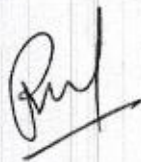


DR RAMMANOHAR LOHIA AVADH UNIVERSITY, AYODHYA

UG/FYUP and PG Programme in Zoology

(Board of Studies of Zoology)

Name of BoS Convenor and Members	Designation	Affiliation
Prof. R. N. Singh	Convenor	Principal, Sant Tulsidas PG College. Kadipur, Sultanpur
Dr Brijesh Kumar Singh	Member	Assistant Professor, Department of Zoology, K S Saket PG College, Ayodhya
Prof. P. P. Manna	Expert	Department of Zoology, BHU Varanasi
Prof. S. K. Srivastava (Retd)	Expert	Department of Zoology, DDU Gorakhpur University, Gorakhpur
Dr Rajiv Kumar Singh	Expert	Principal Scientist, NBFGR, Lucknow

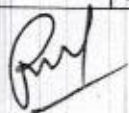


Sunil Kumar Singh

STRUCTURE OF THE SYLLABUS FOR B. Sc. Fourth Year and M. Sc. In ZOOLOGY

EFFECTIVE FROM SESSION: 2025-26

Course Code	Course Type	Course Title	Course Credit	T/P	Evaluation	
					CIE	ETE
A	B	C	D	E	F	G
B. Sc. Semester VII (Fourth Year) / M. Sc. Semester I (First Year)						
	Core	Non-Chordata: General Account	4	T	25	75
	Core	Biochemistry	4	T	25	75
	Core	Principles of Ecology and Wildlife	4	T	25	75
	Elective I (Select any one)	1. Toxicology	4	T	25	75
		2. Ethology	4	T	25	75
	Elective II (Select any one)	1.Practical based on core and First elective	4	P	25	75
		2. Practical based on core and Second elective	4	P	25	75
B. Sc. Semester VII (Fourth Year)/M. Sc. Semester II (First Year)						
	Core	Chordata: General Account	4	T	25	75
	Core	Systematics and Evolution	4	T	25	75
	Core	Animal Physiology	4	T	25	75
	Elective I (Select any one)	Immunology	4	T	25	75
		Endocrinology	4	T	25	75
	Elective II (Select any one)	1.Practical based on core and First elective	4	P	25	75
		2. Practical based on core and Second elective	4	P	25	75
M. Sc. Semester III (Second Year)						
	Core	Histology and Histochemistry	4	T	25	75

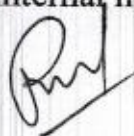


Sunil Kumar Sol

	Core	Developmental Biology	4	T	25	75
	Elective I (Select any one)	1. Morphology, Physiology and Development of Fishes	4	T	25	75
		2. Taxonomy, Morphology and Physiology of Insects	4	T	25	75
	Elective II (Select any one)	1. Practical based on core and First Elective	4	P	25	75
		2. Practical based on core and Second elective	4	P	25	75
	Research Project	Research Project/Dissertation	4	P	50	50
M. Sc. Semester IV (Second Year)						
	Core	Genetics and Molecular Biology	4	T	25	75
	Core	Biological Tools and Techniques	4	T	25	75
	Core	Biostatistics and Bioinformatics	4	T	25	75
	Elective I (Select any one)	1. Applied Ichthyology	4	T	25	75
		2. Applied Entomology	4	T	25	75
	Research Project	Major Research Project/ Dissertation	4	P	50	50

Note: Explanation for Terms used in Columns

1. Column - A to be filled by the University.
2. Column -B defines nature of course/paper. The term 'Core' herein stands for compulsory subject paper. Term 'Elective' refers to a course which is chosen by the student from the two options.
3. Column - C describes the title of the course/ paper.
4. Column- D depicts credits for corresponding course/paper.
5. Column -E, T/P stands for Theory/Practical.
6. Column -F, CIE stands for continuous internal evaluation and depicts the maximum internal marks for the course/paper. Exam to be conducted by the



Sunil Kumar

- subject teacher/ college.
7. Column – G, ETE stands for the end term evaluation or external evaluation and depicts the maximum external marks for the course/paper. ETE to be conducted by the university.
 8. First elective: In each semester it will be a subject elective. Students may select one of the two subject papers under this category.
 9. Second elective: In all four semesters of the program, it will designate a practical paper/course based on core and elective paper.
 10. In Semester III, if a student chooses to study Morphology, Physiology and Development of Fishes, then in Semester IV the student will study Applied Ichthyology. Similarly, if a student chooses to study Taxonomy, Morphology and Physiology of Insects in Semester III, student will have to study Applied Entomology in Semester IV.
 11. In Semester III and IV, every student will carry out a research project and submit its report. Research project may involve survey/field visit/practical/industrial training and will be submitted in writing for evaluation.
 12. Students who opt for 4-year UG Degree (Honors with Research) should drop third paper in Semester VII and VIII and will conduct one research project in each semester. Thus, they will complete their credits by dropping one paper for one project in each semester.



Sumil Kumar Sol

DETAILED SYLLABUS OF ZOOLOGY

B. Sc. SEMESTER VII/M. Sc. (PREVIOUS) SEMESTER I

PAPER-I NON- CHORDATA: GENERAL ACCOUNT

Unit-1: Pranishastra and Bharatvarsh: Ancient Indian texts on Animals, Traditional Indian practices of animal management, veterinary science and conservation, Cultural depiction of Animals in traditional art and festivals, Contributions of Great scholars of Ancient India- Dhanvantari, Chyavan, Charak, Sushrut, Vagbhatta, Jivak, Pal Kapya, Shalihotra, Surpal, and Varahmihir.

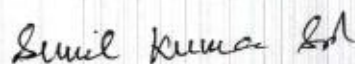
Unit 2: Nutrition and reproduction in Protozoa: Origin of Metazoa, Canal system in Porifera; Polymorphism and Colony formation in Cnidaria; Coral reefs; Parasitic adaptations in Helminths, Larval stages of Trematoda and Cestoda.

Unit 3: Segmental organs in Annelida; Adaptive radiations in Annelida. Organization and affinities of Onychophora; Larval forms in Crustacea; Parasitism in Crustacea; Social life in insects and Mouth parts in insects.

Unit 4: Torsion in gastropods, Larval forms in Echinodermata; Water vascular system in Echinodermata; Affinities of Echinodermata; Brief outlines of the structure and affinities of minor phyla with special reference to Ctenophora, Rotifera, and Phoronida.

Suggested Literature:

1. Advances in invertebrates' reproduction by K.G. Adiyodi and R.G. Adiyodi, Peralam- Kenoth Kerivellur, Kerala.
2. A text book of invertebrates by R L Kotpal, Rastogi Publications, Meerut
3. Invertebrate Zoology by Jordan and Verma, S. Chand Publication New Delhi
4. Invertebrate zoology by Kaestner, Levi & Levi, John Wiley & Sons Inc.
5. Krishi Prasara by Parashara, Asian Agri-History Foundation.
6. Animal husbandry in Ancient India, A T Kumar, R Singh and V Singh, Lambert.
7. Ancient India: R C Majumdar
8. The Invertebrates by L.H. Hymen, McGraw-Hill Book Company.
9. India's contribution to World culture: Sudheer Birodkar
10. Invertebrates Zoology by R.D. Barnes, V Edition. Holt Saunders International edition.



