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 Zoology (Semester-II)

Course Type	Course Code	Course Title	Teaching-Learning Scheme L-P-T	Total Notional Hours	Course credits
DSC	**P2S02NCZOO01**	Molecular and Clinical Genetics	4-0-1	120	04

Course Learning Outcomes:

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

CLO1 Analyse the molecular organization of genes and regulatory elements to evaluate how epigenetic modifications and genomic architecture control the precision of gene expression.
CLO2 Evaluate the biochemical and molecular consequences of diverse mutation types and DNA repair mechanisms to predict their impact
CLO3 Apply principles of Mendelian and non-Mendelian inheritance to diagnose complex genetic disorders and interpret the clinical implications
CLO4 Correlate specific enzymatic deficiencies in metabolic pathways with the pathophysiology of Inborn Errors of Metabolism
CLO5 Appraise advanced genetic mechanisms, including genomic imprinting, anticipation, and mosaicism, to explain atypical inheritance patterns
CLO6 Synthesize knowledge of gene therapy, tissue engineering, and nanotechnology to design innovative molecular strategies for the treatment of chronic genetic and physiological diseases.

Unit	Course Content	Learning Pedagogies*	CLO(s)
I	**Molecular Basis of Gene Function and Mutation: Structure and Organization of Gene:** Gene structure (exons, introns, regulatory regions), Functional genome elements (promoters, enhancers); Gene Expression: Overview of transcription and translation, Regulation of gene expression (basic concepts), Chromatin organization and modelling, Epigenetic regulation: DNA methylation, histone modification; Mutations and Molecular Defects: Types of mutations: point, frameshift, repeat expansions, Molecular consequences of mutations, DNA repair mechanisms	Classroom Lecture Case-Based Learning Problem-Based Learning Inquiry-Based Learning ICT-Enabled Learning Self-Directed Learning	1,2

II	**Mendelian, Biochemical and Metabolic Genetic Disorders:** Inheritance Patterns- Autosomal Dominant, Autosomal Recessive, X-Linked Dominant, X-Linked Recessive, Y-Linked; Mechanism of Dominance and Recessiveness, allelic and locus heterogeneity; Chromosomal Disorders – Down's, Turner's, Klinefelter's, Patau, Edwards, Cri-du-chat; Uniparental Inheritance: Praderwili and Angelman's syndrome IKS Perspective on Heredity: Concept of Beeja (seed) and Beeja Dosha in relation to hereditary disorders **Inborn Errors of Metabolism (IEM):** Amino acid metabolism (e.g., Phenylketonuria), Carbohydrate metabolism (e.g., Galactosemia), Lipid metabolism (e.g., Tay-Sachs disease), Defects in purine and pyrimidine metabolism, Lysosomal storage disorders IKS Perspective on Metabolic Disorders: Agni imbalance and metabolic dysfunction in relation to inborn errors of metabolism Next generation sequencing: ACMG guidelines, New born screening	Classroom Lecture Case-Based Learning Seminar Problem-Based Learning Inquiry-Based Learning ICT-Enabled Learning Micro Project Reflective Practices Self-Directed Learning Research-Oriented Learning	3
III	**Non-Mendelian Inheritance:** Co-dominance, Multiple alleles (ABO blood groups), Epistasis, Penetrance and Expressivity, Pleiotropy, Mitochondrial Inheritance, Multifactorial Inheritance and Quantitative Traits. Hypertension and Diabetes Mellitus Threshold model, Heritability IKS Perspective on Disease Susceptibility: Prakriti (constitutional types) and its relevance to multifactorial inheritance, diabetes, and hypertension **Advanced Genetic Mechanisms:** Genomic imprinting, Anticipation, Mosaicism, Chimerism, X-inactivation, Gene-environment interactions; Polygenic Risk Scores and Genome wide Association Studies, liquid biopsy, single cell genomics	Classroom Lecture Case-Based Learning Seminar Problem-Based Learning Inquiry-Based Learning ICT-Enabled Learning Simulation and Role-Play Micro Project	4

