NEW AND REVISED SYLLABUS

M. Sc. (Previous)

ZOOLOGY

2019-2020

Syllabus will comprise of five theory papers and two Practical.

Each theory paper and practical will be of 100 Marks.

Paper I- NON-CHORDATA, ANIMAL TAXONOMY AND BIOINFORMATICS

Section A: Non-Chordata

Salient features, outline classification and economic significance of non-chordates;

Protozoa- Parasitism in Protozoa

- Porifera- Canal system
- Coelenterata- Polymorphism in Siphonophora
- Helminths- Parasitic adaptation
- Annelida- Adaptive radiation in Polychaeta, Trochophore larva and its significance
- Arthropoda- Evolutionary significance of Trilobites, Biology of following harmful insects:

  Lepisma, Tribolium, House fly and Mosquito
- Mollusca- Nervous system, Pearl culture
- Echinodermata- Larval forms and their significance
- Salient features and affinities- Rotifera, Hemichordata

Section B: Animal Taxonomy & Bioinformatics

(i) Animal Taxonomy

- Basic principles of systematics,
- Binomial Nomenclature
- Methods of classification- Evolutionary, Phenetic, Cladistic, Construction of Cladogram
- Concept of Species and Speciation

(ii) Bioinformatics

- Introduction and scope of Bioinformatics: Concept of digital laboratory
- Basics of information technology, computer, Operating System, network
- Concept of internet protocol (TCP/IP), hypertext, home page, webpage and uniform resource locators (URL)
- Application of bioinformatics: Clinical informatics

Books Recommended

Non Chordata

1. Barnes: Invertebrate Zoology (4th ed 1980, Holt Saunders International)
2. Barnes: The Invertebrates – A Synthesis (3rd ed 2001, Blackwell)
3. Hunter : Life of Invertebrates (1979, Collier Macmillan)
4. Marshall: Parker & Hashwell Textbook of Zoology, Vol I (7th ed 1972, Macmillan)
5. Moore : An Introduction to the Invertebrates (2001, Cambridge University Press)

Animal Taxonomy:

1. Simpson: Principles of Animal Taxonomy
2. Mayer: Principles of Systematic Zoology
3. Kapoor: Principles and Practices of Animal Taxonomy
4. Goto: Animal Taxonomy

BIOINFORMATICS:

1 Lesk: Bioinformatics (2nd ed 2006, Oxford)

2. Westhead et al: Bioinformatics Instant Notes (Indian ed 2003, Viva Books)

3. Mount: Bioinformatics (2nd ed 2006, CBS)

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Paper II- ENVIRONMENTAL BIOLOGY AND ~~TAXONOMY & BIOINFORMATICS~~ EVOLUTION

Section A: ENVIRONMENTAL BIOLOGY & ~~EVOLUTION~~

- Concept of Ecosystem and Energy flow
- Population dynamics: Population characteristics, growth forms, r and k selection, carrying capacity
- Community dynamics: Community structure and Attributes, levels of species diversity and its measurement, and species interaction
- Biogeography: Major terrestrial biomes, Bio-geographical zones of India their major vertebrate fauna
- Ecological succession: Types, mechanisms and concept of climax
- Human impact on the environment and sustainable development
- Conservation biology: Principles of conservation, Major approaches to wild life management, Indian case studies on conservation (Project Tiger, Biosphere reserves)

Section B- EVOLUTION

- Theories of evolution
- Population genetics
- Gene frequencies in Mendelian population
- Hardy-Weinberg equilibrium
- Conditions for the maintenance of genetic equilibrium
- Elemental forces of evolution:

  Mutation, Selection, Random genetic drift, Migration
- Modes of speciation
- Isolating mechanisms
- Evolution at molecular level: Concept of Neutral Evolution, Genomic and Proteomic changes, Molecular Clock and Molecular phylogeny

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Books Recommended:

ENVIRONMENTAL BIOLOGY

1. Cunningham and Saigo: Environmental Science (5th Ed., McGraw Hill, 1999).
2. Odum : Fundamentals of Ecology (Saunders, 1971).
3. Odum and Barett: Fundamentals of Ecology (EWP, 2005).
4. Primark: A Primer of Conservation Biology (2nd Ed., Sinauer, 2004).
5. Raven, Berg, Johnson: Environment (Saunders. 1993).
6. Mayr: Animal Species and Evolution (1966, Belknap Press)

