Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Structure and Curriculum of Two Year PG Programme

Postgraduate Programme of Science and Technology

M.Sc. II in Zoology

Board of Studies

In

Zoology

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

W.e.f. June, 2024

(In Accordance with NEP-2020)

Review Statement

The NEP Cell reviewed the Curriculum of **M.Sc. Zoology** Programme to be effective from the **Academic Year 2024-25.** It was found that, the structure is as per the NEP-2020 guidelines of Govt. of Maharashtra.

Date: 18/07/2024

Place: Latur

NEP Cell
Rajarshi Shahu Mahavidyalaya, Latur
(Autonomous)

CERTIFICATE

I hereby certify that the documents attached are the Bonafide copies of the Curriculum of **M.Sc. in Zoology** Programme to be effective from the **Academic Year 2024-25.**

Date: 14/07/2024

Place: Latur

Dr. D.S. Rathod
Chairperson
Board of Studies in Zoology

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Members of Board of Studies in the Subject Zoology

Under the Faculty of Science and Technology

Sr. No.	Name	Designation	In position
1	**Dr. D.S.Rathod** Head, Department of Zoology Rajarshi Shahu Mahavidyalaya (Autonomous), Latur	Chairperson	HoD
2	**Prof. S. P .Chavan** Director, School of Life Science Swami Ramanand Teerth Marathwada University, Nanded	Member	V.C. Nominee
3	**Prof. Ragvender Rao** Walchand Centre for Research in Nanotechnology & Bio-Nanotechnology Walchand College of Arts and Science, Ashok Chowk, Solapur – 413006 Maharashtra, India	Member	Academic Council Nominee
4	**Dr. Mamidala Estari** Head, Department of Zoology, Infectious Diseases & Metabolic Disorders Research Lab, Kakatiya University, Hanumakonda-506 009. Telangana State, India.	Member	Academic Council Nominee
5	**Prof. D. H. Jadhav** Head, Department of Zoology Maharashtra Mahavidyalaya, Nilanga	Member	Expert from outside for Special Course
6	**Mr. Ishrar Deshmukh** Pharma Pune, Maharashtra, India	Member	Expert from Industry
7	**Dr. Vinay Biradar** Department of Zoology, Savitribai Phule University ,Pune	Member	P.G. Alumni
8	**Dr. K. S. Raut** Rajarshi Shahu Mahavidyalaya (Autonomous), Latur	Member	Faculty Member
	Mr. Datta Nalle Rajarshi Shahu Mahavidyalaya (Autonomous), Latur	Member	Faculty Member
	Mrs. Dhanshree Jagtap Rajarshi Shahu Mahavidyalaya (Autonomous), Latur	Member	Faculty Member
9	**Dr. A. A. Yadav** Rajarshi Shahu Mahavidyalaya (Autonomous), Latur	Member	Member from same Faculty

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 behavior, 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, behavior, 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.

(Dr. D. S. Rathod)
Chairperson
Board of Studies in Zoology

Rajarshi Shahu Mahavidyalaya, Latur

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Rajarshi Shahu Mahavidyalaya (Autonomous), Latur
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PG Skeleton in Accordance with NEP2020
Illustrative Credit Distribution Structure for Two Years/ One Year PG (M.A. /M.Sc. /M. Com)

Year (2 Year PG) Level	Sem	Major 24-28(22-26)per sem 46-56 for two years		RM	OJT/FP	RP	Cum. Cr	Marks	Degree
		Mandatory	Elective						
I 6.0	I	Major I 4Cr Major II 4 Cr Major III 4Cr	MEC I 4 Cr	RMC 4 Cr	*NA*	*NA*	20 Cr	Theory: 01 Cr. = 25 M. Lab Course (Science): 01 Cr. = 50 M.	**PG Diploma (After 03 Year UG Degree)**
	II	Major IV 4 Cr Major V 4 Cr Major VI 4Cr	MEC II 4 Cr	*NA*	OJT I 4 Cr/ FP I 4 Cr	*NA*	20 Cr	OJT/FP: 01 Cr. = 25 M.	
	Total	**Major 24 Cr**	**MEC 08 Cr**	**RMC 04 Cr**	**OJT/FP 04 Cr**	**NA**	**40 Cr**		
	Exit Option: PG Diploma with 40 Credits After 03 Year UG Degree								
II 6.5	III	Major VII 4 Cr Major VIII 4 Cr Major IX 4Cr	MEC III 4 Cr	*NA*	*NA*	RPI 4 Cr	**20 Cr**	RP I & RP II: 01 Cr. = 25 M	**PG Degree (After 03 Year UG Degree)**
	IV	Major X 4 Cr Major XI 4 Cr Major XII 4Cr	MEC IV 4 Cr	*NA*	*NA*	RPII 6 Cr	**22 Cr**		
	Total	**Major 24 Cr**	**MEC 08 Cr**	**NA**	**NA**	**RP 10 Cr**	**42 Cr**		
Cum. Total of I & II Year		**Major 48 Cr**	**MEC 16 Cr**	**RMC 04 Cr**	**OJT/FP 04 Cr**	**RP 10 Cr**	**40+42 =82**		**82 Credits**
	Exit Option: Two Years 04 Sem. PG Degree with 82 Credits After 03 Year UG Degree								

Abbreviations:

1. MEC : Major Elective Course
2. RMC : Research Methodology Course
3. OJT : On Job Training (Internship/Apprenticeship)
4. FP : Field Project
5. RP : Research Project
6. Cum. Cr : Cumulative Credit

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Department of Zoology

M.Sc. II Zoology

Year & Level	Semester	Course Code	Course Title	Credits	No. of Hrs.
M.Sc. II	III	Major-VII	Developmental Biology	03	45
		Practical	Lab Course-V	01	30
		Major-VIII	Principles of Ecology and Evolution	03	45
		Practical	Lab Course-VI	01	30
		Major-IX	Biology of Vertebrate Immune system	03	45
		Practical	Lab Course-VII	01	30
		MEC-III (A)	Animal Behaviour and Applied Zoology	03	45
		Practical	Lab Course-VIII (A)	01	30
		MEC-III(B)	Biostatistics and Bioinformatics	03	45
		Practical	Lab Course-VIII (B)	01	30
		RP-I	Research Project	04	60
	Total Credits			**20**	
	IV	Major-X	Animal Physiology	03	45
		Practical	Lab Course-IX	01	30
		Major-XI	Animal Cell Culture Technology	03	45
		Practical	Lab Course-X	01	30
		Major- XII	Animal biotechnology	03	45
		Practical	Lab Course-XI	01	30
		MEC-IV(A)	Aquaculture and Its application	03	45
		Practical	Lab Course-XII (A)	01	30
		MEC-IV (B)	Genomics and Proteomics	03	45
		Practical	Lab Course-XII (A)	01	30
		OJT I / RP-II	Research Project	06	60
	Total Credits			**22**	
Total Credits (Semester I & II)				**40**	

Programme Outcomes (POs) for M.Sc. Programme	
PO 1	Disciplinary Masters Knowledge Comprehensive in-depth relevant scientific knowledge and its execution in the Specific area of study
PO 2	Scientific Outlook The qualities such as observation, precision, analysis, logical thinking, clarity of thought and expression and systematic approach to work on research projects and explain scientific phenomena.
PO 3	Problem Solving Skills Analytical skills to solve problems, evaluate situations and act responsibly to Communicate, cooperate and lead the team.
PO 4	Interpersonal Skills and Ethics Ability to integrate professional ethics and scientific knowledge in life, organization, society and individual to fulfill the needs of mankind in both moral and material aspects.
PO 5	Self-Directed Life-long Learning Ability to prepare for NET, SET, GATE and other national and international Competitive examinations.
PO 6	Professional Competence Ability to apply the knowledge independently for continuous personal and professional development and identify business opportunities and initiate Action to achieve it
PO 7	Research and Related Skills Technical know-how about identification of local issues and develop lab to land solutions for the benefit of society at large.

