Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

Empowered Autonomous Institution

Structure and Curriculum of Four Year Multidisciplinary Degree (Honors/Research) Programme with Multiple Entry and Exit option

Undergraduate Programme of Science and Technology

B.Sc. (Honors/Research) in Zoology

Board of Studies

in

Zoology

Rajarshi Shahu Mahavidyalaya, Latur

Empowered Autonomous Institution

[UG I Year]

w.e.f. June, 2026

(In Accordance with NEP-2020)

Review Statement

The NEP Cell reviewed the Curriculum of **B.Sc. In Zoology** to be effective from the **Academic Year 2026-27.** It was found that, the structure is as per the NEP-2020 guidelines of Govt. of Maharashtra.

Date: 10/04/2026

Place: Latur

NEP CELL

Rajarshi Shahu Mahavidyalaya, Latur

Empowered Autonomous Institution

CERTIFICATE

I hereby certify that the documents attached are the Bonafide copies of the Curriculum of B.Sc. I Year Zoology to be effective from the Academic Year 2026-27.

Date: 10/04/2026

Place: Latur

(Name and Signature)

Chairperson

Board of Studies in Zoology

Rajarshi Shahu Mahavidyalaya, Latur

Empowered Autonomous Institution

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

Empowered Autonomous Institution

Members of Board of Studies in Zoology

Under the Faculty of Science and Technology

Sr. No.	Name	Designation	In position
1	Dr. Dnyaneshwar Rathod, Associate Professor, Rajarshi Shahu Mahavidyalaya, Latur	Chairperson	HoD
2	Prof. Dr. M.Y. Kulkarni, Head, Dept of Zoology N.S. B College, Nanded	Member	V.C. Nominee
3	Prof. Dr. Mamidala Estari, Kakatiya University, Warangal	Member	Academic Council Nominee
4	Dr. Ravikumar Baburao Shinde, Shri. Pundlik Maharaj Mahavidyalaya, Nandura, Dist. Buldana - 443404	Member	Academic Council Nominee
5	Mr. Balasaheb Venktrao Sager, Fishery Development Officer, Latur	Member	Expert from outside for Special Course
6	Dr. Ravi Solunke, Head, Department of Zoology Dayanand Science College, Nanded	Member	Expert from outside for Special Course
7	Mr. Ishrar Deshmukh, QMS Head, Sai Life Science , Hyderabad	Member	Expert from Industry
8	Mr. Suraj Revankar Assistant Professor, Rajarshi Shahu Mahavidyalaya, Latur	Member	P.G. Alumni
9	Dr. Kakasaheb Raut, Associate Professor, Rajarshi Shahu Mahavidyalaya, Latur	Member	Faculty Member
10	Mr. Datta Nalle, Assistant Professor, Rajarshi Shahu Mahavidyalaya, Latur	Member	Faculty Member
11	Ms. Pratiksha Patil, Assistant Professor, Rajarshi Shahu Mahavidyalaya, Latur	Member	Faculty Member
12	Ms. Sakshi Rajput, Assistant Professor, Rajarshi Shahu Mahavidyalaya, Latur	Member	Faculty Member

From the Desk of the Chairperson…

The Department of Zoology was established in the year 1971. The department has been recognized by our parent University as Research center since 8th May 2003 and now it has been developed into center of teaching and research in Zoology.

To reach the mission of "Pursuit of Excellence" in higher education to make our students globally competent. The departmental staff is committed towards our work with dedication, determination and devotion.

National Education Policy NEP-2020 focuses more on practical rather than theoretical learning. It also focus on developing overall personality of students by incorporating Humanitarian and Constitutional values, creativity and critical thinking, harnessing innovation, use of modern technology and interaction with various stakeholders. It uses the practical based pedagogy to evolve and make education more experiential, holistic, integrated, learner-centric, flexible and developing skill etc. To skilled and trained students can accept the challenge of the future, as we know that the new policy also envisages the refinement and improvement in the Learning Outcome based Curriculum Framework.
The syllabus of B.Sc. I has been designed as per the National Education Policy (NEP), 2020, the present structure comprises Discipline specific courses (DSC), Discipline Specific Electives (DSE), Discipline Specific Minor Course (DSM), Generic/Open Electives (GE/OE), Vocational Specific Course (VSC), Skill Enhancement Course (SEC), Ability Enhancement Course (AEC) etc. The discipline specific courses (DSC) are compulsory and the elective courses can be chosen from the given Basket. Except Ability Enhancement courses, all other courses, comprise theory and practicals.

The project work is specially underlined in this structure. The project will mainly involve experimental work. The students will be asked their choice for project. The Generic Electives will be offered to the students of other departments of the college. The students will have the option to choose one generic elective from the given Basket. The generic elective comprises theory as well as practical. The students will also undertake one Vocational Specific Course (VSC) and one Skill Enhancement Course (SEC) of two credits each. The VSC and SEC also comprise theory and practicals. These courses will be chosen by the students from the concerned basket. One of the DSC is specified for Indian Knowledge Systems (IKS). Indian Knowledge Systems have a strong foundation in Indian Culture, Philosophy and Spirituality and have evolved through thousands of years.

B.Sc. Zoology course will help to understand the behaviour, structure and evolution of animals. Zoologists use a wide range of approaches to do this, from genetics to molecular and cellular biology, as well as physiological processes and anatomy, whole animals, populations, and their ecology. The scope of Zoology as a subject is very broad. The intention is to understand the subject of Zoology in

the evolving biological paradigm in modern times; where, living beings need to be understood at the level of atomic interactions; and comparative systems of organisms need to be studied through the prism of integrated chemical, physical, mathematical and molecular entities to appreciate the inner working of different organisms at morphological, cellular, molecular, interactive and evolutionary levels. The key areas of study within the disciplinary/subject area of Zoology comprise: animal diversity, principles of ecology, comparative anatomy and developmental biology of vertebrates, physiology and biochemistry, genetics and evolutionary biology, animal biotechnology, applied zoology, behaviour, immunology, reproductive biology, and insect, vectors and diseases. B.Sc. degree programme in Zoology also deals with skill enhancement courses such as apiculture, aquarium fish keeping, medical diagnostics, sericulture etc. The depth and breadth of study of individual topics dealt with would vary with the nature of specific Zoology programmes.

Our institution gives importance in mission to provide value and need based education which can be useful to students to get the skill for entrepreneurship and jobs or self-help for earnings. This institution is connected long back with anti-superstition activity to develop the scientific attitude among students. As a part of the efforts to enhance the interest and employability of graduates of Zoology programmes, the curricula for these programmes are expected to include learning experiences that offer opportunities for higher studies and research at reputed laboratories.