Evolution

1. Dobzhansky: Genetics and the Origin of Species (1964, Columbia)
2. Dobzhansky: Evolution (1976, Surjeet Publ).
3. Futuyma: Evolutionary Biology (2005, Sinauer)
4. Graur and Li: Fundamentals of Molecular Evolution (2000, Sinauer)
5. Hall and Hallgrimsson: Strickberger's Evolution (2008, Jones and Bartlet)
6. Hartl and Clark: Principles of Population Genetics (1989 & 1997, Sinauer)
7. Hedrick: Genetics of populations (2005, Jones and Bartlett Publ Inc)
8. Kimura: The Neutral Theory of Molecular Evolution (1983, Cambridge)
9. Nei and Kumar: Molecular Evolution and Phylogenetics (2000, Oxford Univ)
10. White: Modes of Speciation (1978, Freeman)

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Paper III- BIOCHEMISTRY AND MOLECULAR BIOLOGY

- Biochemical composition of cytoplasm.
- pH, Buffers in biological systems, Henderson-Hasselbalch equation
- Carbohydrates: Structure, Classification and Properties
- Lipids: Structure, Classification and Beta oxidation
- Proteins : Structure and classification of Amino acids, Peptide linkage, Levels of structural organization of proteins, Determination of Primary structure, Protein degradation
- Enzymes: Nomenclature and classification, Mechanism of Action, Chemical catalysis (Chymotrypasin), Enzyme kinetics, Michaelis - Menten equation, Regulation of Enzyme activity- Feedback, Allosterism, Covalent modification, Enzyme inhibition, Isozymes.
- Bioenergetics: Glycolysis, Krebs' cycle, Oxidative phosphorylation, Chemiosmotic theory
- Nucleic acids: DNA- Structure, Types, supercoiling and Replication; RNA- Structure, Types, Transcription, Processing of hn RNA (Capping, Poly A tailing and Splicing)
- Genetic code and Protein synthesis
- Control of Gene Expression: Regulation of gene expression in prokaryotes and eukaryotes, Role of chromatin in regulating gene expression and gene silencing

Books Recommended

1. Boyer: Concepts in Biochemistry (3rd ed. 2006, Brooks/ Cole)
2. Lehninger, Nelson & Cox: Principles of Biochemistry (4th ed, 2007, Worth),
3. Berg et al: Biochemistry (6th ed 2007, Freeman)
4. Mathews et al: Biochemistry (6th Ed. 2006, Pearson)
5. Zubay et al: Principles in Biochemistry (2nd ed 1998, WCB)
6. Rawn: Biochemistry (1989, Neil Patterson)
7. Lodish et al: Molecular Cell Biology (6th ed. 2007, Freeman)
8. Stryer: Biochemistry (6th ed. 2006, Freeman)

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Paper IV- CELL BIOLOGY AND GENETICS

(I) Cell Biology

- Introduction to Prokaryotic and Eukaryotic cells
- Cell Membrane: Organization and dynamics of transport
- Cytoskeleton: Structural organization and function
- Cell organelles: Mitochondria, Golgi body, Lysosome, Endoplasmic reticulum
- Protein sorting and their transport
- Cell Signaling: Signaling through G-protein coupled receptors, Signal transduction pathways, Regulation of signalling pathways
- Cell cycle and its regulation
- Cancer: Types, Oncogenes, Tumor suppressor genes, cancer and cell cycle, Metastasis

(II) GENETICS

- Eukaryotic chromatin structure and chromosome organization
- Mendelian Principles of Inheritance
- Concept of Gene: Allele, Multiple allele, Pseudoallele
- Extensions of Mendelian Principles: Codominance, Incomplete dominance, Gene Interactions, Pleiotropy, Genomic imprinting, Penetrance, Expressivity, Phenocopy, Sex Linkage
- Gene Mapping Methods: Linkage maps and Tetrad analysis
- Human Genetics: Pedigree analysis, LOD score for Linkage testing, Karyotypes, Genetic disorders including chromosomal anomalies
- Recombination: Homologous and non homologous recombination

Books Recommended

1. Alberts et al: Molecular Biology of the Cell (2008, Garland)
2. Bostock & Sumner: Eukaryotic Chromosome (1987, North-Holland)
3. Cassimeris et al: Lewin's Cells (2011, Jones Bartlet)
4. Gardner et al: Principles of Genetics (2006, John Wiley)
5. Griffith et al: Modern Genetic Analysis (2008, Freeman)
6. Hartl & Jones: Essential Genetics: A Genomic perspective (2009, Jones & Bartlet)
7. Karp: Cell and Molecular Biology (2010, John Wiley & Sons)