IV	Clinical applications: Karyotyping; Overview of Prenatal Diagnostic Methods; Gene therapy: ex vivo and in vivo strategies Prodrug therapy, Ribozymes, Protein Aptamers, Intrabodies, Triple Helix Forming Oligonucleotides, Antisense Therapy; Cell and Tissue Engineering: Encapsulation Technology and Therapeutics (Diabetes, Hypothyroidism, and Hemophilia) Bio artificial organs, Artificial cells for Hemophilia, Phenylketonuria, and Diabetes; Gene Products – Humulin, Erythropoietin, Growth Hormone/Somatostatin, tPA, Interferon and Recombinant Vaccines; Overview of Nanoparticles, Nano devices – medical micro robotics, Nano robotics, Microbiovers IKS Perspective on Preventive Health: Role of diet (Ahara), lifestyle (Dinacharya), and seasonal adaptation (Ritucharya)	Classroom Lecture Case-Based Learning Seminar Problem-Based Learning Inquiry-Based Learning Research-Oriented Learning ICT-Enabled Learning Simulation Self-Directed Learning	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	1,2	28	1	1	11	13
II	2,3	28	1	1	10	12
III	3,4	32	1	1	11	13
IV	4,5,6	32	1	1	10	12
		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	2	1	1	2	-	-	2	-	-	-	2
CLO 2:	3	2	2	2	3	1	1	2	1	-	-	2
CLO 3:	3	2	2	3	2	-	2	3	-	-	2	2
CLO 4:	3	2	2	2	3	-	1	3	1	-	-	2
CLO 5:	3	3	1	2	1	-	-	2	-	-	-	3
CLO 6:	3	3	2	3	3	1	3	3	2	3	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:**

Sr.No.	Title	Author(s)	Edition/Year	Publisher
1	Molecular Biology of the Cell	Alberts, B. et al.	7th Edn 2022	Garland Science
2	Thompson & Thompson Genetics and Genomics in Medicine	Nussbaum, R. et al.	9th Edn 2023	Elsevier
3	Emery's Elements of Medical Genetics and Genomics	Turnpenny, P. & Ellard, S.	16th Edn 2021	Elsevier
4	Human Molecular Genetics	T. & Read, A	5th Edn 2019	CRC Press
5	Medical Genetics	Jorde, L. B. et al.	6th Edn 2020	Elsevier
6	Charaka Samhita	Sharma, P. V	Reprint 2014	Chaukhambha Orientalia

- **Online Resources (Open Source)**

Sr. No.	Description of Resource(s)	Weblink
1	OMIM (Online Mendelian Inheritance in Man)	https://www.omim.org/
2	NCBI Bookshelf (Genetics/Metabolism)	https://www.ncbi.nlm.nih.gov/books/
3	MedGen (NCBI's Portal for Medical Genetics)	https://www.ncbi.nlm.nih.gov/medgen/

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Master of Science in Zoology (Semester-II)

Course Type	Course Code	Course Title	Teaching-Learning Scheme L-P-T	Total Notional Hours	Course credits
DSC	**P2S02NCZOO02**	Advanced Developmental Biology	4-0-1	120	04

Course Learning Outcomes:

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

CLO1 Analyse the cytological and molecular events of gametogenesis and fertilization to evaluate the mechanisms of gamete activation and the initiation of embryonic development.

CLO2 Evaluate the molecular regulation of differential gene expression, cytoplasmic determinants, and conserved cell signalling pathways (Wnt, Notch, Hedgehog) in governing cell fate and differentiation.

CLO3 Compare the processes of cleavage, gastrulation, and organogenesis across diverse model organisms to interpret the conserved and divergent strategies of germ layer formation.

CLO4 Interpret the experimental basis of embryonic induction and the Spemann Organizer to explain the establishment of body axes and the genetic hierarchy of pattern formation.

