme hydrostatic pressure	15	33%
3	**Thermophiles** Classification, hyperthermophilic habitats and ecological aspects Extremely Thermophilic Archaebacteria Mechanism of Thermophily Commercial aspects of Thermophiles Applications of Thermozymes. **Methanogens** Classification, Habitats, Biochemistry of Methanogenesis, Applications.	15	34%

List of Experiments:

1. Phosphate Uptake Experiment.
2. Fungal Flora Isolation
3. Isolation of Skin Microflora
4. Detection of Microbial Life (simulated life experiment)
5. Biogas Production Experiment

Textbooks:

- Microbial Ecology. Fundamentals and Applications by. Ronald M. Atlas and Richard Bartha. 4th Edition. The Benjamin Cummins Publication Co. Inc, 1998.
- Extremophiles by Johri B.N. 2000. Springer Verlag, NewYork.
- Astrobiology: A brief introduction (2nd ed.). Plaxco, K. W., & Gross, M. (2011). Johns Hopkins University Press.
- Life in the universe (4th ed.)., Bennett, J. O., & Shostak, S. (2016). Pearson.

Reference Books:

- Microbial life in extreme environments by Kushner, Donn J. 1978.
- Brocks Biology of Microorganisms. 8th Edition. (International Edition - 1997) by Michael T. Madigan, John M. Martinko. Jack Parker. Prentice Hall International Inc.
- Encyclopedia of astrobiology. Gargaud, M., Amils, R., Quintanilla, J. C., Cleaves, H. J., Irvine, W. M., Pinti, D. L., & Viso, M. (Eds.). (2011). Springer.

List of Open-Source Software/learning website:

- https://astrobiology.nasa.gov/
- https://www.esa.int/

- https://microbiologysociety.org/
- https://microbeonline.com/microbes-in-space-their-survival-and-importance/
- https://joyfulmicrobe.com/international-space-station-bacteria/#:~:text=When%20a%20NASA%20mission%20leaves%20Earth%2C%20they,(yes%2C%20just%20like%20in%20the%20Marvel%20movies).
- https://www.slideshare.net/slideshow/space-microbiology-food-and-environmental-microbiology/277155039
- https://onlinecourses.nptel.ac.in/noc25_ae35/preview#:~:text=ABOUT%20THE%20COURSE:,topic%20at%20a%20deeper%20level.

Course Learning Outcomes (CLO): On completion of this course, the students will be able to:

CLO	Description	Bloom's Taxonomy Level
CLO1	Define and explain the scope, aims, and basic concepts of space microbiology.	1 Remember 2 Understand
CLO2	Explain, apply, analyze, and evaluate life detection methods, metabolic indicators, and findings from Mars missions related to the search for life.	2 Understand 3 Apply 4 Analyse 5 Evaluate
CLO3	Explain, apply, and analyze microbial diversity, including distribution, abundance, ecological niches, and major groups such as Bacteria, Archaea, and Eukarya.	2 Understand 3Apply 4 Analyze
CLO4	Explain, apply, analyze, and evaluate the diversity and classification of extremophiles including alkalophiles, acidophiles, halophiles, barophiles, thermophiles, and methanogens.	2 Understand 3 Apply 4 Analyze 5 Evaluate
CLO5	Explain, apply, analyze, and evaluate adaptation mechanisms of extremophiles in extreme environments.	2 Understand 3Apply 4 Analyze 5 Evaluate
CLO6	Apply, analyze, evaluate, and design applications of extremophiles in biotechnology, industry, and astrobiology.	3Apply 4 Analyse 5 Evaluate 6 Create

Mapping of CLO s with POs & PSOs

Course Learning Outcomes	Programme Outcomes (POs)																Programme Specific Outcome (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	PSO1	PSO2	PSO3
CLO1		2			1	2			2	1								1	
CLO2	3	3	2	2	3	3			3	3								1	
CLO3	2	2	2		1	2			2					2				1	1
CLO4	2	2	2		1	2			2					2				1	2
CLO5	2	2	2		1	2			2					2			2	2	2
CLO6	3	3	3		3	3			2	2				2					

3: High, 2: Medium, 1: Low

Branch Name:	B.Sc. Biotechnology
Program Code:	SC101
Course Name:	Experimental Biotechnology
Course Code:	18-MIE402-4O
Pre-requisite Course:	

Course Objectives:

- To introduce the principles and importance of Good Laboratory Practices (GLP) in scientific experimentation and research.
- To provide fundamental knowledge of various analytical techniques used in solving scientific problems.
- To develop the ability to identify and analyze scientific problems using appropriate analytical methods.
- To enhance understanding of the applications of analytical techniques across different scientific domains.
- To build skills for designing and planning experiments based on scientific questions and analytical approaches.
- To encourage critical thinking and problem-solving abilities in experimental sciences.