ZOOLOGY

B. Sc. SEMESTER VII / M.Sc. (PREVIOUS) SEMESTER I

PAPER- 2: BIOCHEMISTRY

THEORY

Unit-I: Composition, structure and function of biomolecules (Carbohydrates, lipids, Proteins and Nucleic acids), Structure and function of Hemoglobin; Principles of biophysical chemistry (pH, pK, buffer, Henderson Hasselbalch equation, reaction kinetics and Bioenergetics).

Unit-II: Metabolism: Basic concepts and Design, Glycolysis, Krebs' Cycle, Oxidative phosphorylation, Gluconeogenesis, Glycogen metabolism, Fatty acid metabolism, Protein turnover and Amino acid catabolism, Integration of metabolism.

Unit-III: Catalytic and Regulatory Strategies: Basic concepts of enzymes and enzyme kinetics, Michelis-Menten equation, Mechanism of enzyme action, Enzyme regulation - Allosteric enzymes, isozymes, covalent modification and proteolytic cleavage. Vitamins

Unit-IV: Central Dogma of Information Flow: DNA replication, Transcription and Translation; DNA polymerase and RNA polymerase and Ribosomes.

Suggested Literature:

1. Biochemistry Ninth Ed. by Berg, Tymoczko, Gatto Jr and Stryer, Macmillan
2. Lehninger's Principles of biochemistry by Nelson and Cox W.H. Freeman Company
3. Cell-physiology and Biochemistry by W.D. McElory, Prentice Hall of INDIA Pvt LTD
4. Comparative biochemistry by K.A Munday, Pergmon Press Oxford London
5. Essentials of Biochemistry by Srivastva; Lal; N. Singh, Rekha Publications
6. Essentials of Biological chemistry by Fairley Kil gour, Affiliated east -west Press
7. Harper's Biochemistry by R.K. Murray, D.K Granner, A long medical book.
8. Introduction to biochemistry by J. Awapra, Prentice Hall of INDIA Pvt LTD
9. Fundamentals of Biochemistry by J L Jain et al., S. Chand New Delhi



ZOOLOGY

B. Sc. SEMESTER VII/M.Sc. (PREVIOUS) SEMESTER I

PAPER-III PRINCIPLES OF ECOLOGY AND WILDLIFE:

THEORY

Unit-I: Concept of Ecology and Environment: Abiotic and Biotic factors; Habitat and Niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement. Population Ecology: Characteristics of a population; population growth curves; population regulation; life history strategies (r and K selection); concept of metapopulation.

Unit-II: Community Ecology: Nature of communities; community structure and attributes; levels of species diversity and its measurement; edges and ecotones. Ecological Succession: Types; mechanisms; changes involved in succession; concept of climax.

Unit-III: Ecosystem Ecology: Ecosystem structure; ecosystem function; energy flow and mineral cycling (C, N, P); primary production and decomposition; structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, estuarine). Biogeography: Major terrestrial biomes; biogeographical zones of India.

Unit-IV: Applied Ecology: Environmental pollution; global environmental change; biodiversity: status, monitoring and documentation; major drivers of biodiversity change; biodiversity management approaches. Conservation Biology: Indian case studies on conservation/management strategy (Project Tiger, Biosphere reserves).

Suggested literature:

1. Fundamentals of Ecology Fifth Ed. by Eugene P. Odum and Gray W. Barrett, Cengage
2. What is biodiversity by James Maclaurin and Kim Sterelny, U. Chicago.Edu.
3. Biological Systematics: Principles and Applications 2nd Ed. By Schuh and Brower. Cornell University Press.
4. Phylogenetics: Theory and Practice of Phylogenetic Systematics, 2nd Ed. Wiley,
5. Foundations of Systematics and Biodiversity by Williams and Ebach. 2010. Springer.
6. Biodiversity and Ecosystem Functioning by Shulze and Mooney, Springer Publication.
7. Methods and Practice in biodiversity Conservation by D H worth, Springer publication



ZOOLOGY

B. Sc. SEMESTER VII/M.Sc. (PREVIOUS) SEMESTER I

PAPER IV- ELECTIVE (1) – TOXICOLOGY

THEORY

Unit-1: Toxicology; Introduction, Basic concepts, Types of Toxicants (Heavy metals, Pesticides and Radioactive substances), Exposure of toxicants, Translocation of Toxicants and mechanism of action of Toxicants.

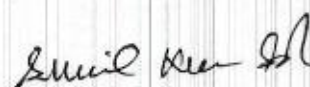
Unit -2: Toxic Action- Acute toxicity, Acute exposure and effect, Dose-Response Relationships, mechanism of acute toxicity- Narcosis, Acetylcholinesterase Inhibition, Ion channel modulators, inhibitors of cellular respiration; chemical carcinogenesis, human carcinogens, mutagenicity assays for identification of carcinogens; Teratogenesis introduction, historical teratogens, critical periods for teratogenesis; Chronic toxicity.

Unit 3: Organ Toxicity- Hepatotoxicity: Types of liver injury- fatty liver, Necrosis, Apoptosis, Cirrhosis, Hepatitis; hepatotoxicants; Nephrotoxicity: Susceptibility of renal system, nephrotoxicants; Respiratory Toxicity-susceptibility of respiratory system, toxic response- Irritation, Cell necrosis, Fibrosis, Emphysema, Endocrine disruptors

Unit-4: Selective Toxicity; Biotransformation, Bioaccumulation and Biomagnification of Xenobiotics; Antidotal Therapy; Toxicity Tests; Biomonitoring of Toxic Chemicals, Bioindicators.

Suggested literature

1. Modern Toxicology - Earnest Hodgson Wiley
2. Toxicology and risk assessment principles. Methods and application by Anna M Fan, Louis W Chang, Marcel Dekker, inc, New York.
3. Concept of Toxicology, Dr. Omkar
4. A Textbook of Modern Toxicology by E. Hodgson Wiley Interscience
5. Casarett & Doull's Essentials of Toxicology -Lange



ZOOLOGY

B. Sc. SEMESTER VII/M.Sc. (PREVIOUS) SEMESTER I

PAPER IV- ELECTIVE (2) – ETHOLOGY

THEORY

Unit I: Introduction and significance of study of Ethology, History and Branches of Ethology, Patterns of behaviour- Instinctive and Learnt, Behavioural Genetics, Evolution of behaviour

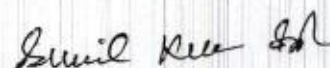
Unit II: Communication and animal signals: Introduction, Auditory communication, Infrasound communication in elephants and whales, Ultrasound communication -Echolocation in Bats, Visual communication- postures and gestures, Bee language, Chemical communication- Pheromones of invertebrates and vertebrates, Functions of scent in vertebrates.

Unit-3: Social Behavior in animals: Introduction, Advantages of being social, Types of social behavior, Altruism, Food sharing, Cooperation and Reciprocation, Eusociality, societies of apes and honey bee. Proximate and Ultimate causes of behavior.

Unit-4: Reproductive behavior in animals; Sexual selection, mating patterns, mating strategies in animals, Territorial behavior, Courtship and Mating Behavior of stickleback and peacock, Parental Care in fishes and amphibians, biological clocks.