CLO5 Appraise the influence of environmental factors, teratogens, and epigenetic modifications on developmental plasticity and the manifestation of congenital anomalies.

CLO6 Integrate the principles of Evolutionary Developmental Biology (Evo-Devo) with regeneration biology to analyze the conservation of genetic toolkits and the evolution of complex body plans

Unit	Course Content	Learning Pedagogies*	CLO(s)
I	Gametogenesis, Fertilization and Molecular Basis of Development: Scope and significance of developmental biology, Gametogenesis: spermatogenesis and oogenesis- Structure and function of gametes; Fertilization: mechanisms, sperm-egg interaction, egg activation; Molecular basis of development: Differential gene expression, Transcriptional and translational regulation, Cytoplasmic determinants, Cell signaling pathways (Wnt, Notch, Hedgehog), Cell adhesion molecules	Classroom Lecture Case-Based Learning Problem- Based Learning Inquiry-Based Learning Self-Directed Learning	1,2

II	Early and Late Embryonic Development: Cleavage: patterns and types, Blastulation and gastrulation, Fate maps, Morphogenetic movements and germ layer formation; Comparative embryology using model organisms: *Caenorhabditis elegans, Drosophila melanogaster,* Amphibia, Birds, Mammals; Induction & competence, Primary embryonic induction, Organogenesis: Ectoderm (neurulation, neural crest), Mesoderm (paraxial, intermediate, lateral plate, splanchnic) and Endoderm development	Classroom Lecture Case-Based Learning Seminar Problem- Based Learning Inquiry- Based Learning Self-Directed Learning	3
III	Axis Formation and Pattern Development: Spemann Organizer experiment, Establishment of body axes in: *Caenorhabditis elegans,* Birds, Mammals; Limb development: Proximo-distal axis, Anterior-posterior axis and dorsal-ventral axis; Pattern formation in *Drosophila*: Maternal effect genes, Segmentation genes and Homeotic genes, Programmed cell death (Apoptosis) in development	Classroom Lecture Case-Based Learning Seminar Problem- Based Learning ICT-Enabled Learning	4
IV	Environmental Influence, Developmental Disorders and Evolution: Environmental regulation of development, Teratogens and developmental abnormalities, Hormonal and epigenetic regulation, Stem cells (ES, iPSCs), Developmental defects and congenital anomalies, Evolutionary developmental biology (Evo-Devo): Conserved genetic pathways, Regeneration biology (limb regeneration), Role of Hox genes, Evolution of body plans IKS Perspective on Development and Prenatal Health: Concepts of Beeja, Garbhini Paricharya and Dhatu formation in relation to embryonic development and congenital disorders	Classroom Lecture Case-Based Learning Seminar Problem- Based Learning Inquiry- Based Learning Industrial Visit/Field Visit	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	1,2	28	1	1	10	12
II	3	28	1	1	10	12
III	4	32	1	1	10	12
IV	5, 6	32	1	1	12	14
		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	2	1	1	1	1	-	-	-	-	-	-
CLO 2:	3	3	2	1	1	2	-	-	-	-	-	-
CLO 3:	3	2	3	2	1	2	-	2	-	-	-	-
CLO 4:	3	3	3	2	2	3	-	2	-	1	1	1
CLO 5:	3	3	3	3	2	3	2	3	2	1	1	1
CLO 6:	3	2	3	1	1	3	2	2	2	1	1	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	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	The Virtual Embryo Zoo	https://virtual-embryo-zoo.sf.czbiohub.org/
2	SDB CoRe (Collaborative Resources)	https://sdbcore.org/

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Master of Science in Zoology (Semester-II)

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	**P2S02NCZOO03**	Molecular and Applied Endocrinology	4-0-1	120	04