(Name and Signature)

Chairperson

Board of Studies in Zoology

Rajarshi Shahu Mahavidyalaya, Latur

Empowered Autonomous Institution

Shiv Chhatrapati Shikshan Sanstha's

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Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

Empowered Autonomous Institution

Faculty of Science and Technology

Structure for Four Year Multidisciplinary Undergraduate Degree Programme in Zoology Multiple Entry and Exit (In accordance with NEP-2020)

Year & Level	Sem	Major		Minor	OE	VSC/ SEC (VSEC)	AEC/ VEC	OJT,FP,CEP, RP	Credit per Sem.	Cum./Cr. per exit
		DSC	DSE							
1	**2**	**3**		**4**	**5**	**6**	**7**	**8**	**9**	**10**
I 4.5	I	DSC I: 04 Cr. DSC II: 04 Cr.	NA	NA	OE-I: 04 Cr.	VSC-I: 02 Cr. SEC-I: 02 Cr.	AEC-I MIL: 02 Cr. VEC-I: 02 Cr.	CC-I: 02 Cr. (NSS, NCC, Sports, Cultural)/ CEP-I: 02 Cr. (SES-I)/ OJT: 02 Cr. / Mini Project: 02 Cr.	22	44 Cr. UG Certificate
	II	DSC III: 04 Cr. DSC IV: 04 Cr.	NA	NA	OE-II: 04 Cr.	VSC-II: 02 Cr. SEC-II: 02 Cr.	AEC-II MIL: 02 Cr. VEC-II: 02 Cr.	Generic IKS: 02 Cr.	22	
	Cum. Cr.	16	-	-	08	04+04= 08	04+02+02=08	04	44	
Exit Option: Award of UG Certificate in Major with 44 Credits and Additional 04 Credits Core NSQF Course / Internship or continue with Major and Minor										

Abbreviations:

1.	DSC	: Discipline Specific Core (Major)
2.	DSE	: Discipline Specific Elective (Major)
3.	DSM	: Discipline Specific Minor
4.	OE	: Open Elective
5.	VSEC	: Vocational Skill and Skill Enhancement Course
6.	VSC	: Vocational Skill Course
7.	SEC	: Skill Enhancement Course
8.	AEC	: Ability Enhancement Course
9.	MIL	: Modern Indian Languages
10.	IKS	: Indian Knowledge System
11.	FSRCE	: Fostering Social Responsibility & Community Engagement
12.	VEC	: Value Education Course
13.	OJT	: On Job Training
14.	FP	: Field Project
15.	CEP	: Community Engagement Programme
16.	CC	: Co-Curricular Course
17.	RP	: Research Project/Dissertation
18.	SES	: Shahu Extension Services

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

Empowered Autonomous Institution

Faculty of Science and Technology

(UG. I Year)

Year & Level	Semester	Course Code	Course Title	Credits	No. of Hrs.
I 4.5	I	101ZOO1101 (DSC-I)	Life and Diversity of Non-chordates	03	45
		101ZOO1103	Lab Course-I	01	30
		101ZOO1102 (DSC-II)	Cell Biology	03	45
		101ZOO1104	Lab Course-II	01	30
		GE-I	From Basket	04	60
		101ZOO1501 (VSC-I)	Biochemical Techniques and Instrumentation	02	45
		(SEC-I)	From Basket	02	45
		(AEC-I)	From Basket	02	45
		(VEC-I)	Constitution of India	02	45
		AIPC/OJT-I	Mini Project	02	45
	Total Credits			**22**	
	II	101ZOO2101 (DSC-III)	Life and Diversity of Chordates	03	45
		101ZOO2103	Lab Course-III	01	30
		101ZOO2102 (DSC-IV)	Developmental Biology	03	45
		101ZOO2104	Lab Course-IV	01	30
		OE-II	From Basket	04	60
		101ZOO2501 (VSC-II)	Sericulture Industry and Marketing	02	45
		(SEC-II)	From Basket	02	45
		(AEC-II)	From Basket	02	45
		CC	CC – I	02	45
		Generic IKS	Introduction to Indian Knowledge System	02	45
	Total Credits			**22**	
Total Credits (Semester I & II)				**44**	

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

Empowered Autonomous Institution

Name of the Programme : B.Sc. In Zoology

Programme Outcomes (POs) for B.Sc. Zoology Programme	
PO 1	**Fundamental Knowledge and Specialization** Students will demonstrate a deep understanding of the fundamental concepts, principles, and processes of animal biology. This includes mastery over animal diversity, morphology, anatomy, physiology, genetics, and evolutionary biology.
PO 2	**Practical Skills and Laboratory Techniques** Graduates will be proficient in standard laboratory and field techniques, including microscopy, dissection, specimen preservation, and biochemical analysis, ensuring high technical competence in biological investigations.
PO 3	**Analytical Competence and Data Interpretation** Students will possess the ability to accurately collect, analyze, and interpret biological data. They will be adept at using statistical tools and bioinformatics to derive meaningful conclusions from complex biological datasets.
PO 4	**Ecological Consciousness and Sustainable Management** Students will develop a strong awareness of environmental issues and biodiversity. They will evaluate the impact of human activities on animal populations and suggest sustainable solutions for managing natural resources, wildlife, and ecosystems.
PO 5	**Scientific Temper and Critical Thinking** Graduates will exhibit a scientific mindset characterized by inquisitiveness and objective reasoning. They will be capable of identifying research gaps, designing controlled experiments, and formulating evidence-based solutions to biological problems.
PO 6	**Ethics, Professionalism, and Animal Welfare** Students will apply ethical principles in all professional activities, focusing on animal welfare, biosafety, and intellectual property rights. They will adhere to legal frameworks and understand the moral implications of biological research.
PO 7	**Communication and Digital Literacy** Graduates will communicate complex biological information effectively through technical reports, presentations, and digital platforms, using modern software to visualize biological systems and patterns for scientific and public audiences.
PO 8	**Career Readiness, Lifelong Learning, and Social Responsibility** Students will explore commercial applications of Zoology (e.g., aquaculture, sericulture) while committing to continuous professional development. They will apply biological knowledge to address social issues like public health and community welfare.

Programme Specific Outcomes (PSOs) for B.Sc. Zoology	
PSO No.	**After completion of this programme the students will be able to -**
PSO 1	**Advanced Biological, Evolutionary, and Molecular Expertise** Demonstrate a profound understanding of complex functional mechanisms, genetic inheritance, systemic physiology, and evolutionary relationships. Students will master the intricate workings of the cell—including signaling pathways and gene expression—while applying modern taxonomic tools to classify organisms using both morphological and molecular data.
PSO 2:	**Ecological Stewardship and Sustainable Environmental Management** Evaluate ecosystem dynamics, conservation biology, and wildlife management strategies. Graduates will be equipped to address global environmental challenges, such as habitat loss and climate change, by implementing scientific interventions and sustainable ecological practices to preserve biodiversity.
PSO 3	**Research Methodology, Technical Proficiency, and Data Analytics** Design and execute independent research projects using advanced laboratory techniques (such as PCR, chromatography, and microscopy) and rigorous field-based data collection. Students will apply sophisticated biostatistical methods and bioinformatics tools to analyze large-scale genomic, proteomic, or ecological datasets with high accuracy.
PSO 4	**Professional Ethics, Applied Zoology, and Scientific Communication** Practice high ethical standards in animal handling and biosafety while translating academic knowledge into socio-economic benefits through applied fields like aquaculture, pest management, and clinical diagnostics. Graduates will effectively communicate complex biological concepts through publication-quality reports and professional presentations.

Semester - I

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

Empowered Autonomous Institution

Faculty of Science and Technology

Department of Zoology

UG I Sem I

Course Type : DSC-I
Course Title : Life and Diversity of Nonchordates
Course Code : 101ZOO1101
Credits : 03 **Max. Marks: 75** **Lectures: 45 Hrs.**

Learning Objectives:

LO1. To understand the diversity and evolutionary trends in non-chordate animals.
LO2. To study the classification, characteristic features, and adaptations of major non-chordate phyla.
LO3. To analyze structural and functional organization in different groups of non-chordates.
LO4. To develop skills in identification, comparison, and interpretation of non-chordate biodiversity.

Course Outcomes:

After completion of the course, the students will be able to-

CO1. Explain the general characters and classification of major non-chordate phyla.
CO2. Describe morphology, anatomy, and life processes in representative non-chordate groups.
CO3. Compare evolutionary trends and adaptive modifications in non-chordates.
CO4. Interpret ecological and economic importance of non-chordate fauna.

