SARDAR PATEL UNIVERSITY
Vallabh Vidyanagar
NAAC 'A' Grade (10-01-2023 To 09-01-2028)
NEP-2020 aligned Curriculum with effect from Academic Year 2026-27

Master of Science in Microbiology (Semester-II)

Course Type	Course Code	Course Title	Teaching-Learning Scheme L-P-T	Total Notional Hours	Course credits
DSC	P2S02NCMIC01	Microbial Genetics	4-0-1	120	04

Course Learning Outcomes:

On completing the course, the students will be able to:

CLO1 Describe molecular basis of mutation, DNA damage, and repair mechanisms.
CLO2 Compare and contrast homologous, site-specific, and transposition recombination.
CLO3 Explain regulation of plasmid copy number, segregation, and compatibility.
CLO4 Design genetic mapping experiments using transformation, transduction, conjugation.
CLO5 Analyse fungal genetics using tetrad and mitotic recombination analysis
CLO6 Integrate molecular genetics tools in synthetic biology and genome engineering.

Unit	Course Content	Learning Pedagogies*	CLO(s)
I	**Genome Stability, Mutation and DNA Repair, Pedigree Analysis** Molecular basis of spontaneous & induced mutations. Mutation rate determination, fluctuation test, Ames test. DNA repair pathways: MMR, BER, NER, recombinational repair, SOS response, adaptive response, oxidative damage repair. Role of repair in cancer biology and microbial survival.	Classroom Lectures Flipped classroom Seminars	1
II	**Phage genetics, Mobile Genetic Elements and Recombination** Phage genetics: T-series bacteriophages and lambda phage biology Plasmids: types, incompatibility, copy number control, partitioning systems. Transposable elements: Tn5, Tn3, Mu, Tn7, IS911, Integrons, conjugative transposons. Homologous recombination: Holliday model, RecBCD pathway, eukaryote meiosis. Site-specific recombination: Serine and tyrosine recombinases, mating type switching. Phage therapy applications	Classroom Lectures Flipped classroom Seminars Case studies	2,3
III	**Horizontal Gene Transfer and Genetic Mapping** Transformation: Natural competence (Bacillus, Streptococcus, Haemophilus), artificial competence, linkage mapping. Transduction: Generalized (P1, P22, Mu) and specialized (lambda); co-transduction mapping. Conjugation: F-plasmid, Hfr, F', interrupted mating, mapping, mobilizable plasmids. Synthetic biology applications, gene drives, and HGT in antimicrobial resistance spread.	Classroom Lectures Seminars Computational tools and virtual laboratories	4

IV	**Phage genetics, Molecular Genetics Tools and Interkingdom Systems** Agrobacterium genetics: Ti plasmid, vir regulon, T-DNA transfer, integration, plant genetic engineering. Biology of Restriction-Modification systems Fungal genetics: Tetrad analysis, mitotic recombination, gene conversion	Classroom Lectures Flipped classrooms Case studies, Computational tool	5,6

- **Assessment Methodologies**

(A) Internal Assessment

a. Internal Formative assessment (30 marks)
(a) Quiz (2 quizzes): 10 marks
(b) Seminar: 05 marks
(c) Assignment: 05 marks
(d) Regularity: 05 marks
(e) Group Learning: 05 marks

b. Internal Summative Assessment: Mid-term tests (20 marks)

(B) External Assessment: End of Term Examination (50 marks)

- **Weightage of Learning Efforts for External Assessment**

Unit	Aligned COs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Application/ Analyse & above (A)	
I	**1**	30	01	01	11	13
II	**2,3**	40	01	01	12	14
III	**4**	30	01	01	10	12
IV	**5,6**	20	01	01	09	11
		120	**04**	**04**	**42**	**50**

- **CLOs – PLOs Matrix**

CLOs \ PLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO 1:	3	1	2	3	2	1	2	2	1	1	–	1
CLO 2:	3	1	1	2	2	1	1	2	1	–	–	1
CLO 3:	3	2	1	2	2	1	1	2	1	–	1	1
CLO 4:	3	2	2	2	3	2	1	3	2	1	1	2
CLO 5:	3	1	2	2	3	1	1	3	2	–	–	1
CLO 6:	3	1	2	2	3	1	1	3	2	–	–	1

Values to **CLO-PLO** matrix are assigned **by judging the importance of the particular CLO in relation to the PLOs.**

CLO – PLO correlation	Value
Strong	**3**
Moderate	**2**
Low	**1**
No correlation	**-**

- **Assessment and Evaluation**

Sr.No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Seminars, Assignments, Quizzes, Written Exam, Class Regularity, Group learning	50%
2	End-Semester Examination	Written Exam	50%

- **Suggested Learning Materials Books:**

Sr.No.	Title	Author(s)	Edition/Year	Publisher
1	Molecular Biology of the Gene	Watson et al.	7, 2017	Pearson.
2	Snyder & Champness Molecular Genetics of Bacteria	Henkin & Peters	5, 2020	ASM Press
3	Lewin's Genes XII	Krebs, Goldstein, Kilpatrick	2017	Jones & Bartlett
4	Gene Cloning and DNA Analysis	Brown, T. A.	8, 2021	Wiley
5	A Crack in Creation: CRISPR and the Future of Genetics	Doudna & Sternberg	2017	
6	Principles of Genetics	Snustad, P. D., Simmons, M	6, 2011	Wiley
7	Modern microbial genetics	Streips, U. N., & Yasbin, R. E	Vol. 344, 2002	New York: Wiley-Liss.
8	Microbial genetics	Maloy, S. R., Cronan, J. E., & Freifelder, D.	1994	Jones & Bartlett Learning.
9	Molecular Genetics	Stent, G. S., & Calendar, R.	1978	

- **Online Resources (Open Source)**

Sr. No.	Description of Resource(s)	Weblink
1	NPTEL – Molecular Genetics	http://www.digimat.in/nptel/courses/video/102104052/102104052.html
2	CRISPR-Cas9 animation (McGovern Institute)	https://mcgovern.mit.edu/2014/11/05/genome-editing-with-crispr-cas9/
3	BioNumbers, EcoCyc, SGD (Saccharomyces Genome Database)	https://bionumbers.hms.harvard.edu/search.aspx?trm=yeast&pi=6; https://frontend.qa.yeastgenome.org/