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

CLO1 Appraise the anatomical and physiological organization of the endocrine system, including the classification and biosynthesis of hormones, to understand their role in systemic homeostasis.
CLO2 Analyse the neuroendocrine integration and feedback mechanisms that regulate hormonogenesis and the systemic transport of diverse hormone classes.
CLO3 Interpret the molecular dynamics of hormone-receptor interactions and the specific intracellular signalling cascades, including GPCR and Tyrosine Kinase pathways, that mediate cellular responses.
CLO4 Evaluate the pathophysiology of endocrine disorders through the interpretation of clinical case studies, laboratory diagnostic reports, and advanced imaging data.
CLO5 Apply classical and advanced endocrine methodologies, such as immunoassays, confocal microscopy, and flow cytometry, to investigate hormone localization and receptor kinetics.
CLO6 Critique the industrial and pharmaceutical applications of synthetic hormones and the impact of endocrine disruptors on reproductive health and environmental safety.

Unit	Course Content	Learning Pedagogies*	CLO(s)
I	Introduction to Endocrine System and hormones; Hormones: Classification, Synthesis and Functions: Classes of hormones: peptide, steroid, thyroid, eicosanoids, pheromones, Hormone synthesis (hormonogenesis), Mechanism of hormones secretions; Regulation of hormone production (Types of regulators); Transport and distribution, Mechanism of hormones action, Signalling (autocrine/paracrine and endocrine); 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 Case-Based Learning Problem-Based Learning Research- Oriented Learning Inquiry-Based Learning Simulation and Role-Play ICT-Enabled Learning Reflective Practices	1,5

II	Mechanism of Hormone Action: Hormone receptors: Membrane receptors, nuclear receptors; Signal transduction pathways: Second messengers (cAMP, IP3, DAG); Hormone regulation and feedback mechanisms, Permissive and synergistic actions; Molecular signaling pathways: GPCR pathways, Tyrosine kinase receptors, Cross-talk between signaling pathways	Classroom Lecture Case-Based Learning Problem-Based Learning	2, 6
III	Endocrine Methodologies: History and overview of endocrinology: Structure and function of endocrine glands: hypothalamus, pituitary, thyroid, adrenal, pancreas, gonads; Neuroendocrine integration; Classical endocrine methodologies: Ablation and replacement, Bioassays, immunoassays, Immunocytochemistry, autoradiography, Hormone-receptor interaction studies, Cloning techniques, Confocal microscopy (hormone receptor localization), Flow cytometry (cell signaling & hormone receptor analysis) and Advanced imaging techniques in endocrine research	Classroom Lecture Case-Based Learning Problem-Based Learning Research-Oriented Learning Collaborative Learning Inquiry-Based Learning	3,4
IV	Pathophysiology and Clinical Endocrinology: 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, Polycystic ovarian syndrome, Diagnostic interpretation (laboratory reports and imaging interpretation), Personalized endocrine therapy IKS Perspective on Endocrine Health and Disease: Concepts of Dosha, Prakriti and Prameha in relation to hormonal balance, metabolic disorders, and personalized medicine	Classroom Lecture Case-Based Learning Problem-Based Learning Research-Oriented Learning Collaborative Learning Simulation and Role-Play ICT-Enabled Learning	4,5,6

- **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	1,5	28	1	1	10	12
II	2,6	28	1	1	10	12
III	3,5	32	1	1	10	12
IV	4,5,6	32	1	1	12	14
		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	2	1	1	1	1	-	-	-	-	-	-
CLO 2:	3	3	2	1	1	2	-	-	-	-	-	-
CLO 3:	3	3	3	2	1	3	-	2	-	-	-	-
CLO 4:	3	2	3	2	2	3	-	2	2	1	1	1
CLO 5:	3	3	3	3	2	3	2	3	2	1	1	1
CLO 6:	3	2	3	2	2	3	2	2	2	1	1	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	Principles and Techniques of Biochemistry and Molecular Biology	Keith Wilson & John Walker	8th Edn (2018)	Cambridge Univ. Press
2	Vertebrate Endocrinology	David O. Norris & James A. Carr	6th Edn (2021)	Academic Press Elsevier)
3	Greenspan's Basic and Clinical Endocrinology	David G. Gardner & Dolores Shoback	10th Edn. (2017/20)	McGraw Hill
4	Endocrinology: An Integrated Approach	Stephen Nussey & Saffron Whitehead	1st Edn. (2022)	BIOS Scientific Publishers
5	Imaging in Endocrine Disorders	Sahdev, A. & Reznek, R.	1st Edn. (2023)	Springer