Paper V- MAMMALIAN PHYSIOLOGY AND ENDOCRINOLOGY

- Homeostasis
- Nerves: Organization of nervous system, Neurons and Glia, Axonal and Synaptic transmission (Membrane potential, Action potential, impulse transmission, synapse, neurotransmitters)
- Muscles: Types, Ultrastructure, muscle proteins, mechanism of muscle contraction, Muscle fatigue
- Nutrition: Digestion and absorption of macronutrients, Hormonal and neural regulation of intestinal functions
- Respiration: Breathing and its Regulation, Respiratory pigments, Transport of respiratory gases
- Excretion: Structure of Nephron, Urine formation and its regulation, Acid base balance
- Circulation: Structure of Heart, Cardiac cycle
- Endocrinology: Mechanism of hormone action, Hypothalamo-hypophysial system
- Endocrine glands: General survey, their hormones, and pathophysiology
- Glucose homeostasis: Role of insulin and glucagon

Books Recommended:

1. Ganong: Review of Medical Physiology (22nd Ed 2005, Lang Medical Publications)
2. Guyton and Hall: Text Book of Medical Physiology (11th Ed 2006, W.B. Saunders)
3. Keel et al: Samson Wright's Applied Physiology (13th Ed1989, Oxford Press)
4. Murray et al: Harper's Illustrated Biochemistry (27th Ed 1989, Appleton & Lange)
5. Bentley: Comparative Vertebrate Endocrinology (1998, Cambridge University Press)
6. Chester-Jones et al: Fundamentals of Comparative Endocrinology (1987, Plenum Press)
7. Norris and Lotes: Vertebrate Endocrinology (5th ed 2007, Academic press)
8. Hadley: Endocrinology, Prentice Hall (2000, International Edition)
9. Turner and Bagnara: General Endocrinology (1984, Saunders)

3. Vorticella
5. Obelia colony
6. Obelia Medusa
7.Plumularia
8. Sertularia
9. Tubularia
10. Bougainvillea
11. Sponge gemmule

Ecological Exercises:

1-Eological Adaptation

a) Floating Habit –Physalia, Velella,
b) Volant Habit _ Exocoetus , Draco, Pteropus , Rhacophorus
c) Fossorial Habit – Gryllotalpa
d) Scansorial Habit – Chameleon
e) Deep sea adaption – Chimera ,Synapyura, Cynoglossus
f) Desert adaption - Uromastix

2- Determination of dissolved O2 and Co2 Content in water sample

Biochemistry Exercises-

1. Preparation of models using colored beads and wire (Nucleotides , Nucleoside, Amino acids and dipeptides)
2. Paper chromatography for the separation of Amino Acids
3. Qualitative detection of protein, reducing sugar and fat.

Museum & specimens

Porifera:-

Euspongia, Hippospongia, Chalina, Hyalonema, Sycon, Euplectella, Spongilla

Coelenterata:-

Pennatula, Physalia, Madrepora, Aurelia, Gorgonia, Corallium, Fungia, Porpita, Alcyonium, Metridium

Platyhelminthes:-

Taenia solium, Fasciola hepatica, Cysticercus

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Aschelminthes:-

Ascaris male, Ascaris female

Annelida:-

Arenicola, Amphitrite, Chaetopterus, Aphrodite, Leech, Nereis, Heteronereis, Sipunculus

Minor phylum:-

1-Bonellia

PERMANENT SLIDES

Protozoa:-

1-Paramecium Conjugation, Paramecium Binary fission, Whole mounts of Euglena, Amoeba, Ceratium, Opalina, Polystomella,Volvox Colony, Monocystis, Nyctotherus, Spirostomum,Trypanosoma, Vorticella, Noctiluca, Actinophrys

Porifera:-

Grantia body T.S., Grantia body L.S., Leucosolenia, Sponge Gemmule, Sponge Spicules

Colenterata:-

Obelia Colony, Obelia medusa, Hydractinea, Campanularia, Ephyra larva Hydra body T.S. passing through testis, Hydra body T.S. passing through ovary

