

SYLLABUS

for

2 YEARS MSC ZOOLOGY PROGRAMME

(Revised Syllabus Approved by Academic Council)



DEPARTMENT OF ZOOLOGY

KRISHNAGURU ADHYATMIK VISWAVIDYALYA

NASATRA, BARPETA

SKELETON OF M.SC ZOOLOGY

SYLLABUS SEMESTER-I

Course Code	Title	Credit	Nature of Course	Internal Marks	End Semester	Total Marks
ZOO-101	Core Course 1 -Taxonomy, Biosystematics and Non-Chordates	6	T	20	80	100
ZOO-102	Core course-2-Biochemistry and Cell Biology	6	T	20	80	100
ZOO-103	Core Course -3 Parasitology	6	T	20	80	100
ZOO-104	Core Course -4 - Taxonomy, Biosystematics	3	P	20	80	100
ZOO-105	Core Course -5-Parasitology and vector biolo, Immunology	3	P	20	80	100
	TOTAL	24				500

SEMESTER-II

Course code	Title	Credit	Nature Of Course	Internal Marks	End Semester	Total Marks
ZOO-201	Core Course6-Endocrinology and Animal Behaviour	6	T	20	80	100
ZOO-202	Core Course7-Animal Physiology	6	T	20	80	100
ZOO-203	Core Course8-Ecology	6	T	20	80	100
ZOO-204	Core Course9-Ecology and Animal Physiology	3	P	20	80	100
ZOO-205	CoreCourse10-Endocrinology and Animal Behaviour	3	P	20	80	100
	TOTAL	24				500

SEMESTER-III

Course Code	Title	Credit	Nature of Course	Internal Marks	End Semester	Total Marks
ZOO-301	Core Course11- Developmental And Reproductive Biology	6	T	20	80	100
ZOO-302	Core Course 12- Genetics and Evolution	6	T	20	80	100
ZOO-303	Discipline Special Elective (DSE-I) ZOO- 303 A- Fish And Fishery Biology-I ZOO-303 B- Entomology-I: Insect Structure and Function	6	T	20	80	100
ZOO-304	Core Course-13- Developmental Biology, Genetics and Evolution	3	P	20	80	100
ZOO-305	Discipline Specific Elective (DSE-2) ZOO-303 C Fish and Fishery Biology ZOO- 305 D- Entomology- I: Insect Structure and Family	3	P	20	80	100
	TOTAL	24				500

SEMESTER-IV

Course Code	Title	Credit	Nature of Course	Internal Marks	End Semester	Total Marks
ZOO-401	Core Course-14- Molecular Biology and Bioinformatics	6	T	20	80	100
ZOO-402	Core Course-15- Bioinformatics and Research Methodology	6	T	20	80	100
ZOO-403	Discipline Specific Elective(DSE-4) ZOO-403 A- Fish and Fishery Biology-II ZOO-403 B- Entomology-II: Insect Physiology and Economic Entomology	6	T	20	80	100
ZOO-404	Dissertation	3	Dissertation	20	80	100
ZOO-406	Discipline Specific Elective(DSE-5) ZOO-406 C- Fish and Fish Biology-II ZOO-406 D- Entomology-II Insect Physiology and Economic Entomology	3	P	20	80	100
	TOTAL	24				500

P.G. 1st Semester

Course code: ZOO-101 (Core)

Paper name: Taxonomy, Biosystematics and Non-Chordates (Theory)

Credits: 6

Learning Objectives:

This course provides an understanding of the existence of various life forms on Earth, as well as detailed knowledge of biosystematics and taxonomic classifications. It will assist the student in comprehending the functional biology of non-chordates as well as the systematic organization of animals based on evolutionary relationships, structural and functional affinities.

Learning Outcomes:

Upon completion of this course, students should be able to understand-

LO1. Have a thorough understanding of the subjects of systematic, taxonomy, and structural organization of animals, particularly non-chordates, along with their functional biology.

LO2. They will be able to understand the evolutionary history and relationships of different non-chordates through functional and structural affinities.

LO3. They can comprehend the economic importance of non chordates, their interaction with the environment.

Unit1: Biosystematics and Taxonomy

1. Basic concept of Biosystematics, taxonomy and classification
2. Newer trends in biosystematics- chemo, cyto and molecular taxonomy (DNA bar coding in explaining
3. Taxonomic key, its types and their role in classification.
4. Taxonomic characters and significance, ICZN.
5. Introduction of Species concept, biological and evolutionary species concept, difficulties in application of biological species concept, Supra and infra-specific and sibling species categories.

Unit2: Biological classification:

- 1.Theories of biological classification .Phylogenetic types of classification, systematic of animals also and hierarchic classification, Zoological nomenclature-basic knowledge of naming on genus and species; Modern scheme of classification into sub-kingdom, division,

section, phyla and minor phyla. Cladistic method of classification, difference in application of phonetic and cladistic classification, Cladogram.

Unit-3: Functional biology of non-chordates:

Osmoregulation in protozoa; Colonial protozoans and theories of origin of metazoans; Life history pathogenecity and control of *Fasciola hepatica*, Exocrine gland (Lac, Wax, Silk and Labial gland), Larval forms of echinoderms, metamorphosis and phylogenetic significance, 16. Mechanism of Excretion and excretory organs in Annelids and Arthropods.

Unit-4: Minorphyla

Salient features and affinities of- 1. Placozoa, 2. Mesozoa, 3.Ctenophora, 4.Rotifera, 5. Phoronida, 6. Sipuncula, and 7.Bryozoa (Ectoporecta).

Books recommended:

1. Barnes: Invertebrate Zoology (Holt-Saunders International, 4th edition, 1980)
2. Barnes: The Invertebrates - A synthesis, 3rd edition, Blackwell, 2001
3. Hunter: Life of Invertebrates, Collier Macmillan Pub. 1979
4. Marshall: Parker & Haswell Text Book of Zoology, Vol. I, 7th edition, Macmillan, 1972
5. Moore: An Introduction to the Invertebrates, Cambridge University Press, 2001
6. Jordan & Verma : Chordate Zoology (1998, S. Chand)
7. Sinha, Adhikari & Ganguly: Biology of Animals (Vol. II, 1998, New Central Book Agency)

Course code: ZOO-102 (Core)

Paper name: Biochemistry and Cell Biology (Theory)

Credits: 6

Learning Objectives:

This course will provide a thorough understanding of general biochemistry and bioenergetics, as well as their biological significance. The core conceptual framework can also help students understand enzyme kinetics and metabolism. As a result, this course will lay the groundwork for further research into micro and macromolecular interactions in biological systems.