- **Online Resources (Open Source)**

Sr. No.	Description of Resource(s)	Weblink
1	Introduction to Endocrinology	https://medtube.net/endocrinology

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Master of Science in Zoology (Semester-II)

Course Type	Course Code	Course Title	Teaching-Learning Scheme L-P-T	Total Notional Hours	Course credits
DSC	**P2S02NCZOO04**	Clinical Genetics and Developmental Biology practicals	0-8-0	120	04

Course Learning Outcomes:

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

CLO1 Demonstrate advanced technical skills in isolating genomic DNA and proteins, and utilize quantitative methods (Colorimetry, Electrophoresis, ELISA) to assess biological molecules.

CLO2 Evaluate inheritance patterns and evolutionary dynamics by applying statistical tools (Chi-square, Hardy-Weinberg), performing pedigree analysis and identifying chromosomal abnormalities through karyotyping.

CLO3 Analyse the molecular and morphological stages of vertebrate and invertebrate development, interpreting the role of signalling pathways (Wnt/Notch), axis formation, and Hox genes in pattern formation.

CLO4 Integrate computational tools (BLAST) and biochemical assays to diagnose inborn errors of metabolism, endocrine disorders, and the molecular basis of genetic diseases.

CLO5 Design and execute evidence-based investigations (mini-projects) to correlate genetic mutations with clinical phenotypes, demonstrating the ability to synthesize complex datasets into coherent scientific reports.

Unit	Course Content	Learning Pedagogies*	CLO(s)
I	1. Isolation and quality assessment of genomic DNA from animal samples 2. Quantification of DNA using colorimetric (Diphenylamine) method 3. Agarose gel electrophoresis for DNA separation and fragment size estimation 4. Protein separation using SDS-PAGE and interpretation of banding patterns 5. Estimation of gene frequency and genotype frequency using the Hardy-Weinberg equilibrium and interpretation of deviations 6. Application of Chi-square (χ^2) test to analyse genetic ratios and population data	Interactive lectures Experiential learning Problem Based Learning Collaborative Learning	1 to 5

	7. Sequence alignment and mutation identification using BLAST 8. Pedigree analysis for Mendelian and non-Mendelian inheritance patterns 9. Karyotype analysis and identification of chromosomal abnormalities (Down, Turner, Klinefelter syndromes) 10. Case-based analysis of inborn errors of metabolism (IEMs) and biochemical defects 11. Mini-project: Data-based investigation (mutation → phenotype correlation / clinical dataset analysis) 12. Case study: Comparative analysis of embryonic stages and anomalies across vertebrates 13. Developmental staging and anomaly analysis in *Danio rerio* 14. Regeneration studies (Planaria) with pathway interpretation 15. Life cycle and developmental genetics of Drosophila melanogaster 16. Study of axis formation and organizer concept (simulation/case-based) 17. Analysis of cell signaling pathways in development (Wnt/Notch/Hedgehog) 18. Fate mapping and germ layer analysis using virtual tools 19. Apoptosis in development and interpretation 20. Case study: Molecular basis of a developmental/ genetic disorder		

- **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)	
	1 to 5	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	2	3	2	3	-	2	2	1	-	1	2
CLO 2:	3	2	2	3	2	1	2	2	2	-	1	2
CLO 3:	3	3	2	1	2	1	1	2	-	-	1	2
CLO 4:	2	3	1	3	3	1	2	3	2	2	2	2
CLO 5:	2	2	3	3	3	2	3	3	2	2	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:**

Sr. No.	Title	Author(s)	Edition/Year	Publisher
1	Clinical Biochemistry: Metabolic and Clinical Aspects	Marshall, W.J. et al.	3rd Edn 2014	Elsevier
2	Practical Skills in Biomolecular Sciences	Brown, T.A.	4th Edn 2019	Pearson

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Master of Science in Zoology (Semester-II)

Course Type	Course Code	Course Title	Teaching-Learning Scheme L-P-T	Total Notional Hours	Course credits
DSC	**P2S02NCZOO05**	Endocrine and Field Laboratory Techniques	0-8-0	120	04

Course Learning Outcomes:

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

CLO1 Apply and analyse advanced laboratory techniques (ELISA, hormone assays, histological processing, biochemical estimations) to generate and interpret biological data accurately.

CLO2 Analyze and evaluate biochemical and hormonal parameters (T3, T4, TSH, cholesterol, glycogen) and interpret clinical case studies of endocrine disorders for diagnostic understanding.

CLO3 Evaluate and integrate concepts of developmental biology (IVF, pattern formation, Evo-Devo, Hox genes) to explain mechanisms of growth, differentiation, and anomalies.

CLO4 Design and apply ecological sampling methods and population models (transects, quadrats, mark–recapture), and analyze field data using statistical and GIS tools.

CLO5 Utilize, evaluate, and synthesize digital tools (spreadsheets, GIS, AI models) to analyse biological datasets and design and present a mini-project integrating experimental and computational approaches.

Unit	Course Content	Learning Pedagogies*	CLO(s)
I	1. IVF technology - case-based learning and visit report 2. Evo-Devo: pattern formation and Hox gene analysis 3. Histoarchitectural study of endocrine gland 4. Determination of T3, T4 and TSH in serum 5. Estimation of cholesterol, inorganic phosphorous and calcium in serum 6. Glycogen estimation and metabolic significance 7. Hormone assay (ELISA -demonstration/data-based) 8. Case study: Diabetes mellitus (Type I & II) and Thyroid disorders (hypo/hyperthyroidism) 9. Mini-project: Clinical endocrine disorder analysis 10. Designing and justifying the use of random, stratified, and systematic transects and quadrats for different habitat types	Interactive lectures Experiential learning Problem Based Learning Collaborative Learning	1 to 5

	11. Practical application of the Mark-recapture method to estimate the population size of mobile organisms. 12. Demonstrating the use of tagging, banding, and QR coding for tracking organisms in a field setting. 13. Utilizing digital tools and spreadsheets for data entry, coding, and basic statistical interpretation in a field context. 14. Introduction to GIS tools for the visualization of biological field data and species distribution mapping 15. Practical execution of maceration, squash, and clearing techniques for initial microscopic analysis 16. Hands-on training in the fixation, dehydration, infiltration, and embedding of tissue samples 17. Performing staining procedures to localize cellular starch, proteins, lipids, and nucleic acids in biological tissues. 18. Interpreting AI predictive models to investigate protein folding and structural function. 19. Using regression and classification models for disease prediction and biomarker discovery		

- **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)	
	1 to 5	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	2	3	2	3	1	1	1	-	-	1	1
CLO 2:	3	3	2	3	2	2	1	2	2	-	1	1
CLO 3:	3	3	2	2	2	1	-	1	2	-	-	1
CLO 4:	3	3	3	3	3	3	2	2	3	1	2	1
CLO 5:	3	3	3	3	3	2	1	3	2	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	Ecological Methods	Southwood, T.R.E. & Henderson, P.A.	4th Edn 2009	Wiley-Blackwell
2	Histological Techniques	Bancroft, J.D. & Gamble, M.	7th Edn 2019	Elsevier
3	Biostatistical Analysis	Zar, J. H.	5th Edn 2010	Pearson

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Master of Science in Zoology (Semester-II)