Helminthes:-

Fasciola W.M., Fasciola T.S. through oral sucker region, Fasciola T.S. through ventral sucker region, Fasciola T.S. through uterus region, Fasciola T.S. through cirrus sac region, Fasciola T.S. through middle region, Redia larva, Cercaria larva, Metacercaria larva, Tape worm Scolex, Tape worm Proglottids- young, mature and Gravid

T. S. Ascaris male, T. S. Ascaris female

Annelida:-

Nereis T.S., Leech T.S. through pharynx, Leech T.S. through Nephridial region, Leech T.S. through Crop region, Leech T.S. through posterior region, Leech T.S. through intestine

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M.Sc. (Previous) Zoology Practical

Lab Course II

Duration - 6 hrs **Distribution of Marks**

Dissection	-	12 marks
Preparation	-	08 marks
Physiology exercise	-	14 marks
Cytogenetics Exercise	-	12 marks
Spotting 1-12	-	24 marks
Class record & chart	-	10 marks
Viva	-	10 marks
Seminar report	-	10 marks

TOTAL =100 MARKS

Dissection:-

1-Nervous system of Pila

2- Nervous system of Unio

3- Nervous system of Aplysia

4- Nervous system of Loligo

5- Nervous system of Octopus

6. Internal anatomy of Holothuria

Preparation:-

Statocyst of Prawn, Hastate plate of Prawn, Mysis, Cypris, Cyclops, Nauplius, Gill of Pila & Unio, Radula of Pila, Pedicillaria, Isolation of Aristotle's Lantern

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Museum Specimens:-

Arthropoda:-

1-Lepas 2- Balanus 3- Sacculina 4- Mysis 5-Squilla 6- Astacus 7- Hippa 8- Eupagurus 9- Cancer 10- Scolopendra 11- Scorpian 12- Limulus 13- Gryllotalpa 14- Belostoma 15- Wasp 16- Apis 17- Termite Queen 18- Julus 19- Silk moth life cycle 20- Honey bee life cycle 21-Melanopus

Mollusca:-

Chiton, Pearl Oyster, Haliotis, Pecten, Patella, Ostrea, Murex, Teredo, Aplysia, Solen, Doris, Loligo, Limax , Sepia, Helix, Octopus, Mytilus, Nautilus

Echinodermata:-

Anthena, Antedon, Holothuria, Echinus, Ophioderma, Clypeaster, Pentaceros

Permanent Slides:-

Arthropoda:-
Culex mouth parts male & female , Anopheles mouth parts male & female, House flies mouth parts, Butterfly mouth parts, Honeybee mouth parts, Xenopsylla (rat flea), Pediculus (human louse), Cimex (bed bug), Cyclops, Lucifer, Nauplius larva, Mysis, Zoea larva, Megalopa Larva

Mollusca :-
Unio gill lamina T.S., Unio T.S. posterior region

Echinodermata:-

Tubefeet Starfish, Echinopluteus larva, Ophiopluteus larva, Sea Urchin pedicillaria (wm)

Cytogenetics:

1- Different stages of Mitotic division in onion root tip

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2- Observation of different stages of mitotic & meiotic division in permanent slides , gaint chromosome and human chromosome

Physiology Exercise:-

1- Bleeding and clotting time
2- Preparation of haemin crystals
3- Determination of haemoglobin percentage
4- Total count of Leucocytes
5- Differential leucocytes count
6- Blood group determination

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M.Sc. (Previous) Zoology Practical

Lab Course I

Duration - 6 hrs **Distribution of Marks**

Dissection	-	12 marks
Preparation	-	08 marks
Ecological exercise	-	12 marks
Biochemistry Exercise	-	14 marks
Spotting 1-12	-	24 marks
Class record & chart	-	10 marks
Viva	-	10 marks
Seminar report	-	10 marks

TOTAL = 100 MARKS

Dissection:

Leech	:	Excretory ,Reproductive & Digestive organs
Earthworm	:	Nerve ring, Reproductive organs
Palaemon	:	Nervous system
Squilla	:	Nervous system
Scorpion	:	Nervous &reproductive system

Preparation:

1. Monocystis smear
2. Volvox colony
3. Paramecium
4. Noctiluca

NEW AND REVISED SYLLABUS

M. Sc. (Final)

ZOOLOGY

Syllabus will comprise of five theory papers and two Practical.

Each theory paper and practical will be of 100 Marks.

There will be three compulsory papers and two papers in opted specialization.