Programme Specific Outcomes (PSOs) for M.Sc. Zoology	
PSO No.	Upon completion of this programme the students will be able to
PSO 1	The Students are expected to acquire the knowledge of animal Science, natural phenomenon, and manipulation of nature and environment by man.
PSO 2	Understanding the scientific terms, concepts, facts, phenomenon and their interrelationship.
PSO 3	Applications of the knowledge develop skills in practical work, experiments and laboratory materials.
PSO 4	Students followed and understood general laboratory practice guidelines, including safety.
PSO 5	They are able to handle instruments for basic and modern analysis.
PSO 6	To develop scientific attitude which is the major objective this makes the students open minded, critical observations, curiosity, thinking etc.
PSO 7	Abilities to apply scientific methods, collection of scientific data, problem solving.
PSO 8	Students are expected to work.
PSO 9	Utilize the developed expertise in concepts, theories, and emerging methodologies to succeed in tackling real-world issues in aquaculture and aquatic science.
PSO 10	Demonstrate advanced knowledge and competency in taxonomy and natural history of aquatic flora and fauna.
PSO 11	Demonstrate hands-on experience in aquatic sampling inventory and measurement techniques. Become an independent, self-motivated professional with the ability to recognize problems in their field of aquaculture and aquatic science and apply critical thinking and problem-solving skills.

Semester - III

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Department of Zoology

Course Type : MMC VII
Course Title : Developmental Biology
Course Code : 602ZOO3101
Credits : 03 **Max. Marks: 75** **Lectures: 45 Hrs.**

Learning Objectives:

LO1 To familiar with the events that lead up to and comprise the process of Gametogenesis fertilization, cleavage to Gastrulation.

LO2 To understands the cytoplasm determinants and autonomous cell specification from differentiation, cell migration to tissue interactions.

LO3 To grab the importance of Homeobox concept, Hormones, cell cycle and apoptosis

LO4 To know the broad relationships of Cell diversification in early animal embryo and Stem cell totipotency, muscular and skeletal system formation in embryo.

Course Outcomes:

After the completion of this course students will be able to:

CO1 Get the knowledge and imaginations in the process of fertilization to Gastrulation.

CO2 Acquire the cell specifications in germ layer formation and cell differentiation.

CO3 Understand the concepts of Axis Formation and Apoptosis.

CO4 Grab the details of cell diversification and will be able it to apply in stem cell therapy and tissue system formation.

Unit No.	Title of Unit & Contents	Hrs.
I	**Basic concepts of development**	**10**
	1. Potency, commitment, specification, induction, competence, 2. Determination and differentiation 3. Morphogenetic gradients 4. Cell fate and cell lineages, stem cells 5. Genomic equivalence and the Cytoplasmic determinants	
	Unit Outcome: UO1 After completion of the unit the students will be familiar with Basic concepts of development.	
II	**Gametogenesis, fertilization and early development:**	**12**
	1. Production of gametes, 2. Cell surface molecules in sperm-egg recognition in animals; 3. Zygote formation, cleavage, blastula formation, 4. Embryonic fields 5. Gastrulation and formation of germ layers in animals; embryogenesis.	
	Unit Outcome: UO1 After completion of the unit the students will acquire the knowledge of Gametogenesis, fertilization and early development	
III	**Morphogenesis and organogenesis in animals**	**11**
	1. Cell aggregation and differentiation in *Dictyostelium;* 2. Axes and pattern formation in *Drosophila*, amphibia and chick 3. Organogenesis –vulva formation in *Caenorhabditis elegans* 4. Eye lens induction 5. Limb development	
	Unit Outcome:	

Unit No.	Title of Unit & Contents	Hrs.
	UO 1. After completion of the unit the students Understand the concepts of Morphogenesis and organogenesis in animals	
IV	**Regeneration, metamorphosis and sex determination.**	**12**
	1. Regeneration in vertebrates 2. Post embryonic development- larval formation 3. Programmed cell death, aging 4. Metamorphosis; environmental regulation of normal development; sex determination.	
	Unit Outcome: UO1 After completion of the unit the students will grab the details of Regeneration, metamorphosis and sex determination.	

Learning Resources:

1. Alberts et al.: Molecular biology of the cell. Garland, 2002.
2. Gilbert: Developmental biology. Sinauers, 2003.
3. Kalthoff: Analysis of biological development. McGraw-Hill, 1996.
4. Wolpert: Principles of development. Oxford, 2002.
5. An Introduction to Embryology, 5th edition (2004), B. I. Balinsky. Publisher - Thomas Asia Pvt. Ltd
6. Developmental Biology, (2001), R. M. Twyman, Publisher - Bios Scientific Publishers LTD.
7. "Molecular Cell Biology" by Harvey Lodish
8. "Developmental Biology: A Very Short Introduction" by John D. Scott
9. Human Embryology and Developmental Biology" by Bruce M. Carlson

Course Type : Lab Course IX
Course Title : Lab Course (Based on MMC VII)
Course Code : 602ZOO4102
Credits : 01 **Max. Marks: 50** **Hours: 30**

Learning Objectives:

LO1 To familiar with the events that take place in cleavage, embryonic and development in Chick and Frogs.
LO2 To understand the developmental process with the help of Chick and Frog as model organisms in knowing the embryonic process.
LO3 Be familiar with the process of regeneration in Invertebrates.
LO4 Be able to understand the developmental process with the help of Chick embryology.

Course Outcomes:

After completion of this course students should be able to:

CO1 Students will get the knowledge of embryonic development in Chick and Frog.
CO2 Learners will acquire the knowledge of happenings in most important events like cleavage to three germ layer formation and organogenesis.
CO3 Learners will be able to differentiate in the regeneration in invertebrates and development in Vertebrates.
CO4 Students will understand the embryonic steps with the help of mounting of embryos at different stages in Chick and Frog.

Sr. No.	**Practical**
1.	Patterns of cleavages in Frog and Chick (slides)
2.	Study of embryonic and post-embryonic development using frog egg as model/charts.
3.	Isolation of chick embryo from fertilized egg.
4.	Isolation of chick blastoderm from fertilized egg.
5.	Mounting of chick embryos and preparation of permanent mounts.
6.	Gross anatomy and histology of chick embryos till 96 hrs.
7.	Early chick development studies: study of embryonic membranes in chick embryo by using model/charts.
8.	Study of cell death during limb morphogenesis in chick embryo.
9.	Study of regeneration in Hydra and Planaria by using model/charts.
10.	Study of developmental stages of zebra fish by using model/charts
11.	Identification of gene expression pattern in developmental stages in Drosophila sp. (from slides/pictures)
12.	In vitro culture of Drosophila.

N.B.: Any Ten Practicals from above list.

Course Type : MMC VIII
Course Title : Principles of Ecology and Evolution
Course Code : 602ZOO3102
Credits : 03 **Max. Marks: 75** **Lectures: 45 Hrs.**

Learning Objectives:

LO1 To understand the environment, population ecology.
LO2 To understand the community ecology, ecological succession, ecosystem ecology.
LO3 To understand the biogeography and biogeographically zones of India.
LO4 To understand the emergence of evolution thoughts Lamarck; Darwin-concept of evolution, Mendelism.
LO5 To understand the concept of molecular evolution.

Course Outcomes:

After completion of this course students should be able to:

CO1 Understood the knowledge of the principles of ecology and evolution.
CO2 Students should have the knowledge about the environment, concept of habitat and niche.
CO3 Students have an understanding of nature and structure of communities, ecosystem.
CO4 Understood the knowledge of origin of cells and unicellular evolution, molecular evolution.