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSE	**P2S02NEZOO01**	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	2	3	2	1	1	2	1	1	2	2
CLO 2:	1	2	1	3	1	1	1	3	1	1	1	2
CLO 3:	1	1	2	3	1	1	1	2	2	1	1	2
CLO 4:	1	2	2	3	1	1	1	2	2	1	1	2
CLO 5:	1	1	1	3	1	1	1	3	1	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, 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 Zoology (Semester-II)

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSE	**P2S02NEZOO02**	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. Operations of ultramicrotome and freezing ultramicrotome. Ultrastructural cytochemistry: Tannin, protein, cell wall polysaccharide, lignin and membrane. Ultrastructural cytochemistry: Enzymes: Peroxidase and phosphatase. Immunocytochemistry.	Classroom Lecture, Seminars, Case-Based Learning, Research-Oriented Learning, Experiential Learning, ICT-Enabled Learning	5, 6
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	30	1	1	10	12
II	5, 6	30	1	1	11	13
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:	3	2	2	1	2	1	1	2	1	1	1	1
CLO 2:	3	2	2	1	3	1	1	2	1	1	1	1
CLO 3:	2	2	3	1	3	1	1	3	1	1	1	1
CLO 4:	2	3	3	1	3	1	1	3	2	1	1	1
CLO 5:	2	2	3	1	3	1	1	3	2	1	1	1
CLO 6:	2	3	3	2	3	1	1	3	2	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	-

- **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	tanical 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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Master of Science in Zoology (Semester-II)

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSE	**P2S02NEZOO03**	Methods in Field Biology	1-2-0	60	02

Course Learning Outcomes (CLOs)

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

CLO1 Analyze and justify the selection of appropriate scientific sampling strategies and field techniques for reliable biological data collection.
CLO2 Critically analyze and interpret field data using statistical tools to derive meaningful biological inferences.
CLO3 Evaluate and optimize the use of digital tools and standardized formats for accurate data management, analysis, and visualization.
CLO4 Design, execute, and critically evaluate a field-based research study, integrating ethical considerations and scientific rigor.

Unit	Course Content	Learning Pedagogies*	CLO(s)
I	Sampling Design, Field Techniques and Data Types: Principles of sampling design: random, stratified, systematic; Field sampling techniques: transect, quadrat, point count; Sampling of mobile vs sessile organisms; Marking and tracking methods: tagging, banding, QR coding; Mark–recapture method *(N = MC/R)*; Types of biological data: qualitative vs quantitative; Sources of sampling error and bias	Classroom Lecture (CL), Problem-Based Learning (PBL), Experiential Learning, ICT-Enabled Learning	1
II	Data Handling, Basic Statistics and Visualization: Data entry, coding, and tabulation; Use of spreadsheets (Excel/basic tools); Descriptive statistics: mean, median, mode, standard deviation; Graphical representation: bar charts, histograms, line graphs; Introduction to GIS (data visualization only); Concept of hypothesis testing; t-test; Interpretation of statistical outputs in field context; Case based practice with sample datasets and graph preparation	Classroom Lecture (CL), Problem-Based Learning (PBL), Experiential Learning, ICT-Enabled Learning	2, 3

III	Research Design, Mini Project and Data Interpretation: Research design in field biology: Problem identification, Hypothesis formulation, Site and species selection; Observational vs experimental studies, Basic data interpretation and inference; Scientific Report writing; Ethical guidelines and legal permissions; Risk assessment and safety protocols	Classroom Lecture (CL), Problem-Based Learning (PBL), Experiential Learning, ICT-Enabled 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 Cos	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Application/ Analyse & above (A)	
I	1	20	1	1	7	9
II	2, 3	20	1	1	6	8
III	3, 4	20	1	1	6	8
		60	03	03	19	25