Paper I- CHORDATA AND ANIMAL BEHAVIOUR

(i) Chordata

- General characteristics and outline classification of Chordata
- Dipnoi and Coelacanth
- Origin of Tetrapoda
- Parental care in Amphibians
- Skull and jaw suspension in reptiles, Origin and evolution of Dinosaurs
- Poisonous snakes and their venom
- Flightless birds; Migration in birds
- Adaptive radiation in Eutheria with special reference to aquatic mammals

(ii) Animal Behaviour

- Introduction to behviour: Proximate and Ultimate Causation
- Innate and Learnt Behaviour
- Biological Rhythms
- Animal Signal And Communications
- Sexual Selection
- Social Organization: Co-operation and Altruism, Eusociality, Concept of Inclusive fitness

Books Recommended

Chordata

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, Willey-Liss)
3. Hildebrand : Analysis of Vertebrate Structure (4th ed, 1995, John Willey)
4. Jordan &Verma : Chordate Zoology (1998, S.Chand)
5. Kotpal: The Birds (4th ed, 1999, Rastogi Publications)
6. McFarland *et.al* : Vertebrate Life (1979, Macmillan Publishing)
7. Parker &Hashwell : Textbook of Zoology, Vol.II (1978, ELBS)
8. Romer &Parsons : The Vertebrate Body (6th ed 1986, CBS Publishing Japan)
9. Young : The life of Vertebrates (3rd ed 2006, ELBS/Oxford)

Animal Behaviour

1. Alcock : Animal Behaviour: An Evolutionary Approach (8th ed 2005, Sinaur)
2. Drickamer, Vessey & Jakob: Animal Behavior: Mechanisms, Ecology, Evolution (2007, McGraw-Hill)
3. Gadagkar: Survival Strategies: Cooperation and Conflict in Animal Societies. (1998, Universities Press)
4. Grier: Biology of Animal Behaviour (1984, Mosby)
5. Krebs & Davis: Behavioural Ecology. (3rded 1993, Blackwell)
6. Lehner: Hand Book of Ethological Methods.(2nd ed 1996, Garland)

Paper II- DEVELOPMENTAL BIOLOGY

- Origin and migration of primordial germ cells. Gametogenesis
- Fertilization in sea urchin and mammal: Acrosomal reaction and gamete interaction, Prevention of polyspermy and egg activation
- Early development: Cleavage, Formation of blastula, Gastrulation, fate maps, cell movement and formation of germ layers in frog and chick
- General concept of potency, commitment, competence and induction (Eye Lens Induction)
- Polarity in *Drosophila*: Role of maternal, Segmentation and Homeotic genes
- HOX gene in vertebrates
- Axis formation in frog (Nieuwkoop Centre and primary organizer), chick and mouse
- Late embryonic development: Vulva formation in *Caenorhabditis,* Formation of neural tube in vertebrates, Development of limb in vertebrates: role of HOX and other pattern-forming genes
- Regeneration
- Aging, Senescence, and programmed cell death

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Books Recommended

1. Alberts et al: Molecular Biology of the Cell (5th ed 2015, Garland)
2. Gilbert: Developmental Biology (10th ed 2014, Saunders)
4. Kalthoff: Analysis of Biological development (1996, McGraw)
5. Wolpert: Principles of Development (3rd ed 2007, Oxford)
6. Balinsky. Introduction to Embryology

Paper III- BIOSTATISTICS AND BIOCHEMICAL AND MOLECULAR TECHNIQUES

(i) Biostatistics

- Collection and classification of data
- Graphical representation of data; Pie chart, Bar diagram, Histogram, Frequency polygon, Cumulative frequency curve (Ogive), Box plot
- Probability theory
- Binomial distribution, Poisson distributions
- Measures of central tendency: Arithmetic Mean, Median, Mode
- Measures of dispersion: Variance, Standard deviation and Standard error, Concept of Coefficient of variation
- Correlation and Regression
- Analysis of variance (ANOVA): One way, post-hoc tests.
- Hypothesis testing: (a) Parametric test (Paired and unpaired t-test), (b)Non Parametric test (Chi-square test)