Unit No.	Title of Unit & Contents	Hrs.
I	**Environment and Population Ecology**	11
	1. The Environment: Physical environment; biotic environment; biotic and abiotic interactions. **2. Habitat and Niche**: Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement. 3. **Population Ecology**: Characteristics of a population; population growth curves; population regulation; life history strategies (r and K selection); concept of metapopulation –demes and dispersal, intergenic extinctions, age structured populations. Species Interactions: Types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis.	
	Unit Outcome: UO 1 After completion of the unit the students will understand the concepts of Environment and Population Ecology.	
II	**Community Ecology, Ecosystem , Biogeography**	11
	1. **Community Ecology**: Nature of communities; community structure and attributes; levels of species diversity and its measurement; edges and acetones 2. **Ecological Succession**: Types; mechanisms; changes involved in succession; concept of climax. 3. **Ecosystem Ecology**: Ecosystem structure; ecosystem function; energy flow and mineral cycling (C, N, and P); primary production and decomposition; structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, estuarine). 4. **Biogeography**: Major terrestrial biomes; theory of island biogeography; biogeographically zones of India.	
	Unit Outcome:	

Unit No.	Title of Unit & Contents	Hrs.
	UO 1After completion of the unit the students will understand the concepts of Community Ecology, Ecosystem, Biogeography	
III	**Unicellular and Organic evolution**	**12**
	1. **Lamarckism; Darwinism**, adaptation, fitness and natural selection; Spontaneity of mutations; the evolutionary synthesis. 2. **Origin of cells and unicellular evolution:** Origin of basic biological molecules; Abiotic synthesis of organic monomers and polymers; Concept of Oparin and Haldane; Experiment of Miller (1953); 3. **The first cell**: Evolution of prokaryotes; Origin of eukaryotic cells; Evolution of unicellular eukaryotes.	
	Unit Outcome: UO1 After completion of the unit the students will understand the concepts of Unicellular and Organic evolution	
IV	**Molecular Evolution and population genetics**	**11**
	1. **Molecular Evolution:** Concepts of neutral evolution, molecular divergence and molecular clocks; Molecular tools in phylogeny, Origin of new genes and proteins; Gene duplication and divergence. 2. **Population genetics:** Populations, Gene pool, Gene frequency; Hardy-Weinberg Law; concepts and rate of change in gene frequency through natural selection, migration and random genetic drift; Adaptive radiation; Isolating mechanisms; Speciation; Allopatricity and Sympatricity; Convergent and divergent evolution; Co-evolution, Sexual selection.	
	Unit Outcome: UO1 After completion of the unit the students will understand the concepts of Molecular Evolution and population genetics	

Learning Resources:

1. Odum: Fundamentals of Ecology (Saunders, 1971)
2. Odum: Basic Ecology (Saunders, 1985)
3. Turk and Turk : Environmental Science (4rth ed. Saunders, 1993)
4. Primark : A Primer of Conservation Biology (2nd ed. Sinauer Associates)
5. Calabrese : Pollutants and High-Risk Groups (John Wiley,1978)
6. Raven, Berg, Johnson : Environment (Saunders College Publishing, 1993)
7. Sharma: Ecology and Environment (Rastogi Publication, 7th ed. 2000) (55)
8. Cunningham and Saigo: Environmental Science (McGraw Hill Boston,5th ed.,1999)
9. Ricklefs and Miller : Ecology (Freeman and Company, New York, 4th ed., 2000)
10. Dobzhansky Th. (1964): Genetics and the Origin of Species. Columbia
11. Kimura M. (1984): The Neutral Theory of Molecular Evolution. Cambridge

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Department of Zoology

Course Type : Lab Course X
Course Title : Lab Course (Based on MMC VIII)
Course Code : 602ZOO3105
Credits : 03 **Max. Marks: 50** **Lectures: 30Hrs.**

Learning Objectives:

LO1 To understand ecosystem, community structure, and their interactions
LO2 To understand various techniques of biodiversity measurement
LO3 To understand various diversity indices.
LO4 To understand evolutionary aspects.

Course Outcomes:

After completion of this course students should be able to:

CO1 Get the Knowledge of Ecosystem and populations.
CO2 Get the knowledge of biodiversity.
CO3 Get the Knowledge of evolution trends.
CO4 Acquire the knowledge of biotic interaction and Biotic Community.

Sr. No.	Practicals
1	Estimation of dissolved Oxygen from given water and soil sample.
2	Estimation of dissolved Carbon dioxide from given water and soil sample.
3	Estimation of dissolved Salinity and chlorinity from given water and soil sample.
4	Estimation of dissolved pH from given water and soil sample.
5	Estimation of nutrients from soil.
6	Estimation of population density of organismsby quadrate method.
7	Study of Insect diversity.
8	Study of landscape.
9	Study of phylogenetic relationships between different animals according to their evolutionary History.
10	Homologues and Analogues Organs in Animals.
11	Study of embryological evidences.
12	Study of Fossils and other connecting links by using chart/specimen.
13	Hardy Weinberg based problems. (3-4 problems)
14	Visit to Sanctuary/ Zoo Parks/National Reserve, etc.

N.B.: Any Ten Practicals from above list.

Rajarshi Shahu Mahavidyalaya, Latur
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Course Type : MMC IX
Course Title : Biology of Vertebrate Immune system
Course Code : 602ZOO3103
Credits : 03 **Max. Marks: 75** **Lectures: 45 Hrs.**

Learning Objectives:

LO1 To understand the concept of immunity, lymphatic system, antigen and different types of immune responses.
LO2 To understand the relationship in antigen and antibody and complement system.
LO3 To grab the importance of Histocompatibility Complex in mouse and HLA system in human
LO4 Learners will understand the role of T and B cells and their role.

Course outcomes:

After completion of this course students should be able to:

CO1 Get the knowledge of immunity and immune responses.
CO2 Acquire the knowledge of antigen and antibody in immune system.
CO3 Grab the details of HLA system in human.
CO4 Understand the role of T and B cells and their role.

Unit No.	Title of Unit & Contents	Hrs.
I	**Immunity and Immune response**	**11**
	1. Innate and acquired immunity 2. Phylogeny and ontogeny of immune system 3. Organization and structure of lymphoid organs 4. Cells of immune system and their differentiation 5. Lymphocyte traffic 6. Nature of immune response 7. Nature of antigens and super antigens 8. Antigenicity and immunogenicity	
	Unit Outcome: UO1 After completion of the unit the students will understand the concepts of Immunity and Immune response	
II	**Antibodies and Complement system**	**11**
	1. Factors influencing immunogenicity 2. Epitomes and haptens 3. Structure and functions of antibodies 4. Antibody mediated effectors functions 5. Antigen-Antibody interactions 6. Complement system	
	Unit Outcome: UO1 After completion of the unit the students will understand the concepts of Antibodies and Complement system	
III	**Major Histocompatibility Complex**	**11**
	1. Major Histocompatibility Complex in mouse and HLA system in human 2. MHC heliotypes 3. Class I and Class II molecules 4. Expression and diversity	

Unit No.	Title of Unit & Contents	Hrs.
	5. Disease susceptibility and MHC/HLA	
	Unit Outcome: UO1 After completion of the unit the students will understand the concepts of Major Histocompatibility Complex	
IV	**Organization and expression of Ig genes and Hypersensitivity**	**12**
	1. Organization and expression of Ig genes 2. activation and differentiation of B and T cells, B and T cell receptors, 3. Cytokines-Structures and functions, cytokine receptors, and immune response 4. Immunological tolerance and Anti-immunity 5. hypersensitivity and autoimmunity, immune response during infections, 6. congenital and acquired immunodeficiency 7. Application of immunological principles, vaccines.	
	Unit Outcome: UO 1 After completion of the unit the students will understand the concepts of Organization and expression of Ig genes and Hypersensitivity	

Learning Resources:

1. Kuby. Immunology, W.H. Freeman, USA.
2. W.Paul. Fundamentals of Immunology. 8th Edition (2022),Lippincott Williams & Wilkins
3. I.M. Roitt Essential immunology, ELBS Edition.
4. Immunology" by David Male, Jonathan Brostoff, David Roth, and Ian A. M. Leslie ,4th Edition (2018)
5. Advanced Immunology: A Practical Guide" by Peter J. Delves and Jonathan B. K. Smith