Unit No.	Title of Unit & Contents	Hrs.
I	**Protozoa and Porifera**	**11**
	• Introduction to non-chordate diversity and classification • Protozoa: General characters and classification • Plasmodium (life cycle and pathogenicity) • Porifera: General characters, and classification, canal system, skeleton • Economic importance of sponges	
	Unit Outcomes: **UO 1.** Explain the basic organization, classification, and biological significance of Protozoa and Porifera.	
II	**Coelenterata (Cnidaria) and Ctenophora**	**12**
	• Cnidaria: General characters and classification • Structure and life cycle of *Obelia* • Corals and coral reefs: formation, types, and importance • Ctenophora: General characters, classification • Comparison between Cnidaria and Ctenophora • Economic and ecological importance	
	Unit Outcome: UO 1. Describe body organization, life cycles, and ecological roles of Cnidaria and Ctenophora.	
III	**Platyhelminthes, Aschelminthes (Nematoda) and Annelida**	**11**
	• Platyhelminthes: General characters and classification	

Unit No.	Title of Unit & Contents	Hrs.
	• Parasitic adaptations in Platyhelminthes • Nematoda: General characters and classification • Life cycle of *Ascaris lumbricoides* • Annelida: General characters and classification • Metamerism and its significance	
	Unit Outcomes: UO 1. Analyze parasitic adaptations and evolutionary significance of Platyhelminthes, Nematoda, and Annelida.	
IV	**Arthropoda, Mollusca, Echinodermata and Hemichordata**	**11**
	• Arthropoda: General characters and classification • Metamorphosis in insects: types and significance • Mollusca: General characters and classification • Echinodermata: General characters and classification • Water vascular system: structure and function • Larval forms of Echinodermata • Hemichordata: General characters, classification and significance • Evolutionary importance of Hemichordates	
	Unit Outcomes: UO 1. Explain advanced non-chordate diversity, functional systems, and evolutionary importance of major phyla.	

Learning Resources:

1. A Text Book of Invertebrates, H.S. Bhamra and Kavita Juneja, Amol Publications PVT.LTD, New Delhi
2. Biology of the Invertebrates, Jan Pechenik (2014). McGraw-Hill Science, 2014
3. Handbook of Invertebrate Zoology for Laboratories and Seaside Work By William KeithBrooks https://www.google.co.in/books/edition/Handbook_of_Invertebrate_Zoology/pkUAAAAAQAAJ?hl=en&gbpv=1&dq=invertebrate+zoology&printsec=frontcover
4. Invertebrate Zoology (Multicolor Edition) By P.S. Verma
5. Invertebrate Zoology, Author - E. L. Jorden and P. S. Verma.
6. Invertebrate Zoology, E.L. Jordan and P.S. Varma, S. Chand and Co. Ltd., New Delhi.
7. Invertebrate Zoology, Jordan &Verma (revised editions) S. Chand and Co. Ltd., New Delhi.
8. Morden text book of Zoology Invertebrate, Author –R.L.Kotpal
9. Non-Chordate Zoology by Dhabi and DhamiPradeep Publication, Opposite Sitla Mandir,Jalndhar-144008
10. Textbook of Zoology Invertebrates-I, Parker and Haswell Paperback – 1 January 2021

Internal Examination Pattern:

CAT – I : Surprised Test

CAT – II : Seminar with Video

Mapping of POs, PSOs and COs:

COs/POs & PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	1	2	-	2	-	1	-	3	-	2	-
CO2	3	2	-	-	2	-	-	-	3	-	1	-
CO3	3	-	2	1	3	-	1	-	3	1	2	1
CO4	2	-	1	3	2	1	2	3	2	3	1	3

Scale : 3 = High, 2 = Moderate, 1 = Low, 0 = No correlation.

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

Empowered Autonomous Institution

Faculty of Science and Technology

Department of Zoology

UG I Sem I

Course Type : DSC-I
Lab Course-I : Based on Life and Diversity of Non-chordates
Course Code : 101ZOO1103
Credits : 01 **Max. Marks: 50** **Lectures: 45 Hrs.**

Learning Objectives:

LO1. To understand the external morphology and diagnostic features of major non-chordate phyla.
LO2. To identify and classify important non-chordate specimens up to phylum/class level.
LO3. To perform basic laboratory techniques such as dissection, slide preparation, and microscopy.
LO4. To develop skills in scientific observation, drawing, labeling, and reporting of practical work.

Course Outcomes:

After completion of the course, the students will be able to-

CO1. Identify and classify non-chordate animals using key morphological characters.
CO2. Prepare temporary/permanent mounts and observe microscopic structures of non-chordates.
CO3. Perform dissections and explain internal anatomy of selected non-chordate groups
CO4. Record observations systematically with scientific diagrams and practical reports.

Unit No.	Title of Unit & Contents	Hrs.
	Practicals	**30**
	1. Study of Protozoa: Amoeba, Paramecium, Euglena (permanent slides/specimens). 2. Study of Porifera: Sycon, Spongilla (specimens and slides) 3. Study of Cnidaria: Hydra, Obelia, Aurelia (slides/specimens) 4. Study of Platyhelminthes: Planaria, Taenia, Fasciola (slides/specimens). 5. Study of Nematoda: Ascaris male and female (specimens).. 6. Study of Annelida: Earthworm, Nereis, Hirudinaria (specimens). 7. Study of Arthropoda (Insecta): Cockroach, Honeybee, Mosquito (specimens). *Focus:* Mouthparts and metamorphosis. 8. Dissection of Cockroach *Study of digestive and reproductive systems.* 9. Study of Crustacea: Prawn/Crab (specimen). 10. Study of Mollusca: Pila, Unio, Sepia (specimens/shells). *Focus:* Shell structure and feeding adaptations. 11. Study of Echinodermata: Starfish, Sea urchin (specimens)	

Unit No.	Title of Unit & Contents	Hrs.
	12. Preparation of permanent stained whole mounts of Hydra, Obelia, Trachea of Cockroach, Crustacean Larva, *Cyclops*, *Daphnia*	

Learning Resources

1. Biology of the Invertebrates, Pechenik, J.A. – McGraw-Hill Education, USA
2. Invertebrate Zoology, Barnes, R.D. – Saunders College Publishing, USA
3. Invertebrate Zoology, Meglitsh, P.A. – Oxford University Press, USA
4. Invertebrate Zoology: A Functional Evolutionary Approach Ruppert, Fox & Barnes Publishing, New Delhi–
5. Modern Textbook of Zoology: Invertebrates, Kotpal, R.L. – Rastogi Publications, India
6. Practical Zoology (Invertebrates) , Nigam, H.C. – S. Chand & Company Ltd., New Delhi
7. Textbook of Zoology (Invertebrates) , Marshall, A.J. & Williams, W.D. – CBS Publishers & Distributors, New Delhi
8. Textbook of Zoology (Invertebrates) , Parker, T.J. & Haswell, W.A. – Macmillan Publishers, London
9. The Invertebrates (Vol. I–VI), Hyman, L.H. – McGraw-Hill Book Company, USA
10. Zoology: A Functional Evolutionary Approach, Ruppert, E.E., Fox, R.S. & Barnes, R.D. – Invertebrate Brooks/Cole (Cengage Learning), USA

Mapping of POs, PSOs and COs:

COs/POs & PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	2	-	1	2	-	1	-	3	1	2	-
CO2	2	3	1	-	2	1	-	-	2	-	3	1
CO3	3	3	-	-	2	2	-	-	3	-	3	2
CO4	2	2	2	-	2	1	3	1	1	-	2	3

Scale : 3 = High, 2 = Moderate, 1 = Low, 0 = No correlation.

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Empowered Autonomous Institution

Faculty of Science and Technology

Department of Zoology

UG I Sem I

Course Type : DSC-II
Course Title : Cell Biology
Course Code : 101ZOO1102
Credits : 03 **Max. Marks: 75** **Lectures: 45 Hrs.**

Learning Objectives:

LO1. To provide fundamental knowledge about cell structure, organization, and cellular components.
LO2. To explain the role of membranes, organelles, and cytoskeleton in cell function.
LO3. To understand cell cycle regulation, mitosis, meiosis, and programmed cell death.
LO4. To introduce modern concepts of cell signaling, cell adhesion, and cellular communication mechanisms.

Course Outcomes:

After completion of the course, the students will be able to-

CO1. Describe the structural organization and functional components of cells.
CO2. Explain the role of cellular organelles and membrane systems in metabolism and energy production.
CO3. Analyze cell cycle events, regulation, and mechanisms of cell division.
CO4. Interpret cell signaling pathways and explain cell interactions and communication processes.

Unit No.	Title of Unit & Contents	Hrs.
I	**Cell Structure and Plasma Membrane**	**11**
	• History and development of Cell Biology • Cell theory and modern cell concept • Prokaryotic and eukaryotic cell: comparison • Structure of plasma membrane (fluid mosaic model) • Membrane lipids, proteins, and carbohydrates • Membrane transport: diffusion, osmosis, facilitated diffusion • Active transport, ion pumps, channels, endocytosis and exocytosis	
	Unit Outcomes: **UO1:** Explain cell organization and describe plasma membrane structure and transport mechanisms..	
II	**Cell Organelles and Endomembrane System**	**11**
	• Endoplasmic reticulum (RER and SER): structure and functions • Golgi apparatus: structure, functions, secretion and packaging • Lysosomes and peroxisomes: biogenesis and functions • Ribosomes: structure and protein synthesis • Mitochondria: structure, oxidative phosphorylation, mitochondrial genome • Nucleus: structure, nuclear envelope, nucleolus, chromatin organization	
	Unit Outcome:	

Unit No.	Title of Unit & Contents	Hrs.
	UO1: Describe major cell organelles and explain their functional role in metabolism, secretion, and energy production.	
III	**Cytoskeleton and Cell Movement**	**11**
	• Cytoskeleton: microtubules, microfilaments, intermediate filaments • Structure and functions of cytoskeletal components • Cilia and flagella: ultrastructure and movement • Centrosome and centrioles • Cell motility: amoeboid movement, muscle contraction (basic concept) • Cell junctions: tight junctions, desmosomes, gap junctions • Extracellular matrix and cell adhesion molecules	
	Unit Outcomes: UO1: Explain cytoskeleton organization and describe its role in cell shape, movement, and cell-cell interaction.	
IV	**Cell Cycle, Cell Division and Apoptosis**	**12**
	• Cell cycle: phases (G1, S, G2, M) and checkpoints • Regulation of cell cycle: cyclins and CDKs • Mitosis: stages and significance • Meiosis: stages and significance • Apoptosis and necrosis	
	Unit Outcomes: UO1: Describe cell cycle regulation, cell division processes, and explain apoptosis.	

Learning Resources:

1. Becker's World of the CellHardin, J., Bertoni, G. & Kleinsmith, L.J.Pearson
2. Cell and Molecular Biology De Robertis, E.D.P. & De Robertis, E.M.F.Lippincott
3. Cell and Molecular Biology: Concepts and Experiments Karp, G.Wiley
4. Cell Biology Powar, C.B. & Daginawala, H.F.Himalaya Publishing House
5. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology Verma, P.S. & Agarwal, V.K.S. Chand
6. Essential Cell BiologyBruce AlbertsGarland Science
7. Molecular Biology of the Cell Alberts, B. et al.Garland Science
8. Molecular Biology of the Gene Watson, J.D. et al.Pearson
9. Molecular Cell Biology Lodish, H. et al.W.H. Freeman
10. The Cell: A Molecular Approach Cooper, G.M. & Hausman, R.E.Sinauer Associates

Internal Examination Pattern:

CAT – I: Surprised Test

CAT – II: Seminar with Video

Mapping of POs, PSOs and COs:

COs/POs & PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	-	1	-	1	-	3	-	1	-
CO2	3	1	2	-	2	-	-	-	3	-	2	1
CO3	3	1	2	-	3	1	1	1	3	-	2	1
CO4	3	-	2	-	3	-	2	2	3	-	2	2

Scale : 3 = High, 2 = Moderate, 1 = Low, 0 = No correlation.

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

Empowered Autonomous Institution

Faculty of Science and Technology

Department of Zoology

UG I Sem I

Course Type : DSC-II
Lab Course-II : Based on Cell Biology
Course Code : 101ZOO1104
Credits : 01 **Max. Marks: 50** **Lectures: 30 Hrs.**

Learning Objectives:

LO1. To develop skills in handling microscopes and laboratory instruments used in cell biology.
LO2. To understand basic techniques for studying cell structure, organelles, and cellular components.
LO3. To perform staining, slide preparation, and microscopic observation of plant and animal cells.
LO4. To gain practical knowledge of cell division, membrane transport, and cytochemical techniques.

Course Outcomes:

After completion of the course, the students will be able to-

CO1. Demonstrate Proficiency in identifying major groups of chordates using morphological keys.
CO2. Describe the Functional Anatomy of various organ systems (digestive, circulatory, and reproductive) in vertebrate models.
CO3. Relate Structure to function regarding specialized chordate adaptations like avian flight or fish buoyancy.
CO4. Apply Ethical Laboratory Practices in the handling and observation of biological specimens.

Unit No.	Title of Unit & Contents	Hrs.
	Practicals	**30**
	1. Study and handling of compound microscope (parts, focusing, magnification, care). 2. Preparation of temporary mount of onion peel to study plant cells. 3. Preparation of temporary mount of human cheek cells to study animal cells. 4. Staining of nucleus using methylene blue / Acetocarmine in cheek cells or onion peel. 5. Study of cell organelles through charts/models: mitochondria, ER, Golgi, ribosomes, lysosomes. 6. Observation of plasmolysis and deplasmolysis in onion epidermal cells. 7. Demonstration of osmosis using potato osmometer experiment. 8. Study of mitosis using onion root tip squash preparation.	

Unit No.	Title of Unit & Contents	Hrs.
	9. Study of meiosis using grasshopper testis / flower bud anther squash (prepared slides). 10. Estimation of cell size using ocular micrometer and stage micrometer.	

Learning Resources

1. An Introduction to Practical Biochemistry Plummer, D.T.McGraw-Hill
2. Cell and Molecular Biology De Robertis, E.D.P. & De Robertis, E.M.F.Lippincott
3. Cell and Molecular Biology: Concepts and Experiments Karp, G.Wiley
4. Cell Biology Powar, C.B. & Daginawala, H.F.Himalaya Publishing House
5. Cell Biology, Genetics, Molecular Biology, Evolution and EcologyVerma, P.S. & Agarwal, V.K.S. Chand
6. Molecular Biology of the Cell Alberts, B. et al.Garland Science
7. Molecular Cell Biology Lodish, H. et al.W.H. Freeman
8. Principles and Techniques of Biochemistry and Molecular BiologyWilson, K. & Walker, J.Cambridge University Press
9. The Cell: A Molecular Approach Cooper, G.M. & Hausman, R.E.Sinauer Associates
10. Theory and Practice of Histological Techniques Bancroft, J.D. & Gamble, M.Churchill Livingstone

Internal Examination Pattern:

CAT – I: Surprised Test

CAT – II: Seminar with Video

Mapping of POs, PSOs and COs:

COs/POs & PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	-	2	-	1	-	3	-	2	-
CO2	3	3	1	-	2	-	-	-	3	-	3	-
CO3	3	1	2	1	3	-	1	-	3	1	2	1
CO4	1	2	-	-	1	3	-	1	1	-	2	3

Scale : 3 = High, 2 = Moderate, 1 = Low, 0 = No correlation.