Learning Outcomes:

Upon completion of this course, students are able to understand-

LO1. The basic structural and functional chemistry of biomolecules.

LO2. Kinetics of enzyme action and metabolism

A: Biochemistry

Unit -1: General Biochemistry

4.1. Water and Biomolecules

1. Biological importance of water, PH, PK and acid-base balance. 2. Types of Buffers and Biological importance 3. Electrolyte and water balance, Acidosis, Alkalosis 4. Concept of chemical bonding, its types and biological application 5. Role of Carbon in life and its biological role 6. Natural products, their physiological & pharmacological importance

4.2 Protein chemistry and function:

1. Protein structure and significance- Primary structure: peptide bond. Secondary structure(α helix, β pleated sheet and bends) 3. Tertiary structure: forces stabilizing tertiary structure, domain and motifs. Quaternary structure 4. Protein-protein interaction 5. Ligand and types of biological ligands. Ligand formation between protein and nucleic acid 6. Lipid and its role in biomembrane.

Unit-2: Functional biology of nucleic acid

1. Structure, folding motifs, conformational flexibility and super coiling of DNA 2. Mechanism of DNA replication 3. RNA-Transcription and post-translational modification.

B. Cell Biology

UNIT-III

1. Complexity and organization of cell- Structural and Molecular feature of Prokaryotic and Eukaryotic cells. 2. Biomembranes- Molecular composition and functional feature of membrane lipid, protein and carbohydrate. 3. Cytoskeletons- Structure and Organization of Microfilament, Microtubule and Intermediate filament. 4. Cell Motility- Muscle contractility, intercellular transport, kinesin-dynin, cilia and flagella.

UNIT-IV

1. Cellular Reproduction- Various Stages and molecular events in mitosis and Meiosis. 2. Extracellular Matrix and Cell Interaction- Cell walls, Adhesion junctions, Tight junctions, Gap junctions, Plasmodesmata. 3. Cell -Cell Adhesion- Ca^{++} dependent and Ca^{++} independent Homophilic Cell-Cell Adhesion. 4. Cell-Cell Signalling- Cell Signalling, Cell surface receptors, G-Protein coupled receptors and Second messenger

Recommended Books

1. Alberts et al: Molecular Biology of the Cell (Garland, 2002)
2. Berg et al.: Biochemistry (5th Ed.), Freeman, 2002
3. Biochemistry (3rd Ed.), Tata-McGraw Hill, 1990
4. Boyer: Modern Experimental Biochemistry and Molecular biology (2nd Ed.),
5. Albert et al.: Molecular Biology of the Cell (4th Ed.), Garland Publishing Inc., 2002
6. Lodish et al.: Molecular Cell Biology (5th Ed.), Freeman and Company, 2004
7. Berg et al.: Biochemistry (5th Ed.), Freeman and Company, 2002
1. 8. Murray et al. Harper's Biochemistry (26th Ed.), Appleton & Lange, 2003.

Course code:ZOO-103 (Core)

Paper name: Parasitology and Vector Biology, Immunology (Theory)

Credit : 6

Learning Objectives:

This course is divided into two parts: advanced parasitology and immunological science. There is an enormous diversity of parasites in nature, and knowing and understanding them well becomes critical in terms of effectively controlling and managing the parasites. The economic impact of these organisms is frequently enormous, making it all the more important to study them.

Parasitology will allow us to correctly diagnose parasites, understand their lifecycles, and control them effectively, as well as use some of them as biocontrol agents. Parasitology, particularly the study of parasite lifecycles, has aided in breaking down stigmas and religious taboos in many societies, liberating many people from superstition and illness.

Learning Outcomes:

At the end of the course, the students should be able to-

LO1. Understand the variation amongst parasites, parasitic invasion in both plants and animals; applicable to medical and agriculture aspects.

LO2. Help to know the stages of the lifecycles of the parasites and the respective infective stages.

LO3. Understand the immune modulator strategies essential for generating or suppressing immune

responses as required in hypersensitivity reactions, transplantation, autoimmune diseases and cancer.

LO4. Design new methods to improve existing vaccines and other immune otherapeutic strategies. Advanced Parasitology and Vector Biology 25L

Unit1: Parasitology

1.1:General consideration of parasites:

1. Types of parasites, Type of hosts, parasite relationship-Symbiosis and commensalism 2. Distribution of diseases and Zoonosis caused by animal parasites 3. Molecular interaction between host & parasites and evasion of immunity 4.Biochemical adaptations of parasites & parasites of veterinary importance.

1.2: Protozoan parasite

1. Distribution, habit and habitat, structure lifecycle and diseases caused by selected pathogenic protozoan parasites of man: a) *Entamoeba histolytica*, b) *Trypanosoma gambiense*, c) *Leishmania donovani*, 2. Physiology of parasitic amoebae of man.

1.3: Helminth parasites

1. General characters, organization and larval forms of Platyhelminthes and Nematelminthes.

2. Distribution, habit and habitat, structure and lifecycle of economically important helminthes parasites of man and domesticated animals: a) *Echinococcus granulosus*, b) *Wuchereria bancrofti*

Unit 2: Vector biology

1. Vectors - insect vectors, mosquito, housefly, bedbug, head louse; 2. Biology of different mosquito; 3. Vector born diseases- human diseases and their control measures. 4. Vector borne viral disease- Dengue and Japanese encephalitis. 5. Vector control-Biological, chemical and physical methods.