Rajarshi Shahu Mahavidyalaya, Latur
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Course Type : Lab Course XI
Course Title : Lab Course (Based on MMC IX)
Course Code : 602ZOO3106
Credits : 03 **Max. Marks: 50** **Lectures: 30 Hrs.**

Learning Objectives:

LO1 To familiar with Antigen-antibody interaction in vitro and ELISA
LO2 To understand the isolation of B-Lymphocytes and Phagocytosis in vitro.
LO3 To grab the importance of lymphoid organs.
LO4 To understand Immunological diagnosis of infection /cancer /Pregnancy

Course outcomes:

After completion of this course students should be able to:

CO1 Get the knowledge of Antigen-Antibody interaction and immunity.
CO2 Acquire the skill of isolation of B-Lymphocytes.
CO3 Understand the role of lymphoid organs in management of Immunity.
CO4 Understand the role of lymphoid organs in management of Immunity
CO5 Students will grab the details of system of diagnosis of infection

Sr. No.	Practicals
1	Antigen-antibody interaction in vitro
2	Enzyme Linked Immunosorbant Assay (ELISA) by double antibodies sandwich techniques.
3	Isolation of B-lymphocytes
4	Phagocytosis in vitro.
5	Separation of gamma globulins from serum.
6	Identification of cells by Blood smear preparation.
7	Histology of lymphoid organs.
8	Immunological diagnosis of pregnancy/infection.
9	Detection of antibodies from blood by rapid plasma reagin assay.
10	Isolation of antibodies, immunoglobulin (IgG), (production of anti-serum).
11	Study of antigen-antibody agglutination reaction by widal test.
12	Determination of antibodies by using VDRL test.
13	To demonstrate antigen-antibody reaction by hemeagglutination reaction.
14	Radio immunoassay of hormones

N.B.: Any Ten Practicals from above list.

Rajarshi Shahu Mahavidyalaya, Latur
(Autonomous)
Department of Zoology

Course Type : MEC III
Course Title : Animal Behaviour and Applied Zoology
Course Code : 602ZOO3201
Credits : 03 **Max. Marks: 75** **Lectures: 45 Hrs.**

Learning Objectives:-

LO1 To grasp the knowledge of different angles of animal behavior.
LO2 To acquires the knowledge of learning and its importance in Ethology.
LO3 To understand social behavior and its importance in life.
LO4 To acquire the knowledge of applied zoology for the employability

Course Outcomes:

After completion of this course students should be able to:

CO1 Grasp the knowledge of different angles of animal behavior.
CO2 Acquire the knowledge of learning and its importance in Ethology.
CO3 Understand social behavior and its importance in life.
CO4 Acquire the knowledge of applied zoology for the employability

Unit No.	Title of Unit & Contents	Hrs.
I	**Ethology**	**12**
	1. Introduction of Ethology 2. Patterns of Behaviour: 3. Individual behavioural pattern 4. Homing behaviour 5. Genetic basis of behaviour 6. Learning behaviour	
	Unit Outcome: UO1 After completion of the unit the students will understand the concepts of Ethology	
II	**Social Behavior patterns**	**11**
	1. Reproductive behavioural pattern 2. Mating behaviour in animals 3. Parental investment 4. Stickle back behaviour 5. Sptimal foraging theory 6. Dominance hierarchies 7. Territoriality 8. Altruism	
	Unit Outcome: UO1 After completion of the unit the students will understand the concepts of evolutionary approach to behavior	
III	**Animal communications**	**11**
	1. Animal communications 2. Social organization in insect and primates 3. Dance language of the honey bee 4. Mimicry and its types 5. Biological rhythms: Circadian, circannual	
	Unit Outcome:	

Unit No.	Title of Unit & Contents	Hrs.
	UO1 After completion of the unit the students will understand the concepts of animal communications	
IV	**Applied Zoology**	**11**
	1. Applied Zoology (Basic concepts, process and application) 2. Sericulture, 3. Apiculture, 4. Fish culture, 5. Poultry keeping 6. Dairy industry, 7. Lac culture	
	Unit Outcome: UO1 After completion of the unit the students will understand the concepts of applied Zoology	

Learning Resources:

1 Adcock: Animal Behaviour- An Evolutionary Approach. (7th ed.) Sinaur Associates, Inc. 2001.

2 Drickamer&Vessey: Animal Behaviour –Concepts, Processes and Methods (2nd ed.), Wadsworth, 1986.

3 Gadekar: Survival Strategies-Cooperation and Conflict in Animal Societies. Universities Press, 1998.

4 Goodenough et al : Perspectives on Animal Behaviour, Wiley, 1993.

5 Grier : Biology of Animal Behaviour, Mosby, 1984.

6 Hallidy and Slater : Animal Behaviour(vols. I-3) Blackwell Scientific Publ., 1983.

7 Krebs &Davis: Behavioural Ecology. (3rd ed.) Blackwell, 1993.

8 Lehner : Hand Book of Ethological Methods.(2nd ed.) Garland, 1996.

9 Manning &Dawkins : An introduction to Animal Behaviour (5th ed.), Cambridge Univ. Press, 1998.

10 Slater &Halliday : Behaviour and Evolution,(1st ed.) Cambridge Univ. Press, 1994.

11 Shukla and Upadhyaya:Economic Zoology(Rastogi publication)

12 Srivatsava :Text Book of Applied Entomology (Kalyani publishers)

13 Venkitaraman:Economic zoology(Sudarshana publishers

Rajarshi Shahu Mahavidyalaya, Latur
(Autonomous)
Department of Zoology

Course Type : Major-VIII)
Course Title : Major-VIII: Lab Course-VIII :(Based on-Major-VIII)
Course Code :
Credits : 03 **Max. Marks: 75** **Lectures: 45 Hrs.**

Learning Objectives:-

LO1 To learn different aspects of Ethology with the help of earthworm and mosquito larvae.
LO2 To learn the different types of behaviors with the help of maggots of housefly, monkeys etc.
LO3 To learn the interspecific behavior in Dogs and Cattles.
LO4 To learn the life cycles of honey bee, Silkworm
LO5 To learn the entrepreneurship by visiting different types of farms like fish farm and Apiary Sericulture farm and reporting.

Course Outcomes:

After completion of this course students should be able to:

CO1 Students will be able to know angles of Ethology with the help model animals.
CO2 Students will be grabbing the behavioral aspects with the help study of insects and Monkey, Dogs and Cattles
CO3 Students will be able to capture the details of life cycles of silkworm and Honey bee
CO4 By visiting different types of Farms and culture places entrepreneurship can bedeveloped.

Sr. No.	Practicals
1	Habituation in earthworms/mosquito larvae.
2	Feeding behavior of housefly
3	An investigation into the locomotory behavior of maggots of the housefly.
4	Study of behavior of troops of monkeys: Individual pattern of behavior, study of social pattern behavior
5	Intraspecific association-Flocking behavior in Pigeons, Behaviour of dog and cattle
6	Mimicry in animals.
7	Visit to study the management of the following: Fish farm, dairy farm, apiculture, sericulture. Submit the report on anyone of the above.
8	Life cycle of silkworm and honey bees. (Use chart/model/material)
9	Study of the structural organization of the bee hive.
10	Communication in animals.
11.	Study of Phototropism by using suitable animals.
12.	To demonstrate the phenomenon of geotaxis by using earthworm.
13	Field visit for study of reproductive behavior in cattles in breeding season.