Suggested Literature:

1. An Introduction to Animal Behaviour by Manning and MS Dawkins Cambridge University Press, UK.
2. Animal Behaviour by John Alcock, Sinauer Association, INC.
3. Animal Behaviour in the Laboratory by P. Silverman, London. Chapman and Hall.
4. Introduction to Animal Behaviour by Rishikesh and Niraj, Campus Books.
5. Text Book of Animal Behaviour by FB Mann PH learning Pvt Ltd.
6. Animal Behaviour by Reena Mathur, Rastogi Publications, Meerut



ZOOLOGY

B. Sc. SEMESTER VII/M.Sc. SEMESTER I

Semester-I Practical

Time: 6 hours

Exercises

Distribution of Marks:

Dissection	10 Marks
Preparation of Permanent Slide	08 Marks
Biochemistry Exercise	08 Marks
Ecological Exercise	08 Marks
Toxicology/Animal behavior	07 Marks
Spotting (10 spots)	20 Marks
Viva voce	07 Marks
Class records	07 Marks

Total Mark: 100 (25- internal evaluation + 75- external examination)

Museum/ Specimens and Slides of Non – Chordata:

Porifera: Study of museum specimens/models; Lecuosolenia, Sycon, Grantia, Euplectella, Hyalonema, Oscarella, Chondrilla, Cliona, Chalina, Spongilla, Euspongia, Hippospongia.

Cnidaria: Tubularia, Bougainvillia, Pennaria, Hydractinia, Sertularia, Campanularia, Millepora, Stylaster, Physalia, Porpita, Velella, Aurelia, Rhizostoma, Tubipora, Alcyonium, Gorgonia, Corallium, Pennatula, Metridium, Adamsia, Cerianthus, Fungia, Madrepora, Pleurobrachia, Beroe.

Helminths: Convoluta, Dugesia, Bipalium, Fasciola, Paramphistomum, Schistosoma, Taenia, Cysticercus larva, Moniezia, Echinococcus, Trichuris, Trichinella, Heterodera, Enterobius, Ascaris, Ancylostoma, Dracunculus, Wuchereria.

Annelida: Aphrodite, Tomopteris, Glycera, Chaetopterus, Arenicola, Sabella, Amphitrite, Serpula, Tubifex, Branchiobdella, Eisenia, Placobdella, Pontobdella, Branchellion, Polygordius.

Arthropoda: Limulus, Palamnaeus, Lycosa, Apus, Argulus, Balanus, Sacculina, Mysis, Gammarus, Squilla, Prawn, Lobster, True crab, Hermit crab, Julus, Scolopendra, Scutigera, Lepisma, Mantis, Stick insect, Grass hopper, Cicada, Termites, Forficula, Pediculus, Ranatra, Dysdercus, Musca, Lady bird beetle, Butterfly, Wasp, Xenopsylla, life history of honey bee, lac insect and silk moth; Study of prepared slides:

Mollusca: Chiton, Dentalium, Pila, Aplysia, Buccinum, Doris, Lymnaea, Mytilus, Patella,

Pecten, Limax, Pearl oyster, Terebra, Nautilus, Loligo, Sepia, Octopus.

Echinodermata: Astropecten, Asterias, Ophiothrix, Echinus, Clypeaster, Thyone, Holothuria, Antedon; Aristotle's lantern. Hemichordata: Study of museum specimens: Balanoglossus, Cephalodiscus. Minor phyla: Representative specimens of Onychophora (Peripatus), Sipunculida (Sipunculus), Echiurida (Bonellia)

Permanent preparation of Paramecium, Ceratium, Noctiluca, Vorticella, Sponge gemmules, sponging fiber and spicules, Obelia and other hydrozoan colonies and Obelia Medusa; Parapodia, Radula of Pila, Gill lamella of Pila, TS Gill lamina of Unio, Statocyst of prawn. To study the different stages of Mitosis in root tip of onion and Meiosis in grasshopper testis.

Study of Permanent Slides: Paramecium Binary fission and Conjugation, Trypanosoma, Vorticella, Noctiluca, Euglena, Sponge Gemmule, Spicules, Obelia colony, Medusa, Scolex of tape worm, mature and gravid proglottid of tape worm; Study of hydatid cyst, larval stages of Fasciola. Parapodium, T.S. of body of leech, Mouth parts of mosquitoes, house fly, honey bee, butterfly, Sarcophaga, Ixodes, Cimex, Daphnia, Cypris, Cyclops, Pediculus, Pthirus, Nauplius, Zoea, Glochidium larva, Bipinnaria, Ophiopluteus, Tornaria larva

Dissection: Nervous system of Pila, Loligo, Palaemon /Squilla

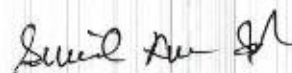
Biochemistry Exercise:

Preparation of model of nucleotide and DNA using wire and beads. Determination of Km Value of an enzyme, Identification of different amino acids in a mixture using paper chromatography, Study of apparatuses/ equipment employed in biochemical analysis – Centrifuge, Spectrophotometer and PCR. Preparation of standard curve using Spectrophotometer, Homogenization and fractionation of cell extract using Centrifuge, Extraction of DNA from any tissue and DNA amplification using PCR, Symptoms of vitamin deficiency

Ecology Exercise:

1. Study of life tables and plotting of survivorship curves of different types from the hypothetical/real data provided
2. Determination of population density in a community by quadrat method and calculation of Shannon-Weiner diversity index for the same community
3. Study of an aquatic ecosystem: Phytoplankton and zooplankton, Measurement of area, temperature, turbidity/penetration of light, determination of pH, and Dissolved Oxygen content (Winkler's method), Chemical Oxygen Demand and free CO₂
4. Study of faunal biodiversity of your campus/locality
5. Report on a visit to National Park/Biodiversity Park/Wild life sanctuary

Toxicology and Ethology: Determination of LC₅₀ of a poison for any fish, Study of effect of ammonia and mercury on rat, Study of common pesticides applied in crop fields, Study of common narcotic drugs, Study of Taxis in Housefly, Study of feeding behavior of any insect, study of types of beaks, feet and nests of birds.



ZOOLOGY

B. Sc. SEMESTER VIII/M.Sc. (PREVIOUS) SEMESTER II

PAPER-I CHORDATEA: GENERAL ACCOUNT

THEORY

Unit-I: Protochordates and Pisces: Origin of Chordata, General characters and classification of chordates, Affinities of Urochordata and Cephalochordata; General Characters and affinities of Cyclostomes; General characters and classification of fishes; Characteristics and affinities of Dipnoi and Coelocanth.

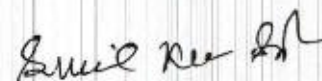
Unit-II: Amphibia: Origin of Tetrapods, Neoteny and Parental care. Reptilia: Origin and Evolution, Adaptive radiation, Dinosaurs, Crocodilia, Poisonous snakes and their venom. Biting Mechanism.

Unit-III: Aves: Origin, General characters and Classification of Birds, Flightless birds, Adaptations for flight, Migration in Birds.

Unit-IV: Mammalia: Origin, General characters and classification of Mammals, Adaptive radiation in Eutheria, Uterus modifications, Aquatic mammals. Dentition in mammals.