B. Immunological sciences

Unit 3: Immunology

1. Cells of the immune system: T-cell generation activation and differentiation, B-cell-generation activation and differentiation;
2. Antibody: types, structure, function, production and diversity;
3. Epitopes and hapten;
4. Major Histocompatibility Complex (MHC)- general organization and inheritance of the MHC, MHC molecules and genes;
5. Complement system - classical, alternative and lectin
6. pathways, regulation of complement system, biological consequence of complement activation ;
7. Cytokine receptors-properties of cytokines, cytokine receptors, cytokine

Books recommended:

1. Animal parasitology- J.D.Smyth (CambridgeUniv.Press.,1976).
2. Foundations of parasitology 6 ed. - L. S. Roberts & J. Janovy Jr (McGraw Hill Publ.,2000).
3. Parasitism-A.O.Bush,J.C.Fernandez&J.R.Seed(CambridgeUniv.Press,2000).
4. Helminthology- Eds. N. Chaudhury & I.Tada(NarosaPublg.House,1994).
5. Helminthes, Arthropods, & Protozoa of domesticated animals 6 ed. - E.J.L. Soulsby (ELBS,1976).
6. Introductiontoparasitology-B.E.Matthews(CambridgeUniv.Press.1998).
7. EcologicalAnimalParasitology-C.R.Kennedy(BlackwellScientificPubl.,1975).
8. Immunology, Kuby, W.F.Freeman, U.S.A
9. Fundamentals of Immunology, W.Paul

Course Code: ZOO -104 (Practical)

Paper Name : Taxonomy, Biosystematics

Credit : 3

Learning Outcome:

LO1: To understand the Measures of dispersion: Variance (Definition, simple problems) Standard

deviation Coefficient of variance. and graphical representation, no formula, and real life example).

LO2: To understand the Chi-Square Test (Fieldwork, graphical representation and real life example) Testing of hypothesis (two tailed only) a) For mean (one population).

LO3: To understand the method of collection and preservation of invertebrates.

(i) :Practical on Biosystematics of non-chordates

1. Taxonomic hierarchical classification invertebrate specimens of nonchordates by local, binomial nomenclature (at least 3 representatives of museum specimen from each phyla)
2. Identification of at least one specimen from each typological species(supra, infra & subspecies categories)
3. Permanent mounting (any three) a) Protozoa (cilia- Paramecium, flagella-Euglena) b) Porifera-freshwater sponges spicules, Coelenterata -Obelia colony c) Cockroach-salivary gland and trachea
4. Study of Invertebrate fossils
5. Dissection: a)Mouth parts of Cockroach, Housefly, Mosquito; b)Reproductive system of cockroach c)Nervous system of cockroach
6. Collection, preservation, curation and identification of non-chordate and chordate species (only pest and cultured species)
7. Preparation of practical record and submission
8. Viva-voce.

Paper code: ZOO- 105 (Practical)

Paper Name: Parasitology and vector biology, immunology

Credit-3

1. Identification of dipteran vectors and study of different stages of the life history of Anopheles Culex ,Aedes, housefly, sandy fly (through slides/chart).
2. Preparation of permanent slide of insect leg, antennae, wings of mosquito/housefly/cockroach. Vector biology:
3. Study of mosquito /housefly diversity species.
4. Histological identification: Primary and secondary lymphoid organs through prepared slide.
5. Histological identification : Primary and secondary lymphoid organs through prepared slide.
6. Preparation of single cell suspension from bone marrow and spleen of mice.
7. Performing the agglutination or precipitation test in ABO bloodgroup
8. Microbial science: 1. Media preparation for microbial culture .Gram staining of bacteria (Lactobacillus).
9. Viva- Voce
10. Practical Records

P.G 2nd semester

Course Code: ZOO- 201 (Core)

Paper Name: ENDOCRINOLOGY AND ANIMAL BEHAVIOUR

Credits:6

Learning Objectives:

The endocrinology section is designed to provide a thorough understanding of non-mammalian and mammalian endocrinology, as well as the physiological roles of the endocrine system. The section on animal behavior focuses on the fundamental concepts of animal behavioural patterns.

Learning Outcomes:

At the end of this course students should enable to

LO1. Understand the role of different hormones in human physiology along with their biosynthesis in the body.

LO2. Understand animal social behavior.

A. ENDOCRINOLOGY

Unit 1: Non-mammalian and mammalian endocrinology

1. Mammalian endocrinology : 1. Endocrine control of molting & reproduction in insect, 2. Structure of Pineal gland & its functions.
2. Mammalian endocrinology: 1. Introduction to endocrine system & classes of hormones-peptide, protein, steroid & prostaglandins, 2. Endocrine cells of pancreas, pancreatic hormones & its role in glucose Homeostasis 3. Thyroid Gland- Biosynthesis of thyroid hormones, Control of secretion & their Physiological roles.
4. Adrenal gland- a) its secretion, physiological action of adrenal hormones, 5. Synthesis of steroid hormones & synthesis of corticosteroid hormones, 6. Role of parathormones in Calcium & phosphate homeostasis.

Unit 2: Reproductive endocrinology

1. Testis- Organization, Physiological roles of androgens & inhibin, Ovary- Organization, Physiological roles of Estrogen, Progesterone, Relaxin & Inhibin.
2. Human reproductive pheromones, role of pheromones in puberty
3. Placental hormones,

Unit 3: Endocrine disorders

1. Overview of endocrine disorders-a). Pituitary gland- Acromegaly & Diabetes insipidus b). Thyroid gland- Goiter & Myxoedema c). Parathyroid gland- Osteoporosis d). Islets of

Langerhans Diabetes mellitus e).Ovary & female infertility Polycystic ovarian f). Obesity

B. ANIMAL BEHAVIOUR

Unit 4: Behavioural biology

4.1:Biological Rhythms & control:

1.Definition & types of rhythms, Zeitgebers, circadian rhythms, Basic types of exogenous rhythms in the human and their significance, Photoperiodism, annual and lunar periodicity. 2. Role of melatonin & neurotransmitters in circadian control,

4.2. Mimicry&coloration: 1. Definition of mimicry & coloration, Types of mimicry, Bateson and mullerian mimicry and significance

4.3 :Interspecific relationship: 2L 1.Definition of Interspecific relationship, Aggregations and social organization.

4.4. Animal behavior& pattern:

1.Animal behavior-innate or inherent behavior, learned behavior, vision and behavior, sound and behavior, Social behaviour: mating, family, and group behavior, advantages of social behavior,

Habitat selection and foraging behavior 2. Genetic, hormonal and evolutionary aspects of behavior.

3. Sexual conflict & Sexual selection: a) intra sexual selection (male rivalry), b) inter-sexual selection (female choice), c) infanticide, sperm competition, d) mate guarding, sexual selection in human

4. Parental care.

Books recommended:

1. Comparative Endocrinology of Invertebrates by High man and Hill.
2. Comparative Vertebrate Endocrinology by P. J. Bentley, Cambridge Univ. Press .
3. General and Comparative Endocrinology by E. J. W. Barrington, Oxford Clarinda Press
4. Endocrinology Vol.1-3 by De Groot L.J.et.al.
5. Text Book of Endocrine Physiology by C. R. Martin, Oxford Univ. Press, New York.
6. Text Book of Endocrinology by Turner and Bangnara (W.B. Sanders).
7. Vertebrate Endocrinology by Mc. Hadley.
8. Text Book of Comparative Endocrinology by Garbman A, and Bern H.A., John Harley and Sous, New York.
9. Alcock: Animal Behaviour- An Evolutionary Approach.(7th ed.) Sinaur Associates, Inc. 2001.

10. Drickamer & Vessey :Animal Behaviour -
Concepts,Processes and Methods(2nded.),Wadsworth,1986.

11. Gadagkar : SurvivalStrategies-
CooperationandConflictinAnimalSocieties.UniversitiesPress,1998

Course Code-ZOO-202 (Core)

Paper Name: ANIMAL PHYSIOLOGY (Theory)

Credits: 6

UNIT I:1.

Body Fluid: Blood, Lymph, Hydrolymph, Hemolymph: Chemical compositions and Functions 2. Cardiac Cycle, Specialized conducting system of heart, generation and conduction of cardiac impulse, neurohormonal regulation of cardiac amplitude and frequency. 3. Respiratory system in vertebrate: Pulmonary ventilation, alveolar ventilation, diffusion and transport of gases, Basal metabolic rate. Respiratory centers: organization and function 4. Counter current mechanism of urine formation, RAS and hormonal regulation of urine formation. Acid-base balance and homeostasis Nutrition: Gastrointestinal hormones and digestive enzymes: chemical nature and functions.

2. UNIT II:

Nervous system: Neurons and types of neurons, Types of synapses and synaptic knobs, Axonal transmission. Membrane potential and generation of action potential. Sodium-potassium pump, Synaptic transmission, neuromuscular junction Excitatory and inhibitory post- synaptic potential, Chemical transmission, neurotransmitters (acetylcholine, or catecholamines, Autonomic nervous system (Sympathetic and parasympathetic). Special sensory system: Eye: Anatomical Organization of retina, Photoreceptors: Processing of visual impulses Ear: Cochlea, basilar membrane, and organ of Corti. Generation of endochochlear potential. Processing of auditory impulses. Muscle: Contractile proteins, Ultrastructure of skeletal muscles, Properties of muscle: muscle twist, summation, tetanus and fatigue, Sliding filament theory of muscle: contraction and regulation.

SUGGESTED BOOKS:

1. Ganong: Review of Medical Physiology (21st Ed.), Lang Medical Publications, 2003 2.
2. Guyton and Hall: Text Book of Medical Physiology (10th Ed.), W.B. Saunders, 2001 17
3. Keele et al: Samson Wright's Applied Physiology (13th Ed.), Oxford Press, 1989
4. Murray et al: Harper's Illustrated Biochemistry (26th Ed.), Appleton & Lange, 2003
5. West: Best and Taylor's Physiological Basis of Medical Practice (11th Ed.), Williams and Wilkins, 1981.

Course Code: ZOO-203 (Core)

Paper Name: ECOLOGY (Theory)

Credits: 6

Learning Objectives:

The purpose of this course is to introduce students to abiotic and biotic interactions in ecosystems, with a focus on environmental variables and different levels of organisation in the ecological hierarchy. Starting with species diversity, this course delves into system stability, ecosystem productivity, and biogeochemical cycling. It also sheds light on various livelihood issues associated with tangible and intangible ecosystem services.

Learning Outcomes: Upon completion of this course, students should be able to

LO1. Understand basic pattern of interaction between environmental variables and biota with special reference to limit of tolerance.

LO2. They will be able to link the different levels of organization in ecology with the basic ecosystem functions.

LO3. The understanding of the livelihood issues will make students more scientific in their approach while implementing conservation action plans at all scales.

Unit 1- Environmental variables and limits, Community

1.1. Environmental variables and limits

1. Organism and its environment: Limits of Tolerance, 2. Adjustment to tolerant limit, 3. Interaction between environmental variables, 4. Macro and micro environments.

1.2. Community

1. Community and ecosystem; community level organization, 2. Analysis of food web design, nutrient flow within community, 3. Niche relationship, parallel and niche overlaps and competition, niche separation, 4. Population structure, population cycles in invertebrates.

Unit 2- Species diversity and coevolution, Stability

2.1. Species Diversity

1. Diversity as a descriptor of ecological community, 2. Measures of the diversity, factor promoting species diversity, 3. Co-evolution, plant-insect interaction, larger herbivores population, 4. Theories of diversities and factors promoting species diversity

2.2-Stability 1. Definition, stability of single species, two three species system, 2.

Diversity and stability, May's paradox, 3. Stability of food web design, 4. Energetic of stable system

Unit 3- Ecosystem and its Productivity, Energy and Mineral cycle

3.1- Ecosystem and Its Productivity

1. Types of forests, wetland and grassland, 2. Ecosystem productivity, 3. Methods of Assessment of Ecosystem Productivity, 4. Ecosystem Goods and Services, Green India Mission
3.2 Energy and Mineral cycles 1. Energy flow model, application of law of thermodynamics, 2. Hydrological, mineral cycle, 3. Artificial inputs in ecosystem and its impact, 4. Soil: structure, characteristics and agricultural practices

Unit 4- Ecosystem service and livelihood issues

1. NTFP (Non timber forest product), Rural employment and ecosystem services, MGNREGA, 2. Forest right act, biodiversity act 2002, IPR, Ramsar conventions, 3. Wetland and forest ecosystem service, 4. Climate change- expected impact on ecosystem service, pollinators

Course Code-ZOO-204

Paper Name: ECOLOGY & ANIMAL PHYSIOLOGY

(PRACTICAL)

Credit: 3

1. Community Analysis Measurements of species diversity and use of software;
(a) Shannon Winner Index (H'), (b) Evenness Index, (c) Equitability Index (E), (d) Community Dominance Index (CDI), (e) Canopy area coverage, (f) Foliage Height Diversity (FDH).
2. Determination of population density in a natural/ hypothetical 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).
4. Determination of ABO blood grouping
5. Estimation of haemoglobin
6. Haemocyte count and estimation of protein in haemolymph.
7. Total RBC and WBC count in human blood men and fish.
8. Test of haemostatic – bleeding time, coagulation time.
9. Haemin crystal
10. Hemocyte count and estimation of protein in haemolymph.
11. Total RBC and WBC count in human blood of man and fish.

Course Code: ZOO-205

Paper Name: Endocrinology and Animal behaviour (Practical)

Credit: 3

1. Dissection of pituitary gland from suitable marketed fish
2. Demonstration of thyroid, adrenal, pancreas & gonads of any suitable vertebrate specimen through dissection
3. Parabiosis (parabiotic behavior) in cockroach
4. Study of histological preparation of pituitary & thyroid gland
5. Study of pituitary, thyroid, parathyroid, pancreas, adrenal, testis & ovary of mammal through permanent slides
6. Identification of gonadotropin in human urine sample
7. Recording & analysis of insect (cricket) & birds calls
8. Study of social insect colonies

P.G 3rd Semester

Course Code: ZOO-301 (Core)

Course Title: Development and Reproductive Biology

Credit: 6

Course Outcome: .

CO1: Information about history and basic concepts of developmental biology.

CO2: To understand the concepts of organogenesis in invertebrates and vertebrates.

CO3: To understand the different functions of peptide and Steroid hormones.

CO4: Understand the Sexual cycles: puberty, oestrous and menstrual cycles. Ovarian event: follicular phase, cycling of non-pregnant uterus and vagina.

CO5: To understands Pregnancy: conception and blastocyst formation, implantation and delayed implantation, placenta: formation, types and functions, hormones in pregnancy.

Contents

UNIT-I

Principle of Developmental Biology: Embryogenesis and Blastogenesis, Ontogenic and Phylogenetic development, Potency, commitment, Specification, Induction, Competence. 2. Fertilization: Dual aspect of Fertilization, Mechanism of Fertilization, Change in the organization of egg cytoplasm after fertilization, Site of sperm entry, Chemistry of fertilization. 3. In Vitro Fertilization (IVF), Embryo transfer, Variations of Embryo transfer, Intracytoplasmic sperm injection (ICSI), Gamete intrafallopian transfer (GIFT).

UNIT-II

1. Morphogenesis: Axes, Compartment formation and pattern formation in *Drosophila*, Wnt and Cadherin pathways. 2. Organogenesis: Vulva formation in *Caenorhabditis elegans*, Island induction. 3. Nucleocytoplasmic Interaction: Method of Nucleocytoplasmic interaction, Transfer of Nuclei, Cytoplasmic influence of nucleus.

UNIT-III

1. Sexual Cycle: Female Sexual Cycle, Menstrual cycle, Cause of Oestrus and Menstrual, Hormonal Regulation of Female cycle. 2. Ovarian Physiology: Folliculogenesis, Ovulation, Steroidogenesis and their regulation. 3. Testicular Physiology: Steroidogenesis, Semination. 4. Transport of Gametes in Reproductive tract.

UNIT-IV

1. Development of Endometrium and Implantation. 2. Physiology of placenta, Placental hormones and function. 3. Pregnancy, Parturition and Lactation in Mammal and their hormonal control.

Recommended Books

1. Balinsky, B.I. 1981 An Introduction to Embryology. W.B Saunders Co., Philadelphia.
2. Gilbert, S.F. 2003. Developmental Biology. Sinamer Associates Inc. Sunderland, Massachusetts, U.S.A.
3. John E. Hall: Text Book of Medical Physiology. Guyton & Hall
4. Kalthoff: Analysis of biological development. McGraw-Hill, 1996.
5. Karp, G. and Berrill, N.J. 1981. Development. McGraw Hill, New York.
6. Nagabhushanam, R. and Sarojini, R. 2002 Invertebrate Embryology. Oxford and IBA Publishing Co.
7. Oppenheimer, S.B. 1980. Introduction to Embryonic Development. Allyn and Bacon, Inc.
8. Saunders, J.W. 1982. Developmental Biology. MacMillan Co., London.
9. Tyagi and Shukla, 2002. Development of Fishes. Jaya Publishing House, New Delhi.

Course Code: ZOO-302 (Core)

Course Title: Genetics and Evolution

Credit: 6

Course Outcome: .

CO1: Comprehensive and detailed understanding of genetic methodology and how quantification of heritable traits in families and populations provides insight into cellular and molecular mechanisms.

CO2: The role of genetic mechanisms in evolution and Natural selection as key to understanding the natural world; how natural selection produces adaptation; the origins of genetic variation; fitness, adaptive genetic change.

CO3: Population genetic consequences of selection, mutation, migration (gene flow), inbreeding; genetic drift, an important evolutionary force. Evolution of social behavior and kin selection; sexual selection; evolution of life history characters.

CO4: The results of natural or artificial selection on quantitative characters: the interplay between heritability and the environment. Evolutionary biology and Human evolution.

CO5: How new species arise; the major species concepts. The history of life; the evolution of humans and understanding evolution and development.

UNIT- I

1. Organisation of genetic material- Nucleosome, Molecular anatomy of eukaryotic chromosome. 2. Genome size and Complexity- C value paradox, Unique and repetitive DNA, Euchromatin and Heterochromatin 3. Microbial Genetics- Bacterial Conjugation, Transformation, Transduction and Sexduction. 4. Somatic Cell Genetics- Cell fusion technology, Chromosome mapping, Application of Somatic Cell Genetics.

UNIT-II

1. Genetics of Cell Cycle- Cyclins and Cyclin Dependent Kinases (CDK), Regulation of CDK-Cyclin activity. 2. Sex Chromosomes- Sex determination, Role of Y chromosome, Dosage Compensation in Drosophila and Human Being. 3. Human Genetics- Normal Human Karyotyping, Autosomal chromosome abnormalities, Principle and Methods of Pedigree Analysis. 4. Chromosomal Disorder.

UNIT-III

1. Evolution of Prokaryotes and Eukaryotes. Micro and Macroeolution. 2. Natural Selection- Concept of stabilizing selection, Frequency dependent selection, Balancing selection, Disruption

selection. 3. Destabilizing factors- Mutation, Genetic drift, Migration, Meiotic drive. 4. Neural Theory- Emergence of Non Darwinian theory of evolution, Neutral theory of evolution (Kimura)

UNIT-IV

1. Isolation Mechanisms- Isolation Mechanisms and their role in speciation, Models of speciation (Allopatric, sympatric, parapatric) 2. Gene frequencies in population- The Hardy-Weinberg principle and analysis of gene frequencies in natural population. Major factors influencing gene frequencies (migration, inbreeding), effects of selection and mutation on gene frequencies. Gene flow b. 3. Molecular basis of evolution- Constructing evolutionary trees, measures of genetic relationship among organisms, Molecular clock of evolution. 4. Origin and Evolution of Primates- Evolution of Anthropoid Primates, The first hominids and origin of modern man.

Recommended Books :

1. Brooker: Genetics : Analysis and Principles (Addison-Wesley, 1999)
2. DeRobertis&DeRobertis: Cell and Molecular Biology (Lee &Febiger, 1987)
3. Griffith et al: Modern Genetic Analysis (Freeman, 2002)
4. Hartl & Jones: Essential Genetics: A Genomic Perspective (Jones &Bartlet, 2002)
5. Lewin, Genes VIII (Wiley, 2004)
6. Russell: Genetics (Benjamin Cummings, 2002)
7. Snustad& Simmons: Principles of Genetics (John Wiley, 2003).
8. T.A.Brown, Genome 3rd, Ed
9. Colbert, E.H. 1969. Evolution of Vertebrates. John Wiley and Sons Inc, New York.
Holstead. 1969 The Pattern of Vertebrate Evolution. Freeman and Co. San Francisco. U.S.A.
10. Hobart M. Smith, 1960 Evolution of Chordate Structure, Holt, Rinehart and Winston. Inc.

Course Code: ZOO-303 A (Elective)

Course Title: Special Paper : Fish and Fishery Biology- I (Course

Credit: 6

Course Outcome: .

:

CO1: To understand the anatomical system viz., skeletal, respiratory, excretory & digestive systems of teleost fishes and biochemical composition of Fish.

CO2: To understand the fish diversity & classification of fishes from Northeast India and diversity of endangered fishes of NE India.

CO3: To understand the various relationship between morphometric parameters & fish diversity.

CO4: To understand the various factors associated with Inland capture fisheries.

CO5: To understand the different components of fish nutrition.

Contents

: Unit-I

Anatomy and Physiology:

1. Skeletal system of teleost - cranium, visceral arches, vertebral column and caudal vertebrae. Integument, types of scales. Pigmentation and colouration. 2. Swim bladder: General structure, composition of gas, hydrostatic control and function. Respiration: aquatic respiration, gills, respiratory pump, gas exchange. Air breathing: condition of air breathing, accessory respiratory organs. 3. Excretion and Osmoregulation. Kidney glomerular and aglomerular, excretion of nitrogenous wastes. Stenohaline and euryhaline teleosts. Osmoregulation in migratory teleosts. 4. Digestion. Alimentary canal and its modification in relation to food and feeding habits. Physiology of digestion.

Unit-II

Applied Fish & Fishery:

1. Fish diversity, classification and systematic. Classification of fishes of Northeast India. Identification of commercial, endemic and ornamental fishes Northeast India. 2. Fishes indices: Length weight relationship, hepatosomatic index, ponderal index, index of fullness, index of preponderance, index of brightness. Maturity, fecundity and gonadosomatic index.

Unit-III

Inland capture Fisheries:

1. Inland capture fisheries of India (with special reference to River Brahmaputra and its fisheries).. 2. Coldwater fisheries: Definition, characteristics of coldwater fisheries, adaptation of coldwater fishes 3. Hill stream fishery, wetland fishery (Beel).

Unit-IV

Fish nutrition, Fish food:

1. Fish nutrition —supplementary feeding, different kinds of process of feeds, feed ingredients.
2. Fish food organisms: zooplankton, phytoplankton and their role in fisheries.

Recommended Books:

1. Brown, M.E. 1957. The Physiology of Fishes. Academic Press, New York Vol. 1 & 2.
2. Brown, M.E. Physiology of fishes, Vols. 1 and 2, Academic press, 1957
3. Evans, D.H. Physiology of Fishes, II Edn.
4. Hoar, W. & Randall, Fish Physiology, Vol I-XV., Acad. Press.
5. Hoar, W.S. & Randall, O.J. Fish Physiology, Vols I-X, Academic Press, 1969- onwards
6. Jayaram, K.C. 2008. Fishes of the Indian Region. Narendra Pub., New Delhi
7. Nelson, J. 2006. Fishes of the World., 4thEdn., Willey Eastern Bk. Ltd.
8. Norman and Greenwood: A History of Fishes, Third Ed., Ernest Bvenn Limited, 1975.
9. S.S. Khanna and H. R. Singh. A textbook of Fish Biology and Fisheries, Narendra Publishing House, 2003
10. Srivastava, C.B.L. A Textbook of Fishery Science and Indian Fisheries,
11. Vishwanath, W., P. C. Mahanta, S. Debajit& N. Anganthoibi. 2011. Coldwater fishes of India—an atlas. Directorate of Coldwater Fisheries Research (Indian Council of Agricultural Research), Bhimtal.
12. Vishwanth, W., W. S. Lakra& U. K. Sarkar. 2007. Fishes of northeast India.

Course Code: ZOO-303 B (Elective)

Course: Title: Special Paper: Entomology-I: Insect Structure and Function

Credit: 6

Course Outcome: .

CO1: To understand the General Characteristics and Classification of Insects and the different segmentation of Insect body and their functions. Students will understand the Head, Thorax and Abdomen and related appendages.

CO2: Student will understand the different types of Mouth parts of insects and the food habit according to the mouth parts.

CO3: To understand the integument system, chemical composition chitin, cuticular protein, moulting etc.

CO4: To understand the muscular system of insect and the application of different muscles in different activities.

CO5: To understand the insect's visual organ, sense organ and effector organs. To understand the Endocrine system and Functions, different hormones and functions, diapause, etc.

Contents:

UNIT:I

1. Segmentation and Body Regions of Insects: The Head- Head segmentation, Head Skeleton, Tentorium, Modification in Head Capsule, Cephalic Appendages, Cervix or Neck, The Thorax- Thoracic Segmentation, Thoracic Skeleton, Endothorax, Thoracic Appendages, Locomotion; The Abdomen- Segmentation, Skeletal Composition, Pre genital, Genital and Post Genital Segments. 2. The Mouthparts of Insects: Different types of Mouthparts, Evolution of Mouthparts, Control of Feeding. The Wings of Insects: Origin of Wings, Morphological variation, Structure and Insect flight. 3. Insect Integument: Structure of Insect Integument, Chemical composition of cuticle chitin, Cuticular proteins, Reselins, Protective functions of cuticular proteins, cuticular lipids, Cuticular modification, Moulting, functions of Integument.

UNIT: II

1. Musculature: Basic Structure and Function of Muscles, Arrangement of muscle, Musculature of Head, The Thoracic Musculature, The Abdominal muscles, muscles attachment to exoskeleton, Skeletal muscle, Synchronous and Asynchronous muscle, Muscles involved in locomotion, Adaptation for running, jumping and walking, Morphology and Physiology of Nonskeletal muscle- visceral muscles, heart muscle and alar muscle. 2. The Visual Organs: The dorsal Ocelli, The Stemmata, The Compound eyes- Structure and functions. The Sense Organs: The General Classification of Sensory receptors, The Mechanoreceptors, The Chemoreceptors and Thermohygroreceptors. The Effector Organs: The sound

producing organs and light producing organs. 3. Development: The Insect Egg, Early Embryonic Development, Embryonic Dynamics, Post embryonic development and metamorphosis.

UNIT: III

1. Endocrine System and Functions: Anatomical Organization, Structure, Hormones, Endocrine Control of Metamorphosis, 2. Glands: Secretion and Functions, Exocrine gland, Silk gland, Wax glands, Cephalic glands, Attractant glands and Poison glands. 3. Ectohormones: Pheromones and Allomones.

Recommended Books :

1. Chapman, R.F., 1998. The Insect Structure and Function, Cambridge University Press.
2. Mani, M.S., 1982. General Entomology, 3rd Edition, Oxford & IBH Publishing Co. Pvt. Ltd.
3. Mani, M.S., 1995. Insects, National Book Trust, India.
3. Publishing House.
4. Saxena, S.C., 1992. Biology of Insects, Oxford & IBH Publishing Co. Pvt. Ltd.
5. Tembhare, D.B., 2012. Modern Entomology, 2nd Revised Edition, Himalaya
6. Wigglesworth, V. B., 1950. Principle of Insect Physiology, Methuen Publishers.
7. Wigglesworth, V. B., 1968. Insect and Physiology, American Elsevier Pub. Co.

Course Code: ZOO-304 (Practical)

Course Title: Developmental Biology, Genetics and Evolution

Credit: 3

Course Outcome: .

CO1: To understand preparation of Chick embryo whole mount and observation of chick embryo development.

CO2: Understanding of reproductive system of male & female cockroach.

Contents:

1. Isolation of chick embryo and preparation of whole mount.
2. Study of developmental stages of Chick/ Frog embryo from permanent slides.
3. Study of Chick/ Frog embryo using vital staining.
4. Dissection of male reproductive system of cockroach.
5. Dissection of female reproductive system of cockroach.
6. Study of sex chromatin in buccal smear and hair bud cells (Human).
7. Preparation of human karyotype and study of chromosomal aberrations with respect to number, translocation, deletion etc from the pictures provided.
8. Study of Hardy-Weinberg equilibrium in human population by taking the example of blood group system (ABO).
9. Construction for phylogenetic trees for proteins using UPGMA or Neighbor joining method (no software to be used)
10. Reproduction of the same phylogeny using MEGA software for the given set of sequences

Course Code: ZOO-305 C (Practical)

Course Title: Special Paper: Fish and Fishery Biology-I

Credit: 3

Course Outcome:

CO1: To understand the identification & classification of common local freshwater fishes.

CO2: To understand the accessory respiratory organs of fishes through dissection.

CO3: To understand the location & significance of Weberian ossicle of teleost fishes

CO4: To understand the haematological parameters of fishes.

CO5: To study the local fishing gears used by fish farmers using traditional methods for fish harvesting.

Contents:

1. Collection of common local freshwater fishes — identification classification and use of key characters, description.
2. Dissection of accessory respiratory organs in Notopterus/ catfishes/ Anabas/ Carps. Dissect and display Weberian ossicle of a teleost, e.g. Labeo rohita
3. Slide preparation, haematology, body parts.
4. Identification of haematological and histological slides, bones, and fishing gears.
5. Study of food and feeding habits of fishes: Bucco-pharynx of economically important fishes. Submission: i) Skeleton submission ii) Specimen submission iii) Fishing gears.
6. Visit to a fish breeding centers
1. 7. Practical record book.
7. Viva-voce

Course Code: ZOO-305 D (Practical)

Course Title: Special Paper: Entomology-I: Insect Structure and Function

Credit: 3

Course Outcome:

CO1: To demonstrate the different mouth parts of insects, so that students will understand the food habit of insects.

CO2: To demonstrate the different types legs, antennae, wings so that students will understand the morphological characters which is helping in identification.

CO3: To understand the preparation of permanent slide of stored grain pest and sting apparatus of honey bee and the Collection and Identification of Stored grain pest, Paddy pest, pest of vegetables, Pest of pulses and Tea pest.

CO4: Preparation of arolium, empodium and pollen basket to understand the specific functions of leg. To understand the Preparation and Identification of Haemocytes.

CO5: To understand the insect collecting evices, methods of insect collection and preservation.

Contents:

1. Mounting of mouthparts of mosquito, cockroach, butterfly and honeybee.
2. Mounting of legs, antennae and wings(at least of two types).
3. Mounting of Stored grain pest.
4. Preparation of arolium, empodium and pollen basket.
5. Mounting of Sting Apparatus of Honey bee.
6. Preparation and Identification of Haemocytes.
7. Detection of Chitin.
8. Study of insect collecting devices.
9. Study of methods of insect collection and preservation.
10. Study of insects of economic importance.
11. Collection and Identification of Stored grain pest, Paddy pest, pest of vegetables, Pest of pulses and Tea pes

P. G. 4th semester

Course Code: ZOO-401 (Core)

Course Title: Molecular Biology and Bioinstrumentation

Credit: 6

Course Outcome:

CO1: To understand the biochemical organization of cell at molecular level.

CO2: To study structure and function of genetic material.

CO3: To study the mechanism of DNA replication, transcription and translation

CO4: To understand the biochemistry of metabolic process.

CO5: To understand the basic concept of instrument.

UNIT- I:

1. Nucleic acid- Molecular Structure and Properties of DNA and RNA. 2. DNA Replication- Replication in Prokaryotes and Eukaryotes, Semi conservative nature of DNA replication, Messelsons- Stahl experiment, Enzymes and proteins associated with replication, DNA polymerases 3. DNA Damage and Repair Mechanism- Different type of DNA Damage, Direct repair system, Excision repair system, Mismatch repair system, DNA break repair.

UNIT- II:

1. Transcription- Basic concept of Prokaryotic and Eukaryotic transcription, Promoters, Transcription factors, Initiation, elongation and termination of transcriptions in Eukaryotes. 2. Post Transcriptional Modification- Post transcriptional processing of RNA, Molecular events in Capping, Polyadenylation and Splicing mechanism 3. Translation- Genetic Code, Mechanism of Initiation, Elongation and Termination.

UNIT- III:

1. Carbohydrate metabolism- Glycolysis, Glycogenolysis, Gluconeogenesis, TCA cycle, Phosphogluconate pathway. 2. Lipid metabolism- Oxidation of fatty acid, Cholesterol biosynthesis and metabolism, Prostaglandins. 3. Protein metabolism- Amino acid Classification, Amino acid degradation, Decarboxylation, Deamination, Ornithine Cycle.

Unit- IV:

Microscopy: Phase contrast microscope, Fluorescence microscope, Electron microscope (TEM and SEM), Confocal microscope General Principle and applications of Colorimeter and

Spectrophotometer. Ultra centrifuge. Beer and Lambert's law. Chromatography-Principles and applications of GLC & HPLC; Electrophoresis- PAGE and Agarose Gel Electrophoresis; Cryopreservation of cells, tissues, organs and organisms. Immunological technique ,Principles of tissue fixation& Staining, Histochemistry Blotting Techniques- Western, Northern and Southern Blotting. Polymerase Chain Reaction (PCR).

Recommended Books

1. Alberts et al: Molecular Biology of the Cell (Garland, 2002)
2. Berg et al.: Biochemistry (5th Ed.), Freeman, 2002
3. Biochemistry (3rd Ed.), Tata-McGraw Hill, 1990
4. Boyer: Modern Experimental Biochemistry and Molecular biology (2nd Ed.), Benjamin/Cumin, 1993
5. Brooker: Genetics : Analysis and Principles (Addison-Wesley, 1999)
6. DeRobertis&DeRobertis: Cell and Molecular Biology (Lee &Febiger, 1987)
7. Griffith et al: Modern Genetic Analysis (Freeman, 2002)
8. Hartl& Jones: Essential Genetics: A Genomic Perspective (Jones &Bartlet, 2002)
9. Karp: Cell and Molecular Biology (John Wiley & Sons, 2002)
10. Lewin, Genes VIII (Wiley, 2004)
11. Lodish et al: Molecular Cell Biology (5th Ed.), Freeman, 2004
12. Pollard &Earnshaw: Cell Biology (Saunders, 2002).
13. Russell: Genetics (Benjamin Cummings, 2002)
14. Snustad& Simmons: Principles of Genetics (John Wiley, 2003).

Course Code: ZOO-402 (Core)

Course Title: Bioinformatics and Research Methodology

Credit: 6

Course Outcome:

CO1: An introduction to Genbank, UCSC, ENSEMBL, EMBL, DDBJ, protein sequence databases: Swissprot, PDB, BLAST, PSI- BLAST (steps involved in use and interpretation of results) and HMMER, BLAST vs FASTA, file formats- FASTA and Clustal W

CO2: An introduction and learning of computational genomics and proteomics, designing a microarray, image analysis and normalization, annotations, protein prediction tools- protein secondary structure, molecular modeling, identification and characterization of protein mass fingerprint, world- wide biological databases.

CO3: To understand the different types of Research. Demonstrate knowledge of research processes (reading, evaluating, and developing); Perform literature reviews using print and online databases; Identify, explain, compare, and prepare the key elements of a research proposal/report; Compare and contrast quantitative and qualitative research.

UNIT-I

1. Introduction to bioinformatics- Definitions of bioinformatics, applications of bioinformatics and scope of bioinformatics. 2. Biological Databases- Primary databases - Nucleotide sequence databases: GenBank, EMBL, DDBJ; Protein sequence databases: SWISSPROT, PIR; Structure databases: PDB, NDB; Secondary databases: PROSITE, Pfam, CATH; Literature database: PubMed; Database searching - Entrez; Database sequence submission BankIt. 3. BLAST and FASTA. 4. Sequence alignment and analysis- Types of sequence alignment, Methods of sequence alignment, Scoring schemes, Data retrieval, Construction of phylogenetic trees.

UNIT-II

1. Basic concept of research: Meaning of research, Objectives of research, Significance in research, Research versus Research methodology. Types of research: Description/ Analytical, Applied/ Fundamental, Quantitative /Qualitative, Conceptual/ Empirical. 2. Research formulation and Designs: Observation and Facts, Prediction and Explanation, Induction, Basic principle of Research design; Meaning, Need and features of good design, Types of Research design. 3. Literature Review: Importance of literature review, Critical Literature review, Identifying gap areas from literature review. 4. Intellectual Property Rights (IPR): Copy right, Designs, Patents, Trademarks, Geographical Indication. 5. Bioethics: Laws in India, Working with man and animals, Consent, Animal Ethical Committees and Constitutions.

Recommended Books

1. Zubay et al: Principles in Biochemistry (2nd Ed.), WCB, 1995
2. Rawns: Biochemistry, