

Raja Mahendra Pratap Singh State University, Aligarh

Structure of syllabus for P.G. Programmes

Program: M.Sc. Zoology Program on the basis of a choice-based credit system 2022-23.

Course/ Paper		Course/Paper	Credits	T/P	Evaluation	
					CIE	ETE
Code	Category	Title				
SEMESTER VII						
RB050701T	Major one	Biological techniques and instrumentation	4	T	25	75
RB050702T	Major two	Molecular and cell biology	4	T	25	75
RB050703T	Major three	Systematic and structure and function of invertebrates	4	T	25	75
RB050704T	Major four	Microbiology and immunology	4	T	25	75
RB050705P	Major five Practical paper	Practical based on theory papers	4	P	25	75
RB050706R	Research project	Topic selection from major subjects /review of literature/industrial training/survey	4	R		
TOTAL CREDITS			24+4	(Minor)* = 28		
SEMESTER VIII						
RB050801T	Major one	Chordate anatomy	4	T	25	75
RB050802T	Major two	Genetics and biotechnology	4	T	25	75
RB050803T	Major three	Animal physiology and biochemistry	4	T	25	75
RB050804T	Major four (Optional paper)	Environmental biology	4	T	25	75
RB050805P	Major five Practical paper	Practical based on theory papers	4	P	25	75
RB050806R	Research project	Report writing/report submission/evaluation	4	R	50	50
TOTAL CREDITS			24			
SEMESTER IX						
RB050901T	Major one	Biostatistics and computer applications	4	T	25	75
RB050902T	Major two	Animal behaviour	4	T	25	75
RB050903T	Major three	Developmental biology	4	T	25	75
RB050904T OR RB050907R	Major four (Select any one)	Insect morphology and anatomy (RB050904T)	4	T	25	75
		Systematics and morphology of fishes (RB050907R)	4	T	25	75

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RB050905P	Major five Practical paper	Practical based on theory papers	4	P	25	75
RB050906R	Research project	Topic selection from major subjects /review of literature/industrial training/survey	4	R		
TOTAL CREDITS			24			
SEMESTER X						
RB051001T	Major one compulsory subject paper	Toxicology	4	T	25	75
RB051002T OR RB051003T	Major two (Select any one)	Insect physiology and development (RB051002T)	4	T	25	75
		Physiology and embryology of fishes (RB051003T)	4	T	25	75
RB051004T OR RB051007T	Major three (Select any one)	Animal systematic (RB051004T)	4	T	25	75
		Aquaculture and fisheries (RB051007T)	4	T	25	75
RB051008T OR RB051009T	Major four (Select any one)	Ecology and applied entomology (RB051008T)	4	T	25	75
		Pisciculture and economic importance of fishes (RB051009T)	4	T	25	75
RB051005P	Major five Practical paper	Practical based on theory papers	4	P	25	75
RB051006R	Research project	Report writing/report submission/evaluation	4	R	50	50
TOTAL CREDITS			24			

* Minor Paper will be from other faculty.

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M.Sc. PREVIOUS SEMESTER VII (year I)

Course	Paper title	Paper code	Unit	Syllabus	Credits
VII	Biological techniques and instrumentation	RB050701 T	I	Basic principles of microscopy, Principle, design, working, applications and limitations of following microscopes: Compound, phase contrast, interference, polarized, fluorescence and epifluorescence, transmission electron, scanning electron and confocal. Fixation and staining techniques for light and electron microscopy Freeze etch and freeze fracture, methods for electron microscopy, Image processing methods in microscopy.	4
			II	Principle, design, working, applications and limitations of the following instruments: pH meter, centrifuge, spectrophotometer and biochemical analyzers , autoclave, laminar flow, hydrophilic Chromatographic techniques-Paper, TLC, Gel Filtration, Affinity, Ion Exchange, Gas and HPLC Electrophoresis-Paper, Agarose Gel, Polyacrylamide gel, SDS PAGE and Isoelectric focusing.	
			III	Blotting techniques: Southern, northern, western and eastern . PCR and its types- Real time, Nested, Multiplex, Reverse Transcriptase, Asymmetric ELISA and its types- Direct, Indirect, Sandwich and Competitive.	
			IV	Sanger DNA Sequencing and Protein sequencing APF, RAPD and AFLP techniques, X-Ray diffraction, NMR and ESR spectroscopy , Different types of radioisotopes used in biology, scintillation counter, GM counter, autoradiography, Electrophysiological methods ECG, EEG, PET, MRI, FMRI, CAT.	