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Master of Science in Microbiology (Semester-II)

Course Type	Course Code	Course Title	Teaching-Learning Scheme L-P-T	Total Notional Hours	Course credits
DSC	P2S02NCMIC02	Enzyme Technology	4-0-1	120	04

Course Learning Outcomes:

On completing the course, the students will be able to:

CLO1 Analyze enzyme kinetics and inhibition mechanisms using appropriate mathematical models to interpret enzyme behaviour under different conditions.
CLO2 Apply standard and advanced techniques for enzyme production, purification, and characterization to obtain functionally active and stable enzymes.
CLO3 Evaluate enzyme immobilization and engineering strategies to enhance enzyme stability, activity, and reusability for industrial applications.
CLO4 Apply enzymes in industrial and biotechnological sectors such as pharmaceuticals, food, and environmental biotechnology.
CLO5 Design and apply enzyme engineering approaches using computational and bioinformatics tools to improve enzyme structure, function, and efficiency.

Unit	Course Content	Learning Pedagogies*	CLO(s)
I	**Introduction to Enzymology and enzyme kinetics** History, Classification, Properties of enzyme, coenzymes, cofactors, multienzyme complex Practical enzymology—Assay, activity, progress curve, factor affecting enzyme activity Principles of enzyme kinetics, Michaelis–Menten kinetics, Linear transformation methods for kinetic analysis, Enzyme inhibition kinetics Primary and secondary plots, Multi-substrate enzyme reactions, Alberty's general rate equation, Sequential and ping-pong reaction mechanisms Kinetic data analysis using statistical and computational tools	Lecture, ICT, Seminars, Inquiry based learning, SDL, Group Discussion	1
II	**Production and Recovery of Enzymes** Fermentation technology for enzyme production [Submerged fermentation (SmF), Solid-state fermentation (SSF)], Media optimization and culture conditions for enzyme production, Scale-up strategies in enzyme production, Sustainable enzyme production and green chemistry principles, Use of renewable substrates and agro-industrial wastes Recovery and Purification, test of purifications, case studies	Lecture, ICT, PBL, Group Discussion, Seminar, Industrial visit	2

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III	**Enzyme Immobilization and Enzyme Engineering** Principles and advantages of enzyme immobilization, Support materials and carriers used for immobilization, Methods of enzyme immobilization, Kinetic behavior of immobilized enzymes, Stability and reusability of immobilized enzymes. Immobilized enzyme reactors, Applications, Case studies Introduction to enzyme engineering, protein structure, structure-function relation and rational enzyme designing. Directed evolution techniques (random mutagenesis, DNA shuffling), High-throughput screening methods, Strategies for improving enzyme stability, substrate specificity and catalytic activity, Case studies of engineered enzymes	Lecture, Programme based learning, Industrial visit, Research oriented, Group Discussion, Seminar	3
IV	**Applications of Free and Immobilized Enzymes, Biosensors** Enzymes in food processing industries (starch processing, dairy and baking), detergent industry (proteases, lipases, amylases), textile industry (desizing, biopolishing, bleaching), pharmaceutical and medical industry, biofuels Principles of enzyme-based biosensors, Components of biosensors (bioreceptor, transducer, signal processor), Applications of biosensors	Lecture, Programme based learning, Industrial visit, Research oriented, Seminar	4
V	**Protein Computational Biology** Biological databases for enzyme sequence and structure analysis, Sequence similarity, Multiple sequence alignment and phylogenetic analysis, Protein structure databases (PDB), Structural visualization tools for proteins, Prediction of enzyme active sites and binding pockets, Comparative modelling of enzymes, Molecular docking for enzyme–substrate interaction, Abzymes, Synzymes, Isoenzymes, Ribozymes	Lecture, Course based learning, Programme based learning, Industrial visit, Project based	5

- **Assessment Methodologies**

(A) Internal Assessment
  - **a. Internal Formative assessment (30 marks)**
    - **(a) Quiz (2 quizzes): 10 marks**
    - **(b) Seminar: 05 marks**
    - **(c) Assignment: 05 marks**
    - **(d) Regularity: 05 marks**
    - **(e) Group Learning: 05 marks**
  - **b. Internal Summative Assessment: Mid-term tests (20 marks)**

(B) External Assessment: End of Term Examination (50 marks)

- **Weightage of Learning Efforts for External Assessment**

Unit	Aligned COs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Application/ Analyse & above (A)	
I	1, 5	28	1	2	8	11
II	2, 4	28	1	2	8	11
III	3	24	1	2	7	10
IV	4	20	1	2	6	9
V	5	20	1	2	6	9
		120	**5**	**10**	**35**	**50**

- **CLOs – PLOs Matrix**

CLOs \ PLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO 1:	3	2	3	2	2	1	1	2	2	1	1	1
CLO 2:	3	3	1	1	3	1	1	1	1	1	1	2
CLO 3:	2	3	1	3	2	1	2	2	1	3	3	2
CLO 4:	2	3	1	2	2	2	2	1	1	3	3	2
CLO 5:	3	3	3	2	3	1	1	3	3	2	3	2

Values to **CLO-PLO** matrix are assigned **by judging the importance of the particular CLO in relation to the PLOs.**

CLO – PLO correlation	Value
Strong	**3**
Moderate	**2**
Low	**1**
No correlation	**-**

- **Assessment and Evaluation**

Sr.No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Seminars, Assignments, Quizzes, Written Exam, Class Regularity, Group learning	50%
2	End-Semester Examination	Written Exam	50%

- **Suggested Learning Materials Books:**

Sr. No.	Title	Author(s)	Edition/Year	Publisher
1	The chemical kinetics of enzyme action:	K. J. Laider and P. S. Bunting		Oxford University Press, London.
2	Enzyme Structure and mechanism	Alan Fersht		Reading, USA
3	Fundamentals of Enzymology:	Nicholes C. Price and Lewis Stevens		Oxford Univ. Press
4	Enzymes	M. Dixon, E. C. Webb, CJR Thorne and K. F. Tipton,		Longmans, London
5	Enzyme Technology	Anusha Bhaskar and V.G. Vidhya		MJP Publishers, Chennai, India