Rajarshi Shahu Mahavidyalaya, Latur
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Department of Zoology

Course Type : MEC-III (B)
Course Title : Biostatistics and Bioinformatics
Course Code :
Credits : 03 **Max. Marks: 75** **Lectures: 45 Hrs.**

Learning Objectives:

LO1 To understand Correlation, regression, analysis of variance
LO2 To understand the Distributions and Muetrovariate statistics
LO3 To understand the Basics of IT, Data archiving systems
LO4 To understand the emergence of Data base management: software, packages and tools

Course Outcomes:

After completion of this course students should be able to:

CO1 Understood the knowledge of the ANOVA
CO2 Students should have the knowledge about the environment, concept statistics.
CO3 Students have an understanding of nature and structuredata systems.
CO4 Understood the knowledge of database management.

Unit No.	Title of Unit & Contents	Hrs.
I	**Correlation, regression, analysis of variance**	**12**
	Correlation: Types of correlation, Calculation of correlation in continuous data andordinal data. Regression: Linear regression, regression coefficient. Analysis ofVariance (ANOVA): One way, post-hoc tests. Hypothesis testing: Parametric tests(Paired and unpaired t-test, z-test, F-test) & Non Parametric tests (Chi-square test, Mann-Whitney U-test)	
	Unit Outcome: UO1 After completion of the unit the students will understand the concepts of correlation, regression, analysis of variance	
II	**Distributions and Muetrovariate statistics**	**11**
	Measures of central tendency and dispersal; probability distributions (Binomial, Poisson and normal); Sampling distribution; Difference between parametric andnon-parametric statistics; Confidence Interval; Errors; Levels of significance; Regression ; Basic introduction to Muetrovariatestatistics	
	Unit Outcome: UO1 After completion of the unit the students will understand the concepts of correlation, regression, analysis of variance	
III	**Basics of IT Data archiving systems**	**11**
	Introduction and scope of bioinformatics: concept of digital laboratory. Basics of information technology, computer, operating systems, network. Concept of internetProtocol (TCP/IP), hypertext, home-page, web-page and uniform resource locators (URL). Introduction to data archiving systems (FASTA format, Accession, and GI-Number)	
	Unit Outcome: UO1 After completion of the unit the students will understand the concepts of basics of IT; Data archiving systems	
IV	**Data base management: software, packages and tools**	**11**

Unit No.	Title of Unit & Contents	Hrs.
	Basic features and management systems of following: Nucleic acid sequences databases, Genome databases, Protein sequence, structures and interacting proteins databases, Literature databases, Biodiversity and ecosystem based databases. Introduction to data retrieval systems, Search engines, Entrez, sequence retrieval system (SRS) and protein identification resource (PIR). Introduction to molecular sequence analysis software packages and tools, Prediction of motifs, folds and domains, Sequence alignments (BLAST and Clustal W) and phylogenetic trees (PHYLIP). Applications of bioinformatics: Clinical informatics, Chemioinformatics sources and pharmacoinformatics	
	Unit Outcome: UO1 After completion of the unit the students will understand the concepts of Data base management: software, packages and tools	

Learning Resources:

1 Daniel, W.W. (2012) Biostatistics: A Foundation for Analysis in Health Sciences (10th edition) John Wiley.
2 Milton, J.S. &Tsokos, J.O. (1992) Statistical Methods in the Biological and Health Sciences (2nd edition) McGraw Hill.
3 Zar, J.H. (2013) Biostatistical Analysis (5th edition) Pearson.
4 Barnes, M.R. and Gray, I.C. (2003) Bioinformatics for geneticists, Wiley.
5 Mount, D.W. (2006) Bioinformatics (2nd edition) CBS.

Rajarshi Shahu Mahavidyalaya, Latur
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Department of Zoology

Course Type : Lab Course XII
Course Title : Lab Course (Based on MEC-III(B))
Course Code : 602ZOO3203
Credits : 03 **Max. Marks: 50** **Lectures: 30 Hrs.**

Learning Objectives:

LO1 To understand Correlation, regression, analysis of variance
LO2 To understand the Distributions and Muetrovariate statistics
LO3 To understand the Basics of IT, Data archiving systems
LO4 To understand the emergence of Data base management: software, packages and tools

Course Outcomes:

After completion of this course students should be able to:

CO1 Understood the knowledge of the ANOVA
CO2 Students should have the knowledge about the environment, concept statistics.
CO3 Students have an understanding of nature and structuredata systems.
CO4 Understood the knowledge of database management.

Sr. No.	Practicals
1.	Problems on mean, mode and median
2.	Problems on standard deviation and standard error
3.	Calculation of correlation coefficient values and finding out the probability
4.	Calculation of 'F' value and finding out the probability value for the F value.
5.	Student's t-test: Independent and dependent. Hand calculation and calculation using MS Excel.
6.	ANOVA and Tukey's HSD: Hand calculation and calculation using MS Excel.
7.	Handling and interpretation of Nucleic acid and protein databases.
8.	Sequence retrieval from databases
9.	Pair-wise alignment of sequences (BLAST) and interpretation of the output
10.	Sequence homology and Gene annotation. Translation of a nucleotide sequence and selection of the correct reading frame of the polypeptide from the output sequences
11.	Construction of phylogenetic tree.
12.	Comparative analysis of different databases in metabolomics.
13.	Graphical representation of data ; histogram; polygon frequency curve; pie diagram
14.	To determine homologous sequence of nucleotide to predict the gene and its functions.
15.	To determine the protein that contains query sequence as one of its component for identification of query sequence and its functions.

Semester - IV

Rajarshi Shahu Mahavidyalaya, Latur
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Department of Zoology

Course Type : MMC X
Course Title : Animal Physiology
Course Code : 602ZOO4101
Credits : 03 **Max. Marks: 75** **Lectures: 45 Hrs.**

Learning Objectives:-

LO1 To understand different working aspect of Animal physiology like Digestion, Excretion Circulation, Respiration, Nervous co-ordination and sense organs etc.
LO2 To learn the importance of normal functioning of all systems and their coordination and regulation.
LO3 To understand social interactions between Endocrinology and Reproduction.
LO4 To gain knowledge of stress and its effects on body physiology leading to Adaptations.

Course Outcomes:

CO1 Students will be able to grasp the knowledge of Animal Physiology with the help of mechanism of working.
CO2 Learner would acquire the knowledge of animal physiology and will be able to explain. Students will be able to explain the details of functioning of vital body systems.
CO3 Learner would acquire the knowledge of Animal physiology for the finding the
CO4 Abnormal functioning and cause of it in physiological sense.

Unit No.	Title of Unit & Contents	Hrs.
I	**Blood and circulationand Cardiovascular System**	**12**
	1. **Blood and circulation:**closed and open circulatory system, Composition and functionblood, Haemopoiesis, blood volume and regulation, Haemoglobin, ho meostasis. 2. **Cardiovascular System:**Structure of heart, ECG, Cardiac cycle, blood pressure, neural and chemical regulation of heart.	
	Unit Outcome: UO1 After completion of the unit the students will understand the concepts of Blood and circulation and Cardiovascular System	
II	**Respiratory and Nervous system**	**11**
	1. **Respiratory system**:Anatomy of Respiratory system, transport of gases, neuraland chemical regulation of respiration. 2. **Nervous system:** Neurons, action potential, central, peripheral nervous system, neural control of muscletone and posture. 3. **Sense organs:** Vision, hearing and tactile response.	
	Unit Outcome: UO1 After completion of the unit the students will understand the concepts of Respiratory and Nervous system	
III	**Excretorysystem and Thermoregulation**	**11**
	1. **Excretory system**:Physiology of excretion, V.S. of kidney, structure of nephron, urine formation, composition of urine, micturition, osmoregulation, acid-base balance. 2. **Thermoregulation**:Comfort zone, body temperature physical, chemical,neural regulation, acclimatization.	
	Unit Outcome:	

Unit No.	Title of Unit & Contents	Hrs.
	UO1 After completion of the unit the students will understand the concepts ofExcretory system and Thermoregulation	
IV	**Digestive system, Endocrinology and reproduction**	**11.**
	1. **Digestive system**: Digestion, absorption, energy balance, BMR. 2. **Endocrinology and reproduction** : Endocrine glands, basic mechanism of hormone action, hormones and diseases; reproductive systems.	
	Unit Outcome: UO1 After completion of the unit the students will understand the concepts ofDigestive system, Endocrinology and reproduction	

Learning Resources:

1. Essentials of Animal Physiology –Rastogi
2. Ganong's Review of Medical Physiology
3. Schaums Outline of Human Anatomy and Physiology, Third Edition (Schaums Outline Series)
4. Animal Physiology: From Genes to Organisms" by Laurie B. Scott and Richard W. Hill
5. Biology of Animals: Physiology and Behavior" by David J. Bennett and Daniel M. V. Gilleard

Rajarshi Shahu Mahavidyalaya, Latur
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Department of Zoology

Course Type : Lab Course VIII
Course Title : Lab Course (Based on MMC X)
Course Code : 602ZOO4104
Credits : 03 **Max. Marks: 50** **Lectures: 30 Hrs.**

Learning objectives:

LO1 To make the students to understand the hematological and immunological techniques.
LO2 To make the students to understand the hematological techniques conducted in laboratories including, complete blood count, blood grouping, blood films, and differential count.
LO3 To make the students to understand the process of digestion by qualitative detection of digestive enzymes.
LO4 To make the students to understand the analytical techniques know the functional status of different organ.

Course Outcomes:

Learners would understand the different physiological process of animals
CO1 Learners would be able to understand functional status of organ
CO2 Learners would be able to understand complete blood count, blood grouping, blood films, and differential count.
CO3 Learners would understand the respiratory status of animals
CO4 Learners would understand the different constitution of bodily fluids.

Sr. No.	**Practicals**
1	Qualitative detection of digestive enzymes (protease, Amylase and Lipase) in cockroach/ Crab.
2	Detection of human salivary amylase.
3	Estimation of oxygen consumption in fish/ Crab or any other suitable aquatic animal.
4	Determination of total erythrocytes by Heamocytometer
5	Determination of total leucocytes by Heamocytometer
6	Preparation of peripheral blood smear and determination of Differential leucocytescount (DLC).
7	Measurement of blood pressure by sphygmomanometer.
8	Estimation of Haemoglobin by Sahli's method
9	Estimation of urine / serum creatinine from blood
10	Estimation of urine / serum urea by diacetyl monoxime method 11Colorimetric estimation of blood/serum cholesterol.
11	ESR of blood.
12	Determination of clotting time of blood by capillary tube method.
13	Preparation of haematin crystals.
14	Determination of bilirubin in serum.
15	Qualitative detection of Nitrogenous waste products (Ammonia, Urea.)
16	To estimate BMI (Body mass Index).
17.	Determination of bleeding time of blood by capillary tube method

N.B.: Any Ten Practicals from above list.

Rajarshi Shahu Mahavidyalaya, Latur
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Department of Zoology

Course Type : MMC-XI
Course Title : Animal Cell Culture Technology
Course Code : 602ZOO4102
Credits : 03 **Max. Marks: 75** **Lectures: 45 Hrs.**

Learning Objectives:

LO1 To give students knowledge about various equipment and materials for animal cell culture technology and characters of cells.
LO2 To give students knowledge about nutritional requirements of cells and growth media.
LO3 To teach basic techniques of mammalian cell culture.
LO4 Enable students to understand biology & characterization of cultured cells and cell surgery methods.

Course Outcomes:

CO1 Students have a greater understanding of equipments& materials for animal cell culture technology.
CO2 Students enable to understand characters of cells. Students enable to understand nutritional requirements of cells &different kinds of growth media.
CO3 Students enable to understand primary cell culture and types of cell culture.
CO4 Students have greater understanding of preparation & methods of cell surgery

Unit No.	Title of Unit & Contents	Hrs.
I	**Equipments and Materials for animal Cell Culture Technology:**	**12**
	1. Basic Aseptic Techniques, 2. Design of Tissue Culture LaboratoryEquipments : Laminar Flow Hoods, CO2 incubator, Open and closed cultures,Microscopes, centrifuge, Refrigerators and Freezers, pipetting aids, Miscellaneous small items of Equipments, Materials, filters, Miscellaneous Items. 3. Characters of cells :Cells in primary culture 4. Established Cell lines, Tumor/cancer originated cells	
	Unit Outcome: UO1 After completion of the unit the students will understand the concepts ofEquipments and Materials for animal Cell Culture Technology	
II	**Nutritional Requirements of Cells and growth media:**	**11**
	1. Basal salt solution (BSS), Minimum Essential Medium, Serum dependent defined media , Serum independent defined media – Cell specific media , 2. Basic Techniques of mammalian cell culture: Primary Cell culture : Isolation and separation of cells, viable cell count, maintenance of cell culture	
	Unit Outcome: UO1 After completion of the unit the students will understand the concepts of Nutritional Requirements of Cells and growth media	
III	**Biology and Characterization of cultured cells:**	**11**
	1. Types of cell cultures: a. Monolayer ,b. Suspension , c. Clone culture , d. Stem cell culture	

Unit No.	Title of Unit & Contents	Hrs.
	2. Contamination Testing of Culture , Viability measurement and cytotoxicity, Measurement of growth parameters, 3. Cell cycle analysis and Synchronization of cultures,	
	Unit Outcome: UO1 After completion of the unit the students will understand the concepts of Biology and Characterization of cultured cells	
IV	**Cell Fusion Methods:**	**11**
	1. **Fusogens**: a. Virus induced , b. Chemical induced, c. Liposome induced (Preparation of liposomes and use) 2. Hybridoma cell preparations and their properties, Use of Hybridoma technology 3. **Applications of Animal Cell Culture**: Evaluation of Chemical carcinogenicity, Cell malignancy Testing.Toxicity Testing, Karyotyping and cytogenetic characterization.	
	Unit Outcome: UO1 After completion of the unit the students will understand the concepts of Cell Fusion Methods.	

Learning Resources:

1. Bruce Albert et al “Molecular Biology of the Cell”
2. Cell and Tissue Culture
3. Methods in enzymology (Cell culture)
4. Cell Culture: Methods and Applications" by Paul J. R. Fry
5. Molecular Cloning: A Laboratory Manual" by Michael R. Green and Joseph Sambrook
6. Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications" by R. Ian Freshney.

Course Type :
Course Title : Lab Course IX (Animal Physiology)
Course Code :
Credits : 03 **Max. Marks: 50** **Lectures: 30 Hrs.**

Learning objectives:

LO1 To make the students to understand the haematological and immunological techniques.
LO2 To make the students to understand the haematological techniques conducted in laboratories including, complete blood count, blood grouping, blood films, differential count.
LO3 To make the students to understand the process of digestion by qualitative detection of digestive enzymes.
LO4 To make the students to understand the analytical techniques know the functional status of different organ.

Course outcomes:

CO1 Learners would understand the different physiological process of animals
CO2 Learners would be able to understand functional status of organ
CO3 Learners would be able to understand complete blood count, blood grouping, blood films, and differential count.
CO4 Learners would understand the respiratory status of animals

Sr. No.	Practicals
1.	Preparation of glass wares for cell culture
2.	Preparation of media
3.	Isolation of cells by enzyme digestion
4.	Separation of cells by suitable methods
5.	Viable cell count
6.	Primary cell culture and its maintenance
7.	Measurements of growth parameters
8.	Cell cycle analysis
9.	Karyotype studies
10.	Freezing of cells
11.	Viability staining of cells

N.B.: Any Ten practical from above list.

Course Type :
Course Title : Major-X (Animal Biotechnology)
Course Code :
Credits : 03 **Max. Marks: 75** **Lectures: 45 Hrs.**

Learning objectives:

LO1 Provide students with necessary knowledge about Environmental biotechnology and bioremediation.
LO2 Enable students to understand Aquaculture and livestock Biotechnology.
LO3 Enable studentsto evaluateBioprocess and fermentation technology
LO4 Provide students with knowledge of Biotechnology in human welfare.