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

Empowered Autonomous Institution

Faculty of Science and Technology

Department of Zoology

UG I Sem I

Course Type : VSC-I
Course Title : VSC: Biochemical Techniques and Instrumentation
Course Code : 101ZOO1501
Credits : 02 Max. Marks: 50 Lectures: 45 Hrs.

Learning Objectives:

LO1. To understand the fundamental principles colorimetric, Chromatography and spectrophotometric
LO2. To learn the Principle and working of Centrifugation,
LO3. To Evaluate Principle and working of Electrophoresis, blotting techniques
LO4. To develop practical skills for qualitative and quantitative analysis of biological molecules using advanced techniques.

Course Outcomes:

After completion of the course, students will be able to-

CO1. Demonstrate knowledge of various biochemical instruments and their working principles.
CO2. Perform standard biochemical assays using appropriate laboratory techniques with accuracy and safety.
CO3. Analyze biomolecules using techniques such as chromatography, electrophoresis, and spectrophotometry.
CO4. Apply modern biochemical tools and instrumentation in research and industrial applications for problem solving and innovation.

Unit No.	Title of Unit & Contents	Hrs.
I	**Principle and working**	**08 Hrs.**
	Spectrophotometer, Colorimeter Thin layer chromatography Column Chromatography Ion Exchange Chromatography	
	Unit Outcome: **UO 1.** Understand Principle and working of Spectrophotometer, Colorimeter and Chromatography:	
II	**Principle and working**	**07 Hrs.**
	Centrifugation, Electrophoresis (Agarose and Polyacrylamide) , Southern Blotting, Northern Blotting and Western Blotting Polymerase chain reaction ,Cloning, Cell culture Hybridoma technology	
	Unit Outcome: UO 1. Understand about Handling and principal of centrifugation	
III	**Practicals**	**15 Hrs.**
	1. Estimation of Glucose in Biological Fluids	

	2. Estimation of amino acid by Paper / Thin chromatography 3. Demonstration on polyacrylamide gel electrophoresis (PAGE) of proteins	
	Unit Outcome: Learn about Principle and working of Centrifugation, Electrophoresis, and blotting techniques	
IV`	**Practicals**	**15 Hrs.**
	1. Demonstration of separation of lipids by TLC. 2. Glucose by DNS method. 3. Protein by Biuret method. 4. Extraction and estimation of DNA	

Learning Resources:

1. Advanced Lab Practices in Biochemistry & Molecular Biology, by Agarwal, Dreamtech Press (1 November 2019)
2. Basic Techniques in Biochemistry and Molecular Biology, by R.K. SharmaSangha Dreamtech Press (25 June 2020); Dreamtech Press
3. Basics of Clinical Biochemistry & Instrumentation, by Bachcheti, Vayu Education of India; Revised edition (1 January 2015)
4. Biochemistry and Molecular Biology K. Wilson and J. Walker Eds. 2005. Cambridge University Press.
5. Biological Instrumentation and methodology, Bajpai, P.K. S. Chand & Co. Ltd 2006.
6. Introduction to Instrumentation in Life Sciences, By A SHARMA P S BISEN, CRC Press 1 January2012
7. Introduction to instrumentation of Life Sciences, by Sharma, Notion Press; 1st edition (1 January 2019)
8. Practical research methods 4.Dawson, C. (2002), UBS Publishers, New Delhi.
9. Principles and Techniques of Biochemistry and Molecular Biology, by Keith Wilson(Editor), John Walker, Cambridge University Press; 7th edition (4 March 2010)
10. Principles and techniques of Practical Biochemistry K. Wilson and KH Goulding. 1986.. (3 edn) Edward Arnold, London

Internal Examination Pattern:

CAT – I: Surprised Test

CAT – II: Seminar with Video

Mapping of POs, PSOs and COs:

COs/POs & PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1												
CO2												
CO3												
CO4												

Scale : 3 = High, 2 = Moderate, 1 = Low, 0 = No correlation.

Semester - II

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

Empowered Autonomous Institution

Faculty of Science and Technology

Department of Zoology

UG I Sem II

Course Type : DSC-III
Course Title : Life and Diversity of Chordata
Course Code : 101ZOO2101
Credits : 03 **Max. Marks: 75** **Lectures: 45 Hrs.**

Learning Objectives:

LO1. To learn the fundamental characters, origin, and classification of Chordata.
LO2. To study the diversity, organization, and evolutionary importance of Protochordates and Agnatha.
LO3. To learn the structural and adaptive features of major vertebrate groups such as fishes and amphibians.
LO4. To understand the diversity, adaptive radiation, and evolutionary trends in reptiles, birds, and mammals.

Course Outcomes:

After completion of the course, the students will be able to-

CO1. Explain the defining characteristics and classification of chordates.
CO2. Describe the diversity and significance of protochordates and jawless vertebrates.
CO3. Compare major vertebrate groups based on structural features and adaptations.
CO4. Analyze evolutionary trends and adaptive radiation among chordates.

Unit No.	Title of Unit & Contents	Hrs.
I	**Introduction and Classification of Chordata**	**11**
	• General characteristics of Chordate • Basic chordate plan: notochord, dorsal nerve cord, pharyngeal gill slits, post-anal tail, endostyle/thyroid • Origin and evolution of chordates (brief account) • Classification of Chordata up to class level • Comparative account of chordates and non-chordates • General organization of vertebrates	
	Unit Outcomes: **UO1:** Identify diagnostic chordate characters and explain the classification and evolutionary significance of chordates.	
II	**Protochordata and Agnatha**	**11**
	• Protochordates: general characters and classification • Urochordata: salient features, life cycle, examples (Herdmania, Ascidia) • Cephalochordata: Amphioxus (Branchiostoma) structure and significance • Affinities of Protochordates with vertebrates • Agnatha (Cyclostomata): general characters and classification • Examples: Petromyzon (Lamprey), Myxine (Hagfish) • Evolutionary importance of cyclostomes	

Unit No.	Title of Unit & Contents	Hrs.
	Unit Outcome: UO1: Describe Protochordates diversity, explain their affinities with vertebrates, and evaluate the significance of agnathans in chordate evolution.	
III	**Pisces and Amphibia**	**11**
	• Pisces: general characters and classification • Chondrichthyes and Osteichthyes: comparative study with examples • Adaptations for aquatic life: fins, scales, gills, swim bladder, lateral line system • Amphibia: general features and classification • Adaptations for amphibious life • Metamorphosis in amphibians • Parental care in amphibians	
	Unit Outcomes: UO1: Compare fish classes, explain aquatic adaptations, and describe amphibian diversity and transition from aquatic to terrestrial habitat.	
IV	**Reptilia, Aves and Mammalia**	**12**
	• Reptilia: general characters, classification, and examples • Adaptations for terrestrial life: scales, amniotic egg, locomotion • Aves: general characters and classification • Flight adaptations: feathers, wings, pneumatic bones, air sacs • Migration and nesting behavior (brief account) • Mammalia: general characters and classification up to orders • Adaptive radiation in mammals: aquatic, aerial, arboreal, desert and terrestrial mammals • Evolutionary trends in chordates	
	Unit Outcomes: UO1: Explain vertebrate diversity, compare adaptations in reptiles, birds, and mammals,	

Learning Resources:

1. A Textbook of Vertebrate Zoology Dhami, P.S. & Dhami, J.K.R. Chand & Co. Modern
2. A Textbook of Zoology (Vertebrates)Parker, T.J. & Haswell, W.A.Macmillan
3. Chordate Zoology Jordan, E.L. & Verma, P.S.S. Chand & Company
4. Evolutionary Developmental Biology of Vertebrates
5. Hall, B.K.Springer Vertebrates: Comparative Anatomy, Function, Evolution Kardong, K.V.McGraw-Hill
6. Integrated Principles of Zoology Hickman, C.P. Jr., Roberts, L.S. & Larson, A.McGraw-Hill
7. Textbook of Zoology: Vertebrates Kotpal, R.L.Rastogi Publications
8. The Life of Vertebrates Young, J.Z.Oxford University Press
9. Vertebrate Evolution Romero-Herrera, A.E. & Lehmann, Academic Press
10. Vertebrate Life Pough, F.H., Janis, C.M. & Heister, J.B.Pearson Education

Internal Examination Pattern:

CAT – I: Surprised Test

CAT – II: Seminar with Video

Mapping of POs, PSOs and COs:

COs/POs & PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	1	2	-	2	-	1	-	3	-	1	-
CO2	3	2	-	2	2	-	-	-	3	2	2	-
CO3	3	2	2	-	3	-	1	-	3	-	2	1
CO4	3	-	3	1	3	-	2	-	3	1	2	1

Scale : 3 = High, 2 = Moderate, 1 = Low, 0 = No correlation.

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

Empowered Autonomous Institution

Faculty of Science and Technology

Department of Zoology

UG I Sem II

Course Type : DSC-III

Lab Course-III: Based on Life and Diversity of Chordates

Course Code : 101ZOO2103

Credits : 01 **Max. Marks: 50** **Lectures: 30 Hrs.**

Learning Objectives:

LO1. To identify and Classify to enable students to identify various chordate specimens and classify them based on distinct taxonomic features.

LO2. To anatomical Understanding: To provide practical knowledge of the internal anatomy and organ systems of representative chordates through virtual or physical dissection.

LO3. To evolutionary Analysis: To understand the evolutionary significance of specialized structures like the notochord, gills, and skeletal modifications.

LO4. To ecological Adaptations: To analyze how different chordate groups have adapted to aquatic, terrestrial, and aerial environments.

Course Outcomes:

After completion of the course, the students will be able to-

CO1. Demonstrate Proficiency in identifying major groups of chordates using morphological keys.

CO2. Describe the Functional Anatomy of various organ systems (digestive, circulatory, and reproductive) in vertebrate models.

CO3. Relate Structure to function regarding specialized chordate adaptations like avian flight or fish buoyancy.

CO4. Apply Ethical Laboratory Practices in the handling and observation of biological specimens.

Unit No.	Title of Unit & Contents	Hrs.
	Practicals	**30**
	1. Protochordate Identification: Microscopic and macroscopic study of *Amphioxus*, *Herdmania*, and *Balanoglossus*. 2. Agnatha Study: Morphological observation of *Petromyzon* (Lamprey) and *Myxine* (Hagfish). 3. Cartilaginous vs. Bony Fish: Comparative study of the external features and scales (placoid, cycloid, ctenoid) of *Scoliodon* and *Labeo*. 4. Amphibian Diversity: Observation of specialized forms like *Axolotl* larva, *Ichthyophis*, and *Hyla*. 5. Reptilian Morphometry: Identification of poisonous and non-poisonous snakes and study of turtle/tortoise shells. 6. Avian Adaptations: Study of various types of beaks, claws, and feathers (contour, down, filoplume).	

Unit No.	Title of Unit & Contents	Hrs.
	7. Mammalian Identification: Study of primitive mammals (*Prototheria* and *Metatheria*) using museum specimens. 8. Osteology - The Axial Skeleton: Detailed study of the skull and vertebral column of a typical mammal (e.g., Rabbit or Rat). 9. Osteology - The Appendicular Skeleton: Study of the pectoral and pelvic girdles and limb bones of a vertebrate. 10. Dissection/Virtual Simulation I: Study of the digestive and arterial systems of a fish (e.g., *Scoliodon* or Carp). 11. Dissection/Virtual Simulation II: Observation of the cranial nerves and internal ear of a vertebrate model. 12. Permanent Slide Preparation: Preparation and mounting of fish scales or protochordate sections.	

Learning Resources

1. A Textbook of Vertebrate Zoology Dhami, P.S. & Dhami, J.K.R. Chand & Co.
2. A Textbook of Zoology (Vertebrates) Parker, T.J. & Haswell, W.A.Macmillan
3. Chordate Zoology Jordan, E.L. & Verma, P.S.S. Chand & Company
4. Digital Dissection Software (e.g., Frog UTS, Bio Digital Various Platforms
5. Integrated Principles of Zoology Hickman, C.P. Jr. et al.McGraw-Hill
6. Modern Textbook of Zoology: Vertebrates Kotpal, R.L.Rastogi Publications
7. Practical Zoology: Vertebrates S.S. Lal Rastogi Publications
8. The Life of VertebratesYoung, J.Z.Oxford University Press
9. Vertebrate Life Pough, F.H. et al.Pearson Education
10. Vertebrates: Comparative Anatomy, Function, Evolution Kardong, K.V.McGraw-Hill

Internal Examination Pattern:

CAT – I: Surprised Test

CAT – II: Seminar with Video

Mapping of POs, PSOs and COs:

COs/POs & PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	-	2	-	1	-	3	-	2	-
CO2	3	3	1	-	2	-	-	-	3	-	3	-
CO3	3	1	2	1	3	-	1	-	3	1	2	1
CO4	1	2	-	-	1	3	-	1	1	-	2	3

Scale : 3 = High, 2 = Moderate, 1 = Low, 0 = No correlation.

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

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Faculty of Science and Technology

Department of Zoology

UG I Sem II

Course Type : DSC-III
Course Title : Developmental Biology
Course Code : 101ZOO2102
Credits : 03 **Max. Marks: 75** **Lectures: 45 Hrs.**

Learning Objectives:

LO1. To understand the basic concepts, scope, and significance of developmental biology.
LO2. To study gametogenesis, fertilization, cleavage, blastulation, and gastrulation as key stages of early development.
LO3. To learn the role of extra-embryonic membranes, placenta, and regeneration in development.
LO4. To understand stem cell biology and basic reproductive disorders such as male and female sterility.

Course Outcomes:

After completion of the course, the students will be able to-

CO1. Explain basic developmental concepts and describe gametogenesis and fertilization.
CO2. Describe cleavage, blastulation, gastrulation movements, and formation of germ layers.
CO3. Explain extra-embryonic membranes, placenta formation, and regeneration in animals.
CO4. Understand stem cell concepts and analyze causes of male and female sterility.

Unit No.	Title of Unit & Contents	Hrs.
I	**Introduction and Gametogenesis**	**11**
	• Definition, scope, and importance of developmental biology • Basic developmental processes: growth, differentiation, and morphogenesis • Types of eggs based on yolk distribution and cleavage patterns • Gametogenesis: spermatogenesis and oogenesis • Structure of sperm and ovum • Fertilization: mechanism and significance • Cortical reaction and prevention of polyspermy	
	Unit Outcomes: **UO1:** Explain the scope of developmental biology and describe gametogenesis and fertilization processes.	
II	**Cleavage, Blastulation and Gastrulation**	**11**
	Cleavage: definition and types (holoblastic and meroblastic) Patterns of cleavage: radial, spiral, bilateral, discoidal Morula formation and blastulation Types of blastula Gastrulation: definition and significance Gastrulation movements: invagination, involution, ingression, delamination, epiboly Formation of germ layers and their derivatives	

Unit No.	Title of Unit & Contents	Hrs.
	Organizer concept (Spemann organizer – basic idea)	
	Unit Outcome: UO1: Describe cleavage patterns, blastula formation, gastrulation movements, and germ layer development.	
III	**Extra-Embryonic Membranes, Placenta and Regeneration**	**11**
	• Extra-embryonic membranes: amnion, chorion, yolk sac, allantois • Functions of extra-embryonic membranes • Placenta: definition, structure, and functions • Types of placenta (basic classification) • Regeneration: definition and types • Examples of regeneration in animals (Hydra, Planaria, Salamander) • Role of regeneration in development and healing	
	Unit Outcomes: UO1: Explain extra-embryonic membranes, placenta formation, and regeneration with suitable examples	
IV	**Stem Cells, Male and Female Sterility**	**12**
	Stem cells: definition, properties, and types (totipotent, pluripotent, multipotent) Embryonic stem cells and adult stem cells Applications of stem cells in medicine (basic overview) Introduction to reproductive biology and fertility Male sterility: causes (low sperm count, hormonal imbalance, genetic causes, infections) Female sterility: causes (ovulation disorders, PCOS, hormonal imbalance, blocked fallopian tubes) Assisted reproductive technologies (ART): IVF, ICSI (basic idea	
	Unit Outcomes: UO1: Explain stem cell types and applications and describe major causes of male and female sterility	

Learning Resources:

1. An Introduction to EmbryologyBalinsky, B.I.Saunders
2. Chordate Embryology Verma, P.S. & Agarwal, V.K.S. Chand & Company
3. Developmental Biology Browder, L.W.Saunders
4. Developmental Biology Gilbert, S.F.Sinauer Associates
5. Embryology and Developmental BiologyCarlson, B.M.Elsevier
6. Essential Developmental BiologySlack, J.M.W.Wiley-BlackwellHuman
7. Evolutionary Developmental BiologyHall, B.K.Springer
8. Molecular Biology of the CellAlberts, B. et al.Garland
9. Principles of Development Wolpert, L. et al.Oxford University Press
10. ScienceLangman's Medical Embryology Sadler, T.W.Lippincott Williams & Wilkins

Internal Examination Pattern:

CAT – I: Surprised Test

CAT – II: Seminar with Video

Mapping of POs, PSOs and COs:

COs/POs & PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	1	-	-	2	-	-	-	3	-	1	-
CO2	3	1	1	-	2	-	1	-	3	-	1	-
CO3	3	-	2	-	2	-	1	1	3	-	2	-
CO4	2	-	2	-	3	2	2	3	2	-	2	3

Scale : 3 = High, 2 = Moderate, 1 = Low, 0 = No correlation.

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

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Faculty of Science and Technology

Department of Zoology

UG I Sem II

Course Type : DSC-IV
Lab Course-IV: Developmental Biology
Course Code : 101ZOO2104
Credits : 01 **Max. Marks: 50** **Lectures: 30 Hrs.**

Learning Objectives:

LO1. To develop practical skills in observing and identifying different embryonic developmental stages.

LO2. To understand laboratory techniques used in developmental biology such as slide preparation, staining, and microscopy.

LO3. To study gametogenesis, fertilization, cleavage, and embryogenesis through models, charts, and prepared slides.

LO4. To gain hands-on experience in studying regeneration, metamorphosis, and developmental abnormalities.

Course Outcomes:

After completion of the course, the students will be able to-

CO1. Identify various stages of embryonic development using microscopy and prepared specimens.

CO2. Prepare, stain, and observe developmental biology slides with proper laboratory techniques.

CO3. Demonstrate practical understanding of cleavage, gastrulation, and organogenesis through experimental observations.

CO4. Maintain laboratory records, interpret observations, and follow ethical and safety guidelines.

Unit No.	Title of Unit & Contents	Hrs.
	Practicals	**30**
	1. Study of laboratory instruments used in developmental biology (microscope, dissecting microscope, glassware). 2. Study of types of eggs (microlecithal, mesolecithal, macrolecithal) using charts/models. 3. Study of frog sperm and ovum through prepared slides. 4. Study of spermatogenesis using prepared slides (mammalian testis). 5. Study of oogenesis using prepared slides (mammalian ovary). 6. Study of fertilization stages through charts/models (sperm entry, cleavage initiation). 7. Study of cleavage stages (2-cell, 4-cell, 8-cell, morula) using prepared slides/models. 8. Study of blastula and gastrula stages using prepared slides/models. 9. Study of neurulation stages using prepared slides (neural plate, neural groove, neural tube).	

Unit No.	Title of Unit & Contents	Hrs.
	10. Study of chick embryo development (24 hr, 48 hr, 72 hr) using prepared slides/specimens. 11. Study of regeneration in Hydra / Planaria (demonstration/observation). 12. Study of metamorphosis stages in frog (tadpole stages) using charts/specimens.	

Learning Resources

1. An Introduction to Embryology Balinsky, B.I.Saunders
2. Chordate Embryology Verma, P.S. & Agarwal, V.K.S. Chand & Company
3. Developmental Biology Browder, L.W.Saunders
4. Developmental Biology Gilbert, S.F.Sinauer Associates
5. Embryology and Developmental BiologyCarlson, B.M.Elsevier
6. Essential Developmental BiologySlack, J.M.W.Wiley-BlackwellHuman
7. Evolutionary Developmental BiologyHall, B.K.Springer
8. Molecular Biology of the CellAlberts, B. et al.Garland
9. Principles of Development Wolpert, L. et al.Oxford University Press
10. Science Langman's Medical Embryology Sadler, T.W.Lippincott Williams & Wilkins

Internal Examination Pattern:

CAT – I: Surprised Test

CAT – II: Seminar with Video

Mapping of POs, PSOs and COs:

COs/POs & PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	-	2	-	1	-	3	-	2	-
CO2	2	3	-	-	2	1	-	-	2	-	3	1
CO3	3	3	2	-	3	-	1	-	3	-	3	1
CO4	1	2	2	-	1	3	3	1	1	-	2	3

Scale : 3 = High, 2 = Moderate, 1 = Low, 0 = No correlation.

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

Empowered Autonomous Institution

Faculty of Science and Technology

Department of Zoology

UG I Sem II

Course Type : VSC-II
Course Title : VSC: Sericulture and Marketing
Course Code : 101ZOO2501
Credits : 02 **Max. Marks: 50** **Lectures: 45 Hrs.**

Learning Objectives:

LO1. To understand the biological lifecycle and diversity of silkworm species.
LO2. To master the technical requirements for mulberry cultivation and silkworm rearing.
LO3. To identify and manage common pests and diseases in sericulture.
LO4. To analyze the economic structure, processing techniques, and marketing of silk products.

Course Outcomes:

After completion of the course, students will be able to-

CO1. Differentiate between mulberry and non-mulberry sericulture based on species and host plants.
CO2. Demonstrate proficiency in rearing techniques from hatching to cocoon harvesting.
CO3. Implement preventive measures against viral, fungal, and bacterial infections in silkworms.
CO4. Evaluate silk quality and apply marketing principles to the commercial silk industry.

Unit No.	Title of Unit & Contents	Hrs.
I	**Biology of Silkworms and Rearing Technology**	**08 Hrs.**
	• Introduction: History and scope of sericulture in India. • Diversity: Types of Silkworms (Mulberry, Eri, Tasar, and Muga) and their food plants. • Mulberry Cultivation: Soil preparation, plantation methods, and leaf harvesting. • Rearing: Rearing house requirements, disinfection, and environmental conditions (temperature and humidity). • Life Cycle: Egg handling, brushing, chawki rearing, and late-age rearing.	
	Unit Outcome: **UO 1.** Students will be able to design a standard rearing house layout and schedule mulberry plantation cycles.	
II	**Pests, Diseases, and Silk Marketing**	**07 Hrs.**
	• Pathology: Study of Pebrine, Flacherie, Muscardine, and Grasserie diseases. • Pest Management: Control of the Uzi fly and other common predators. • Post-Cocoon Technology: Stifling, reeling, and spinning processes.	

	• Marketing: Silk grading, price determination, and the role of cooperatives and government agencies. • **Economics:** Cost-benefit analysis of a small-scale sericulture unit.	
	Unit Outcome: UO 1. Students will be able to diagnose silkworm diseases and formulate a marketing strategy for silk cocoons	
III	**Practicals: Laboratory Techniques and Morphology**	**15 Hrs.**
	1. Morphological study of the life cycle of *Bombyx mori* (Egg, Larva, Pupa, Adult). 2. Anatomical study of the silk glands in the mature silkworm larva. 3. Identification of different types of silk cocoons and silk waste. 4. Microscopic examination of Pebrine spores and Muscardine fungi.	
	Unit Outcome: UO1. Students will be able to identification and study life cycle of Bombyx mori, anatomy of silk gland, Pebrine spores and Muscardine	
IV`	**Practicals: Field Practices and Economics**	**15 Hrs.**
	1. Estimation of leaf yield from a mulberry garden. 2. Calculation of Shell Ratio and Cocoon Silk Percentage. 3. Practical demonstration of cocoon stifling and reeling (industrial visit/lab simulation). 4. Preparation of a project report for a commercial sericulture startup	

Learning Resources:

1. An Introduction to Sericulture – *M. Madan Mohan Rao* – BS Publications
2. Handbook of Silkworm Rearing – *Yahei Tazima* – Fuji Publishing Co., Japan
3. Seri Business Manual – A User's Guide – *Central Silk Board, India* – Central Silk Board Publication
4. Sericulture and Pest Management – *A. Jadhav & T. V. Sathe* – (Includes crop management aspects affecting quality and cocoon economics)
5. Sericulture and Rural Development – *G. Sandhya Rani* – (Reference on rural marketing & development aspects in sericulture)
6. Sericulture and Silk Production: A Handbook (Small-Scale Textiles Series) – *Prabha Shekar & Martin Hardingham* – (Handbook focusing on entrepreneurship & small-scale industry)
7. Sericulture Manual, Vol. 1: Mulberry Cultivation (FAO Manual Series) – *FAO / United Nations* – FAO Publication
8. Sericulture Principles, Practices, Biotechnology and Breeding – *Hasan, Abhishek Belagalla, Hembram & Bashir Ayoub* – Routledge (Academic)
9. Sericulture Technology / Introduction to Sericulture Technology – *P. Karthika* – AIB Saliha Publication
10. Sericulture: Cultivation, Processing and Marketing – *Ramakrishna Naika, P. Venkataravana & Sunil Kumar T* – Daya Publishing House (2024

Internal Examination Pattern:

CAT – I: Surprised Test

CAT – II: Seminar with Video

Mapping of POs, PSOs and COs:

COs/POs & PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	1	-	2	1	-	-	2	3	1	-	1
CO2	2	3	1	-	2	2	-	3	2	-	3	3
CO3	3	2	1	-	3	2	-	2	3	-	2	2
CO4	1	1	3	-	2	1	2	3	1	-	2	3

Scale : 3 = High, 2 = Moderate, 1 = Low, 0 = No correlation.

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Extra Credit Activities

Sr. No.	Course Title	Credits	Hours T/P
1	MOOCs	Min. of 02 credits	Min. of 30 Hrs.
2	Certificate Courses	Min. of 02 credits	Min. of 30 Hrs.
3	IIT Spoken English Courses	Min. of 02 credits	Min. of 30 Hrs.

Guidelines:

Extra -academic activities

1. All extra credits claimed under this heading will require sufficient academic input/ contribution from the students concerned.
2. Maximum 04 extra credits in each academic year will be allotted.
3. These extra academic activity credits will not be considered for calculation of SGPA/CGPA but will be indicated on the grade card.

Additional Credits for Online Courses:

1. Courses only from SWAYAM and NPTEL platform are eligible for claiming credits.
2. Students should get the consent from the concerned subject Teacher/Mentor/Vice Principal and Principal prior to starting of the course.
3. Students who complete such online courses for additional credits will be examined/verified by the concerned mentor/internal faculty member before awarding credits.
4. Credit allotted to the course by SWAYAM and NPTEL platform will be considered as it is.

Additional Credits for Other Academic Activities:

1. One credit for presentation and publication of paper in International/National/State level seminars/workshops.
2. One credit for measurable research work undertaken and field trips amounting to 30 hours of recorded work.
3. One credit for creating models in sponsored exhibitions/other exhibits, which are approved by the concerned department.
4. One credit for any voluntary social service/Nation building exercise which is in collaboration with the outreach center, equivalent to 30 hours
5. All these credits must be approved by the College Committee.

Additional Credits for Certificate Courses:

1. Students can get additional credits (number of credits will depend on the course duration) from certificate courses offered by the college.
2. The student must successfully complete the course. These credits must be approved by the Course Coordinators.
3. Students who undertake summer projects/ internships/ training in institutions of repute through a national selection process, will get 2 credits for each such activity. This must be done under the supervision of the concerned faculty/mentor.

Note:

1. The respective documents should be submitted within 10 days after completion of Semester End Examination.
2. No credits can be granted for organizing or for serving as office bearers/ volunteers for Inter-Class / Associations / Sports / Social Service activities.
3. The office bearers and volunteers may be given a letter of appreciation by the respective staff coordinators. Besides, no credits can be claimed for any services/ activities conducted or attended within the college.
4. All claims for the credits by the students should be made and approved by the mentor in the same academic year of completing the activity.
5. Any grievances of denial/rejection of credits should be addressed to Additional Credits Coordinator in the same academic year.
6. Students having a shortage of additional credits at the end of the third year can meet the Additional Credits Coordinator, who will provide the right advice on the activities that can help them earn credits required for graduation.

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Examination Framework

Theory:

40% Continuous Assessment Tests (CATs) and 60% Semester End Examination (SEE)

Practical:

50% Continuous Assessment Tests (CATs) and 50% Semester End Examination (SEE)

Course	Marks	CAT & Mid Term Theory				CAT Practical		Best Scored CAT & Mid Term	SEE	Total
1	2	3				4		5	6	5 + 6
		Att.	CAT I	Mid Term	CAT II	Att.	CAT			
DSC/DSE/ GE/OE/Minor	100	10	10	20	10	-	-	40	60	100
DSC	75	05	10	15	10	-	-	30	45	75
Lab Course/AIPC/ OJT/FP/SEC (Science & Technology)	50	-	-	-	-	05	20	-	25	50
VSC/SEC/ AEC/VEC/CC	50	05	05	10	05	-	-	20	30	50

Note:

1. All Internal Exams are compulsory
2. Out of 02 CATs best score will be considered
3. Mid Term Exam will be conducted by the Exam Section
4. Mid Term Exam is of Objective nature (MCQ)
5. Semester End Exam is of descriptive in nature (Long & Short Answer)
6. CAT Practical (20 Marks): Lab Journal (Record Book) 10 Marks, Overall Performance 10 Marks