(ii) Biochemical and Molecular Techniques

- Centrifugation: Principle, Types and applications
- Spectrophotometry: Principle, Types and applications
- Electrophoresis: Principle, Agarose and polyacrylamide gel
- Chromatography: Principle and types, Column chromatography (Gel filtration, Ion exchange, Affinity), Introduction to FPLC and HPLC
- Detection of proteins, DNA-protein and protein-protein interactions: Western blotting, DNA foot printing, EMSA
- Recombinant DNA techniques: Restriction enzymes, Cloning vectors, Preparation and screening of cDNA and genomic DNA libraries, Southern and Northern hybridizations, Polymerase chain reaction: Principle and Applications

Books Recommended:

Biostatistics

1. Daniel (2000) Biostatistics: A Foundation for Analysis in Health Sciences. John Wiley.
2. Quinn & Keough (2002) Experimental Design and Data Analysis for Biologists. Cambridge Univ
3. Rastogi (2008) Fundamentals of Biostatistics. ANE Books
4. Sokal & Rohlf (2000) Biometry. Freeman.
5. Steel & Torrie (1980) Principles and Procedure of Statistics: A Biometrical Approach. McGraw Hill Book Co.
6. Zar (2003) Biostatistical Analysis. Pearson

Biochemical & Molecular Techniques

1. Boyer: Modern Experimental Biochemistry and Molecular biology (2nd ed 1993, Benjamin/Cumin)
2. Holme and Peck: Analytical Biochemistry (3rd ed 1998, Tata McGraw Hill)
4. Plummer: An Introduction to Practical Biochemistry (3rd ed 1990, Tata-McGraw Hill)
5. Switzer and Garrity: Experimental Biochemistry (92nd ed 1999, Freeman)
6. Wilson and Walker: Principles of Biochemical and Molecular Biological Techniques (6th ed 2006, Cambridge University Press)

Specialization: ENTOLMOLOGY

Paper IV- INSECT MORPHOLOGY, PHYSIOLOGY AND TAXONOMY

- Study of the morphology, development, metamorphosis and evolution of insects;
- Physiology of digestion, excretion; metamorphosis and diapause including endocrine aspects.
- An outline classification of insects; characters and identification of the economically important families.
- The distribution and bionomics of the following order:
- Thysanura, Orthoptera, Diptera, Isoptera, Mallophaga, Hemiptera, Dictyoptera, Thysanoptera, Lepidoptera, Hymenoptera and Coleoptera.
- Social insects and Insect hormones.

BOOKS RECOMMENDED

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 (1993, 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)

Paper V- Applied Entomology and Ecology of Insects

- 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.
- 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:
    i. Pests of food grain and food products: Sitophylus oryzae, Phizopertha denimida, Tragoderma, Tribolium castonium, Callosobruchus chinensis, Sitottrega cereallella, Coreyra cephalonica.
    ii. Pests of cotton: Dysdercus koenijii, Pectinophora gossypiella
    iii. Pests of sugarcane: Pyrilla perpusilla, Tryprhiza nivella
    iv. Pests of crops yielding cereal products: Leptocorisa varicornis, Locust
    v. Pests of oilseed, fruits and vegetables: Aulacophora forvecollis, Bagrada picta, Idiocerus atkinsoni
- Ecological factors governing insect development and metamorphosis. Bee keeping, Lac and silk industry in India. Plant protection and extension entomology in India.
- Medical Entomology:
    i. Pests of Public importance and their control- Mosquito, house fly, bed bug, lice, Fleas
    ii. Insect borne diseases of man- Typhus, yellow fever, dengue, encephalitis, plague, Leishmaniasis, Sleeping sickness, Malaria, Filaria

iii. Insect venom and allergens

- Forensic Entomology :
  - i. Insect succession on corpse
  - ii. Determination of time of Death

BOOKS RECOMMENDED

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

Specialization: FISH AND FISHERIES

Paper IV- MORPHOLOGY, PHYSIOLOGY AND SYSTEMATICS

- Outlines of functional morphology (origin of paired fins, Air bladder, Webberian Ossicles, Sound and Electric organs, Lateral line system)
- Physiology of Digestion, Respiration, Excretion, Osmoregulation and Reproduction (Gonads, role of Hypothalamo-Hypophysial hormones in reproduction)
- 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

BOOKS RECOMMENDED

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. Pillay: Aquaculture: Principles and Practices: Fishing News Books: (2005, First Indian reprint)
9. Gupta and Gupta: General and applied Ichthyology (Fish and Fisheries) (2006,Chand)
10. Bone and Moore: Fish Biology

PAPER V- APPLIED ICHTHYOLOGY

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

Books Recommended:

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)