Suggested readings:

1. Wilson and Walkers: Principles And Techniques Of Biochemistry And Molecular Biology 8Ed by Hoffman A & Cloakie S.
2. Molecular Biology of the Cell 5 Ed: by Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff and Keith Roberts.
3. Experimental Biochemistry by John M. Clark (Editor), Robert L. Switzer and Liam F. Garrity.
4. A text book of Molecular Biology, Bioinstrumentation and Biotechniques by Vikas Yadav and Parul Yadav.
5. Physical Biochemistry - Applications to Biochemistry and Molecular Biology by Freifelder David.
6. Physical Biochemistry: Principles and Applications by David Sheehan.

Molecular and cell biology	RB050702 T	I	DNA replication: Prokaryotic and eukaryotic DNA replication, enzymes and accessory proteins involved in replication, origin of replication, replication fork; initiation, elongation and termination of replication. Transcription: Transcription unit, RNA polymerases, transcription factors; initiation, elongation and termination of transcription in prokaryotes and eukaryotes, post transcriptional modifications (capping, polyadenylation, splicing and RNA editing).	4
		II	Translation: Genetic code; initiation, elongation and termination of translation in prokaryotes and eukaryotes. Regulation of gene expression: Regulation at transcription level (operon system, lac and trp operons), role of chromatin in gene expression, RNA interference.	
		III	Cell structure and functions: Structural organization and function of intracellular organelles: nucleus, mitochondria, Golgi bodies, endoplasmic reticulum and lysosomes. Cellular membrane and cytoskeleton: Lipid bilayer, Chemical composition of cell membrane, membrane proteins, movement of substances across cell membranes; Structure and organization of microtubules, intermediate filaments and microfilaments and their role in cell motility.	

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M.Sc. PREVIOUS SEMESTER VII (year I)

		IV	<p>Cell signaling: Signaling molecules and cell surface receptors, signalling through G-protein coupled receptors, second messengers.</p> <p>Cell division and cell cycle: Mitosis and meiosis, cell cycle and its regulation, apoptosis.</p>	
<p>Suggested readings:</p> <ol style="list-style-type: none"> 1. Molecular Biology by Freifelder. 2. Genes XII by Lewin. 3. Molecular biology of the gene by Watson et al. 4. Molecular Biology of the Cell by Alberts et al. 5. Molecular Cell Biology by Lodish et al. 6. Cell: A Molecular Approach by Cooper. 7. Cell and Molecular biology by Gerald Karp 8. Cell and Molecular biology by De Robertis. 9. Genome 3 by T. A. Brown. 10. The World of Cell by Becker et al. 11. Cell Biology by Pollard et al. 				
<p>Systematic and structure and function of invertebrates</p>	<p>RB050703 T</p>	I	<p>Systematic: International code of Zoological nomenclature, Taxonomic Procedures; New trends in taxonomy.</p> <p>Basis of classification: Symmetry, coelom, segmentation, germ layers and level of organization</p> <p>Organization of coelom: Acoelomates, Pseudocoelomates, Coelomates; Protostomia and Deuterostomia.</p>	<p>4</p>
		II	<p>Locomotion: Flagellar and Ciliary movement in Protozoa.</p> <p>Nutrition and Digestion: Patterns of feeding and digestion in lower metazoans, Filter feeding in Polychaeta, Mollusca and Echinodermata.</p> <p>Respiration: Organs of respiration: Gills, Lungs and Trachea. Respiratory pigments, Mechanism of respiration.</p>	
		III	<p>Excretion: Organs of excretion: Coelom, Coelomo-ducts, Nephridia and Malpighian tubule.</p> <p>Nervous system: Primitive nervous system: Coelenterata and Echinodermata.</p> <p>Advanced nervous system: Annelida and Mollusca.</p>	
		IV	<p>Invertebrate larvae: Larval forms of free-living invertebrates; Larval forms of parasites.</p> <p>Minor Phyla: Concept and significance. Organization and general characters of Rotifera, Ctenophora, Sipunculida and Onychophora.</p> <p>Parasites of Protozoans and Helminths</p>	
<p>Suggested readings:</p> <ol style="list-style-type: none"> 1. Invertebrate structure and function. ; Barrington. E. J. W. Thomas Nelson & Sons Ltd. London 2. The Invertebrates; Hyman. L. H.; McGraw Hill Co New York 3. Invertebrate Zoology, III edition. ; Barnes. R.D. 4. The invertebrates. Vol.1. Protozoa through Ctenophora, Hyman, L.H. McGraw Hill Co., New York. 5. Evolution of Metazon life cycle, Jagerstain, G. Academic Press, New York & London. 6. The Invertebrates. Vol.2. Hyman, L.H. McGraw Hill Co., New York. 7. The Invertebrates. Vol.8. Hyman, L.H. McGraw Hill Co., New York. and London 8. Invertebrate Zoology Barnes, RD. W.B.Saunders Co., Philadelphia 9. A Biology of higher invertebrates, Russel-Hunter, WD. McMillan Co. Ltd., London 10. The Invertebrates smallercolomate groups, Vol.5. Hyman, L.H. McGraw Hill Co., New York. 11. Animal Parasitism. Cad. C.P.Prentice Hall Inc., New Jersey. 				

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M.Sc. PREVIOUS SEMESTER VII (year I)

12. Student Text Book of Zoology. Vol.I, II and III. Sedgwick.A. Central Book Depot, Allahabad.

Microbiology and Immunology	RB050704 T	I	Introduction to microbes: Culturing bacteria in different media, purification of strains and various methods of short and long term storage; Mutations in bacteria and isolation of mutants; Ame's test; F-plasmids, their conjugation and role in gene mapping. Applications of microbiology.	4
		II	Viruses and Phages: Types of phages, Importance of bacteriophages in genetics and molecular biology, Fine structure of bacteriophage lambda; Life cycle of bacteriophages: lysogeny and lytic options; Transduction: generalized and specialized transduction; Complementation test; Reteroviruses and their mechanism of replication, Structure and genomics of HIV.	
		III	Immunology – I: General concept of Immune system: Adaptive and acquired immune system, cells and molecules involved in both type of immune systems; Active and passive immunity; Antigens, immunogens and haptens, antigenicity and immunogenicity; Immunogenic or antigenic response of B and T cells; Structure and function of antibody molecules; concept of epitopes and paratopes; Humoral and cell mediated immunity.	
		IV	Immunology – II: Generation of antibody diversity: monoclonal and polyclonal antibodies, Hybridoma technology; antigen-antibody interactions, MHC molecules; Antigen processing and presentation; Activation and differentiation of B and T cells, B and T cell receptors; the complement system; Toll-like receptors; Hypersensitivity and autoimmunity; Cytokines (Interleukins, Chemokines, Interferons, CSF etc); Vaccines.	

Suggested readings:

1. Kuby Immunology by Judy Owen, Jenni Punt and Sharon Stranford.
2. Roitt's Essential Immunology.
3. The Immune System by Peter Parham.
4. Cellular and Molecular Immunology 6th Edition by Shiv Pillai, Abdul K Abbas and Andrew H Lichtman.
5. Bailey & Scott's Diagnostic Microbiology.
6. Prescott's Microbiology by Joanne Willey, Linda Sherwood and Christopher J.Woolverton.

Practical based on theory papers	RB050705 P			4
Minor				4
Research Project	RB050706 R		Topic selection from major subjects/ Review of literature/ Industrial training/ Suryey.	4
TOTAL CREDITS				28

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M.Sc. PREVIOUS SEMESTER VIII (year I)

Course	Paper title	Paper code	Unit	Syllabus	Credits
VIII	Chordate anatomy	RB050801T	I	Chordate Origin: Concepts of Protochordata, Nature of Vertebrate Morphology and classification to Vertebrate. Vertebrate Integument: General structure and function of skin and their derivatives.	4
			II	Circulatory system: Blood, Evolution of Heart and Aortic Arches. Digestive System: Digestive Tract and Digestive Glands	
			III	Respiratory System: Respiratory Tissues characteristics and Different Respiratory Organs In Chordates. Urinogenital System: Male and Female urinogenital system in tetrapods.	
			IV	Skeletal System: skeletal elements of the body, Skull, Vertebral column, Limbs and Girdles (In Tetrapods). Sense Organs: Cutaneous Receptors, Chemoreceptors, Lateral line System, Stato-acoustic organs, Electroreception. Nervous System: Anatomy of brain in relation to its function, Spinal Cord and cranial nerves, peripheral and autonomus nervous system.	
Genetics and Biotechnology	RB050802T	I	Gene Action- From genotype to phenotype- Penetrance and expressivity, Gene interaction, Phenocopy, Genomic imprinting, Linkage and crossing over, Sex linked, Sex influenced, Sex limited characters, Pedigree analysis, Gene mapping; Extranuclear inheritance- Mitochondrial genes and Maternal effect.	4	
		II	Sex determination in human, <i>Drosophila</i> and other animals; Dosage compensation of X-linked genes- Hyperactivation of X-linked gene in male <i>Drosophila</i> and Inactivation of X-linked gene in female <i>Drosophila</i> ; Types of mutation, Mutagens, Mutant types (Lethal, conditional, Biochemical, loss of function, Gain of function, Germinal versus somatic, Insertional mutagenesis).		
		III	Tools and techniques of Biotechnology: Recombinant DNA technology, Restriction enzymes, Linkers/Adapters, Selection and screening of recombinants, Cloning vectors- Plasmid, Phages, Cosmids, Transposons, Shuttle and expression vectors, Gene library, C-value paradox.		
		IV	Application of Biotechnology: Industrial Biotechnology, Biofuels, Bioremediation, Biodegradation, Biofertilizers, Single cell Protein. Genetic manipulation of animal cells: Transgenic animals, Gene knockout, formation and selection of embryonic stem cells; Gene therapy: Human diseases targeted for gene therapy, vectors and delivery systems.		
<p>Suggested readings: Principles of Genetics by E. J. Gardener <i>et al.</i> Molecular biology of the gene by J. D. Watson. Biotechnology by Satyanarayana. Principles and techniques of biochemistry and molecular biology by Wilson and Walker.</p>					
Animal physiology and Biochemistry	RB050803T	I	Physiology of digestion: Digestion and absorption of proteins, carbohydrates and lipids, Regulation of digestion and absorption. Physiology of respiration: Respiratory volumes and capacities, mechanism of breathing, transport and exchange of gases, O ₂ - dissociation curve, regulation of respiration. Physiology of circulation: Blood composition, blood coagulation, structure and working of human heart, cardiac cycle and its regulation.	4	

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M.Sc. PREVIOUS SEMESTER VIII (year I)

			<p>Physiology of excretion: Process of urine formation, counter current mechanism, regulation of excretion.</p>
		II	<p>Neuro-physiology: Generation and conduction of nerve impulse, synaptic transmission, physiology of sense organs. Muscular physiology: Types of muscles and muscle proteins, Molecular mechanism of muscle contraction. Physiology of Endocrine system: Overview of endocrine glands, mechanism of hormone action.</p>
		III	<p>Biomolecules Biomolecules (carbohydrates, lipids, proteins, nucleic acids and vitamins), Stabilizing interactions (van der waals, electrostatic, hydrogen bonding, hydrophobic interaction etc.), Types and structure of amino acids, Secondary structure of Proteins (α-helix, β-sheet, motifs, folds, domains, Ramachandran plot), Tertiary and quaternary structure of proteins, Nucleic acids: DNA structure and forms of DNA, Types and structure of RNA. Oxidative phosphorylation and ATP synthesis.</p>
		IV	<p>Enzyme Kinetics and Bioenergetics Introduction To Enzymes: Apoenzyme, Holoenzyme, Prosthetic Group, Cofactors, Coenzymes, Abzymes, Ribozymes. Immobilized Enzymes Enzyme Kinetics: Michaelis-Menten Equation, Enzyme Inhibition – Competitive & Non-Competitive Enzyme Regulation: Allosteric Regulation, Covalent Modification, Zymogens, Proenzymes, Isozymes.</p>

Suggested readings:

1. BRS Physiology by Linda S. Costanzo. Publisher: Lippincott Williams and Wilkins
3. Comparative Animal Physiology by CL Prosser and FA Brown. Publisher: W.B. Sanders Co.
4. Fundamentals of Human Physiology by Stuart Ira Fox. Publisher: McGraw-Hill Education - Europe
5. Ganong's Review of Medical Physiology by Brooks, Boitano and Barman. Publisher: McGraw Hill
6. Guyton & Hall Textbook of Medical Physiology by V Hall & R Kurpad. Publisher: Elsevier
8. Principles of anatomy and physiology by Derrickson and Tortora.
9. Principles of biochemistry, by Lehninger.
10. Biochemistry by Donald Voet and Judith Voet.
11. Biochemistry by Harper.
12. Biochemistry by Jeremy M. Berg, John L. Tymoczko, Lubert Stryer.

<p>Environmental biology (Optional paper)</p>	<p>RB050804T</p>	I	<p>Ecosystem: Concept of Ecosystem, laws of limiting factors, energy flow, trophic levels, food chain, ecological niches, Biotic community: Structure, stratification and growth.</p>	<p>4</p>
		II	<p>Population ecology: Structure, growth and population, population growth curves. Pollution: Air, water, land, noise, radiation, sources, effects and control.</p>	
		III	<p>Conservation of natural resources. Wildlife conservation in India, National action plan (NAP).</p>	
		IV	<p>Conservation of wildlife (Ex situ and In situ conservation): Biosphere reserves, Sancturies and National parks. Vanishing wildlife: Protection of endangered species of animals.</p>	
<p>Practical based on theory papers</p>	<p>RB050805P</p>			<p>4</p>
<p>Research Project</p>	<p>RB050806R</p>		<p>Research project report writing/ Report submission and evaluation.</p>	<p>4</p>

Suggested readings:

1. Developmental Biology by Scott F. Gilbert.

M.Sc. PREVIOUS SEMESTER VIII (year I)

	2. Principles of development by Lewis Wolpert, Cheryll Tickle, Alfonso Martinez Arias. 3. Human embryonic stem cells development by Ali H Brivenlou. 4. Developmental Biology by Leonard Roosevelt. 5. Chordate embryology by PS Verma and VK Agarwal.				
				TOTAL CREDITS	24

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M.Sc. Semester IX (Year II)

Course	Paper title	Paper code	Unit	Syllabus	Credits
IX	Biostatistics and computer applications (Major 1)	RB050901T	I	Biostatistics introduction, terms and symbols, collection and types of data. Applications of Biostatistics. Presentation of Data (Pie charts, ogive, Histograms Bar diagrams), Sample and Sampling techniques.	4
			II	Measures of central tendencies (Mean, Median, Mode). Measures of dispersion (standard deviation, variance), coefficient of variation.	
			III	Correlation & Regression analysis, Plotting of the regression line and calculations on regression equation. Test of significance (chi square, t test, F test) Analysis of Variance Type I and type II errors.	
			IV	Internet basics, terminology, information retrieval, MS office, Introduction to power point presentation- image, data handling and graphical tools. MS word (Editing, copying, moving, formatting, table insertion etc). MS Excel tools for presentation of data, web hosting and web page designing, Bioinformatics	
	Animal behavior (Major 2)	RB050902T	I	Introduction to animal behaviour, Patterns of behaviour, Reflexes, Types of reflexes, orientation, Kinesis (Orthokinesis and Klinokinesis); Taxis, types of taxis; Sun-compass orientation; motivation.	4
			II	Learning behaviour or Acquired behaviour: Non-associative learning (Habituation, Sensitization), Associative learning (Classical conditioning, Trial and Error learning), Latent learning, Insight learning (Reasoning, Intelligence, Cognitive thinking), Phase-specific learning (Imprinting), memory.	
			III	Parental care and migration; Types and causes of migration. Neuro-endocrine control of behaviour; Sexual behaviour, courtship, sexual selection; territorial behaviour.	
			IV	Patterns of communications (Chemical, visual, light, audio, tactile); infra sound and echo-location; Pheromones, Social behaviour with reference to insects.	
<p>Recommended books:</p> <ol style="list-style-type: none"> 1. An Introduction to Animal Behavior by Aubrey Manning & Marian Stamp Dawkins. Publisher : Cambridge University Press 2. Animal Behavior: A synthesis of Ethology and Comparative Psychology by Hinde. Publisher : McGraw-Hill, NY 3. Animal behavior: An evolutionary approach by J Alcock. Publisher: Sinauer Assoc., Sunderland, Mass. USA 4. Behavioral Ecology by JR Krebs and NB Davies. Publisher : Blackwell, Oxford, U.K 5. Perspectives on Animal Behavior By Judith Goodenough, Betty McGuire, Elizabeth Jakob. Publisher: John Wiley & Sons. 6. Principles of Animal Communication by Bradbury & Verhrencamp. Publisher: Sinauer Assoc., Sunderland, Mass. USA 7. Sociobiology: The New Synthesis by EO Wilson. Publisher: Harvard Univ. Press, Cambridge, Mass. USA 8. The Evolution of Communication by M Hauser. Publisher : MIT Press, Cambridge, Mass. USA 9. The evolution of Parental Care by TH Clutton-Brock. Publisher: Princeton Univ. Press, Princeton, NJ, USA 10. The Mechanisms and Evolution of Behavior by JL Gould. Publisher: Norton. 					

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M.Sc. Semester IX (Year II)

Developmental Biology (Major 3)	RB050903T	I	1- Basic concept of gamete. 2- Gametogenesis: a) Spermatogenesis. b) Oogenesis. 3- Types of cc eggs. 4- Fertilization, Infertility, Artificial insemination.	4
		II	1. Cleavage. 2. Blastulation. 3. Fate map construction. 4. Gastrulation. 5. Determination. 6. Differentiation. 7. Regeneration. 8. Competence.	
		III	Chick embryology: 1. Structure of hen's egg. 2. Copulation, ovulation and maturation and oviposition. 3. Development of chick embryo up to the formation of primitive streak. 4. Development of foetal membranes in chick. 5. Placentation in Mammals.	
		IV	Organogenesis: 1. Development of Eye. 2. Development of Brain. 3. Development of Heart. 4. Metamorphosis in Chordates. 5. Aging and Senescence. 6. Stem cells and their types.	
(Major 4) (Based on the specialisation) *Students will have to opt one paper RB050904T OR RB050907T	RB050904T (Insect Morphology and Anatomy)	I	General organisation of the insect body, Head: Orientation of insect head, Sutures and area of the cranium, tentorium, gnathal appendages (antenna and mouth parts). Thorax: pterothorax, thoracic appendages (legs and its modification; wing and wing coupling).	4
		II	Morphology of male and female reproductive system. Digestive system: General structure of digestive system and its modifications, salivary glands, cardiac and pyloric valves, peritrophic membrane and rectal pads.	
		III	Respiratory system: General organisation of trachea and spiracles; type of spiracles; air sacs. Circulatory system: General structure of heart and its modifications, haemolymph and haemocytes. Excretory system: Malpighian tubules and other excretory organs.	
		IV	Nervous system: Structure of brain and nerve chord (CNS, PNS and SNS). Sense organs: mechanoreceptors; chemo-receptors; auditory organs; sound and light producing organs.	
	RB050907T (Systematics and morphology of fishes)	I	Salient features of fishes, Berg's classification with its merits and demerits. Comparison of <i>Ostracoderms</i> and <i>Placoderms</i> . Classification and general characters of Agnatha. Affinities of cyclostomata. Key note characters of <i>Petromyzon</i> and <i>Myxine</i> .	
		II	Origin, classification, general characteristics and affinities of <i>Holocephali</i> and <i>Dipnoi</i> . Salient features and outline classification (upto orders with suitable examples) of <i>Elasmobranchs</i> and <i>Teleostomi</i> . Deep sea water and hill stream adaptations in fishes.	

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M.Sc. Semester IX (Year II)

			<p>III</p> <p>Integuments: A. Origin, derivatives and types of scales. B. Colouration: Types of chromatophores and significance of colouration. Fins: Types and modifications of fins.</p>	
			<p>IV</p> <p>Digestive system: Structure of alimentary canal with digestive glands, adaptive modifications in digestive tract. Respiratory fishes: Structure and adaptive significance of gills, ventilation of gills. Swim bladder and Weberian ossicles. Electric organs and light producing organs in fishes.</p>	
	Practical Paper (Major 5)	RB050905P		4
	Research Project 6	RB050906R		4
			TOTAL CREDITS	24

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M.Sc Semester X (II Year)

Course	Paper title	Paper code	Unit	Syllabus	Credits
X	(Major 1) Toxicology	RB051001T	I	Environmental toxicology: Food additives. Air, water and soil pollutants. Principles of systematic toxicology. Applications of toxicology.	4
			II	Human toxicology and medical ethics. Development of toxicology as special branch of science, different branches of toxicology, factors affecting toxicology.	
			III	Type of toxicants and their respective modes of actions. Genotoxic agents and their toxicities.	
			IV	Nephrotoxic agents and their toxicities. Hepatotoxic agents and their toxicities. Methods of analyzing and estimating toxicity in vertebrates.	
	*Students will have to opt any one paper from RB051002T OR RB051003T	RB051002T (Insect Physiology and Development)	I	Digestive system: Nutritional requirements of insect, physiology of digestion, digestion of special food stuffs (wool, collagen, keratin, pollen, silk, wax), fat body. Respiratory system: Respiratory adaptations in aquatic, terrestrial and endoparasitic insects.	4
			II	Circulatory system: Physiology of circulation and modifications. Excretory system: Physiology of excretion, metabolic pathways of synthesis of uric acid, urea and ammonia.	
			III	Sense organs: Production and reception of sound; mechanism of photoreception and light production. Reproductive physiology: oogenesis; yolk formation; spermatogenesis and transfer of sperms; mating and fertilization; role of pheromones.	
			IV	Endocrinology: hormones of neurosecretory cells, corpus cardiacum, corpus allatum and prothoracic gland, types of metamorphosis, hormonal control of metamorphosis and moulting/ecdysis.	
RB051003T (Physiology and Embryology of Fishes)		I	Food, digestion and nutrition: Methods of determining food and feeding habits; physiology of digestion. Blood vascular system: Heart and circulatory vessels, Blood and blood forming organs, Thermoregulation. Respiratory system: Gaseous exchange at the gill surface; fish blood as gas carrier, water and ion transport across the gills; Air Breathing Fishes: Adaptation for air breathing; accessory respiratory organs.		
		II	Excretion and Osmoregulation: Functions of fish kidney, Osmoregulatory and excretory organs, excretory products, endocrine control of excretion and Osmoregulation. Nervous System & Sense Organs: Cranial and Autonomic nervous system, Stato-acoustic (Lateral line system); Chemoreceptors; organ of sight and organ of smell in fishes.		
	III	Reproduction & development: Types of reproduction in fishes, Reproductive system, reproductive cycles and breeding season and spawning. Structure and kinds of eggs, maturation, cleavage and early embryonic development, Hatching and post embryonic development including fundamentals of morphogenesis.			

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M.Sc Semester X (II Year)

		IV	Endocrine Glands: Pituitary, Thyroid, Gonads, adrenal, Pancreas, Cells and tissues of fish immune system. Migration and Parental care in Fishes.	
<p>(Major 3)</p> <p>*Students will have to opt any one paper from RB051004T OR RB051007T</p>	<p>RB051004T (Insect systematic s)</p>	I	Introduction to entomology: Evolution of insects with special reference of fossil insects; causes of success of insects. Overview of insect classification Collection & Preservation of insects	4
		II	Salient features of Apterygota orders: Protura, Collembola, Diplura and Thysanura. Salient features of Palaeopteran orders: Ephemeroptera and Odonata.	
		III	Knowledge of following Neopteran orders with their families: Plecoptera; Embloptera; Orthoptera (Acrididae, Gryllidae, Tettigonidae, Locust and phase theory of locust); Phasmida; Dermoptera; Blattaria; Mantodea; Phlebotomera (Anoplura and Mallophaga); Psocoptera; Isoptera; Thysanoptera; Heteroptera (Coreidae, Pyrrhocoridae, Reduviidae, Lygaeidae, Tingidae, Belostomatidae, Nepidae, Gerridae); Homoptera (Membracidae, Jassidae, Aleurodidae, Psyllidae, Aphididae, Coccidae).	
		IV	Detailed knowledge of following Exopterygota orders with families: Coleoptera (Carabidae, Dytiscidae, Dermestidae, Hydrophilidae, Chrysomelida, Meloidae, Coccinellidae, Burprestidae, Tenebrionidae, Cerambycidae, Scarabaeidae, Curculionidae); Lepidoptera (Noctuidae, Sphingidae, Pyrrilidae, Bombycidae, Papilionidae, Nymphalidae, Pieridae); Hymenoptera (Ichneumonidae, Braconidae, Chalcidoidea, Vespoidea, Apoidea, Formicoidea); Diptera (Tipulidae, Psychodeade, Chironomidae, Simuliidae, Culicidae, Itonididae, Tabanidae, Asilidae, Syrphidae, Agromyzidae, Muscidae, Trypetidae, Hippoboscidae, Drosophilidae); Trichoptera; Aphinaptera.	
	<p>RB051007T (Aquaculture and Fisheries)</p>	I	Introduction and History of Fisheries and Cultivation Of Fisheries. Fresh Water Fish Culture in India. Culture Of Major Carp, Exotic Carp, And Air Breathing Fishes. Reservoir Fisheries, Riverian Fisheries, Cold Water Fisheries and Marine Fisheries.	
		II	Crustacean fisheries- Prawn and crab fisheries. Molluscan fisheries and pearl industries	
		III	Ecology and productivity of ponds, lakes, rivers. Biota and Algal blooms. Planktons types and their role in fish life. Methods of fishing – Fishing efforts, crafts and gears.	
		IV	Artificial aquaculture – Aquarium and aquarium fishes. Fish Transportation and Marketing – Handling and transportation of fresh water fishes. Fishery Education and Management –Central Institute of Fisheries Education (CIFE), Central Inland Captured Fisheries Research Institute (CICFRI), Central Institute of Fresh Water Aquaculture (CIFA), Central Marine Fisheries Research Institute (CMFRI). Fisheries legislation for	

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M.Sc Semester X (II Year)

			resource management.	
<p>(Major 4)</p> <p>*Students will have to opt any one paper from RB051008T OR RB051009T</p>	<p>RB051008T (Ecology and Applied Entomology)</p>	I	<p>Ablotic and Biotic factors influencing insect life:</p> <p>1. Effect of temperature on insect development.</p> <p>2. Insect Parasitism</p> <p>3. Entomophagous insects</p> <p>4. Social life in Termites, bees and Ants</p> <p>5. Parental care</p> <p>6. Myrmecophily and Termitophily</p>	4
		II	<p>1. Insect control by use of Insecticides</p> <p>2. Biological control, Male sterility</p> <p>3. Integrated Pest management (IPM).</p>	
		III	<p>Life history, damage and control of the main pests of: Sugarcane crop, Fruit crops, Cotton crop, Paddy crop, Stored grains.</p>	
		IV	<p>Insect vectors of various diseases like Malaria, Dengue, Filariasis, Kala-azar, Yellow fever, Sleeping sickness, Loa-Loa etc. transmitted to cattles and man & their control measures.</p>	
	<p>RB051009T (Pisciculture and Economic importance of fishes)</p>	I	<p>Introduction to Pisciculture; Cultivable fishes- Characteristics of cultivable fishes, Indigenous and exotic species, Common cultivable fish species; Procurement of stocking material- Collection, Identification and Transport of seed; Induced breeding- Stripping and Hypophysation technique.</p>	
		II	<p>Construction of Fish farm- Selection of site, Arrangement of Fish farm; Maintenance of Fish farm- Control of Aquatic vegetation, Restoration and improvement of pond bottom, liming, Pond fertilization, Control of various physio-chemical factors, Control of predatory and weed fishes, Control of aquatic insects, Artificial feeding, harvesting.</p>	
		III	<p>Special Fish culture- Composite fish culture, culture, Integrated fish culture; Aquarium and aquarium fishes; Fish preservation, processing and pathology- Cause of spoilage and Methods of preservation; Fish diseases and their control.</p>	
		IV	<p>ECOMONIC IMPORTANCE: Economic importance of fish; Nutritive value; Common edible fish; Fish by-product; Larvicidal fish- Indian and exotic, Harmful fish.</p>	
<p>Practical (Major 5)</p>	<p>RB051005P</p>			4
<p>Research Project</p>	<p>RB051006R</p>			4
TOTAL CREDITS				24

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M.Sc Semester X (II Year)

Suggested readings:

Physiology and Embryology of Fishes

1. Singh H.R. : Advances In Fish Biology, Hindustan Publishing Corp., 1994.
2. Kyle: The Biology of Fishes, 2007.
3. Srivastava C.B.L.: Fish Biology, Narendra Publication House, 2008.
4. Khanna S. S. & Singh H.R. A Text Book of Fish Biology & Fisheries, Narendra Publ. House, 2014.

Pisciculture and Economic Importance

- General and Applied Ichthyology: (fish and fisheries) by Gupta S.K. and P. C. Gupta.
Fish and Fisheries by Prof. Kamleshwar Pandey and Dr. J. P. Shukla.
A text book of fish biology by S. S. Khanna.
Introduction to fish technology by J. M. Regenstein and C. E. Regenstein.
Ichthyology by Lagler *et al.*

Insect morphology and anatomy, Insect systematic and Ecology and Applied Entomology

1. The Insects: Structure and Function (5th Edition) by R.F. Chapman.
2. Principles of Insect Morphology by R.E. Snodgrass.
3. Imms' General Textbook of Entomology 10th Ed by O.W Richards and R.G Davies.
4. Insects that Feed on Trees and Shrubs by W. T. Johnson & H. H. Lyon.
5. Modern Entomology by Tembhare.
6. Handbook of Entomology (4th Edition) by T. V. Prasad.
7. Principles of Applied Entomology by K.N. Ragumoorthy, M.R. Srinivasan and V. Balasubramani.
8. Applied Entomology (ICAR - JRF, SRF, ARS, SAUs Entrance Exams) by DS Reddy.

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