Course Outcomes:

Upon completion of the course students will be able to:

CO1 Utilize the developed expertise in concepts, theories, and emerging methodologies to succeed in tackling real-world issues in animal biotechnology and aquatic science.
CO2 Demonstrate advanced knowledge and competency in bioremediation techniques.
CO3 Demonstrate hands-on experience in aquatic sampling inventory and measurement techniques.
CO4 Apply practical and theoretical knowledge for aquaculture research and Animal Biotechnology.

Unit No.	Title of Unit & Contents	Hrs.
I	**Biotechnology and Bioremediation**	**12**
	Environmental biotechnology: Introduction, water pollution control: primary and secondary treatment. Pollution monitoring: Biotechnological tools for pollution monitoring (DNA prob and Biosensor) Bioremediation: Definition, types, microbial degradation of xenobiotics(Hydrocarbons, Pesticides and Polychlorinated biphenyls). Role of genetically engineered microorganism in bioremediation ,Biomining and Bioleaching.	
	Unit Outcome: UO1 After completion of the unit the students will understand the concepts of Biotechnologyand Bioremediation.	
II	**Aquaculture and livestock Biotechnology**	**11**
	Aquaculture Biotechnology :Application of biotechnological tools for disease diagnosis and management in aquatic organisms(DOT-ELISA, Gene prob PCR and Probiotics) livestock Biotechnology :Assisted reproductive technology- invitro fertilization , embryo transfer , Artificial insemination, Gamete intrafallopian transfer and oocyte donation for livestock improvement -Advantages and disadvantages	
	Unit Outcome: UO1 After completion of the unit the students will understand the concepts ofAquaculture and livestock Biotechnology	
III	**Bioprocess and fermentation technology**	**11**
	Bioprocess/fermentation technology : products of commercial importance from bioprocess.	

Unit No.	Title of Unit & Contents	Hrs.
	Bioreactors: principle, design of conventional and advanced types (continuous stirred tank bioreactor-CSTB and airlift bioreactor). Fermentation process: selection of culture media and gases sterilizationof media , fermenters and air filters. Biotransformation: principle and biotransformation of ethanol (separation, concentration, purification and formulation) biofuels.	
	Unit Outcome: UO1 After completion of the unit the students will understand the concepts ofBioprocess and fermentation technology	
IV	**Biotechnology in human welfare**	**11**
	Biosensors: principle, types ,application of biosensors. Human genome project: introduction, objectives, principle, major contributions of HGP Gene therapy: types of gene therapy, vectors used, gene therapy for cancer. DNA application: DNA in diagnosis of genetic diseases, DNA fingerprinting , DNA and RNA vaccines. Bioweapons.	
	Unit Outcome: UO1 After completion of the unit the students will understand the concepts ofBiotechnology in human welfare	

Learning Resources:

1. Animal Biotechnology: Science and Technology" edited by S. P. Ghosh
2. Principles of Animal Genetics and Biotechnology" by Stuart J. M. Wright
3. Biotechnology in Animal Breeding and Genetics" by V. P. Gupta and A. K. Yadav
4. Applied Animal Biotechnology: Techniques and Applications" edited by S. P. S. Kumar and A. R. Singh
5. Genetic Engineering and Biotechnology: Applications in Animal Science" edited by R. B. S. Sharma

Course Type :
Course Title : Lab CourseX (Animal Biotechnology)
Course Code :
Credits : 03 **Max. Marks: 50** **Lectures: 30 Hrs**

Learning Objectives:

LO1 Enable students to understand basic concept Principles Animal Biotechnology.
LO2 Enable students to understand principal and techniques of Recombinant DNA Technology.
LO3 Enable students to understand Construction of Genomic Library.
LO4 Enable students to understand electrophoresis techniques.

Course Outcomes:

Upon completion of the course students will be able to:

CO1 Utilize the developed expertise in concepts, practical, and emerging methodologies in animal biotechnology.
CO2 Can Perform Experiments Like Isolation Of Genomic DNA From Bacteria.
CO3 Will able to isolate DNA from various samples.
CO4 Will able to handle PCR.

Sr.no.	Practical
1	Preparation of Buffers and Reagents
2	Principle of Centrifugation
3	Agarose Gel Electrophoresis
4	SDS-Polyacrylamide Gel Electrophoresis
5	Isolation of Plasmid DNA from Bacteria
6	Restriction Digestion of Plasmid DNA
7	Isolation of Bacterial Genomic DNA
8	PCR and Optimization of Factors Affecting PCR
9	Southern Blotting
10	Northern Blotting
11	Western Blotting
13	Biochemical Techniques
14	Isolation of DNA from blood.

N.B.: Any Ten Practicals from above list.

Rajarshi Shahu Mahavidyalaya, Latur
(Autonomous)
Department of Zoology

Course Type : MEC-IV (A)
Course Title : MEC-IV (A)Aquaculture and its Application
Course Code :
Credits : 03 **Max. Marks: 75** **Lectures: 45 Hrs.**

Learning Objectives:-

LO1 To learn the fresh water aquaculture and its different type aquaculture enclosures.
LO2 To learn the importance of Aquaculture engineering,
LO3 To learn the importance of selection of species in aquaculture practices and pre-stocking management
LO4 To learn Post stocking management and growth management.

Course Outcomes:

CO1 Students will be able to get the knowledge of freshwater aquaculture and correlate it with filling of food gap and application of it.
CO2 Learner would acquire the skill of Topography of site selection.
CO3 Learners would acquire the knowledge of pre-stocking and post -stocking.
CO4 Learners would acquire the knowledge of Soil and Water quality parameters.

Unit No.	Title of Unit & Contents	Hrs.
I	**Aquaculture Systems and Methods**	**12**
	Scope and definition; biological and technological basis; Traditional, extensive, semi - intensive and intensive culture; Monoculture, Polyculture, Cage culture, Pen culture, raft culture, race way culture, sewage fed fish culture, **Selection of Sites:** Survey and location of suitable site topography and characteristics of soil; water source; hydrometerological data.	
	Unit Outcome: UO1 After completion of the unit the students will understand the concepts of Aquaculture Systems and Methods	
II	**Aquaculture Engineering**	**11**
	Design and construction of pond, layout and aquaculture farm, construction, water intake, drainage; aeration and aerators; tips for better aquaculture practices; design and construction of hatcheries. Hydrology of Ponds: Types of ponds; sources of water – precipitation, direct run off, stream inflow, ground water inflow, regulated inflow; losses of water– evaporation, seepage, outflow, consumptive use, embankment ponds.	
	Unit Outcome: UO1 After completion of the unit the students will understand the concepts of Aquaculture Engineering	
III	**Selection of Species and Stocking**	**11**
	Selection of Species: Biological characteristics of aquaculture species; economic and market considerations; seed resources, collection and transportation. **Pre Stocking Management:** Sun drying, ploughing / tilling, desliting, liming andfertilization, eradication of weed fishes. **Stocking:** Acclimatization of seed and release; species combinations; stocking, density; ratio.	

