



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 Biochemistry (Semester-II)

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	P2S02NCBIC01	Bioanalytical Techniques	4-0-1	120	04

Course Learning Outcomes:

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

- CLO 1:** Explain the physical principles and laws (e.g., Beer-Lambert, van Deemter, sedimentation) governing electrochemical, spectroscopic, and separation techniques used in biochemical research.
- CLO 2:** Apply spectroscopic methods (UV-Vis, NMR, IR, CD) and electrochemical sensors to identify, quantify, and analyze the structural properties of organic and inorganic biological species.
- CLO 3:** Design strategy and for the purification and isolation of biomolecules and cell organelles by manipulating variables in chromatography (HPLC/FPLC/GC) and centrifugation.
- CLO 4:** Demonstrate proficiency in high-resolution separation and detection methods, including 2D-gel electrophoresis, isoelectric focusing, and molecular blotting (Southern, Northern, and Western).
- CLO 5:** Interpret complex data sets derived from flow cytometry, fluorescence, and chemiluminescence to assess cellular processes and molecular interactions.
- CLO 6:** Select and combine appropriate analytical techniques to solve practical problems in diagnostic biochemistry, protein purification, and molecular characterization.

Unit	Course Content	Learning Pedagogies*	CLO(s)
I	UNIT- I - Electrochemical techniques & Spectrophotometry Basic principles of electrochemistry - pH electrode- ion-selective- gas- sensing and oxygen electrodes – Biosensors: Principle, types and applications. Principles and techniques of colorimetry & spectrophotometry- Beer-Lambert's Law- instrumentation - hypo and hyperchromicity – Spectroscopy Principle, instrumentation and applications of UV, Visible, IR (including FTIR and ATR), AAS, NMR, CD spectroscopy, Flow cytometry Instruments for measuring fluorescence and phosphorescence, Methods of Fluorescence Measurement, Chemiluminescence, Fluorometric determination of inorganic and organic species, Application of molecular luminescence spectroscopy, Problems.	Classroom Lecture (CL) Problem-Based Learning (PBL) Seminars (Student-led) Micro- Projects Collaborative Learning, ICT - Enabled Learning	1,2



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II	<p>UNIT- II Chromatography Introduction, classification of chromatographic methods, Elution chromatography on columns, Migration rates of solutes: distribution constants, retention time and retention factor, selectivity factor.</p> <p>Zone broadening & column efficiency, van Deemeter equation, optimization of column performance, column resolution, effect of relative and selectivity factor on resolution, effect of resolution on retention time, variables that affect column performance, problems.</p> <p>Types of chromatography - column, thin layer, paper, adsorption, partition, gas -liquid ion exchange, affinity, HPTLC, High Performance Liquid Chromatography, FPLC -principles of each type- instrumentation and accessories- detection methods & systems – qualitative and quantitative applications.</p>	<p>Classroom Lecture (CL) Problem- Based Learning (PBL) Seminars (Student-led) Micro-Projects Collaborative Learning, ICT Enabled Learning</p>	3
III	<p>UNIT- III – Centrifugation Basic principles of Centrifugation – instrumentation, centrifugation units - Types of centrifuges rotors, accessories - centrifugation methods - sedimentation velocity - sedimentation equilibrium – colloids - cell fractionation methods.</p>	<p>Classroom Lecture (CL) Problem- Based Learning (PBL) Seminars (Student-led) Micro-Projects Collaborative Learning, Case-based learning (CBL), ICT - Enabled Learning</p>	4
IV	<p>UNIT- V –Electrophoresis Types of Electrophoresis – paper and gel – agarose and PAGE – pulsed field – capillary – isoelectric focusing – 2D gel electrophoresis. Blotting techniques: western, Southern & northern. Applications</p>	<p>Classroom Lecture (CL) Problem- Based Learning (PBL) Seminars (Student-led) Micro-Projects Collaborative Learning, Industrial Visit, ICT - Enabled Learning</p>	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**



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(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	1,2	34	1	1	11	14
II	3	34	1	1	11	13
III	4	24	1	1	09	12
IV	5,6	28	1	1	09	11
		120	5	5	40	50

• CLOs – PLOs Matrix

CLO \ PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9
CLO1	3	1	1	1	1	-	-	-	2
CLO2	3	3	2	2	2	1	-	1	2
CLO3	3	3	1	3	2	2	-	1	2
CLO4	3	2	2	2	1	2	-	-	2
CLO5	2	3	3	3	3	1	1	1	3
CLO6	3	3	3	3	3	3	2	2	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%



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- Suggested Learning Materials Books:**

Sr. No.	Title	Author(s)	Edition/Year	Publisher
1	Bio separations –Principles and Techniques	B. Sivasanker	2005	Prentice –Hall of India
2	Principles of instrumental analysis	Skoog, D. A., Holler, F. J., & Crouch, S. R.	2017	Cengage learning
3	Principles and Techniques of Biochemistry and Molecular Biology	Keith Wilson and John Walker	2005	Cambridge University Press.USA.

- Online Resources (Open Source)**

Sr. No.	Description of Resource(s)	Weblink
1	Swayam	https://onlinecourses.swayam2.ac.in/e-learning/preview/ini26_cy02
2	Swayam	https://nptel.ac.in/courses/104108124

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Master of Science in Biochemistry (Semester-II)

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	P2S02NCBIC02	Enzyme Technology	4-0-1	120	04

Course Learning Outcomes (CLOs)

On completion of this course, 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	CLO1, CLO5



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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	CLO2,
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, PBL, Industrial visit, Research oriented, Group Discussion, Seminar	CLO3,
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, PBL, Industrial visit, Research oriented, Group Discussion, Seminar	CLO4
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, CBL, PBL, Industrial visit, Project based, Group Discussion, Seminar	CLO5

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



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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 CLOs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Analyse & above (A)	
I	CLO1, CLO5	28	1	2	8	11
II	CLO2, CLO4	28	1	2	8	11
III	CLO3	24	1	2	7	10
IV	CLO4	20	1	2	6	9
V	CLO5	20	1	2	6	9
		120	05	10	35	50

- **CLOs–PLOs Matrix**

CLO	PLO								
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9
CLO1	3	3	1	2	2	1	1	1	2
CLO2	3	2	1	3	2	2	1	1	2
CLO3	3	3	1	3	3	2	1	2	2
CLO4	3	3	2	2	3	2	2	3	2
CLO5	2	2	1	3	3	2	1	2	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%



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● Suggested Learning Materials Books:

Sr. No.	Title	Author(s)	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 https://www.sciencedirect.com/journal/enzyme-and-microbial-technology
2	Enzyme Technology and Biotransformation	https://www.studocu.com/in/document/visvesvaraya-technological-university/enzyme-technology-and-biotransformation/3527329897-c01-introduction/30748875



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Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	P2S02NCBIC03	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	Classroom Lecture Problem-Based Learning, Seminars (Student-led) Micro-Projects Collaborative	3



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	<p>complex in immune activation and signal transduction pathways 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</p>	<p>Learning, ICT-Enabled Learning</p>	
III	<p>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</p>	<p>Classroom Lecture, Problem-Based Learning, Seminars (Student-led) Micro-Projects Collaborative Learning, Case-based learning</p>	4,5
IV	<p>Vaccines and immunotherapeutics 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</p>	<p>Classroom Lecture, Problem-Based Learning, Seminars (Student-led) Micro-Projects Collaborative Learning, Industrial Visit, ICT-Enabled Learning</p>	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



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(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	1,2	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
CLO 1:	3	2	1	1	2	1	1	1	1
CLO 2:	3	2	1	2	2	1	1	1	1
CLO 3:	3	3	1	2	2	1	1	1	1
CLO 4:	3	3	2	2	2	1	2	2	1
CLO 5:	3	3	2	2	3	1	2	2	1
CLO 6:	3	3	2	3	3	2	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, Written Exam, Class Regularity, Group learning	50%
2	End-Semester Examination	Written Exam	50%



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● Suggested Learning Materials Books:

Sr.No.	Title	Author(s)	Edition/Year	Publisher
1	Kuby immunology	Owen, J. A., Punt, J., &Stranford, S. A.	8 th ed. 2019	WH Freeman and co. New York.
2	Cellular and molecular immunology	Abbas, A. K., Lichtman, A. H., & Pillai, S.	9 th ed. (2018)	Elsevier Health Sciences.
3	Immunology (8th Edn)	Male, D., Brostoff, J., Roth, D., & Roitt, I.	8 th ed.2012	Elsevier Health Sciences.
4	Janeway's Immunobiology	Murphy, K., & Weaver, C.	9 th 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	7 th 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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Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	P2S02NCBIC04	Advanced Techniques for Biomolecules, Lab -1	0-8-0	120	04

Course Learning Outcomes (CLOs):

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

CLO1: Demonstrate proficiency in analytical techniques including UV–Visible spectroscopy, FTIR, NMR, and mass spectrometry for characterization of biomolecules.

CLO2: Apply chromatographic techniques (HPLC, flash chromatography, gel permeation chromatography) for separation, purification, and molecular weight determination of biomolecules.

CLO3: Determine physicochemical properties of biomolecules, including partition coefficient and electrophoretic behavior.

CLO4: Perform and interpret immunological assays such as ELISA, agglutination, neutralization, complement fixation, and immunofluorescence tests.

CLO5: Analyze experimental data obtained from biochemical and immunological techniques for accurate interpretation and reporting.

CLO6: Demonstrate laboratory skills, data handling, troubleshooting, and preparation of structured scientific reports.

Unit	Course Content	Learning Pedagogies*	CLO(s)
I	<ol style="list-style-type: none">1. Characterization of various biomolecules using UV-Visible spectroscopy.2. FTIR analysis and data interpretation3. Determination of partition coefficient between two phases.4. Demonstration of HPLC and Flash chromatography5. Gel permeation chromatography and the concept of molecular weight determination of biomolecules.6. Characterization of various biomolecules using nuclear magnetic resonance.7. Characterization of various biomolecules using mass spectrometry8. Bactericidal action of serum9. Complement fixation test (demonstration)10. Neutralization test11. Heme agglutination test12. Serum electrophoresis13. ELISA, Dot Blot14. Immunofluorescence test	Experiential Learning, Problem-Based Learning, Research-Oriented Learning, Micro-Projects/Mini Research Tasks, Industrial Visit/Institutional Visit,	1-6



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- Assessment Methodologies

(A) Internal Assessment (50 marks)

a. Internal Formative assessment (30 marks)

- Regularity :05 marks
- Performance in Laboratory: 05marks
- Laboratory Record: 05
- Group Learning: 05
- Spotting/Quiz: 05
- 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 CLOs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Application/ Analyse & above (A)	
I	1 to 6	120	10	10	30	50

- 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%

- CLOs – PLOs Matrix

CLO \ PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9
CLO1	3	2	1	1	2	1	1	1	1
CLO2	3	3	1	2	3	1	1	1	1
CLO3	2	3	1	1	2	1	1	1	1
CLO4	3	3	2	2	2	1	2	1	1
CLO5	2	3	2	2	2	1	1	1	1
CLO6	2	2	3	2	2	3	2	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	0



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• Suggested Learning Materials Books:

Sr. No.	Title	Author(s)	Edition/Year	Publisher
1	Standard Methods of Biochemical Analysis.	Thimmaiah S. K.	(2012)	Kalyani Publishes, New Delhi, India
2	An introduction to practical Biochemistry	David T. Plummer	(2017)	McGraw Hill book company
3	Biochemical Methods	S. Sadasivam and A. Manickam	2 nd	New Age International (P) Limited, Publishers, India
4	Principles and Techniques of Biochemistry and Molecular Biology	Keith Wilson & John Walker	8th (2018)	Cambridge University Press
5	Biophysical Chemistry (Part II: Techniques for the Study of Biological Structure and Function)	Charles R. Cantor & Paul R. Schimmel	1980 (reprint)	W.H. Freeman
6	Practical Biochemistry: Principles and Techniques	Keith Wilson & John Walker	7th (2010)	Cambridge University Press
7	Protein Purification: Principles and Practice	Robert K. Scopes	3rd (1994)	Springer
8	Gel Electrophoresis of Proteins and Nucleic Acids	R. Westermeier	4th (2016)	Walter de Gruyter
9	Introduction to Spectroscopy	Donald L. Pavia	5th (2015)	Cengage Learning
10	Laboratory Safety for Chemistry Students	Robert H. Hill & David C. Finster	2nd (2016)	Wiley

• Online Resources (Open Source)

Sr. No.	Description of Resource(s)	Weblink
1	JoVE (Journal of Visualized Experiments)	jove.com
2	LabXchange	labxchange.org
3	Biochemistry Free & Easy	biochem.science.oregonstate.edu
4	NIH Principles of Chromatography	chromatography.nih.gov



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Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	P2S02NCBIC05	Enzyme Technology, Lab -2	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	Course Content	Learning Pedagogies*	CLO(s)
I	<ol style="list-style-type: none">1. Isolation and Screening of Enzyme-Producing Microorganisms from Environmental Samples2. Determination of Enzyme Production Potential of Selected Microbial Strains3. Optimization of Culture Conditions (pH, Temperature, Incubation Time) for Enzyme Production4. Optimization of Nutritional Parameters (Carbon and Nitrogen Sources) for Enzyme Production5. Production of Enzymes under Submerged Fermentation Conditions6. Extraction of Crude Enzyme from Microbial Culture7. Purification of Enzymes by Precipitation and Dialysis Techniques8. Determination of Enzyme Activity by Quantitative Assay of Reaction Products	Experiential Learning, Problem-Based Learning, Research-Oriented Learning, Micro-Projects/Mini Research Tasks, Industrial Visit/ Institutional Visit	1-6



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	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) 11. Optimization of pH and Temperature for Enzyme Activity 12. Determination of Effect of Temperature on Enzyme Stability 13. Determination of Enzyme Inhibition Kinetics and Identification of Inhibition Type 14. Immobilization of Enzymes and Comparative Analysis of Free and Immobilized Enzyme Activity		
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- **Assessment Methodologies**

(A) **Internal Assessment (50 marks)**

a. **Internal Formative assessment (30 marks)**

- i. **Regularity :05 marks**
- ii. **Performance in Laboratory: 05marks**
- 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 CLOs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Application/Analyse & above (A)	
I	1 to 6	120	10	10	30	50

- **CLOs – PLOs Matrix**

CLOs \ PLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9
CLO1	2	3	2	3	2	2	1	1	2
CLO2	2	3	1	3	3	1	1	2	2
CLO3	3	3	2	3	3	3	1	2	2
CLO4	3	3	2	3	3	2	1	1	2
CLO5	2	3	2	3	2	2	2	2	2
CLO6	2	3	2	3	3	3	2	2	3



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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
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



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- **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	P2S02NEBIC01	Biostatistics Using R	0-8-0	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	<p>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.</p>	Classroom Lectures, Case Based Learning, Problem Based Learning, Micro-Projects	1,2,3
II	<p>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:</p>	Micro-Projects, ICT-Enable Learning,	3,4,5



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- 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
CLO 1:	3	3	2	3	2	1	–	–	2
CLO 2:	2	3	3	2	2	1	–	1	2
CLO 3:	3	3	2	3	2	1	–	1	2
CLO 4:	3	3	2	3	3	1	–	1	2
CLO 5:	2	2	3	3	2	2	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	-



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● 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	R for Data Science	https://r4ds.had.co.nz
2	StatQuest with Josh Starmer	https://www.youtube.com/@statquest
3	Swirl	https://swirlstats.com
4	Modern Statistics for Modern Biology	https://web.stanford.edu/class/bios221/book/
5	R Graph Gallery	https://r-graph-gallery.com
6	NCI Data Visualization with R	https://bioinformatics.ccr.cancer.gov/docs/data-visualization-with-r/
7	ComplexHeatmap Complete Reference	https://jokergoo.github.io/ComplexHeatmap-reference/book/
8	Datanovia	https://www.datanovia.com/en/lessons/heatmap-in-r-static-and-interactive-visualization/
9	Coursera — Statistics with R (Duke)	https://www.coursera.org/specializations/statistics
10	Biostatistics for Biomedical Research	https://hbiostat.org/bbr
11	STHDA	http://www.sthda.com/english/
12	Physalia Courses	https://www.physalia-courses.org/courses-workshops/course13/
13	HarvardX — Statistics and R	https://pll.harvard.edu/course/statistics-and-r
14	EMBL Bio-IT R & Statistics Resources	https://bio-it.embl.de/centres/csda/r-statistics-resources



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Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSE	P2S02NEBIC02	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	<p>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.</p>	Classroom Lecture, Seminars, Case-Based Learning, Experiential Learning, ICT-Enabled Learning, Self-Directed Learning	1, 2, 3,4
II	<p>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.</p>	Classroom Lecture, Seminars, Case-Based Learning, Research-Oriented Learning,	5, 6



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	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 CLOs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Application/ Analyse & above (A)	
I	1 to 4	30	1	1	10	12
II	5, 6	30	1	1	11	13
		60	02	02	21	25

- **CLOs – PLOs Matrix**

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



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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	Termarcaphi 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



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Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSE	P2S02NEBIC03	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	<p>Basic concepts of Development, fertilization and early development</p> <p>Induction, competence, induction, specification, determination, differentiation, dedifferentiation, redifferentiation; Fate maps, cell fate, cell lineages; Stem cells: potency, genomic equivalence, cytoplasmic determinants</p> <p>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</p> <p>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</p>	<p>Classroom Lecture</p> <p>Case-Based Learning</p> <p>Problem-Based Learning</p> <p>Inquiry-Based Learning</p> <p>ICT-Enabled Learning</p> <p>Reflective Practices</p> <p>Self-Directed Learning</p> <p>Research-Oriented Learning</p>	1,2
II	<p>Morphogenesis and organogenesis in plants and animals</p> <p>Organization of shoot and root apical meristem, shoot and root development, leaf development and phyllotaxy, transition to flowering, floral meristems, organogenesis and floral development</p>	<p>Classroom Lecture</p> <p>Case-Based Learning</p> <p>Seminar</p>	3,4



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	Cell aggregation and differentiation in Dictyostelium, axes and pattern formation in Drosophila, amphibia and chick; organogenesis - vulva formation in <i>Caenorhabditis elegans</i> , 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	Problem-Based Learning Inquiry-Based Learning ICT-Enabled Learning Micro Project Reflective Practices Self-Directed Learning Research-Oriented Learning	
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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	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
CLO 1:	3	2	1	2	2	1	1	1	2
CLO 2:	3	3	2	2	2	1	1	1	2
CLO 3:	3	3	2	3	3	2	1	2	2
CLO 4:	3	3	2	2	3	1	2	3	2



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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 etal.	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 Kalth off	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		
DSE	P2S02NEBIC04	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

- **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**



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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
CLO 1:	3	2	1	1	2	1	1	1	2
CLO 2:	3	3	2	2	2	1	1	1	2
CLO 3:	3	3	2	3	2	2	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%

• 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



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 Biochemistry (Semester-II)

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. & Reznick, R.	1st Ed. (2023)	Springer

● Online Resources (Open Source)

Sr. No.	Description of Resource(s)	Weblink
1	Endocrinology	https://onlinecourses.swavam2.ac.in/e-learning/preview/cec20_bt21