Teaching and Examination Scheme:

Teaching Scheme (Hours per .)				Evaluation Scheme (Marks)				
				Theory (Marks)		Practical (Marks)		
Lecture (L)	Tutorial (T)	Practical (P)	Credit	University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	Total (Marks)
3	-	2	4	50	25	--	25	100

Subject Contents:

Unit	Content	Lectures	Weightage
1	**Basics of Laboratory Research:** Good Lab Practices, Concept of buffering and Preparation of Solutions and Reagents Electrophoresis (Part 1): Basic Concept of Electrophoresis, performance of electrophoresis and its applications Electrophoresis: Horizontal Gel electrophoresis, discussion about scientific questions and related experiments to solve them utilizing electrophoresis	15	33%
2	**Chromatography (Part I):** Analytical techniques in purification of biomolecules; Column chromatography, HPLC. Chromatography (Part II): Analytical techniques in purification of biomolecules; Column chromatography, HPLC. **Chromatography (Part III):** Discussion about scientific questions and related experiments to solve them utilizing chromatography Immunology Techniques: Immunological tools, Antibody Generation and Purification, ELISA, Radial Immuno-diffusion, Western blotting and Immuno-precipitation.	**15**	**34%**
3	**Cell Biology Techniques (Part 1):** Basics of cell-culture, isolation of cells from tissue and fractionation. **Cell Biology Techniques (Part 2):** Immuno-localization, cell sorting, and discussion about scientific questions and related experiments to solve them utilizing cell biology techniques. **Molecular Biology (Part 1):** Primer designing, Polymerase chain reaction, Different variants of PCR and their applications. **molecular Biology (Part 2)** Blotting Techniques, DNA and protein sequencing techniques and their applications	**15**	**33%**

List of Experiments:

1. ELISA
2. RIA
3. TLC
4. Paper Chromatography
5. PCR

Textbooks:

1. H-P Schmauder, M Schweizer and L M Schweizer., Methods in Biotechnology, (eds), Taylor & Francis Publishers, 2002.

Reference Books:

1. K. Wilson & J. Walker, Practical Biochemistry: Principles and Techniques. (eds) Cambridge University Press, New York, 1995.
2. Douglas A. Skoog and James J. Leary, Principles of Instrumental Analysis. 4th Edition. Saunders College Publishing, 1992.
3. C. R. Kothari, Research methodology: Methods and Techniques, 3rd Edn., New age International 2014.
4. R. Kumar, Research methodology a step-by-step guide for beginners, Sage Publications, London, 2011.
5. C.G. Thomas, Research methodology and scientific writing, Ane books, Delhi, 2015.

List of Open-Source Software/learning website:

https://onlinecourses.nptel.ac.in/noc22_bt60/preview

Course Learning Outcomes (CLO): On completion of this course, the students will be able to:

CLO	Description	Bloom's Taxonomy Level
CLO1	Explain the principles of Good Laboratory Practices (GLP).	1 Remember
CLO2	Describe various analytical techniques and their working principles.	2 Understand
CLO3	Apply suitable analytical techniques to solve scientific problems.	3Apply
CLO4	Analyze scientific questions and interpret analytical results	4 Analyze
CLO5	Evaluate the effectiveness of different analytical methods for given problems	5 Evaluate
CLO6	Design experiments to address specific scientific questions	6 Create

Mapping of CLO s with POs & PSOs

Course Learning Outcomes	Programme Outcomes (POs)																Programme Specific Outcome (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	PSO1	PSO2	PSO3
CLO1			1		1	2			2	1		2						1	
CLO2						3			3	3	3	3	2						
CLO3			2		1	2			2		2	2	2	2				1	1
CLO4									2		2	2	2	2				1	2
CLO5	2	2	2		1	2			2		2	2	2	2			2	2	2
CLO6	3	3	3		3	3			2	2	3	3	3	2					

3: High, 2: Medium, 1: Low