

John Wilson Education Society's
Wilson College
(Autonomous)
Mumbai - 400007

Affiliated to the

UNIVERSITY OF MUMBAI

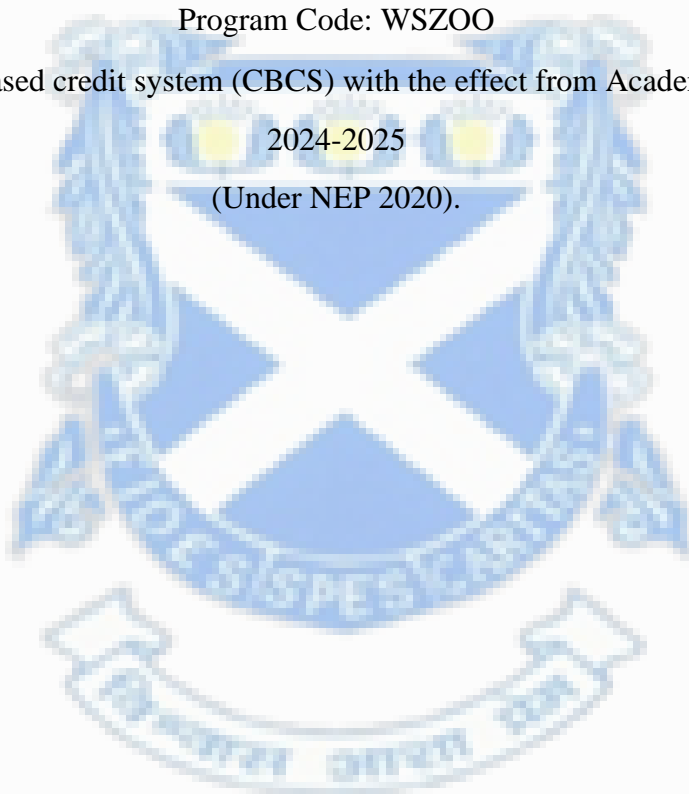
NEP SYLLABUS FOR M.S.c.-2 2024-25

Program Code: WSZOO

Choice based credit system (CBCS) with the effect from Academic year

2024-2025

(Under NEP 2020).



PREAMBLE

The Government of Maharashtra implemented NEP 2020 from the academic year 2024 – 2025. The autonomous colleges were guided to prepare and implement NEP syllabus from the coming academic year. As per the guidelines the Wilson College (Autonomous) Zoology department starting its preparation for the NEP syllabus for Second year PG course. Series of department meetings and rounds of deliberation contributed in shaping the NEP 2020 Zoology syllabus. Second year PG syllabus is designed with 2 main courses in both semesters with Elective courses in Sensory Physiology and Maintenance of Animal models & Animal Biotechnology . A complete course devoted to Research Project and dissertation is included. The Mandatory courses such as Phylogeny of Non-Chordates and Chordates, Immunology and Cancer Cell biology, Cell communication, signalling, Enzymology & Endocrinology, Reproductive Physiology are designed in order to elevate the comprehension and knowledge of the learners. The Zoology department of the Wilson College will always be thankful to all teachers who have put in their valuable time and thoughts during the designing of the syllabus and the department is also very much thankful to the BOS members for their valuable and valid suggestions. With this the Zoology department feels proud and present to all the NEP 2024 Second year PG syllabus.

PROGRAM OUTLINE 2024 – 2025.

	SEM	COURSE CODE	COURSE TITLE	CREDITS
M.Sc.-2	III	WSZOOMT631	Ecophysiology, Chronobiology and Behavioural Ecology	4
		WSTOOMB632	Immunology and Cancer Cell Biology	4
		WSZOOET631	Sensory Physiology	2
		WSZOORP631	Research Proposal	4
		WSTOOMP633	Ecophysiology, Chronobiology and Behavioural Ecology Practical	2
		WSZOOMP634	Immunology and Cancer Cell Biology Practical	2
		WSZOOEP632	Sensory Physiology Practical	2
	IV	WSZOOMT641	Cell communication, Enzymology & Endocrinology	4
		WSZOOMT642	Reproductive Physiology	4
		WSZOOET641	Maintenance of Animal models & Animal Biotechnology	2
		WSZOOMP643	Cell communication, Enzymology & Endocrinology Practical	2
		WSZOOMP644	Reproductive Physiology Practical	2
		WSZOOEP642	Maintenance of Animal models & Animal Biotechnology Practical	2
		WSZOORP641	Research Project	6

M.Sc. – 2, Sem 3, (Mandatory paper 1 + Mandatory paper 2+ Elective paper)

PROGRAMME SPECIFIC OUTCOME (PSOs), SEM-3.

PSO1: The learner will acquire knowledge about physiological and behavioral adaptations of animals to various environmental factors.

PSO2: The learner will acquire knowledge about various concepts of immunology and cancer biology.

PSO3: The learner will know various types of sensory receptors, physiological effectors and special senses and their function.

PSO4: The learner will become accustomed to learning, interaction, and behavior of animals to various environmental factors.

PSO5: The learner will become conversant with practice of common immunological laboratory procedures used to detect and measure immune response.

PSO6: The learners will become familiar with various sensory and effector receptors. special sense organs and their mechanism.

PSO7: The learner will be acquainted with concepts of cellular communication, mechanism of enzymes and endocrine regulation in organisms.

PSO8: The learner will learn various aspects of reproductive physiology, infertility and associated disorders and techniques used in assisted reproductive techniques.

PSO9: The learners will be able to demonstrate the technique in animal care, management and various techniques in animal tissue culture.

PSO10: The learner will acquire knowledge of various endocrine glands and its characteristics.

PSO11: The learner will learn various aspects of reproductive physiology in different organisms, modes of contraception and be able to summarize the principles, indications and techniques in assisted reproductive techniques.

PSO12: The learner will become expert in maintaining and handling laboratory animals and also able to describe transgenic animals and their applications.

M.SC. – 2, SEM – 3, MANDATORY PAPER 1 (Ecophysiology, Chronobiology and Behavioural Ecology)

Program: NEP M.Sc. – II				Semester: 3	
Course Code: WSZOOMT631					
Course Title: Ecophysiology, Chronobiology and Behavioural Ecology					
Teaching scheme				Evaluation scheme	
Lectures (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Continuous Internal Assessment (CIA)	Semester End Examination
4	4	NA	(4 + 2) = 6	40	60
Learning Objectives:					
<ul style="list-style-type: none"> ● To evaluate the physiology and life cycle of organisms in varying environmental conditions. ● To enable the learner to familiarize with various adaptations of animals to extreme habitats. ● To introduce to the learner, biological clocks and habitual behaviour. 					
Course Outcomes:					
CO1:The learner will acquire knowledge about concepts of animal adaptations to various environmental factors.					
CO2:The learner will comprehend adaptations of animals in extreme habitats.					
CO3:The learner will get familiar with physiology and life cycle of animals in marine freshwater and terrestrial habitat. we					
CO4:The learner will analyze concepts of various biological rhythms and photoperiodism.					
CO5:The learner will comprehend factors responsible for the development and evolution of animal behaviour.					

Detailed Syllabus

Course Code: WSZOOMT631	Ecophysiology	4 Credits / 60 Hour
UNIT 1	Ecophysiology I: Adaptations and Habitats.	15 Hours
	<p>1.1 Temperature as an environmental factor</p> <ul style="list-style-type: none"> 1.1.1 Thermal environments and thermal exchanges 1.1.2 Thermal limits of survival 1.1.3 Biochemical and physiological effects of temperature. 1.1.4 Temperature and rate effects: Temperature dependent E~S affinity, Lipoprotein enzymes 1.1.5 Thermal resistance of dormant and active cells 1.1.6 Ectothermy and endothermy 1.1.7 Endothermy in invertebrates 1.1.8 Biochemical adaptations of Ectothermy: Antifreeze substances, Heat shock proteins 	
	<p>1.2 Oxygen as an environmental factor</p> <ul style="list-style-type: none"> 1.2.1 Oxygen dependencies in living organism 1.2.2 Anoxia adaptations in invertebrates 1.2.3 Adaptations of vertebrates during prolonged diving 1.2.4 Oxygen-sensitive pathways in organisms 	
	<p>1.3 Radiation as an environmental factor.</p> <ul style="list-style-type: none"> 1.3.1 Radiation as an environmental parameter: 1.3.2 The solar spectrum 1.3.3 Biomolecules involved in perception and trapping of solar radiations: 1.3.4 Chlorophyll, Bacterio-rhodopsin, Rhodopsin and Vitamin A 	
UNIT 2	Ecophysiology II :A Closer Look at Adaptation	15 hours
	<p>2.1 Animal Adaptations in Extreme Habitats</p> <ul style="list-style-type: none"> 2.1.1 Hot and dry habitats: deserts- 2.1.2 Very cold habitats 2.1.3 High-altitude habitats 2.1.4 Aerial habitats 2.1.5 Deep sea 	
	<p>2.2 Marine life: Physiological (thermal, respiratory, reproductive) and life cycle adaptations.</p>	
	<p>2.3 Fresh water: Physiological and life cycle adaptations.</p>	
	<p>2.4 Terrestrial life: Physiological and life cycle adaptations.</p>	

UNIT 3	Chronobiology		15 hours
	3.1	<p>Chronobiology: Introduction, History and Milestones, Clocks, The biological timing system: Concepts and methods, Types: Ultradian, circadian and circannual rhythms.</p>	
	3.2	<p>Rhythm characteristics: Free running rhythms, Entrainment and masking in the natural and artificial environment Zeitgebers: Photic and nonphotic, Parametric and non-parametric entrainment.</p>	
	3.3	<p>3.3.1 Circannual rhythms: Proximate and Ultimate factors, Circannual control of seasonal processes 3.3.2 Photoperiodism: Concepts and photoperiodic time measurement models, Seasonal processes and photoperiodic control mechanisms.</p>	
	3.4	<p>3.4.1 Organization of circadian system in multicellular organisms: Concept of central and peripheral clock system Retinal and pineal clocks 3.4.2 Melatonin: Input to or output of the clock system 3.4.3 Anatomy of the circadian clock: Clock in the suprachiasmatic nucleus (SCN) as an example</p>	
UNIT 4	Behavioral Ecology		15 hours
	4.1	<p>An evolutionary approach to Animal behavior: 4.1.1 Objectives of behavior, mechanism of behavior: Neural control of behavior, sensory processes and perception, ecology of senses. 4.1.2 Role of Hormones in various behavior-aggression, territoriality, and migration 4.1.3 Role of pheromone-Insects social organization; Pheromone effects in mammals- LeeBoot, Whitten, Bruce, Collidge and Castro-Vandenberg effects</p>	
	4.2	<p>Development of behavior: 4.2.1 Types: Innate behavior(orientation,kineses,taxes, motivation,tropism,reflex and nest building)learned behavior(sensitization and habituation, associative learning, imprinting, reasoning,trial-and-error, discrimination, and language learning,bird song) Social behavior: Types of social groups, advantages of grouping,origin and roots to sociality. 4.2.2 Anti predator behavior- Avoiding detection through color and colouration.</p>	

	4.3	<p>Evolution and Genetics of behavior:</p> <p>Genes and behavioral evolution, Hamilton's rule, kin selection, cost and benefits of sex and sexual selection, genetic control of behavior(single and multiple gene effect) Eg:Genetics of burrow shape in Oldfield mouse and Deer mouse.</p>	
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REFERENCES:

1. Environmental Physiology Of Animals Second Edition Pat Willmer, Graham Stone And Lán Johnston
2. Environmental Biochemistry And Physiology Peter W. Hochachka
3. Environmental Physiology Of Animals Andrei Nikolaevich
4. Vertebrate Ecophysiology: An Introduction To Its Principles And Applications. Don Bradshaw
5. Grassland Ecophysiology And Grazing Ecology G. Lemaire, J. Hodgson, A. De Moraes, P.C. De F. Carvalho And C. Nabinger
6. Introduction To Chrono Biology Mrs. Gauri R. Sathaye Dr. Prashant S. Duraphe
7. Chronobiology: Biological timekeeping C. Dunlap • Jennifer J. Loros • Patricia J. Decoursey
8. Insect Chronobiology Hideharu Numata Kenji Tomioka
9. Textbook Of Reproductive Physiology, Chronobiology And Social Physiology Shyamal Kanti Das Chandan Roy
10. A Textbook Of Animal Behaviour And Chronobiology Manoj Kumar Mohanty Saroj Kumar Mishra Subodh Chandra Praharaj
11. Chronobiology Of Marine Organisms Ernest Naylor
12. A Concise Book Of Animal Behaviour And Chronobiology Dr. Tarkeshwar Dr. Kapinder
13. Cellular And Molecular Bases Of Biological Clocks Models And Mechanisms For Circadian Timekeeping. Leland N. Edmunds.
14. Animal Behaviour (Ethology) Dr. V.K. Agarwal
15. Fundamentals Of Animal Behaviour J.P. Shukla
16. Patterns Of Behavior Richard W. Burkhardt, Jr.

Program: NEP M.Sc. – II				Semester: 4	
Course Code: WSTOOMP633					
Course Title: Practicals based on Ecophysiology, Chronobiology and Behavioural Ecology.					
				Evaluation scheme	
Lectures (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Continuous Internal Assessment (CIA)	Semester End Examination
2	4	NA	(2 + 2) = 4	20	30
Learning Objectives:					
<ul style="list-style-type: none"> ● To evaluate the physiology and life cycle of organisms in varying environmental factors. ● To enable the learner to acquire knowledge of animals interaction and aggressive behaviour ● To introduce to the learner, circadian rhythms and habitual behaviour. 					
Course Outcomes:					
CO1:The learner will acquire knowledge about effect of varying temperature on activity of enzymes					
CO2:The learner will be able to identify and evaluate various ethological aspects.					
CO3:The learner will get familiar with physiology and life cycle of animals and the effect of environmental parameters on behaviour and physiology.					

Practical 1

Course Code WSZOO	Practical No.	Practicals based on Ecophysiology, Chronobiology and Behavioural Ecology.	2 Credits
	1	Effect of varying temperature on activity of digestive enzyme ,viz.amylase, Trypsin.	
	2	Assay of circadian rhythms using animal model systems.	
	3	Ambulatory blood pressure monitoring and circadian analysis.	
	4	Identification of ethological aspects: Habituation (insects, snails), conditioning,courtship behavior.	
	5	Study of interaction and aggression behavior in <i>Betta splendens</i> fishes.	
	6	Effect of temperature on the respiratory rate of fishes.	
	7	Study of climbing assay in Drosophila.	
	8	Effect of light and dark phase in drosophila.	
	9	Study of behavioral catalogue and ethogram.	
	10	Study of learning in rats through T maze technique.	

**M.S.C – II, SEM – 3, MANDATORY PAPER 2. (IMMUNOLOGY AND
CANCER CELL BIOLOGY**

Program: NEP M.Sc. – II				Semester: III	
Course Code: WSTOOMT632					
Course Title: IMMUNOLOGY AND CANCER CELL BIOLOGY					
Teaching scheme				Evaluation scheme	
Lectures (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Continuous Internal Assessment (CIA)	Semester End Examination
4	4	NA	(4 + 2) = 6	40	60
Learning Objectives:					
<ul style="list-style-type: none"> ● To enable the learner to outline the steps involved in immune responses, including antigen recognition, activation of immune cells, and effector functions. ● To evaluate the process of antigen presentation and its significance in adaptive immunity. ● To identify and describe common immunological disorders such as autoimmune diseases, hypersensitivities, and immunodeficiencies. ● To introduce to the learner, various checkpoints in the cell cycle and apoptosis, alterations in signaling pathways and role of mutations in cancer. 					
Course Outcomes:					
CO1: The learner will acquire knowledge about concepts of immunology, enabling them to explain the mechanisms of innate and adaptive immunity					
CO2: The learner will comprehend various molecular defense mechanisms, the roles of major immune cells and their interactions in the immune response.					
CO3: The learner will get familiar with pathophysiology of immunological disorders and their impact on the immune system and overall health.					
CO4: The learner will analyze various immunological principles and their applications in healthcare in terms of therapeutics, vaccines, and organ transplantation.					
CO5: The learner will comprehend factors responsible for apoptosis, variations in cell cycle and their role in development of cancer.					

Detailed syllabus.

Course Code: WSTOOMT632	Sub unit	Course/ Unit Title Immunology and Cancer Cell Biology	4 Credits / 60 Hours
UNIT 1		IMMUNOLOGY	15 hours
	1.1	Overview of the immune systems 1.1.1 Components of the immune system, 1.1.2 Principles of innate (non-specific) and adaptive(acquired) immunity 1.1.3 Antigen and immunogenicity, 1.1.4 Clonal selection theory. 1.1.5 Antibodies (vertebrates and invertebrates) 1.1.6 Immunological memory. 1.1.7 Antibody diversity: Mini gene theory, Mutation theory, Germ line theory, Somatic recombination, V (D) J recombination, Combinatorial diversity, Junctional diversity	
	1.2	Antigen recognition by immune cells: 1.2.1 Innate Immunity- Pattern recognition in the innate immune system 1.2.2 TLRs and their role in innate immune response 1.2.3 Antigen recognition by B lymphocytes 1.2.4 Molecular mechanism behind BCR formation 1.2.5 B lymphocyte development and survival. 1.2.6 Immunoglobulin class switching	
	1.3	MHC complex 1.3.1 Nomenclature and general organization 1.3.2 Structure and function of Class I and Class II molecule 1.3.3 Antigen processing cells 1.3.4 Antigen processing and presentation to T lymphocytes 1.3.5 MHC restriction.	
	1.4	The Complement System 1.4.1 Types (Classical, lectin and alternative pathway) 1.4.2 Functions 1.4.3 Components 1.4.4 Activation and regulation of the complement 1.4.5 Biological consequences of the complement activation	
UNIT 2		ADVANCED IMMUNOLOGY	15 hours
	2.1	Hypersensitivity (HS): Features and immune response along with example of each type 2.1.1 Type I: Allergies and anaphylaxis – IgE, Mast cell degranulation, biologically active agents, clinical manifestations. 2.2.2 Type II: Antibody mediated HS reactions; Mechanism,	

		<p>pathogenicity and cases of type II reactions; Hemolytic-disease of newborn (HDN).</p> <p>2.2.3 Type III: Immune complex mediated HS reactions: Mechanism & pathogenicity of type III reactions. Arthus reaction, Serum sickness.</p> <p>2.2.4 Type IV: Delayed type (or) cell-mediated HS reactions; Mechanisms and pathogenicity, Tuberculin reaction.</p> <p>2.2.5 Type V: Stimulatory HS reactions. Mechanism and pathogenicity, Grave's disease.</p>	
	2.3	<p>General account of Immunodeficiency diseases</p> <p>2.3.1 Primary immunodeficiency</p> <p>2.3.2 Secondary Immunodeficiency</p> <p>2.3.3 Malnutrition and immunodeficiency</p>	
	2.4	<p>Immunologic Tolerance & Autoimmunity</p> <p>2.4.1 Establishment & maintenance of tolerance</p> <p>2.4.2 Types- central & peripheral</p> <p>2.4.3 Autoimmunity</p> <p>2.4.4 Treatments for autoimmune disease : Systemic Lupus, Erythematosus, Rheumatoid Arthritis, Coeliac disease .</p>	

UNIT 3	CLINICAL IMMUNOLOGY		15 hours
	3.1	<p>Transplantation Immunology</p> <p>3.1.1 Basis of graft rejection</p> <p>3.1.2 Clinical manifestation of graft rejection</p> <p>3.1.3 General and specific immunosuppressive therapy and Immune tolerance to allograph</p> <p>3.1.4 Clinical transplantation</p>	
	3.2	<p>Immunology of infectious diseases:Immune responses in-</p> <p>3.2.1 Viral infections</p> <p>3.2.2 Bacterial infections</p> <p>3.2.3 Parasitic infections</p> <p>3.2.4 Fungal infections</p>	
	3.3	<p>Neuroimmunology:</p> <p>3.3.1 Cells of the CNS, blood brain barrier,</p> <p>3.3.2 Encephalitis, meningitis</p> <p>3.3.2 Neurotropic viruses (Encephalitis caused by Nipah virus, Zika virus)</p> <p>3.3.3 Neuroinflammation in diseases (Multiple sclerosis, dementia)</p>	
	3.4	<p>Types of Vaccines:</p> <p>3.4.1 Peptide vaccines-synthetic drugs (engineered proteins)</p> <p>3.4.2 Genetic immunization-DNA vaccines, Antisense DNA,</p> <p>3.4.3 Therapeutic ribozymes</p> <p>3.4.4 Vector Vaccines-Vaccine directed against viruses</p> <p>3.4.5 Anti-idiotypic vaccine for cancer treatment.</p> <p>3.4.6 Multivalent subunit vaccine.</p> <p>3.4.7 Anti fertility vaccine</p>	

UNIT 4	CANCER CELL BIOLOGY		15 hours
	2.1	2.1.1 Overview of cell cycle (Components of cell cycle and control system) 2.1.2 Regulation and checkpoints of cell cycle in eukaryotes-(Cyclins and CDK complexes) Extracellular control of cell division 2.1.3 Cell growth and apoptosis: Morphological and biochemical features of apoptosis Necroptosis Caspases (effector molecules) Executioners of the apoptosis process Extrinsic and intrinsic apoptotic pathway 2.1.4 Role of mitochondria in cell death: Mechanism of mitochondrial outer membrane permeabilization (MOMP) Cell death effectors released from mitochondria 2.1.5 Senescence and cancer 2.1.6 General characteristics of transformation of normal cell to cancerous cells. Gain of function mutation in tumor suppressor Loss of function mutation in proto-oncogene 2.1.7 Chemo resistance and cancer 2.1.8 Immunogenicity of cancer cell death 2.1.9 Cancer treatment: Immunotherapy.	

References

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2. Immunology – Essential and Fundamental; Pathak, S., &Palan, U.; Science Publishers;2005
3. Immunology: A textbook; Rao, C. V.;Alpha Science Int'l Ltd.; 2005
4. Ananthanarayan and Paniker's textbook of microbiology; C.J. Paniker (Ed.); Ananthanarayan, R.; Orient Blackswan; 2005
5. Textbook of Immunology; Haleemkhan, Rajendra Sagar, Sadguna
6. Prescott's Microbiology;Ninth Edition; JoanneM.Willey,Linda M. Sherwood & Christopher J.Woolverton; McGraw-Hill Education; 2014
7. Cellular and molecular immunology; Abbas, A. K., Lichtman, A. H. &Pillai S.; Elsevier Health Sciences; 2014
8. Roitt's essential immunology (Vol. 20); Delves,P. J., Martin, S. J., Burton, D. R., &Roitt, I.M.;JohnWiley& Sons; 2011
9. The elements of immunology; Khan,F. H.; Pearson Education, India; 2009
10. Janeway's Immunobiology; Murphy,K., &Weaver, C.; Garland Science;2016
11. Fundamental Immunology; Paul, W.E.; Philadelphia: Lippincott-Raven;1999
12. Bernard R. Glick and Jack J. Pasternack, Molecular Biotechnology – Principles and applications of recombinant DNA, ASM Press, Washington DC.
13. Immunology - Introductory Textbook; Shetty, N.; New Age International; 2005

Practical 2

Program: NEP M.Sc. – II				Semester: 4	
Course Code: WSZOOMP634					
Course Title: Practical 2 based on Immunology and Cancer Cell Biology					
				Evaluation scheme	
Lectures (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Continuous Internal Assessment (CIA)	Semester End Examination
2	4	NA	(2 + 2) = 4	20	30
Learning Objective: <ul style="list-style-type: none"> ● To acquaint the learner with hands-on methods used for immunology. ● To make the learner familiarize with various immunological techniques and their principles. ● To make the learner comprehend the applications of immunology and cancer biology 					
Course Outcomes: CO1: Learner will demonstrate knowledge and practice of common immunological laboratory procedures used to detect and measure the immune response. CO2: Learner will be able to describe various applications of studying immunology and cancer biology. CO3: Learners will be able to summarize the principles, indications and techniques in immunology.					

Course Code WSZOOMP634	Practical No.	Practicals based on IMMUNOLOGY AND CANCER CELL BIOLOGY	2 Credits
	1.	Performance of Ouchterlony technique to demonstrate immune-diffusion.	
	2.	Demonstration of single radial immune-diffusion of antibody and antigen.	
	3.	Study of counter-current immune-electrophoresis.	
	4.	Study of Agglutination Reaction: a) Tube Agglutination Reaction b) Slide Agglutination Reaction c) Indirect Agglutination Inhibition Reaction	
5.	Separation of Lymphocytes.		
6.	Study of Phagocytosis.		

	7.	Identification of histological slides of lymphoid tissue: a) Spleen b) Thymus c) Lymph node d) Bone marrow	
	8.	Demonstration of ELISA.	
	9.	Study of vaccines: Polio, COVID-19, HPV.	

M.SC. – II, SEM -1, ELECTIVE COURSE. SENSORY PHYSIOLOGY

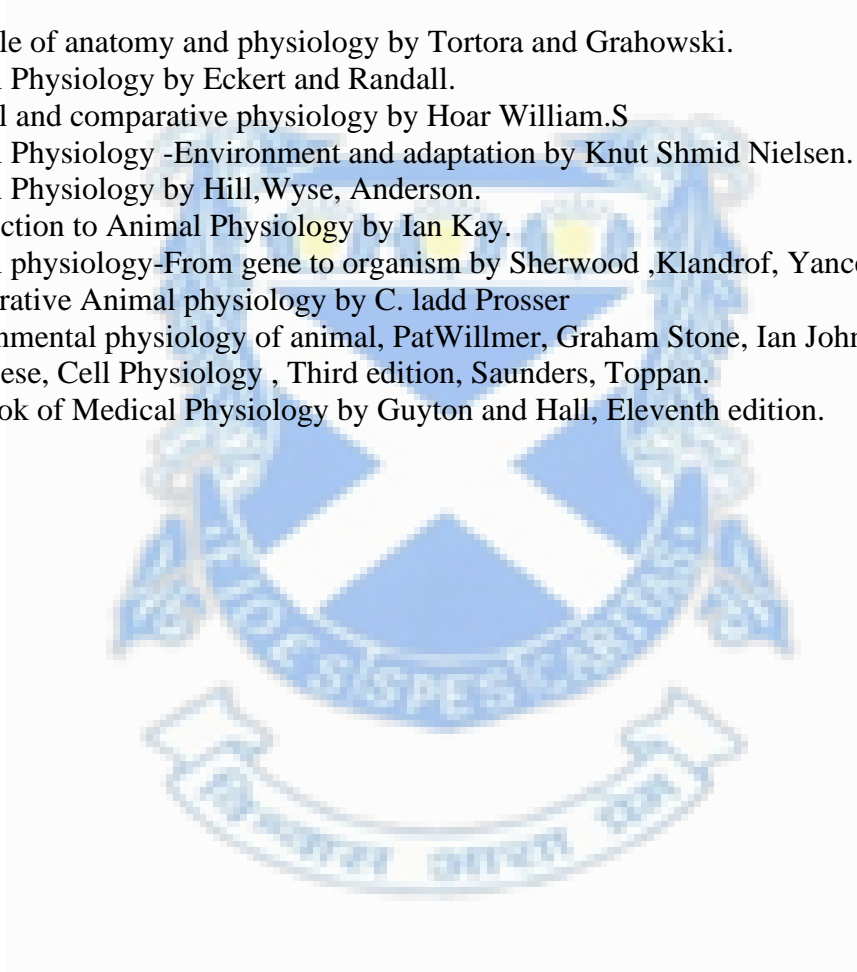
Program: NEP M.Sc. – I				Semester: III	
Course Code: WSZOOET631					
Course Title: Sensory Physiology					
Teaching scheme				Evaluation scheme	
Lectures (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Continuous Internal Assessment (CIA)	Semester End Examination
2	4	NA	(2 + 2) = 4	20	30
<p>Learning Objectives:</p> <ul style="list-style-type: none"> ● To make the learners acquainted with the modality, coding and features of sensory adaptation. ● To make the learners familiar with various sensory receptor kinds and their unique roles. ● To make the learners evaluate the development of different physiological effectors and the sensory system. ● To make the learners summarize the different Sensorys laws. ● To make the learners anticipate different physiological aging-related alterations in the sensory system. 					
<p>Course Outcomes:</p> <p>CO1: Learners will be able to define different kinds of sensory receptors and their unique purposes.</p> <p>CO2: Learners will be able to discuss the coding, adaptability, and sensory modality.</p> <p>CO3: Learners will be able to identify & explain various sense organs and their functioning.</p> <p>CO4: Learners will be able to list the various laws of senses in brief.</p> <p>CO5: Learners will be able to correlate the aging process with sense organs.</p>					

Detailed syllabus.

Course Code: WSZOOET631	Sub unit	Course/ Unit Title Sensory Physiology.	2 Credits / 30 Hours
UNIT 1		Receptors Physiology	15 hours
	1.1	General overview of sensory system.	
	1.2	Structure,function and classification of receptors.	
	1.3	Modality and Intensity of receptors.	
	1.4	Receptor adaptation and Sensory coding.	
	1.5	Types of receptors 1.5.1 Mechanoreceptors 1.5.2Thermoreceptors 1.5.3 Electoreceptors 1.5.4 Photoreceptors 1.5.5 Chemoreceptors 1.5.6 Nociceptor. 1.5.7Magnatoreceptor	
UNIT 2		Physiology of effectors.	15 hours
	2.1	Evolution of the sensory system.	
	2.2	Physiology of effectors: 2.2.1 Cnidoblasts 2.2.2 Chromatophores 2.2.3 Electric organ	
	2.3	Special senses 2.3.1 Olfaction. 2.3.2Vision - structure of different types of eyes and physiology of vision. 2.3.3 Hearing and equilibrium- structure of external ear and physiology of equilibrium,otolithic organ.	
	2.4	Laws of sensory physiology 2.4.1 Muller's Doctrine of specific nerve energies 2.4.2 Bell Magendie law 2.4.3 Law of projection 2.4.4 Weber Fechner law.	
	2.5	Aging and the special senses.	

References:

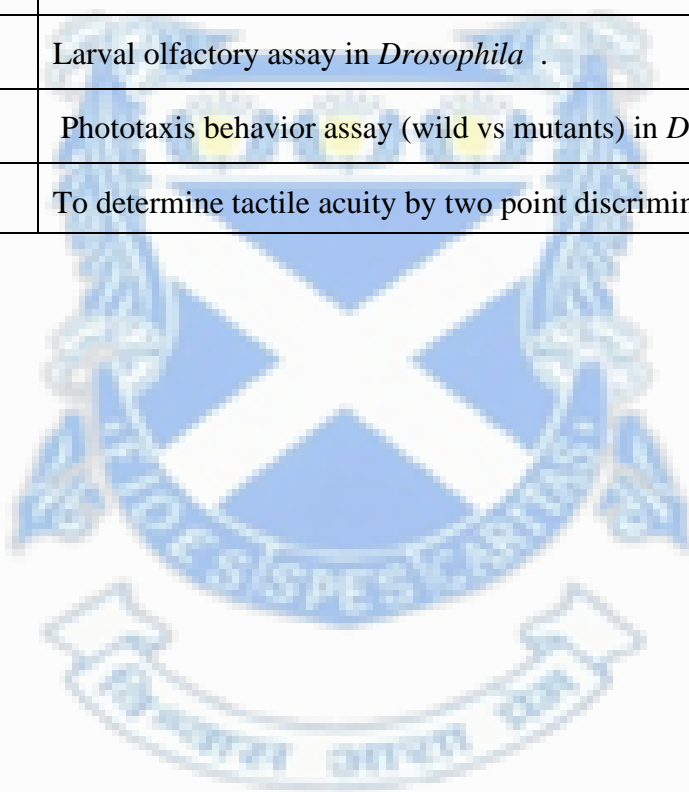
1. Principle of anatomy and physiology by Tortora and Grahowski.
2. Animal Physiology by Eckert and Randall.
3. General and comparative physiology by Hoar William.S
4. Animal Physiology -Environment and adaptation by Knut Shmid Nielsen.
5. Animal Physiology by Hill,Wyse, Anderson.
6. Introduction to Animal Physiology by Ian Kay.
7. Animal physiology-From gene to organism by Sherwood ,Klandrof, Yancey.
8. Comparative Animal physiology by C. ladd Prosser
9. Environmental physiology of animal, PatWillmer, Graham Stone, Ian Johnston., second edition,
10. A.G Giese, Cell Physiology , Third edition, Saunders, Toppan.
11. Textbook of Medical Physiology by Guyton and Hall, Eleventh edition.



Program: NEP M.Sc. – I				Semester: III	
Course Code: WSZOOEP632					
Course Title: Practical based on Sensory Physiology					
Teaching scheme				Evaluation scheme	
Lectures (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Continuous Internal Assessment (CIA)	Semester End Examination
-	4	NA	2	20	30
Learning Objectives: <ul style="list-style-type: none"> • To make the learners familiar with various invertebrate physiological effectors. • To make the learners familiar with the various types of receptors found in different animals. 					
Course Outcomes: CO1: Learners will be able to explain the histology of various sensory receptors. CO2: Learners will be able to describe the sense organs in fishes. CO3: Learners will be able to deduce the tactile acuity.					

ELECTIVE PRACTICAL.

Course Code WSZOOEP632	Practical No.	Practical based on Sensory Physiology	2 Credits
	1.	Study of various types of invertebrate physiological effectors- olfactory, Gustatory, Photoreceptor, Internal ear of mammal, Mechanoreceptors	
	2.	Study of Irritability in <i>Paramecium</i>	
	3.	Study of otolith from fish.	
	4.	Study of lateral line systems from fish.	
	5.	Larval olfactory assay in <i>Drosophila</i> .	
	6.	Phototaxis behavior assay (wild vs mutants) in <i>Drosophila</i> .	
	7.	To determine tactile acuity by two point discrimination test.	



M.SC. – 2, SEM -3, RESEARCH PROPOSAL

Program: NEP M.Sc. – II				Semester: 3	
Course Code: WSZOORP631					
Course Title: Research Proposal.					
Teaching scheme				Evaluation scheme	
Lectures (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Continuous Internal Assessment (CIA)	Semester End Examination
4	0	NA	4	-	60
<p>Learning Objectives:</p> <ul style="list-style-type: none"> ● To make the learners gather information and interpret specific results for the particular research findings. ● To make the learners able to create strategies to collect sampling and proceed accordingly. 					
<p>Course Outcomes:</p> <p>CO1: Learners will be able to search for information from research article/ journals</p> <p>CO2: Learners will be able to design the research proposal.</p> <p>CO3: Learners will be able extract crude research abstracts into simpler forms and write literature reviews.</p>					

M.Sc. -2, NEP Syllabus 2023 – 2024.

M.Sc. – 2, Sem 4, (Mandatory paper 1 + Mandatory paper 2+ Elective paper)

M.SC. – 2, SEM – 4, MANDATORY PAPER 1
(Cell communication, Enzymology & Endocrinology)

Program: NEP M.Sc. – II				Semester: 4	
Course Code: WSZOOMT641					
Course Title: Cell communication , Enzymology & Endocrinology					
Teaching scheme				Evaluation scheme	
Lectures (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Continuous Internal Assessment (CIA)	Semester End Examination
4	4	NA	(4 + 2) = 6	40	60
Learning Objectives: To introduce concepts of cellular signaling. To initiate the learner in the process of cellular communication as well as protein sorting. To familiarize the learner with the concepts of enzyme activity and kinetics . To introduce the learner to various endocrine glands,hormones & its Phylogeny in vertebrates & invertebrates.					
Course Outcomes: CO1: The learner will be able to describe the process of cell signaling. CO2: The learner will be able to explain the various components of cell communication. CO3:The learner will be able to distinguish between the types of enzyme kinetics . CO4:The learner will be able to discuss the features of the endocrine system in vertebrates and invertebrates.					

Detailed Syllabus

Course Code: WSZOOMT641	Sub unit	Course/ Unit Title Cell communication, Enzymology & Endocrinology	4 Credits / 60 Hour
UNIT 1		Cell communication & signaling	15 Hours
	1.1	1.1.1 Hormones and their receptors 1.1.2 Cell surface receptor 1.1.3 Signaling through G-protein coupled receptors. 1.1.4 Secondary messengers. 1.1.5 Regulation of signalling pathways 1.1.6 Bacterial chemotaxis & Quorum sensing 1.1.7 General principles of cell communication- Cell adhesion and roles of different adhesion molecules, Gap junction, Extracellular matrix 1.1.8 Protein sorting and transportation 1.1.9 Signaling in development & differentiation- Receptor Tyrosine Kinase ,Ras pathway in <i>Drosophila</i> and <i>C. elegans</i>	
UNIT 2		Enzymology	15 hours
	2.1	2.1.2 Specificity of Enzyme Action: Types of specificity - The active site , The Fischer Lock-and-key hypothesis - The Koshland induced-fit hypothesis 2.2.3 Enzyme Kinetics- i) Single substrate kinetics: Equilibrium and Steady state kinetics, significance of Km, Vmax & Kcat. Pre-steady state and Relaxation kinetics. ii) Multisubstrate kinetics: General rate equation, compulsory order, random order and pingpong mechanisms and their primary and secondary plots. 2.2.4 Enzyme inhibition and its kinetics: Reversible and irreversible inhibition, competitive, noncompetitive and uncompetitive, mixed, partial, substrate and allosteric inhibition 2.2.6 Enzyme mechanisms: Lysozyme, Chymotrypsin	
UNIT 3		Vertebrate Endocrinology	15 Hours
	1.1	1.1.1 Neuroendocrine Integration-Afferent Pathways,Efferent pathways, Integration centers 1.1.2 Neuroendocrine reflex- First order, Second Order,Third order 1.1.3 Hormones as messengers	

	1.2	Vertebrate endocrine glands- Structure, hormones and functions 1.2.1 Hypothalamus 1.2.2 Pituitary 1.2.3 Thyroid, 1.2.4 Parathyroid 1.2.5 Adrenal 1.2.6 Pancreas 1.2.7 Thymus 1.2.8 Placenta, corpus luteum 1.2.9 GI tract, Kidney, Heart 1.2.10 Ultimobranchial gland 1.2.11 Corpuscles of stannius 1.2.12 Pineal 1.2.13 Mauthner cells	
	1.3	Phylogeny and ontogeny of Thyroid in class -Pisces, Amphibia, Reptilia and Mammals	
	1.4	Phylogeny and ontogeny of Adrenals in class Pisces, Amphibia, Reptiles and Mammals	
	1.5	Caudal neurosecretory system in fishes-Dahlgren cells	
	1.6	Hypothalamo- hypophyseal- gonadal axis, HPA axis, HPT axis	
UNIT 4		Invertebrate Endocrinology	15 Hours
	4.1	Hormones as chemical messengers in Invertebrates	
	4.2	Invertebrate endocrine system; Hormones and their functions in Coelenterata, Annelida and Mollusca	
	4.3	Invertebrate endocrine system; Hormones and their functions in Arthropoda and Echinodermata	
	4.4	4.4.1 Anatomical Organization, Structure of endocrine glands in Invertebrates-Corpora cardiaca, Corpora allata, Moulting glands, X & Y organs of crustaceans , Green glands, Epitracheal glands and Inka cell, Mandibular organs in crustaceans	
	4.5	Scope of invertebrate endocrinology- Hormones used in shrimp and prawn culture	

REFERENCES:

1. Animal Physiology by Roger Eckert & David Randall.
2. Principles Of Anatomy and Physiology by Gerard J. Tortora & Sandra Reynolds Grabowski .
3. Animal Physiology by Sherwood, Klandorf, Yancey.
4. Animal Physiology by Richard Hill and Gordon A. Wyse
5. Medical Physiology by Archer C Guyton.
6. Comparative Endocrinology of Invertebrates, by Kennetil by Highman and Hill.
7. John F- Laycock and Peter H. Wise, Essential of endocrinology.
8. Wiliamas R.H.(1974). Textbook of endocrinology, V.Ed. Saunders Press, London.
9. Benjamin Levin-Gene VII, Oxford University Press.
10. Lodish et al., Molecular Cell Biology.
11. Anthony W. Norman and Gerald Litwack-Hormones-Academic Press.Inc.
12. Endocrinology, Vol.1-3, by Degroot [L.J.et al.](#)
13. An Introduction to Invertebrate Endocrinology by A.S. Tombes.
14. General Endocrinology by Turner & Bagnara.

Practical 1

Program: NEP M.Sc. – I				Semester: 4	
Course Code: WSZOOMP643					
Course Title: Practical based on Cell communication, signaling & Endocrinology					
Teaching scheme				Evaluation scheme	
Lectures (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Continuous Internal Assessment (CIA)	Semester End Examination
NA	8	NA	6	40	60
Learning Objective: <ul style="list-style-type: none"> ● To introduce the learner to methods of studying the activities of enzymes, various endocrine glands. 					
Course Outcomes: CO1: The learner will be able to estimate the activity of enzymes. CO2: The learner will be able to identify & describe various glands in the organism. CO3: The learner will be able analyze the impact of enzyme activity in the organisms.					

Course Code WSZOOMP643	Practical No.	Practical based on Cell communication, signaling & Endocrinology	2 Credits
	1.	Study of the life cycle of Axolotl.	
	2.	Demonstrate/study endocrine gland in crab/Prawn.	
	3.	Study of effect of various factors like substrate concentration/pH/Temperature/ activator/Inhibitor & determination of Km of a given enzyme salivary/pancreatic amylase.	
	4.	Effect of acetylcholine / Adrenaline on fish chromatophores.	

	5.	Preparation and submission of slides of adrenal, ovary and testis in vertebrate (Goat/Chicken) using microtomy technique.	
	6.	Study of Endocrine disorders in human (Slides / Photographs / TC tools/models/charts/photographs).	
	7.	Effect of Eyestalk ablation on the blood glucose level in crab/Prawn.	
	8.	Estimation of calcium level in the given blood sample.	
	9.	Estimation of Glucose level in the given blood sample.	

M.S.C – I, SEM – 2, MANDATORY PAPER 2. REPRODUCTIVE PHYSIOLOGY

Program: NEP M.Sc. – 2				Semester: IV	
Course Code: WSZOOMT642					
Course Title: Reproductive Physiology					
Teaching scheme				Evaluation scheme	
Lectures (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Continuous Internal Assessment (CIA)	Semester End Examination
4	4	NA	(4 + 2) = 6	40	60
Learning Objectives:					
<ul style="list-style-type: none"> ● To describe the anatomy and function of the male and female reproductive systems. ● To explain the hormonal regulation of the menstrual cycle, spermatogenesis, processes of spermatogenesis and oogenesis. ● To explain the roles of hormones in reproduction and describe how hormonal imbalances can affect fertility and reproductive health. ● To discuss various methods of contraception, including their mechanisms of action and effectiveness. ● To identify common reproductive disorders and discuss the causes, symptoms, and potential treatments for these disorders and infertility. 					
Course Outcomes:					
CO1: The learner will acquire knowledge of the anatomy, physiology, and endocrinology of the male and female reproductive systems.					
CO2: The learner shall comprehend the physiology and regulation of implantation process, pregnancy, parturition and lactation.					
CO3: The learner will be able to identify and analyze common reproductive disorders, understanding their causes, symptoms, and potential treatments.					
CO4: The learner will be familiar with different ART procedures, including techniques, indications, success rates, and ethical considerations.					

Detailed syllabus.

Course Code: WSZOOMT642	Sub unit	Course/ Unit Title Reproductive Physiology	4 Credits / 60 Hours
UNIT 1		MALE REPRODUCTIVE PHYSIOLOGY	15 hours
	1.1	1.1.1 Male reproductive system and accessory organs- Brief description of histomorphology and hormonal regulation 1.1.2 Spermatogenesis – cycle and wave of seminiferous epithelium, 1.1.3 Sperm maturation – morphological and biochemical events, influence of accessory organ secretions; capacitation, Signal transduction pathway in acrosome reaction.	
	1.2	Biochemistry of semen 1.2.1 Hormonal control of spermatogenesis 1.2.2 Ultrastructure of spermatozoa a. Stem cell renewal in testis b. Sertoli cell: structure and function; Leydig cell: generation of Leydig cell, steroidogenesis; c. Leydig and Sertoli cell proliferation during foetal and postnatal development	
UNIT 2		FEMALE REPRODUCTIVE PHYSIOLOGY	15 hours
	2.1	2.1.1 Female reproductive system organs (Brief description of histomorphology and hormonal regulation) a. Types of reproductive cycles b. Estrous cycle c. Menstrual cycle	
	2.2	Physiology of: 2.2.1 Folliculogenesis- Follicular development and selection; Role of extra-and intra-gonadal factors in folliculogenesis, ; Oocyte maturation and its regulation 2.2.2 Ovulation: factors involved in follicular rupture; Luteinization and luteolysis; Follicular atresia Physiology and hormonal regulation of: a. Implantation b. Pregnancy c. Parturition d. Lactation – mammary gland development and lactogenesis, letdown reflex, feedback inhibition of lactation.	

	2.3	2.3.1 Immunophysiology of male and female reproduction 2.3.2 Immunology of pregnancy 2.3.3 Pubertal changes- Onset of puberty in human, factors affecting onset of puberty; Precocious, delayed or absent puberty; 2.3.4 Reproductive Ageing – Menopause; Andropause 2.3.5 Metabolic control of reproduction	
UNIT 3		INFERTILITY & REPRODUCTIVE DISORDERS	15 hours
	3.1	Male infertility: Abnormalities of sperm: azoospermia, oligozoospermia, asthenozoospermia, teratozoospermia; varicocele, cryptorchidism, ejaculatory disorders.	
	3.2	Female infertility Female reproductive disorder: Endometriosis, Polycystic Ovarian Syndrome (PCOS), Primary ovarian failure (POF), amenorrhoea	
	3.3	Idiopathic infertility 3.3.1 Role of EDCs on fertility 3.3.2 Genetic basis for male and female infertility 3.3.3 Mutational analysis in genes for hormones, receptor and gamete development.	
	3.4	3.4.1 Sexual differentiation & developmental abnormalities – male & female 3.4.2 Spontaneous pregnancy loss 3.4.3 Pregnancy disorders – Pre-eclampsia, IUGR, Labour abnormalities 3.4.4 Endocrine disorders – Hyperprolactinemia 3.4.5 Autoimmune disorders and fertility 3.4.6 Genetic disorders and fertility	
UNIT 4		ASSISTED REPRODUCTIVE TECHNOLOGIES	15 hours
	4.1	Maintaining and setting ART Laboratory	
	4.2	Assisted Reproductive Techniques: a. Intrauterine Insemination (IUI) b. Intracytoplasmic sperm Injection, Semen analysis c. Ovulation induction d. Oocyte Retrieval e. In Vitro Fertilization (IVF) f. In Vitro Maturation (IVM) g. Embryo Transfer (ET) h. Intra Fallopian Transfer (IFT) i. GIFT, ZIFT j. TESE 4.2.2 Sperm banks a. Cryopreservation of gametes, embryos and cord blood b. Preimplantation genetic diagnosis- PGD 4.3 Ethical issues of ART	

		4.4 Surrogacy	
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References:

1. The Physiology of Reproduction, Vol 1 and 2, Ernst Knobil and Jimmy D. Neil, (ed), Raven Press.
2. Male Reproductive Function, Christina Wang, (ed), Kluwer Academic Publishers.
3. The ovary, (ed), Solly Zuckerman Zuckerman, Barbara J. Weir, T. G. Baker. Academic Press.
4. The ovary, Peter C.K. Leung and Eli Y. Adashi, (ed), Elsevier (Academic Press), 2004.
5. Cell and Molecular Biology of Testis, (ed), Claude Desjardins and Larry L. Ewing. Oxford University Press, USA 60 | P a g e
6. Reproductive Endocrinology: Physiology, Pathophysiology, and Clinical Management, Samuel S. C. Yen, Robert B. Jaffe, Robert L. Barbieri, (ed), Saunders publisher. USA

Program: NEP M.Sc. – II				Semester: 4	
Course Code: WSZOOMP644					
Course Title: Practical 2 based on Reproductive Physiology					
				Evaluation scheme	
Lectures (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Continuous Internal Assessment (CIA)	Semester End Examination
2	4	NA	(2 + 2) = 4	20	30
Learning Objective: <ul style="list-style-type: none"> ● To acquaint the learner with concepts of reproductive physiology. ● To make the learner familiarize with various techniques used for ART. ● To make the learner comprehend the applications of Assisted Reproductive Techniques. ● To make the learner explore the ethical, social, and regulatory considerations regarding Assisted Reproductive Techniques. 					
Course Outcomes: CO1: Learners will be able to analyze reproductive biology of different organisms. CO2: Learner will be able to describe various applications of studying reproductive physiology. CO3: Learners will be able to summarize the principles, indications and technique in ART. CO4: Learners will be able to know the ethics and safety issues regarding ART.					

Practical 1

Course Code WSZOOMP523	Practical No.	Practical based on Reproductive Physiology	2 Credits
	1.	Detection of pregnancy hormone from given sample of urine/birth control pill	
	2.	Study of different methods of contraception and their effect on human physiology- Oral contraceptives, UID, Vaginal rings, Hormone Patches, Condoms.	
	3.	Study of the following permanent slides, museum specimens and materials a. Mammalian sperm and ovum b. Study of menstrual cycle in humans	
	4.	Study of estrous cycle of rat/mouse and identification of stage by vaginal smear.	
	5.	Demonstrate/ observation of male/female reproductive system of crab/prawn.	
	6.	Histochemical localization of 3 B and 17 B steroid dehydrogenases in suitable animal tissues.	
	7.	Study of types of placenta.	
	8.	Study of histology of human male reproductive accessory organs.	
	9.	Study of Assisted Reproductive Techniques. a. Identification of ART by use of suitable pictures/videos. b. Case Studies	
	10.	Field visit to an IVF Centre/ Veterinary Hospital.	

M.SC. – 1, SEM -2, ELECTIVE COURSE.

Program: NEP M.Sc. – II				Semester: 4	
Course Code: WSZOOET641					
Course Title: Maintenance of Animal models & Animal Biotechnology					
				Evaluation scheme	
Lectures (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Continuous Internal Assessment (CIA)	Semester End Examination
2	4	NA	(2 + 2) = 4	20	30
<p>Learning Objective:</p> <ul style="list-style-type: none"> ● To acquaint the learner to maintain clean and safe living environments for model organisms. ● To educate the learner about the ethical issues pertaining to the use of animals in research and care. ● To make the learner familiarize with various techniques for genetic manipulation to create transgenic animals. ● To make the learner comprehend the applications of transgenic animal in disease model, and pharmaceutical production. ● To make the learner explore the ethical, social, and regulatory considerations for the use of transgenic animals. 					
<p>Course Outcomes:</p> <p>CO1: Learners will be able to maintain the Animal house of different organism.</p> <p>CO2: Learner will be able to describe various application of studying animal model.</p> <p>CO3: Learners will be able to summarize the principles and technique in transgenesis, including gene insertion, and its application in various fields.</p> <p>CO4: Learners will be able to know the ethics and safety issues regarding transgenic animal.</p>					

Detailed syllabus.

Course Code:	Sub unit	Course/ Unit Title	2 Credits / 30 Hours
UNIT 1		Maintenance of Animal models & Animal Biotechnology	15 hours
	1.1	Animal House:- Infrastructure and maintenance, Physical condition in animal House.	
	1.2	Animal Care and management of the laboratory animal. a) Hydra b) <i>C. elegans</i> c) <i>Drosophila</i> d) Zebra fish e) Mice.	
	1.3	Application of Animal models a) Models for diseases- Diabetic Rat model, Thyroidectomized rat. b) Models for immunological studies- Paw Oedema, Splenectomy. c) Models for toxicity- CCl ₄ model, paracetamol model. d) Aging model-Drugs induced (Galactosamine). e) Model for Endocrinology and Reproductive Biology- In vitro study of estrous cycle, Implantation, pregnancy.	
	1.4	Animal Ethics laws and CPCSEA Guidelines.	
	1.5	Animal Tissue culture. a) Basic equipment and glasswares used in cell culture (Laminar air flow, Autoclave, CO ₂ incubator, Centrifuge) b) Media used in cell culture. c) Basic sterile aseptic technique. d) Cell Lines- Primary and Established cell lines.	
UNIT 2		Animal Biotechnology.	15 hours
	2.1	Introduction to transgenic animals.	
	2.2	Methods of Creating transgenic animal a) DNA Microinjection b) Retroviral Method c) Embryonic stem cell method d) Genome editing with CRISPR-Cas system.	
	2.3	Application of transgenic animals a) As model diseases i) Rabbit model as cardiovascular disease ii) Zebra Melanoma model. b) Transgenic animal as Bioreactors-Antithrombin production in Goat.	

		c) Production traits as food animal-Transgenic Salmon. d) Xenotransplantation- Production of donor organs in pigs.	
	2.4	Regulations of transgenic animals.	
	2.5	Patenting genetically engineered animals.	

REFERENCES

1. Animal Biotechnology by R Sasidhara, MJP publishers.
2. Animal Biotechnology- Recent concepts and development by P Ramadass MJP publishers.
3. Animal Transgenesis and cloning by Louis, Marie, Houdebine.
4. Molecular Biotechnology- Principles and applications of recombinant DNA by Bernard Glick and Cheryl L Patten, Sixth edition.
5. How to use Hydra as a model system to teach biology in the classroom - Scientific Figure on ResearchGate. Available from: https://www.researchgate.net/figure/Daily-maintenance-of-Hydra-culture-A-Hydra-mass-cultures-are-maintained-in-Pyrex_fig4_225293195 [accessed 21 Apr, 2024]
6. Biotechnology by John E Smith. Cambridge university Press, Fifth edition.
7. Basic Biotechnology by Colin Ratledge, Bjørn Kristiansen, Third edition, Cambridge university Press.
8. Animal Cell Culture: A practical approach by R.I. Freshney, IRL press.
9. A manual of basic techniques by R.I. Freshney, Willy-Liss and Sons publication.
10. Animal cell culture technique by Martin Clynes, Springer publication.
11. Freshney, R.I: Culture of Animal cells, Wiley Publications, New York. Ed. Jhon R.W.
12. Animal cell culture- practical approach, Oxford University press, Oxford. Ed.
13. R. Basega : Cell growth and division : A practical approach , IRL press Oxford University
14. Martin Clynes: Animal cell culture techniques, Springer- Verlag, New York. F.Grasveld,
15. George V. Kallias: Transgenic Animals, Academic press, Sandiego, USA.
16. Asok Mukhopadhyay: Animal cell technology, IK International publishing House, New Delhi.
17. R. E. Speir, J. B. Griffiths, W. Berthold (Ed), Animal Cell Technology – Products of today, prospects of tomorrow, Butterworth –Heinman Publishers

SEM 4, ELECTIVE PRACTICAL.

Program: NEP M.Sc. – II				Semester: 4	
Course Code: WSZOOEP642					
Course Title: Maintenance of Animal models & Animal Biotechnology					
				Evaluation scheme	
Lectures (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Continuous Internal Assessment (CIA)	Semester End Examination
-	4	NA	2	20	30
Learning Objective: To familiarise the learner with maintaining clean and safe dwelling habitats for model organisms. To help learners understand the applications of transgenic animals in disease modelling and pharmaceutical manufacture. To have students explain the toxicity of paracetamol in fish.					
Course Outcomes: CO1: Learners will be able to maintain and take care of various organisms' animal homes. CO2: Learner will be able to explain the different applications of animal models and transgenic animals CO3: Learners will be able to comprehend the fundamentals of animal tissue culture technology. CO4: Learners will be able to detect the toxicity of paracetamol in fish.					

SEM 4, ELECTIVE PRACTICAL.

Course Code	Practical No.	Practical based on Animal Care and maintenance.	2 Credits
	1.	Maintenance of different animal models in laboratory- Hydra/ <i>C. elegans</i> / <i>Drosophila</i> / Zebrafish/ Mice.	
	2.	Paracetamol toxicity in fish.	
	3.	Packaging of different glasswares for animal cell culture(Pipettes, test tube, conical flask, petri plate)	
	4.	Performing aseptic transfer technique.	
	5.	To prepare basic culture media (BSS) for animal tissue culture.	
	6.	To demonstrate various streaking techniques using <i>Saccharomyces cerevisiae</i> .	
	7.	Separation of Viable cells from animal tissue by Trypsinization method.	
	8.	To study the growth curve in <i>Saccharomyces cerevisiae</i> .	
	9.	To study various animal model a) mice b) Rat c) Hamster d) Guinea pig e) Rabbit f) Monkey g) chimpanzee.	
	10.	To study various Transgenic animal a) C C cat b) Snuppy dog c) Transgenic trout d) Transgenic salmon e) Transgenic silkworm.	

M.SC. – 2, SEM -4, RESEARCH PROJECT.

Program: NEP M.Sc. – I				Semester: 4	
Course Code: WSZOORP641					
Course Title: Research project					
Teaching scheme				Evaluation scheme	
Lectures (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Continuous Internal Assessment (CIA)	Semester End Examination
NA	8	NA	6	40	60
Learning Objective: <ul style="list-style-type: none">● To develop research attitudes among the students.● To establish the skill obtained from theory to practical.● To inculcate the principle of research in students.					
Course Outcomes: <p>CO1: The learner will be able to apply the knowledge gathered from the program to apply in different technical and skill based projects</p> <p>CO2: The learner will be adapting a professional attitude and technical knowledge from the program.</p> <p>CO3: The learner will be able to manage the challenges they may encounter in the future.</p> <p>CO4: The learner will be able to analyze and extract scientific data.</p>					