- **Online Resources (Open Source)**

Sr. No.	Description of Resource(s)	Weblink
1	Enzyme and Microbial Technology	Enzyme and Microbial Technology | Journal | ScienceDirect.com by Elsevier
2	Enzyme Technology and Biotransformation	3527329897 C01 - Intro to Enzyme Tech: Goals & Biocatalysts - Studocu

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Course Type	Course Code	Course Title	Teaching-Learning Scheme L-P-T	Total Notional Hours	Course credits
DSC	P2S02NCMIC03	Cellular and Molecular Immunology	4-0-1	120	04

Course Learning Outcomes:
On completing the course, the students will be able to:

CLO1 Analyze immune system organization, lymphoid architecture, and antigen processing–presentation mechanisms.
CLO2 Comprehend immunogenetic mechanisms including antibody diversity, TCR diversity, and immune regulation.
CLO3 Analyze immune cell signalling pathways (BCR, TCR, cytokines) in activation and homeostasis.
CLO4 Evaluate immune dysfunctions including hypersensitivity, autoimmunity, and transplantation responses
CLO5 Interpret tumor–immune interactions and immune evasion mechanisms.
CLO6 Design advanced immunological applications including monoclonal antibodies, CAR-T therapy, and vaccines.

Unit	Course Content	Learning Pedagogies*	CLO(s)
I	**Fundamentals of the Immune System** Introduction to immunology, Immune Recognition and Lymphoid Architecture, Advanced lymphoid organ microanatomy (e.g., germinal centres, follicular dendritic cells), Ontogeny and lineage commitment of immune cells from HSCs. Molecular Immunogenetics and Signalling V(D)J recombination, somatic hypermutation, affinity maturation, Class switch recombination mechanisms and epigenetic regulation. TCR generation. Regulation of transcription in immune cell lineages (role of GATA3, T-bet, FOXP3). Major Histocompatibility Complex: Organisation and inheritance of MHC, Structure and function of MHC class-I and class-II, MHC genes.	Classroom Lecture, Problem-Based Learning, Seminars (Student- led) Micro-Projects Collaborative Learning, ICT - Enabled Learning	1,2
II	**Regulation of Immune Response** B-cell receptor, Immunoglobulin super family; principles of cell signalling; B cell maturation, activation and differentiation; class switching and generation of antibody diversity T-cell maturation, activation and differentiation and T-cell receptors; functional T Cell subsets, TCR-CD3 complex in immune activation and signal transduction pathways.	Classroom Lecture Problem-Based Learning, Seminars (Student- led) Micro-Projects Collaborative Learning, ICT - Enabled Learning	3

	Cytokines: properties, receptors, cytokine network and therapeutic uses, Cytokine signalling pathways Antigen processing and presentation (Endogenous and Exogenous pathways) Effector Immune Responses- Antibody and Cell-mediated Immunity, ADCC		
III	**Clinical Immunology** Immunological tolerance: Central and peripheral tolerance, Mechanisms of tolerance Tissue repair and homeostasis of the immune system. Hypersensitivity: Types and mechanisms with suitable examples Autoimmunity: Mechanisms and therapy Transplantation Immunology- Principles of transplantation, therapeutic approaches to control rejection. Tumour immunology: tumour antigens; immune response to tumours and tumour evasion of the immune system, cancer immunotherapy, and immunodeficiency disorders	Classroom Lecture, Problem-Based Learning, Seminars (Student-led) Micro-Projects Collaborative Learning, Case-based learning	4,5
IV	**Vaccines and Immunotherapeutics** Recombinant DNA vaccines: antibody genes and antibody engineering: generation of monoclonal antibodies, chimeric, hybrid monoclonal antibodies; catalytic antibodies and generation of immunoglobulin gene libraries, idiotypic vaccines and marker vaccines, viral-like particles (VLPs), dendritic cell-based vaccines, vaccine against cancer, T cell-based vaccine and therapeutic vaccine. Systems immunology and computational models of immune networks, CART therapy. T regulatory cells and applications	Classroom Lecture, Problem-Based Learning, Seminars (Student-led) Micro-Projects Collaborative Learning, Industrial Visit, ICT -Enabled Learning	6

- **Assessment Methodologies**

(A) Internal Assessment

a. **Internal Formative assessment (30 marks)**
   (a) Quiz (2 quizzes): 10 marks
   (b) Seminar: 05 marks
   (c) Assignment: 05 marks
   (d) Regularity: 05 marks
   (e) Group Learning: 05 marks

b. **Internal Summative Assessment: Mid-term tests (20 marks)**

(B) External Assessment: End of Term Examination (50 marks)

- **Weightage of Learning Efforts for External Assessment**

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Unit	Aligned COs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Application/ Analyse & above (A)	
I	1,2	30	01	01	12	14
II	3	30	01	01	12	14
III	4.5	30	01	01	09	11
IV	6	30	01	01	09	11
		120	**04**	**04**	**41**	**50**

- **CLOs – PLOs Matrix**

CLOs \ PLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO 1:	3	2	1	2	2	1	1	1	1	**-**	**-**	1
CLO 2:	3	1	2	1	1	1	1	1	2	**-**	**-**	1
CLO 3:	**3**	**2**	**2**	**1**	**2**	**1**	**1**	**1**	**2**	-	-	**1**
CLO 4:	2	1	1	3	1	1	3	1	-	1	1	2
CLO 5:	2	1	2	2	2	1	2	2	1	1	1	2
CLO 6:	2	3	2	2	3	2	3	2	2	1	3	3

Values to **CLO-PLO** matrix are assigned **by judging the importance of the particular CLO in relation to the PLOs.**

CLO – PLO correlation	Value
Strong	**3**
Moderate	**2**
Low	**1**
No correlation	**-**

- **Assessment and Evaluation**

Sr. No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Seminars, Assignments, Quizzes, Written Exam, Class Regularity, Group learning	50%
2	End-Semester Examination	Written Exam	50%

- **Suggested Learning Materials Books:**

Master of Science in Microbiology (Semester-II)

Sr. No.	Title	Author(s)	Edition/Year	Publisher
1	Kuby immunology	Owen, J. A., Punt, J., &Stranford, S. A.	8th ed. 2019	WH Freeman and co. New York.
2	Cellular and molecular immunology	Abbas, A. K., Lichtman, A. H., & Pillai, S.	9th ed. (2018)	Elsevier Health Sciences.
3	Immunology (8th Edn)	Male, D., Brostoff, J., Roth, D., & Roitt, I.	8th ed.2012	Elsevier Health Sciences.
4	Janeway's Immunobiology	Murphy, K., & Weaver, C.	9th ed. 2016	Garland Science.
5	Immunology, Infection and Immunity	Gerlad B. Pier, Jeffrey B. Lyczak & Lee M Wetzler	2004	ASM Press
6	Fundamentals of Immunology	William. E. Paul	7th ed.2013	Lippincott Williams & Wilkins,

- **Online Resources (Open Source)**

Sr. No.	Description of Resource(s)	Weblink
1	Immunology	https://onlinecourses.nptel.ac.in/noc25_bt58/
2	Advanced Immunology	https://www.immunopaedia.org.za/online-courses/
3	Advanced Immunology	https://www.aai.org/Education/Courses

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Master of Science in Microbiology (Semester-II)

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	P2S02NCMIC04	Microbial Genetics and Immunology Laboratory	0-8-0	**120**	04

Course Learning Outcomes (CLOs)

On completion of this course, students will be able to:

CLO1 Perform standard molecular genetics techniques including conjugation, transformation, and transduction.
CLO2 Design and execute genetic mapping experiments.
CLO3 Analyze genetic data using computational tools.
CLO4 Demonstrate skills in immunological sample handling and assays including serum separation, bactericidal activity of serum, and complement fixation techniques
CLO5 Evaluate antigen–antibody interactions using immunological assays such as neutralization tests, hemagglutination tests, ELISA, and dot blot techniques.
CLO 6 Apply protein separation and detection techniques including serum electrophoresis and immunofluorescence for qualitative and quantitative analysis of biomolecules.
CLO 7 Maintain laboratory records and interpret results in the context of genetic and immunological experimental data.

Unit/ Sr.No	Course Content	Learning Pedagogies*	CLO(s)
1	Isolation of Bacteriophage from natural source, enrichment of lysate and enumeration of phage by plaque assay method	Interactive lectures Problem-Based Learning	1 To 7
2	Measurement of growth-one step growth curve using a T even phage and determination of burst size		
3	Induced mutagenesis by UV and Chemicals in *E. coli*/ *Serratia marcescens* (5-BU/NTG/EES)		
4	Transformation of *E. coli* by plasmid DNA and computation of transformation efficiency.	Experiential learning Research-Oriented Learning Micro-Projects/Mini Research Task Industrial Visit/Institutional Visit	
5	Bacterial Conjugation (F^+ x F^-); Analysis of Interrupted Mating data for mapping.		
6	Transduction in *E. coli* and analysis of transduction data for mapping.		
7	Agrobacterium mediated Transformation		
8	**Dry lab:** Tetrad analysis using experimental data		
9	Bactericidal action of serum		
10	Complement fixation test (demonstration)		

11	Neutralization test		
12	Heme agglutination test		
13	Serum electrophoresis		
14	ELISA, Dot Blot		
15	Immunofluorescence test		

- **Assessment Methodologies**

(A) Internal Assessment (50 marks)

a. Internal Formative assessment (30 marks)

i. Regularity :05 marks
ii. Performance in Laboratory: 05 marks
iii. Laboratory Record: 05
iv. Group Learning: 05
v. Spotting/Quiz: 05
vi. Viva Voce: 05

b. Internal Summative Assessment

Problem based learning: 20

(B) External Assessment: 50 marks

- **Weightage of Learning Efforts for External Assessment**

Unit	Aligned COs	Total Learning	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Application/ Analyse & above (A)	
	1 to 7	120	10	10	30	50

- **CLOs – PLOs Matrix**

CLOs \ PLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO 1:	3	3	1	1	3	1	1	1	1	1	1	3
CLO 2:	3	3	2	2	3	1	1	3	2	1	1	3
CLO 3:	2	2	3	1	2	1	1	2	3	1	1	2
CLO 4:	2	3	1	1	3	1	2	1	1	2	1	2
CLO 5:	3	3	2	2	3	2	2	2	2	2	1	3
CLO 6:	2	3	2	1	3	2	1	1	2	1	1	2
CLO 7:	2	2	2	2	2	3	2	2	1	1	1	2

Values to **CLO-PLO** matrix are assigned **by judging the importance of the particular CLO** in relation to the **PLOs**.

CLO – PLO correlation	Value

Master of Science in Microbiology (Semester-II)

Strong	3
Moderate	2
Low	1
No correlation	-

- **Assessment and Evaluation**

Sr.No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Laboratory Performance, Laboratory Records, Team work, Viva Voce Regularity, Problem Solving.	50%
2	End-Semester Examination	Practical Exam(Approach, Performance, Interpretation and Spots/Viva)	50%

- **Suggested Learning Materials Books:**

Sr.No.	Title	Author(s)	Edition/Year	Publisher
1	Experiments in Bacterial Genetics: A Laboratory Manual	Lionello Bossi, Andrew Camilli, Angelika Gründling	2024	Cold Spring Harbor Laboratory Press
2	Molecular Cloning: A Laboratory Manual	Michael R. Green, Joseph Sambrook	4th Edition, 2012	Cold Spring Harbor Laboratory Press
3	Short Protocols in Molecular Biology	Frederick M. Ausubel, Roger Brent , Robert E. Kingston , David D. Moore , J. G. Seidman, John A. Smith	1995	John Wiley & Sons

- **Online Resources (Open Source)**

Sr. No.	Description of Resource(s)	Weblink
1	**Restriction Endonuclease Database REBASE**	http://rebase.neb.com

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Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSE	P2S02NEMIC01	Biostatistics Using R	0-4-0	60	02

Course Learning Outcomes (CLOs)

On completing the course, the students will be able to:

CLO1: Demonstrate proficiency in R programming for biological data manipulation, cleaning, and preprocessing.