Unit No.	Title of Unit & Contents	Hrs.
	Unit Outcome: UO1 After completion of the unit the students will understand the concepts of Selection of Species and Stocking	
IV	**Post Stocking Management**	**11**
	Post Stocking Management: Water and soil quality parameters required for optimum production, control of aquatic weeds and aquatic insects, algal blooms; specific food consumption, food conversion ratio (FCR), protein efficiency ratio, biological value of protein. **Growth:** Measurement of growth; length - weight relationship; methods of determination of age in fishes, ponderal index; growth hormones.	
	Unit Outcome: UO1 After completion of the unit the students will understand the concepts of Post Stocking Management	

Learning Resources:

1. Mathew Landau. 1995. Introduction to Aquaculture. Daya Publishing House, New Delhi.
2. Pillay, T. V. R. 1993. Aquaculture: Principles and Practices. Fishing News Books. Black Well Scientific Publications.
3. MPEDA, 1991. Hand Book on Shrimp Farming, Kochi, India.
4. Jhingran, V. G. 1982. Fish and Fisheries of India. Hindustan Publishing Corporation, New Delhi. Chakrabarti, N. M. 1998. Biology, Culture and Production of Indian Major Carps. Narendra Publishing House, New Delhi.
5. Coche, A. G. and J. F. Muir. 1996. Pond Construction and Fresh Water Fish Culture – Pond Farm Structures and Layouts – Simple Methods for Aquaculture. FAO. DayaPublishing House, New Delhi. Upadhyay, A. S. 1995. A Hand Book on Design, Construction and Equipments in Coastal Aquaculture (Shrimp Farming). Daya Publishing House, New Delhi.
6. Wheaton, F. W. 1985. Aquaculture Engineering. MPEDA, Cochin.

Course Type : MEC-IV (B)
Course Title : Lab Course XIII (Aquaculture and Its Application)
Course Code :
Credits : 03 **Max. Marks: 50** **Lectures: 30 Hrs.**

Learning Objectives:-

LO1 To learn the lay out fresh water / brackish water fish farm and hatchery.
LO2 To learn the types of filters and production cost of a fresh water farm.
LO3 To learn importance of cultivable fish species, ponderal index, Length weight relationship.
LO4 To learn the design of Chinese hatchery, cages, aerators etc.

Course outcomes:

CO1 Learner would acquire the skill of construction of fish farm and Chinese hatchery
CO2 The learners will be able to find out the importance of filters and production cost of a fish farm
CO3 Learners will be come to know the importance of Cultivable fish species.
CO4 Learners will be able to know the different aspects of Freshwater Aquaculture.

Sr. No.	Practical
1	Design and layout of fresh water and brackish water farms.
2	Estimation and calculations of production costs of fresh water fish farm.
3	Different types of filters/ Dark and light bottle -Pond productivity.
4	Length weight relationship.
5	Pondera -index.
6	Study of Cultivable fish & Shell fish Species.
7	Study of different types of Cages and pens.
8	Study of Aerators.
9	Design and construction of Chinese hatchery.
10	Estimation of hardness of freshwater.
11	Estimation of alkalinity, salinity of freshwater.
12	Survey report of one fresh water farm.
13	Visit to fish farm/Seed production centre or hatchery.

N.B.: Any Ten Practicals from above list.

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Department of Zoology

Course Type : MEC-IV (B)
Course Title : MEC-IV (B)Genomics and proteomics
Course Code :
Credits : 03 **Max. Marks: 75** **Lectures: 45 Hrs.**

Learning Objectives:-

LO1 To learn the concept of genomics of proteomics.
LO2 To learn the importance of genome and its functions.
LO2 To learn the importance of gene expressions.
LO3 To understand analysis of proteins.

Course Outcomes:

CO1 Students will be able to get the knowledge of genomics of proteomics.
CO2 Learner would acquire the skill of sequencing and spectrometry.
CO3 Learners would acquire the knowledge of Sample Preparation, Solubilization, etc.
CO4 Learners would acquire the knowledge of Applications of Genomics and Proteomics Analysis

Unit No.	Title of Unit & Contents	Hrs.
I	**Introduction to Genomics and Proteomics**	**12**
	Organization and structure of genomes, Genome size, Sequence complexity, Introns and Exons, Genome structure in viruses and prokaryotes, Isolation of Chromosomes, chromosome micro dissection, Retrofitting. The Proteome, Mining proteomes, Bridging Genomics and Proteomics.	
	Unit Outcome: UO1 After completion of the unit the students will understand the concepts ofGenomics and Proteomics.	
II	**Gene Identification and Expression**	**11**
	Genome annotation, traditional routes of gene identification, detecting open-reading Frames, software programs for finding genes, Identifying the function of a new gene, determining gene function by sequence comparison and through conserved protein structure Global expression profiling – Introduction, traditional approaches to expression profiling, Analysis of RNA expression, applications of genome analysis and genomics.	
	Unit Outcome: UO1 After completion of the unit the students will understand the concepts of gene identification and expression.	
III	**Analysis of Proteomes**	**11**
	Analysis of proteomes - Two-dimensional polyacrylamide gel electrophoresis, Sample Preparation, Solubilization, Reduction, Resolution, Reproducibility of 2-DEDetecting proteins in polyacrylamide gels. Mass spectrometry based methods for protein identification- De novo sequencing using mass spectrometric data- Correlative mass spectrometric based identification strategies, 2-DE gel electrophoresis coupled with mass spectrometry	
	Unit Outcome: UO1 After completion of the unit the students will understand the concepts of analysis of proteasomes.	

Unit No.	Title of Unit & Contents	Hrs.
IV	**Applications of Genomics and Proteomics Analysis**	**11**
	Analysis of Genomes – Human, Mouse, Plasmodium falciparum, Saccharomyces cerevisiae, Mycobacterium tuberculosis. Application of proteome analysis- drug development and toxicology, Pharmaceutical Applications, Proteomics in drug Discovery in human, phage antibodies as tools, Glycobiology and Proteomics in plant genetics and breeding.	
	Unit Outcome: UO1 After completion of the unit the students will understand the concepts of applications of genomics and proteomics analysis.	

Learning Resources:

1. Genomics: A Practical Guidebook by David B. Searls
2. Principles of Genome Analysis and Genomics by Sandy B. Primrose and Richard M. Twyman
3. Introduction to Genomics by Arthur M. Lesk
4. Genomics: The Essential Guide to Genomic and Proteomic Research" by Massimo Del Mar and Maria A. Leoni
5. Proteomics: From Protein Sequence to Function by S. R. Pennington and M. J. Dunn
6. Introduction to Proteomics: Tools for the New Biology by Daniel C. Liebler
7. Comprehensive Proteomics: A Guide to Proteome Analysis edited by John R. Yates, III

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Course Type : MEC-IV (B)
Course Title : Lab Course XIII (Genomics and proteomics)
Course Code :
Credits : 03 **Max. Marks: 50** **Lectures: 30 Hrs.**

Learning Objectives:-

LO1 To learn the performing DNA amplification technique.
LO2 To learn to understand genotyping.
LO3 To learn importance of GWAS.
LO4 To learn the design of DNA sequencing.

Course outcomes:

CO1 Learner would acquire the skill of DNA sequencing.
CO2 The learners will be able to find out the importance ofGene Expression Profiling
CO3 Learners will be come to know the importance of Mass Spectrometry.
CO4 Learners will be able to know the different aspects of Quantitative Proteomics.

Sr. No.	Practical
1	DNA Sequencing: Determining the nucleotide sequence of a DNA molecule.
2	Amplifying specific DNA regions for analysis using PCR.
3	Genotyping: Identifying genetic variations such as single nucleotide polymorphisms (SNPs) and insertions/deletions (INDELs).
4	Genome-Wide Association Studies (GWAS**):** Identifying genetic variants associated with diseases or traits.
5	Whole Genome Sequencing (WGS): Sequencing the entire genome of an organism to understand its genetic makeup.
6	Gene Expression Profiling: Measuring gene activity under various conditions.
7	Comparative Genomics: Comparing genomic sequences between different species to understand evolutionary relationships and functional elements.
8	Mass Spectrometry (MS): Identifying and quantifying proteins and their modifications.
9	Protein Microarrays: Profiling protein interactions and expressions across multiple samples.
10	Quantitative Proteomics: Measuring the relative or absolute abundance of proteins in different samples.
11	Proteomic Data Analysis: Interpreting data from proteomics experiments to identify proteins and their functions.
12	Protein–Protein Interaction Studies: Identifying and characterizing interactions between proteins.
13	Protein Gel Electrophoresis: Separating proteins based on size and charge.

N.B.: Any Ten practical from above list.