Suggested literature:

1. Harvey et al: The Vertebrate Life (2006)
2. Colbert et al: Colbert's Evolution of the Vertebrates: A history of the backboned animals through time (5th ed 2002, Wiley - Liss)
3. Hildebrand: Analysis of Vertebrate Structure (4th ed 1995, John Wiley)
4. Kenneth V. Kardong (2015) Vertebrates: Comparative Anatomy, Function, Evolution McGraw Hill
5. McFarland et al: Vertebrate Life(1979, Macmillan Publishing)
6. Parker and Haswell: Text Book of Zoology, Vol. II (1978, ELBS)
7. Romer and Parsons: The Vertebrate Body (6th ed 1986, CBS Publishing Japan)
8. Young: The life of vertebrates (3rd ed 2006, ELBS/Oxford)
9. Neilsen (2012). Animal Evolution: Interrelationships amongst living Phyla. Oxford



ZOOLOGY

B. Sc. SEMESTER VIII/M.Sc. (PREVIOUS) SEMESTER II

PAPER II- SYSTEMATICS AND EVOLUTION:

THEORY

Unit-I: Historical aspects of systematics; Trends in biosystematics: concepts of different conventional and newer approaches – chemotaxonomy, cytotaxonomy, molecular taxonomy, numerical taxonomy.

Unit-II: Dimensions of speciation and taxonomic characters: Species concepts, species category, subspecies and infraspecific categories, hierarchy of categories, taxonomic and non-taxonomic characters. Concept of lineage: Types and production of additional lineage; Procedures in taxonomy: collection, preservation and identification; Taxonomic keys- their merits and demerits, systematic publications. International code of zoological nomenclature (ICZN) –its operative principles.

Unit III: Basic concept of organic evolution, Evidences of Evolution, Theories of Evolution- Lamarckism and Darwinism, Neo Lamarckism and Neo Darwinism, Post –Darwinian concepts of evolution: Gradualistic vs. Non-gradualistic theories, Mayr's Founder Principle, Gould's punctuated equilibrium theory, Kimura's neutral theory; Adaptation and Speciation.

Unit-IV: Evolution of populations. Genes in population; Mechanisms causing populations to evolve, Hardy Weinberg Law and Sewall Wright effect, Modern synthetic theory of evolution. Micro evolution and Macro evolution, Evolution of Horse, Evolution of Man, Evolutionary Trees.

Suggested Literature:

1. Mielli A: Biology Systematics, Chapmon and Hall
2. Ridley M: Evolution, Blackwell science
3. Briggs et al: Evolution, cold spring Harbor Laboratory press New York, U.S.A.
4. Futuyama DJ: Evolution Sinauer associates inc. USA
5. Kapoor V C: Animal Taxonomy and Biodiversity, 8th Ed., Oxford and IBH Publishing
6. Freeman and Herron: Evolution, Person /prentice hall
7. Mayer et al: Methods and principle of systematic Zoology, McGraw – Hill
8. Felsenstein J: Numerical Taxonomy Springer – Verlag Berlin Heidelberg New York
9. Schenk and Masters: Procedure in Taxonomy Stanford University Press.
10. Rastogi V B: Organic evolution 15th Ed Medtech Science Press



ZOOLOGY

B. Sc. SEMESTER VIII/M.Sc. (PREVIOUS) SEMESTER II

PAPER III - ANIMAL PHYSIOLOGY:

THEORY

Unit-1: Physiology of Digestion and Absorption of Proteins, Carbohydrates, Lipids and Nucleic Acids; Secretion and regulation of various digestive juices. Physiology of Respiration; mechanism and regulation of breathing, gaseous exchange in terrestrial and aquatic animals, Oxygen and Carbon dioxide transport, factors affecting oxygen dissociation and respiratory pigments.

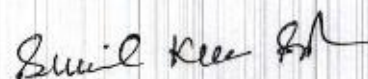
Unit-2: Excretion; Urine formation (Glomerular filtration, Tubular reabsorption and Secretion, Counter current mechanism and Hormonal regulation), Acid-base balance and Homeostasis, Circulation; Blood- Composition, Blood Group and Coagulation; Heart- Structure, Origin and Conduction of heart beat and its regulation, cardiac cycle.

Unit-3: Muscles; Types, ultrastructure, chemistry and molecular mechanism of striated muscle contraction and its regulation. Nervous System- Structure of Neuron and Neuroglial cells, mechanism of conduction and transmission of nerve impulse, Synapse and synaptic transmission.

Unit-4: Thermoregulation; Thermoregulation based animal categories, mechanism of thermoregulation and thermal acclimatization, Physiology of sense organs; Eyes and Ears.

Suggested Literature:

1. Animal Physiology by M. Brown, Apple Academic Press.
2. Animal Physiology by R.C. Sobte, Narosa Publishing House.
3. Animal Physiology by F.R. Haninsworth
4. Comparative Animal Physiology by C.L. Prosser, W.B. Saunders Company.
5. Comparative Physiology of Animal by R. W. Hill; P.D. Sturke.
6. Environmental Physiology of Animals by P. Willmer; G. Stone, Blackwell Science Ltd.
7. General and Comparative Physiology by W.S. Hoar, Prentice Hall of India Pvt. Ltd.
8. Marshall's Physiology of Reproduction by G.E. Lamming, Churchill Livingstone.
9. Neural and Integrative Animal Physiology by C.L. Prosser, Wiley India Pvt. Ltd.
10. Principles of Animal Physiology by J.A. Wilson.



ZOOLOGY

B. Sc. SEMESTER VIII/M.Sc. (PREVIOUS) SEMESTER II

PAPERR IV- ELECTIVE (I): PRINCIPLES OF ENDOCRINOLOGY:

THEORY

Unit-I: Introduction and evolutionary perspective of Endocrinology, Hypothalamus, structure and function, Brain nuclei SON, PVN, POA, Arcuate nucleus. Pituitary gland, structure and function (adenohypophysis, Neurohypophysis, pars intermedia), Hypo and Hyperfunction of Pituitary gland; Thyroid gland, Structure and Function, Biosynthesis of Thyroid hormones, Mechanism of action of Thyroid hormones, Hypo and Hyperfunction of Thyroid; Pancreas: Insulin, glucagon and other secretions.

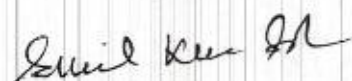
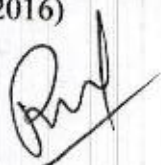
Unit-II: Endocrine regulatory molecules, Chemical classification of hormones, Hormone receptors, Mechanism of hormone action, Neurotransmitters and neuropeptides, Regulatory pathways. Chemical regulation of feeding and digestion.

Unit-III: Neuroendocrine integration; Hypothalamo-hypophysial axis, Feedback mechanisms, Adrenal gland-cellular organization, Catecholamines and General Adaptation Syndrome.

Unit-IV: Endocrine regulation of homeostasis; Hormones and Homeostasis, Electrolytes and water balance (Renin-Angiotensin system), Energy homeostasis, Parathyroid gland, Calcium homeostasis, Endocrine regulation of bone morphogenesis. Hormones of Adrenal cortex.