CLO2: Construct advanced biological visualizations including bar plots with error bars, box plots, and violin plots to represent data variability.

CLO3: Apply and interpret parametric and non-parametric tests appropriate for specific experimental designs in life sciences.

CLO4: Execute and validate regression models (simple, multiple, and logistic) for biological prediction and association studies.

CLO5: Effectively communicate statistical findings using professional-grade R outputs and comprehensive analysis pipelines.

Unit	Course Content	Learning Pedagogies*	CLO(s)
I	**Introduction to R Environment:** Data Visualization in Bioscience I: scatter plots, box plots, bar graphs with error bars, aesthetics, axis labelling, legends, and theme customization. Data Visualization in Bioscience II: Heat maps using heatmap or Complex Heatmap packages, Violin plots t-Test: One sample, two sample, paired t-test One-Way ANOVA: Checking Assumptions using visualization methods and tests Post-Hoc Analysis for ANOVA Categorical Data Analysis: Test of proportion, Chi-square test Association etc.	Classroom Lectures, Case Based Learning, Problem Based Learning, Micro-Projects,	1,2,3
II	**Non-Parametric Alternatives I:** Wilcoxon Signed-Rank Test and Mann-Whitney U Test as Alternatives to t-Tests Non-Parametric Alternatives II: Kruskal-Wallis Test and Dunn's Post-Hoc Test as Alternatives to One-Way ANOVA Simple Linear Regression: Multiple Regression: Logistic Regression: Case Study:	Micro-Projects, ICT-Enable Learning, Classroom Lectures, Case Based Learning, Problem Based Learning	3,4,5

- **Assessment Methodologies**

(A) Internal Assessment
  - **a. Internal Formative assessment (15 marks)**
    - **(a) Quiz: 05 marks**
    - **(b) Class Regularity: 05 marks**
    - **(c) Assignment: 05 marks**
  - **b. Internal Summative Assessment (10 marks)**

(B) End of Term Examination: 25 marks

- **Weightage of Learning Efforts for External Assessment**

Unit	Aligned CLOs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Application/ Analyse & above (A)	
I	1,2,3	30	02	02	07	11
II	3,4,5	30	03	03	08	14
		60	**05**	**05**	**15**	**25**

- **CLOs – PLOs Matrix**

CLOs \ PLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO 1:	1	2	3	1	2	1	-	2	3	1	1	2
CLO 2:	1	1	3	2	2	3	-	1	3	1	1	2
CLO 3:	2	2	3	2	2	1	1	2	2	1	1	1
CLO 4:	2	2	3	2	2	1	1	2	3	1	1	1
CLO 5:	1	1	2	3	2	3	1	2	3	1	1	2

Values to **CLO-PLO** matrix are assigned **by judging the importance of the particular CLO** in relation to the **PLOs**.

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-

- **Assessment and Evaluation**

Sr.No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Seminars, Assignments, Quizzes, Group Learning, Written Exam	50%
2	End-Semester Examination	Written Exam	50%

- **Suggested Learning Materials Books:**

Sr. No.	Title	Author(s)	Edition/Year	Publisher
1	Dalgaard, P.	Introductory Statistics with R	2008	Springer Science & Business Media
2	Logan, M.	Biostatistical Design and Analysis Using R: A Practical Guide	2010	Wiley-Blackwell.
3	Zar, J. H.	Biostatistical Analysis	2010	Pearson Education

- **Online Resources (Open Source)**

Sr.No.	Description of Resource(s)	Weblink
1	Free textbook	https://learningstatisticswithr.com/
2	R for Data Science: Online textbook	**https://r4ds.hadley.nz/**
3	Modern Statistics with R: Online textbook	**https://www.modernstatisticswithr.com/**
4	simpleR – Using R for Introductory Statistics: Online textbook	**https://cran.r-project.org/doc/contrib/Verzani-SimpleR.pdf**
5	Swirl: Interactive R package learning resource	**https://swirlstats.com/**
6	Cloud based hands on tutorials	**https://posit.cloud/learn/recipes**
7	Harvard University's "Statistics and R"	**https://pll.harvard.edu/course/statistics-and-r**

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Master of Science in Microbiology (Semester-II)

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSE	P2S02NEMIC02	Microtechniques	1-2-0	**60**	02

Course Learning Outcomes (CLOs)

On completing the course, the students will be able to:

CLO1 Explain principles and procedures of sample preparation techniques such as maceration, squash, and clearing for microscopic analysis.

CLO2 Describe fixation, dehydration, infiltration, embedding, and staining methods used in light microscopy and evaluate their significance in tissue preservation.

CLO3 Apply microtomy techniques using rotary, sliding, and cryostat microtomes for sectioning biological specimens.

CLO4 Analyse histochemical localization of cellular components such as carbohydrates, proteins, lipids, lignin, and nucleic acids in plant tissues.

CLO5 Interpret principles and procedures involved in electron microscopy sample preparation including fixation, ultrathin sectioning, staining, and grid preparation.

CLO6 Evaluate ultrastructural cytochemistry and enzyme localization techniques, including immunocytochemistry, for advanced cellular studies.

Unit	Course Content	Learning Pedagogies*	CLO(s)
I	**Techniques in Light Microscopy** Maceration, squash and clearing techniques. Sample preparation for light microscopy. Classification of fixatives, formulas (Plants). Processing samples for light microscopy: Fixation, dehydration, infiltration, embedding media, staining (Stains and staining procedures- negative and positive staining procedures). Microtomes: Rotary, sliding, cryostat. Histochemical localization of metabolites for light microscopy: Starch, proteins, lipids, total carbohydrates, lignins, polyphenols, nucleic acid, histones, cutin, suberin and waxes. Localization of enzymes: Peroxidase, acid phosphatase and succinic dehydrogenase.	Classroom Lecture, Seminars, Case-Based Learning, Experiential Learning, ICT-Enabled Learning, Self-Directed Learning	1, 2, 3, 4
II	**Techniques in Electron Microscopy** Freeze etching and freeze fracturing. Sample preparation for Electron microscope: Fixatives, double fixation, dehydration and infiltration, embedding media and embedding, sectioning (semi thin sectioning, ultrathin sectioning), grids, formvar coating, Staining for electron microscopy. Fixation and embedding of particulate samples like bacteria, virus etc.	Classroom Lecture, Seminars, Case-Based Learning, Research-Oriented Learning,	5, 6

	Operations of ultramicrotome and freezing ultramicrotome. Ultrastructural cytochemistry: Tannin, protein, cell wall polysaccharide, lignin and membrane. Ultrastructural cytochemistry: Enzymes: Peroxidase and phosphatase. Immunocytochemistry.	Experiential Learning, ICT-Enabled Learning	
III	**Techniques in Light Microscopy** Maceration, squash and clearing techniques. Sample preparation for light microscopy. Classification of fixatives, formulas (Plants). Processing samples for light microscopy: Fixation, dehydration, infiltration, embedding media, staining (Stains and staining procedures- negative and positive staining procedures). Microtomes: Rotary, sliding, cryostat. Histochemical localization of metabolites for light microscopy: Starch, proteins, lipids, total carbohydrates, lignins, polyphenols, nucleic acid, histones, cutin, suberin and waxes. Localization of enzymes: Peroxidase, acid phosphatase and succinic dehydrogenase.	Classroom Lecture, Seminars, Case-Based Learning, Experiential Learning, ICT-Enabled Learning, Self-Directed Learning	1, 2, 3, 4

- **Assessment Methodologies**

(A) Internal Assessment

a. **Internal Formative assessment (15 marks)**
   (a) **Quiz: 05 marks**
   (b) **Seminar: 05 marks**
   (c) **Group Learning/Assignment: 05 marks**
b. **Internal Summative Assessment (10 marks)**

(B) End of Term Examination: 25 marks

- **Weightage of Learning Efforts for External Assessment**

Unit	Aligned Cos	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Application/ Analyse & above (A)	
I	1 to 4	20	1	1	6	8
II	5, 6	20	1	1	7	9
III	1 to 4	20	-	-	8	8
		60	02	02	21	25

- **CLOs – PLOs Matrix**

CLOs \PLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO 1:	2	2	1	1	3	1	-	1	1	1	-	2
CLO 2:	3	2	1	2	3	1	1	1	1	1	-	2
CLO 3:	1	3	1	1	3	1	-	1	2	-	-	2
CLO 4:	3	2	2	2	3	1	1	2	2	2	1	2
CLO 5:	2	2	2	1	3	1	-	1	3	-	-	2
CLO 6:	3	2	2	2	3	1	1	2	3	1	1	2

Values to **CLO-PLO** matrix are assigned **by judging the importance of the particular CLO** in relation to the **PLOs**.

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-

- **Assessment and Evaluation**

Sr.No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Seminars, Assignments, Quizzes, Group Learning, Written Exam	50%
2	End-Semester Examination	Written Exam	50%

- **Suggested Learning Materials Books:**

Sr.No.	Title	Author(s)	Edition/Year	Publisher
1	Microscopy and Microtechnique	R. Marimuthu	2017	MJP Publishers
2	Plant Microtechnique	Johansen	1940	McGraw-Hill Inc., USA
3	Botanical Microtechnique and Cytochemistry	Berlyn	1976	Wiley–Blackwell, USA
4	Study of Plant Structure	O'Brien & McCully	1969	Termarcarphi Pty. Ltd.
5	Botanical Microtechniques: Principle and practice	S. M. Khasim	2002	Capital Publishing Company

- **Online Resources (Open Source)**

Sr. No.	Description of Resource(s)	Weblink
1	Transmission Electron Microscopy	https://nptel.ac.in/courses/113106924
2	Fundamentals of Cryo-Electron Microscopy	https://nptel.ac.in/courses/102108668
3	Electron Microscopy-I	https://archive.nptel.ac.in/content/storage2/courses/102103047/module6/lec34/1.html

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSE	P2S02NEMIC03	Developmental Biology	2-0-0	60	02

Course Learning Outcomes (CLOs)

On completing the course, the students will be able to:

CLO1: Understand key concepts of Developmental Biology including cell fate, induction, and differentiation in plants and animals.

CLO2: Explain gametogenesis, fertilization, and early embryonic development along with underlying molecular mechanisms.

CLO3: Analyze morphogenesis and organogenesis using model organisms like *Drosophila melanogaster* and *Caenorhabditis elegans*.

CLO4: Apply developmental principles to plant systems including embryogenesis, seed formation, and environmental regulation.

Unit	Course Content	Learning Pedagogies*	CLO(s)
I	Basic concepts of Development, fertilization and early development Induction, competence, induction, specification, determination, differentiation, dedifferentiation, redifferentiation; Fate maps, cell fate, cell lineages; Stem cells: potency, genomic equivalence, cytoplasmic determinants Gametogenesis: spermatogenesis and oogenesis-structure and function of gametes; Fertilization: mechanisms, sperm-egg interaction, egg activation; Molecular basis of development; development of germ layers in animals Male gametophyte development, embryo sac development and double fertilization in plants, embryogenesis, establishment of symmetry in plants, seed formation, embryo and endosperm developmental dynamics and germination	Classroom Lecture Case-Based Learning Problem-Based Learning Inquiry- Based Learning ICT-Enabled Learning Reflective Practices Self-Directed Learning Research-Oriented Learning	1,2
II	Morphogenesis and organogenesis in plants and animals Organization of shoot and root apical meristem, shoot and root development, leaf development and phyllotaxy, transition to flowering, floral meristems, organogenesis and floral development Cell aggregation and differentiation in Dictyostelium, axes and pattern formation in Drosophila, amphibia and chick;	Classroom Lecture Case-Based Learning Seminar Problem-Based Learning	

	organogenesis - vulva formation in *Caenorhabditis elegans*, eye lens induction, limb development and regeneration in vertebrates, differentiation of neurons, post embryonic development - larval formation, metamorphosis; environmental regulation of normal development; sex determination	Inquiry-Based Learning ICT-Enabled Learning Micro Project Reflective Practices Self-Directed Learning Research-Oriented Learning	3,4

- **Assessment Methodologies**

(A) Internal Assessment

a. Internal Formative assessment (15 marks)

(a) Quiz: 05 marks

(b) Seminar: 05 marks

(c) Group Learning/Assignment: 05 marks

b. Internal Summative Assessment (10 marks)

(B) End of Term Examination: 25 marks

- **Weightage of Learning Efforts for External Assessment**

Unit	Aligned CLOs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Application/ Analyse & above (A)	
I	**1,2**	30	02	04	06	12
II	**3,4**	30	02	04	07	13
		60	**04**	**08**	**13**	**25**

- **CLOs – PLOs Matrix**

CLOs \ PLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO 1:	3	1	1	2	1	1	1	2	1	2	1	1
CLO 2:	3	1	1	1	1	1	1	1	1	1	1	1
CLO 3:	3	2	3	2	3	1	1	3	2	1	1	2
CLO 4:	2	2	1	1	2	1	2	2	1	3	2	2

Values to **CLO-PLO** matrix are assigned **by judging the importance of the particular CLO** in relation to the **PLOs**.

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-

- **Assessment and Evaluation**

Sr. No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Seminars, Assignments, Quizzes, Group Learning, Written Exam	50
2	End-Semester Examination	Written Exam	50

- **Suggested Learning Materials Books:**

Sr. No.	Title	Author(s)	Edition/Year	Publisher
1	Developmental Biology	Scott F. Gilbert & Michael J.F. Barresi	13th Ed. (2023)	Oxford University Press
2	Principles of Development	Lewis Wolpert et al.	6th Ed. (2019/20)	Oxford University Press
3	Essential Developmental Biology	Jonathan Slack	4th Ed. (2021)	Wiley-Blackwell
4	Langman's Medical Embryology	T.W. Sadler	15th Ed. (2023)	Wolters Kluwer
5	Analysis of Biological Development	Klaus Kalthoff	2nd Ed. (2000)	McGraw-Hill

- **Online Resources (Open Source)**

Sr. No.	Description of Resource(s)	Weblink
1	Introduction to Developmental Biology	https://nptel.ac.in/courses/102106084

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Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	P2S02NCMIC05	Enzyme Technology Laboratory	0-8-0	**120**	04

Course Learning Outcomes (CLOs)

On completion of this course, students will be able to:

CLO1 Design and execute protocols for isolation, screening, and selection of enzyme-producing microorganisms from environmental samples.

CLO2 Analyze and optimize physicochemical (pH, temperature, incubation time) and nutritional parameters (carbon and nitrogen sources) for enhanced enzyme production.

CLO3 Demonstrate proficiency in enzyme production under submerged fermentation and perform downstream processing including extraction, purification (salt precipitation, dialysis), and protein quantification.

CLO4 Evaluate enzyme activity, reaction kinetics, and catalytic efficiency using quantitative assays, progress curves, and kinetic models (Michaelis–Menten and linear transformations

CLO5 Assess the effects of environmental factors (pH, temperature) and inhibitors on enzyme activity and stability, and interpret enzyme inhibition mechanisms.

CLO6 Develop and compare immobilized enzyme systems with free enzymes, and critically analyze their efficiency, stability, and potential industrial applications.

Unit/ Sr.No	Course Content	Learning Pedagogies*	CLO(s)
1	Isolation and Screening of Enzyme-Producing Microorganisms from Environmental Samples	Experiential Learning,	1 To 6
2	Determination of Enzyme Production Potential of Selected Microbial Strains		
3	Optimization of Culture Conditions (pH, Temperature, Incubation Time) for Enzyme Production	Industrial Visit/Institutional Visit,	
4	Optimization of Nutritional Parameters (Carbon and Nitrogen Sources) for Enzyme Production		
5	Production of Enzymes under Submerged Fermentation Conditions	Research-Oriented Learning,	
6	Extraction of Crude Enzyme from Microbial Culture		
7	Purification of Enzymes by Precipitation and Dialysis Techniques		

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8	Determination of Enzyme Activity by Quantitative Assay of Reaction Products	Problem Based Learning,	
9	Determination of Enzyme Reaction Progress Curve (Product Formation vs Time)		
10	Determination of Substrate Saturation Curve and Enzyme Kinetics (Michaelis–Menten and Linear Plots).	Collaborative Learning,	
11	Optimization of pH and Temperature for Enzyme Activity		
12	Determination of Effect of Temperature on Enzyme Stability	Micro-Projects/Mini Research Tasks,	
13	Determination of Enzyme Inhibition Kinetics and Identification of Inhibition Type		
14	Immobilization of Enzymes and Comparative Analysis of Free and Immobilized Enzyme Activity		

- **Assessment Methodologies**

(A) Internal Assessment (50 marks)

a. Internal Formative assessment (30 marks)

i. Regularity :05 marks
ii. Performance in Laboratory: 05 marks
iii. Laboratory Record: 05
iv. Group Learning: 05
v. Spotting/Quiz: 05
vi. Viva Voce: 05

b. Internal Summative Assessment
Problem based learning: 20

(B) External Assessment: 50 marks

- **Weightage of Learning Efforts for External Assessment**

Unit	Aligned COs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Application/ Analyse & above (A)	
	1 to 6	120	10	10	30	50

- **CLOs – PLOs Matrix**

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CLOs \ PLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO 1:	2	3	2	2	3	1	2	3	2	3	2	2
CLO 2:	2	3	2	2	3	1	1	2	1	2	2	2
CLO 3:	3	3	1	1	3	1	1	1	2	1	2	3
CLO 4:	3	2	3	2	3	2	1	2	2	1	1	3
CLO 5:	3	2	2	2	3	2	1	2	1	2	1	3
CLO6:	2	3	1	3	3	2	2	2	1	2	3	2

Values to **CLO-PLO** matrix are assigned **by judging the importance of the particular CLO** in relation to the **PLOs**.

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-

- **Assessment and Evaluation**

Sr.No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Laboratory Performance, Laboratory Records, Team work, Viva Voce Regularity, Problem Solving.	50%
2	End-Semester Examination	Practical Exam (Approach, Performance, Interpretation and Spots/Viva)	50%

- **Suggested Learning Materials Books:**

Sr.No.	Title	Author(s)	Edition/Year	Publisher
1	An Introduction to Practical Biochemistry	David T. Plummer	3rd Ed., 2001	McGraw-Hill
2	Practical Biochemistry: Principles and Techniques	Keith Wilson & John Walker	7th Ed., 2010	Cambridge University Press
3	Laboratory Manual in Biochemistry	J. Jayaraman	2nd Ed., 2011	New Age International
4	Experimental Biochemistry: A Student Companion	Beedu Sasikala	1st Ed., 2014	Academic Press

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5	Methods in Enzymology (Series)	Sidney P. Colowick & Nathan O. Kaplan (Editors)	Multiple Volumes	Academic Press
6	Enzyme Assays: A Practical Approach	Robert Eisenthal & Michael J. Danson	2nd Ed., 2002	Oxford University Press
7	Biochemical Methods	S. Sadasivam & A. Manickam	3rd Ed., 2008	New Age International
8	Laboratory Techniques in Biochemistry and Molecular Biology (Series)	T. S. Work & E. Work	Multiple Volumes	Elsevier
9	Principles and Techniques of Biochemistry and Molecular Biology	Keith Wilson & John Walker	7th Ed., 2010	Cambridge University Press
10	Basic Biochemical Methods	S. K. Sawhney & Randhir Singh	1st Ed., 2000	Narosa Publishing

- **Online Resources (Open Source)**

Sr.No.	Description of Resource(s)	Weblink
1	Step-by-step protocols for enzyme assays, protein purification, and molecular biology techniques	https://www.protocols.io
2	Open-access experimental protocols and methods in life sciences (includes enzyme techniques)	https://www.nature.com/protocolexchange
3	Video-based demonstrations of enzyme kinetics, chromatography, electrophoresis, and lab techniques	https://www.jove.com
4	Educational resources and lab protocols for biochemistry and molecular biology techniques	https://www.bio-rad.com/en-in/applications-technologies
5	OpenWetWare: community-driven platform with detailed experimental protocols and lab notes	https://openwetware.org
6	NCBI Bookshelf and resources explaining experimental methods and biochemical assays	https://www.ncbi.nlm.nih.gov/books
7	LabXchange (Harvard) – interactive simulations and lab-based learning modules in biology and biochemistry	https://www.labxchange.org

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Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSE	P2S02NEMIC04	Molecular Endocrinology	2-0-0	60	02

Course Learning Outcomes (CLOs)

On completing the course, the students will be able to:

CLO1: Demonstrate understanding of endocrine glands and hormone classification

CLO2: Analyse hormone synthesis secretion and regulation mechanisms

CLO3: Evaluate certain endocrine diseases with reference to etymology symptoms treatment modalities

Unit	Course Content	Learning Pedagogies*	CLO(s)
I	Introduction to Endocrine System and hormones; Hormones: Classification, Synthesis & Functions: Classes of hormones: peptide, steroid, thyroid, eicosanoids, pheromones, Hormone synthesis, storage, transport, metabolism; Endocrinology of pregnancy, parturition and lactation; Synthetic hormones: Insulin analogues, Steroid drugs; Industrial applications: Fertility regulation, Growth promoters, Endocrine disruptors (EDcs), Pharmaceutical hormone production	Classroom Lecture Research-Oriented Learning Inquiry-Based Learning ICT-Enabled Learning Reflective Practices	1,2
II	Pathophysiology of Endocrine Glands: Overview of methods to study Hormone-receptor interactions, Disorders of endocrine glands: Pituitary, thyroid, adrenal, pancreas, gonads; Hormone imbalance and diseases, Hormone replacement therapy Clinical case studies: Diabetes mellitus, Hypo/hyperthyroidism, Cushing's syndrome, PCOS, Diagnostic interpretation (laboratory reports and imaging interpretation), Personalized endocrine therapy	Classroom Lecture Case-Based Learning Problem-Based Learning Research-Oriented Learning Collaborative Learning	2,3

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- **Assessment Methodologies**

(A) Internal Assessment

a. **Internal Formative assessment (15 marks)**
   (a) **Quiz: 05 marks**
   (b) **Seminar: 05 marks**
   (c) **Group Learning/Assignment: 05 marks**

b. **Internal Summative Assessment (10 marks)**

(B) End of Term Examination: 25 marks

- **Weightage of Learning Efforts for External Assessment**

Unit	Aligned CLOs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Application/ Analyse & above (A)	
I	**1,2**	30	02	04	06	12
II	**2,3**	30	02	04	07	13
		60	04	08	13	25

- **CLOs – PLOs Matrix**

CLOs \ PLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO 1:	3	1	1	1	1	1	1	1	1	1	1	1
CLO 2:	3	2	2	2	1	1	1	2	1	1	1	1
CLO 3:	2	2	1	3	1	2	3	2	1	2	2	2

Values to **CLO-PLO** matrix are assigned **by judging the importance of the particular CLO** in relation to the **PLOs**.

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-

- **Assessment and Evaluation**

Sr. No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Seminars, Assignments, Quizzes, Group Learning, Written Exam	50
2	End-Semester Examination	Written Exam	50

Master of Science in Microbiology (Semester-II)

- **Suggested Learning Materials Books:**

Sr. No.	Title	Author(s)	Edition/ Year	Publisher
1	Principles and Techniques of Biochemistry and Molecular Biology	Keith Wilson & John Walker	8th Ed. (2018)	Cambridge Univ. Press
2	Vertebrate Endocrinology	David O. Norris & James A. Carr	6th Ed. (2021)	Academic Press Elsevier)
3	Greenspan's Basic and Clinical Endocrinology	David G. Gardner & Dolores Shoback	10th Ed. (2017/20)	McGraw Hill
4	Endocrinology: An Integrated Approach	Stephen Nussey & Saffron Whitehead	1st Ed. (2022)	BIOS Scientific Publishers
5	Imaging in Endocrine Disorders	Sahdev, A. & Reznek, R.	1st Ed. (2023)	Springer

- **Online Resources (Open Source)**

Sr. No.	Description of Resource(s)	Weblink
1	Endocrinology	https://onlinecourses.swayam2.ac.in/e-learning/preview/cec20_bt21

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