- **CLOs – PLOs Matrix**

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

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

- **uggested Learning Materials Books:**

Sr. No.	Title	Author(s)	Edition/Year	Publisher
1	Measuring Biological Diversity	Anne E. Magurran	2004	Blackwell Publishing
2	Ecological Methodology	Charles J. Krebs	2nd, 2014	Benjamin Cummings
3	Biostatistical Analysis	Jerrold H. Zar	5th, 2010	Pearson
4	Sampling Methods for Ecology	T.R.E. Southwood & P.A. Henderson	3rd, 2000	Blackwell Science

- **Online Resources (Open Source)**

Sr. No.	Description of Resource(s)	Weblink
1	National Ecological Observatory Network	https://www.neonscience.org/

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Master of Science in Zoology (Semester-II)

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSE	**P2S02NEZOO04**	AI in Biology	2-0-0	60	02

Course Learning Outcomes (CLOs)

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

CLO1 Analyse the fundamental principles of Artificial Intelligence and Machine Learning architectures to evaluate their specific applications in genomic, proteomic, and evolutionary biology.
CLO2 Apply advanced computational algorithms and machine learning frameworks to extract biologically meaningful patterns from high-throughput "Omics" datasets.
CLO3 Interpret AI-driven predictive models in molecular biology to investigate protein folding, drug-target interactions, and the molecular signatures of complex diseases.
CLO4 Critique the ethical implications, data privacy challenges, and algorithmic biases associated with AI implementation in clinical diagnostics and biological research.

Unit	Course Content	Learning Pedagogies*	CLO(s)
I	Fundamentals of AI and Machine Learning: Introduction to Artificial Intelligence: Types of AI: Narrow AI, Generative AI; Basics of Machine Learning: Supervised learning, Unsupervised learning, Reinforcement learning; Applications of AI in biological sciences	Classroom Lecture (CL), Self learning	1
II	AI in Computational Biology and Bioinformatics: Introduction to Computational Biology and Bioinformatics, Data preprocessing and feature extraction in biological datasets, Prediction of protein structure and function; AI approaches in molecular docking and drug design; Classification and clustering methods; AI in Molecular Evolutionary Genetics Analysis (MEGA); Regression models in biological studies	Classroom Lecture (CL), Problem-Based Learning (PBL), ICT-Enabled Learning	2, 3
III	AI in Health and Research: AI in disease diagnosis and biomarker discovery; AI in epidemiology and disease prediction; Role of AI in modern biological research; AI tools: overview and applications, Ethics in AI: Data privacy, Bias and reliability; Risk analysis and future perspectives	Classroom Lecture (CL), Collaborative 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 Cos	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Application/ Analyse & above (A)	
I	1	20	1	1	7	9
II	2, 3	20	1	1	6	8
III	3, 4	20	1	1	6	8
		60	03	03	19	25

- **CLOs – PLOs Matrix**

CLOs \ PLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO 1:	2	2	1	2	1	-	1	2	1	-	1	2
CLO 2:	1	3	2	3	2	-	-	2	1	1	2	2
CLO 3:	3	3	1	3	1	2	1	3	2	1	2	2
CLO 4:	1	2	-	1	-	2	3	2	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, 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	Artificial Intelligence: A Modern Approach	Stuart Russell, Peter Norvig	4th Ed., 2020	Pearson
2	AI in Healthcare	Adam Bohr, Kaveh Memarzadeh	2020	Academic Press
3	Ethics of Artificial Intelligence and Robotics	Vincent C. Müller (Ed.)	2020	Oxford University Press
4	AI in Computational Biology and Bioinformatics	Ramsundar *et al.*,	2019	O'Reilly Media / Shroff Publishers
5	AI in Molecular Evolution and Drug Discovery	Brown, N.	1st Edn 2020	Royal Society of Chemistry

- **Online Resources (Open Source)**

Sr. No.	**Description of Resource(s)**	**Weblink**
1	MEGA Software & MEGA-GPT	https://www.megasoftware.net/
2	WHO AI in Health Ethics	https://www.who.int/health-topics/artificial-intelligence