Suggested literature:

1. Vertebrate Endocrinology: David O. Norris, James A. Carr, 2013, 5th Edition, Academic Press
2. General Endocrinology by Turner C. D., Affiliated East West Press, New Delhi
3. Comparative Vertebrate Endocrinology: P. J. Bentley, 3rd Edition, Cambridge University Press
4. Neuroendocrinology: Charles B. Nemeroff, CRC, US
5. An Introduction to Neuroendocrinology: Richard E. Brown, 2005, Cambridge University Press
6. Endocrinology: Mac E. Hadley, Jon E. Levine, 2009, 6th Edition, Pearson Education
7. Molecular Endocrinology: F. F. Bolander, 3rd Edition, 2004, Elsevier Academic Press
8. Essential Endocrinology: Darville Brook, C.G. & Marshall, Wiley Blackwell
9. Endocrinology at a Glance: Greenstein B, Wiley Blackwell
10. General and Comparative Endocrinology: John B. Allard, Cunming Duan, Intelliz Press LLC (2016)



ZOOLOGY

B. Sc. SEMESTER VIII/M.Sc. (PREVIOUS) SEMESTER II

PAPER IV- ELECTIVE (2)- IMMUNOLOGY:

THEORY

Unit-I: Types of Immunity (Innate, Adaptive, humoral, cell-mediated), Cells of Immune system (B & T lymphocytes, Phagocytes, Granulocytic cells, Mast cells, NK Cells, Dendritic cells), Organs of Immune system- (Primary and secondary lymphoid organs- Thymus, Bone marrow, lymph nodes, spleen, MAST), Generation of B & T cell responses.

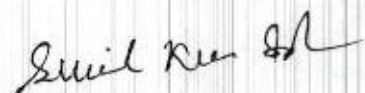
Unit-II: Immunoglobulins (structure, Types/Classes & functions) Epitopes, Maturation differentiation and activation of BCR and TCR. Monoclonal and polyclonal antibodies. Antibody diversity Organization & Expression of Immunoglobulin genes.

Unit-III: Antigen antibody interactions (Agglutination Reactions, Precipitation Reactions, cross reactivity, Antibody affinity and avidity, Immunofluorescence, flow cytometry, Western blotting, Immunoelectron microscopy, RIA, ELISA and it's types.

Unit-IV: Antigen: types, processing & presentation, Major Histocompatibility complex: classes, structure, expression, immune responsiveness, and disease susceptibility (HLA) Complement system-classical, alternative, lectin pathways, Vaccine.

Suggested literature:

1. Thomas J. Kindt, Richard A. Goldsby, Barbara A. Osborne, Janis Kuby (2007) Kuby Immunology. W H Freeman
2. Delves Peter J., Martin Seamus J., Burton Dennis R., Roitt Ivan M. (2017). Roitt's Essential Immunology, 13th Edition. Wiley Blackwell
3. Ian. R. Tizard: Immunology, Saunders college Publishing Chicago, New York.
4. Nandini Shetty (2005) Immunology Introductory Textbook. New Age International.
5. Carlberg and Velleur: Molecular Immunology, Springer International Publishing



ZOOLOGY

B. Sc. SEMESTER VIII/M.Sc. SEMESTER

II

Practical: Time: 6 hours

Exercises

Distribution of Marks:

Dissection	15 marks
Systematics and Evolution	05 marks
Physiology exercise	10 marks
Immunology/ Endocrinology	10 marks
Spotting (10 spots)	20 marks
Viva voce	7 marks
Class records	8 Marks

Total Marks: 100 (25 - internal evaluation + 75- external examination)

Museum / Specimens of Chordata:

Protochordata: Urochordata: Study of museum specimens/whole mount: Oikopleura, Herdmania, Ascidia, Pyrosoma, Doliolum, Salpa.

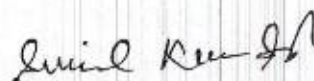
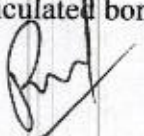
Cephalochordata: Branchiostoma

Cyclostomata: Study of museum specimens /models: Petromyzon, Myxine; Ammocoete larva.

Pisces: Study of museum specimens/ models: Sphyrna (hammer – headed shark), Trygon, (string –rays), Pristis , Raja (skate), Torpedo (electric –rays), Chimaera, Polypterus, Acipenser, Polydon , Amia, Lepidosteus, Hilsa, Harppodon , Notopterus, Labeo, Catla, Cyprinus, Cirrhina, Heteropneustes, Clarias, Wallago, Mystus, Anguilla, Exoceteus, Hippocampus, Channa, Amphipnous, Anabas, Synaptura, Echeneis, Neoceratodus, Protopterus, Lepidosiren; Study of disarticulated bone of carp.

Amphibia: Study of museum specimen /models: Ichthyophis, Uraeotyphlus, Cryptobranchus, Ambystoma, Axolotl, larva, Salamandra, Amphiuma, Triturus, Proteus, Necturus, Siren, Alyles, Bufo, Hyla, Rhacophorus, study of disarticulated bone of frog.

Reptilia: Study of museum specimen/models chelone, Sphenodon, Hemidactylus, Calotes, Draco, Phrynosoma, Iguana, Heloderma, Varanus, Ophisarus, Typhlops, Python, Natrix, Ptyas, Dendrophis, Bungarus, Naja, Russelle's viper, Pit viper, Hydrophis, Crotalus, Crocodilus, Alligator, Gavialis, Ichthyosarus, Dimentron, Brontosarus, Tyranosarus, Stegosarus, study of disarticulated bones of Varanus



Aves: Study of museum specimens /models: Archaeopteryx, Milvus (kite), Gyps (vulture), Pavo(peacock), Columba (pigeon), Eudynamys (koel), Psittacula (parrot), Bubo (owl), Coracias (nilkanth), Dinopium (Woodpecker), House sparrow, Corvus (crow); study of disarticulated bones of fowl.

Mammals: study of museum specimens / models: Echidna, Ornithorhynchus, Macropus, Erinaceus, Shrew, Pteropus, Bat, Loris, Manis, Hystrix, Funambulus, Rattus, Oryctolagus, Lepus, Herpestes, Lutra, (otter), Civet cat, Macaca, study of disarticulated bones of Rabbit.

Physiology Exercises: Bleeding and clotting time, Preparation of Haemin crystals, Determination of Haemoglobin percentage, Total count of Leucocytes, Erythrocytes, Differential Leucocyte Count, Blood group determination.

Systematics and Evolution: Zoological names of animals, study of fossils and models of extinct animals, study of Geological time scale through charts, Calculation of gene and genotype frequencies

Dissection: General Anatomy and cranial nerves of Labeo/Wallago and

General anatomy and Neck nerves of Rat, Oral hood and Velum of Branchiostoma (Ex situ)

Second Semester ELECTIVE (1)-: Immunology lab: Examination of Peripheral blood smears for blood cells, demonstration of Western Blot Analysis and ELISA, Immunofluorescence staining of B and T Cells. Study of Vaccination chart for infants.

Second Semester: ELECTIVE (2)- Endocrinology lab:

1. Dissection and display of Endocrine glands in laboratory bred rat*
2. Study of the permanent slides of all the endocrine glands
3. Demonstration of Castration/ ovariectomy in laboratory bred rat*
4. Estimation of plasma level of any hormone using ELISA kit



ZOOLOGY

M.Sc. (FINAL) SEMESTER III

PAPER I- HISTOLOGY AND HISTOCHEMISTRY:

THEORY

Unit-I: Fixation and Fixatives. Types of fixatives. Chemistry of fixation. Choice of Fixatives. Tissue processing. Dehydration. Clearing and embedding.

Unit-II: Microtomy. Types of microtomes. Sectioning paraffin blocks. Staining of paraffin sections. Principle and methods of staining. Histological stains. Haematoxylin and Eosin.

Unit-III: Principles and methods of histochemical localization and identification of the following: Carbohydrate moieties Glycogen and glycoproteins with oxidizable vicinal diols by Periodic acid Schiff method Glycoproteins with carboxyl groups and/or O-sulphate esters by Alcian blue methods, Protein end groups General proteins by Bromophenol blue method-NH₂ groups by Ninhydrin-Schiff method - SS groups by Performic acid -Schiff and performic acid- alcian blue methods

Unit-IV: Principles and methods of histochemical localization and identification of the following: Lipid moieties General lipids by Sudan black B method Neutral lipids by total Sudan III and Sudan IV methods Nucleic acids Methyl green pyronin for DNA and RNA Feulgen reaction for DNA Enzymes: Acid and alkaline phosphatases by Metal precipitation and Azo dye methods. Immunocytochemistry: Basic principles. Fluorescence histochemistry: Basic principles.

Suggested literature:

1. Bancroft, J.D. & Stevens, A. Theory and Practice of Histological techniques, Churchill Livingstone, 2002
2. Casselman, W. G. B: Histochemical techniques, John Wiley, 1959
3. Pearse A.G.E.: Histochemistry; Theoretical and Applied (Vol. I, II & III), (4th ed.), Churchill Livingstone
4. Prabhu and Shagirtha: Tools and Techniques in life Sciences, Lambert Academic Publishing
5. Kingsbury B. F: Histological technique- A Guide for use in a Laboratory course in Histology
6. Mondal S K: Manual of histological techniques, Publisher- Jaypee Brothers Medical
7. Wilson and Walker: Principles and techniques of Biochemistry and molecular Biology



ZOOLOGY

M.Sc. (FINAL) SEMESTER III

PAPER-II DEVELOPMENTAL BIOLOGY:

THEORY

Unit-I: Basic concepts of development: Potency, commitment, specification, competence, Induction, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; mutants and transgenics in analysis of development.

Unit-II: Gametogenesis, fertilization and early development: Production of gametes, cell surface molecules in sperm-egg recognition in animals; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals.

Unit-III: Morphogenesis and organogenesis in animals: Axes and pattern formation in *Drosophila*, amphibia and chick; Organogenesis – vulva formation in *Caenorhabditis elegans*, eye lens induction, limb development; differentiation of neurons, Environmental regulation of normal development; sex determination.

Unit-IV: Post embryonic development- regeneration in vertebrates, metamorphosis in insects and amphibia; Programmed cell death, aging and senescence

Suggested literature:

1. Developmental Biology: T. Subramaniam, (Reprint) 2013, Narosa Publishing House Pvt. Ltd., New Delhi
2. Essential Developmental Biology: Jonathan M. W. Slack, (3rd ed.) 2012, Wiley-Blackwell.
3. Developmental Biology: From a Cell to an Organism (Genetics & Evolution) eBook: Russ Hodge, 2009, Infobase Publishing.
4. Current Topics in Developmental Biology: Roger A. Pedersen, Gerald P. Schatten, 1998 Elsevier.
5. Developmental biology: Werner A. Müller, 2012, Springer Science & Business Media.
6. Human Embryology and Developmental Biology E-Book: Bruce M. Carlson, 2018, Elsevier Health Sciences.
7. Developmental Biology: Michael J. F. Barresi, Scott F. Gilbert, 2019, Oxford University Press.



ZOOLOGY

M.Sc. (FINAL) SEMESTER III

PAPER III- ELECTIVE (I):

MORPHOLOGY, PHYSIOLOGY & DEVELOPMENT OF FISHES:

THEORY

Unit-I: Outlines of functional morphology (origin of paired fins, air bladder, webberian ossicles, sound and electric organs, lateral line system).

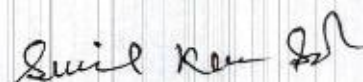
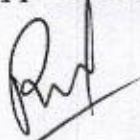
Unit-II: Physiology of digestion, respiration, excretion, osmoregulation and reproduction (gonads, role of hypothalamo-hypophysial hormones in reproduction).

Unit-III: Trends in the classification of Fishes (Evolutionary and Genealogical) Systematics and bionomics of at least one important fish from following fish orders (with particular reference of Uttar Pradesh): Beloniformes, Clupeiformes, Mastacembeliformes, Mugiliformes, Cypriniformes (Cyprini and Siluri), Ophiocephaliformes, Perciformes

Unit- IV: Breeding Techniques: Bundh breeding: Types of bundhs: a) dry bundhs b) Wet bundhs c) Modern bundhs Artificial fertilization by stripping, Induced breeding by hypophysation: Definition, Hormones responsible for induced breeding, Dissection and removal of pituitary gland, Preservation and storage of pituitary gland, Preparation of gland suspension for injection and dosage. Collection, rearing and selection of brooders, Synthetic hormones used in induced breeding.

Suggested literature:

1. Datta-Munshi & Hughes: Air-breathing fishes of India (1992, Oxford and IBH)
2. Evans: The Physiology of Fishes (2006, CRC Press)
3. Hoar & Randall: Fish Physiology, Series Vol. I - XIV (1979-2006, Academic Press)
4. Jhingran: Fish and Fisheries of India (1985, Hindustan Publishing Corporation)
5. Khanna and Singh: Textbook of Fish Biology and Fisheries (2003, Narendra Publishing House)
6. Lagler et al.: Ichthyology (2003, John Wiley)
7. Srivastava: Fishes of U.P. and Bihar (2002, Vishwavidyalaya Prakashan)
8. Pillar Aquaculture: Principles and Practices: Fishing News Books: (2005, First Indian reprint)
9. Gupta and Gupta: General and applied Ichthyology (Fish and Fisheries) (2006, Chand)



ZOOLOGY

M.Sc. (FINAL) SEMESTER III

PAPER III- ELECTIVE (2):

TAXONOMY, MORPHOLOGY AND PHYSIOLOGY OF INSECTS THEORY

Unit-I: Study of the morphology, development, metamorphosis and evolution of insects.

Unit-II: Physiology of digestion, excretion; metamorphosis and diapause including endocrine aspects.

Unit-III: An outline classification of insects; characters and identification of the economically important families. Social insects and Insect hormones.

Unit-IV: The distribution and bionomics of the following order: Thysanura, Orthoptera, Diptera, Isoptera, Mallophaga, Hemiptera, Dictyoptera, Thysanoptera, Lepidoptera, Hymenoptera and Coleoptera.

Suggested literature:

1. Chapman: The Insects: structure and function (4th ed, 1998, ELBS)
2. Imms: A general text book of Entomology, 2 vols (1997, Asia Publishing House)
3. McGavin: Essential Entomology (2001, Oxford Univ Press)
4. Srivastava: A text book of applied Entomology, Vol I & II, Kalyani Publishers.
5. Wigglesworth: Principles of Insect Physiology (1972, ELBS)
6. Gullan and Cranston: The Insects: An outline of entomology (5th ed, 2014, Wiley Blackwell)



ZOOLOGY

M.Sc. (FINAL) SEMESTER III

Practical: Time: 6 hours

Exercises	Distribution of Marks:
Dissection	15 marks
Histology	10 marks
Developmental Biology	05 marks
Fishery/ Entomology	10 marks
Spotting (10 spots)	20 marks
Viva voce	7 marks
Class records	8 Marks

Total Marks: 100 (25- internal evaluation + 75- external examination)

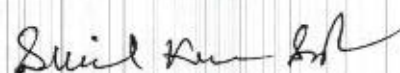
HISTOLOGY AND HISTOCHEMISTRY LAB: Microtomy and staining: Hematoxylin-eosin – Demonstration, Histopathology: Study of histopathological changes (permanent slides) – gastric ulcers, cirrhosis of liver, breast tumors, cystic follicles of ovary, pancreas in diabetics, cryptorchid testis and leukemia. Histochemistry: Histochemical localization of glycogen in rat/mouse liver by Bauer Feulgen technique. To study different cell types such as buccal epithelial cells, neurons, striated muscle cells using Methylene blue.

DEVELOPMENTAL BIOLOGY PRACTICALS

1. Study of whole mounts and sections of developmental stages of frog through permanent slides: Cleavage stages, blastula, gastrula, neurula, tail-bud stage, tadpole (external and internal gill stages)
2. Study of whole mounts of developmental stages of chick through permanent slides: Primitive streak (13 and 18 hours), 21, 24, 28, 33, 36, 48, 72, and 96 hours of incubation (Hamilton and Hamburger stages)
3. Study of the developmental stages and life cycle of *Drosophila* from stock culture
4. Study of different sections of placenta (photomicrograph/ slides)
5. Project report on *Drosophila* culture/chick embryo development

ELECTIVE (I)- Practical lab: FISH AND FISHERIES

1. Morphometric and meristic characters of fishes
2. Study of *Petromyzon*, *Myxine*, *Pristis*, *Chimaera*, *Exocoetus*, *Hippocampus*, *Gambusia*, *Labeo*, *Heteropneustes*, *Anabas*
3. Study of different types of scales (through permanent slides/ photographs).
4. Study of crafts and gears used in Fisheries
5. Study of air breathing organs in *Channa*, *Heteropneustes*, *Anabas* and *Clarias*

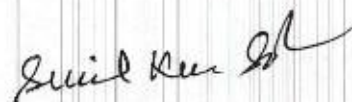


6. Demonstration of induced breeding in Fishes (video)
7. Demonstration of parental care in fishes (video)
8. Project Report on a visit to any fish farm/ pisciculture unit/Zebrafish rearing Lab.

Dissection of Cranial nerve, Weberian ossicles, air bladder, and accessory respiratory organ of fishes.

ELECTIVE (2)- Practical lab: ENTOMOLOGY

1. Study of one specimen from each insect order
 2. Study of different kinds of antennae, legs and mouth parts of insects
 3. Study of head and sclerites of any one insect
 4. Study of insect wings and their venation.
 5. Study of insect spiracles
 6. Methodology of collection, preservation and identification of insects.
 7. Morphological studies of various castes of *Apis*, *Camponotus* and *Odontotermes*
 8. Study of any three insect pests and their damages
 9. Study of any three beneficial insects and their products
- Field study of insects and submission of a project report on the insect Biodiversity.
 Dissection of Sting apparatus of Honey bee, Reproductive system of Scorpion,
 Nervous system of cockroach and Grasshopper

ZOOLOGY

M.Sc. (FINAL) SEMESTER IV

PAPER-1: GENETICS AND MOLECULAR BIOLOGY

THEORY

Unit-I: Mendelian principles: Dominance, segregation, independent assortment. Concept of gene: Allele, multiple alleles, Pseudoalleles, complementation tests, Extensions of Mendelian principles: Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy, linkage and crossing over, sex linkage, sex limited and sex influenced characters.

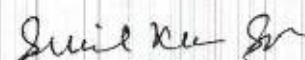
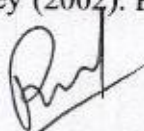
Unit-II: Gene mapping methods: Linkage maps, tetrad analysis, mapping with molecular markers, mapping using somatic cell hybrids. Extra chromosomal inheritance: Inheritance of Mitochondrial and chloroplast genes. Human genetics: Pedigree analysis, Lod score for linkage testing, karyotypes, genetic disorders. Quantitative genetics: Polygenic inheritance, heritability and its measurements, QTL mapping. Mutation: Types, causes and detection, Structural and numerical aberrations of chromosomes.

Unit-III: DNA replication, repair and recombination (Unit of replication, enzymes involved, replication origin and replication fork, fidelity of replication, extrachromosomal replicons, DNA damage and repair mechanisms, homologous and site-specific recombination). RNA synthesis machinery (transcription factors, formation of initiation complex, transcription activator and repressor), RNA processing (Capping, elongation, and termination, RNA editing, splicing, and polyadenylation), Structure and function of different types of RNA and RNA transport.

Unit-IV: Protein synthesis and processing (Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code, aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, and translational proof-reading, translational inhibitors, Post-translational modification of proteins). Control of gene expression (regulating the expression of phages, viruses, prokaryotic and eukaryotic genes, role of chromatin in gene expression and gene silencing).

Suggested literature:

1. Concepts of Genetics by William Klug, Pearson
2. Fundamental of human genetics by Sanjay Madsal, New Central Book Agency, Londo
3. Genetics by P.K Gupta, Rastogi publication
4. Genetics by E. Conrad, Apple academics press
5. Modern Genetics Analysis: Integrating genes and genome, by Griffiths et al., W.H. freeman and company, New York, USA
6. Genes by Lewin, Jones and Bartlen Publishers, Boston, USA
7. Molecular Cell Biology: Lodish et al, Freeman & Co, USA (2004).
8. Molecular Biology of the Cell: Alberts et al Garland (2002).
9. Karp: Cell and Molecular Biology: Wiley (2002). Pierce B. Genetics. Freeman (2004).



ZOOLOGY

M.Sc. (FINAL) SEMESTER IV

PAPER-II BIOLOGICAL TOOLS AND TECHNIQUES

THEORY

Unit-1: Centrifugation; Principle, types and Applications; Principle and Uses of analytical instruments; Flame photometry and Spectrophotometry.

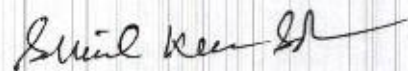
Unit-2: Separation and identification of biomolecules by Chromatography: Paper and thin layer Chromatography, Gel exclusion Chromatography, High performance Liquid Chromatography (HPLC), Affinity Chromatography.

Unit-3: Electrophoresis techniques: General principles, Support media; Electrophoresis of proteins and nucleic acid; capillary Electrophoresis, Principles of differential and density centrifugation.

Unit-4: Recombinant DNA techniques; Restriction Enzymes, Cloning Vectors, Preparation and Screening of cDNA and Genomic DNA libraries, Southern and Northern Hybridization, PCR; Principles and Applications. Detection of Proteins, DNA-Protein and Protein-Protein interaction; Western Blotting, DNA Foot Printing, EMSA.

Suggested Literature:

1. Essential Laboratory Techniques by S.R. Gallagher, E.A. Wiley.
2. An introduction to Practical Biochemistry by D.T. Plummer.
3. Bio Instrumentation: Tools and Techniques by Baig and Sinha, IIP International publishers
4. Tools and Techniques in Modern Biological Sciences, S Mukherjee, Lambert
5. Recombinant Protein Expression in Mammalian cells, Methods and protocols by D L Hacker, Humana Press
6. PCR Methods and Protocols, L. Domingues, Humana Press
7. Biotechnology by Satyanarayana and Chakrapani, Books and Allied Ltd
8. Principles and Techniques of Biochemistry and Molecular Biology, 6th Edition by Keith Wilson and John Walker, Cambridge University Press.
9. Light Microscopy in Biology: A practical Approach, 2nd Edition by Alan J. Lacey, Oxford University Press.
10. Electron Microscopy: Principles and Techniques of Biologist by John J. Bozzola, Lonnie D. Russell, Jones & Bartlett Publ.



ZOOLOGY

M.Sc. (FINAL) SEMESTER IV

PAPER III- BIOSTATISTICS AND BIOINFORMATICS

THEORY

Unit-1: Biostatistics Introduction, Descriptive and Inferential statistics, Types of data, Sampling technique: methods of sampling, choices of sampling methods, sampling and non-sampling errors: tabulation and graphic representation of data; Frequency distribution, tabulation, bar diagram, histogram, pie diagram; Measures of Central tendency; Mean, Median, Mode,

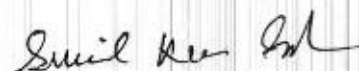
Unit-2: Measures of dispersion: variance and standard variation, coefficient of variation, ANOVA, measures of skewness, coefficient of skewness, kurtosis; probability: theorems on probability, application of permutation and combination, Test of significance-t, F, Chi-square test; Correlation and Linear Regression.

Unit-3: Bioinformatics; Introduction and scope of Bioinformatics, Archiving and retrieval of information; Search engines, databases (Nucleic acid sequences, genomes, protein sequence and structure, bibliographic), Access to molecular biology databases {Entrez, Sequence retrieval system (SRS), Protein identification resource (PRI)}, Sequence alignment and Phylogenetic tree.

Unit-4: Basic components of computer- hardware (CPU, input, output, storage devices), software (operating systems). Application software: Introduction to MSWORD word processor- editing, copying, moving, formatting, table insertion, drawing flowcharts, etc., Introduction to PowerPoint, image and data handling. Introduction to M S EXCEL use of worksheet to enter data, edit data, copy data, move data; use of inbuilt statistical functions for computation of mean, S.D., correlation and regression, graphical tools in excel for presentation of data.

Suggested literature:

1. Biostatistical Analysis Fifth ed. Jerrold H Zar, Pearson
2. Biostatistics by P N Arora and P.K Malhan, Himalaya publishing house
3. Principles of Biostatistics by Pagano M. Gauvreau, K (2000), Duxbury press, USA
4. Fundamental of Biostatics by I A Khan and A Khanam, Ukaaz publication, Hyderabad
5. Barnes & Grey (ed): Bioinformatics for geneticists, Wiley (2003)
6. Lesk: Bioinformatics, Oxford (2003, Indian ed)
7. Westhead et al: Bioinformatics Instant Notes, Viva Books (2003, Indian ed)



ZOOLOGY

M.Sc. (FINAL) SEMESTER IV

PAPER IV: ELECTIVE (1): APPLIED ICHTHYOLOGY

THEORY

Unit-I: Cold water, Estuarine and Marine Fisheries of India, Fish farming in India: Type of fish farming, Fish ponds, Physico-chemical and biological characteristics of Ponds, Manuring and fertilization of fish ponds, Control of weed and Predators.

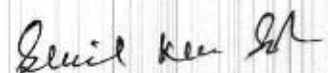
Unit-II: Fish seed production and management: Induced Breeding; Hatcheries, Spawning, collection, rearing, stocking, and transport of fish.

Unit-III: Methods of Fishing, Fishing Gears & Crafts with particular reference to Uttar Pradesh, Important Exotic fishes; Larvivorous fishes and Public Health; Fish as food and fish by products; Diseases of food fishes.

Unit-IV: Principles and methods of Fish Preservations: Traditional and advanced methods of fish preservation- sun- drying, salt drying, pickling, smoking, chilling, freezing, canning etc., Invasive fish species and their impact on indigenous fishes. Aquarium fishes and their maintenance.

Suggested Literature:

1. Hall: Ponds and Fish Culture (1994, Agro Botanical Publishers)
2. Khanna and Singh: Textbook of Fish Biology and Fisheries (2003, Narendra Publishing House)
3. Lagler, Bardach, Miller and May Passino: Ichthyology (2003, John Wiley)
4. Nilsson & Holmgren: Fish Physiology Recent Advances (1986, Croom Helm)
5. Singh: Advances in Fish Research, Vol. I and II (1993 and 1997, Narendra Publishing House)
6. Srivastava: A Textbook of Fishery Science and Indian Fisheries (1985, Kitab Mahal)
7. Pillay: Aquaculture; Principles and Practices: Fishing News Books; (2005, First Indian reprint)



ZOOLOGY

M.Sc. (FINAL) SEMESTER IV

PAPER IV- ELECTIVE (2): APPLIED ENTOMOLOGY

THEORY

Unit-I: Principles and methods of different types of insect control with special reference to cultural, biological and chemical control. Fundamentals of chemistry, properties, formulation of insecticides; brief description of appliances employed.

Unit-II: Mode of action of insecticides and physiology of insect resistance to insecticide. Some economically important pests with particular reference to biology and control of the following: Pests of food grain and food products: *Sitophilus oryzae*, *Rhizopertha dominica*, *Trogoderma*, *Tribolium castaneum*, *Callosobruchus chinensis*, *Sitotraga cerealella*, *Coreyra cephalonica*. Pests of cotton: *Dysdercus koenigii*, *Pectinophora gossypiella*, Pests of sugarcane: *Pyrilla perpusilla*, *Tryporhiza nivella*, Pests of crops yielding cereal products: *Leptocorisa varicornis*, Locust, Pests of oilseed, fruits and vegetables: *Aulacophora foveicollis*, *Bagrada picta*, *Idiocerus atkinsoni*.

Unit- III: Ecological factors governing insect development and metamorphosis. Bee keeping, Lac and Silk industry in India. Plant protection and extension entomology in India.

Unit IV: Pests of Public importance and their control- Mosquito, house fly, bed bug, lice, Fleas, Insect borne diseases of man- Typhus, yellow fever, dengue, encephalitis, plague, Leishmaniasis, Sleeping sickness, Malaria, Filariasis, Insect venom and allergens, Insect succession on corpse, Determination of time of Death.

Suggested Literature:

1. David and Ramamurthy: Elements of Economic Entomology (6th ed.), Namrutha, 2011
2. Gullan & Cranston, The Insects: An Outline of Entomology (5th ed.) Wiley Blackwell, 2014
3. Imms: A General Text Book of Entomology (2 vols.), Asia Publishing House, 1997
4. Ishaaya and Degheele: Insecticides with novel modes of action: Mechanism and Application Springer-verlag, 1998
5. Ishaaya: Biochemical sites of insecticide action and resistance Springer-Verlag, 2001
6. Norris et al: Concepts in Integrated Pest Management, Prentice-Hall, 2002

RESEARCH PROJECT/ DISSERTATION

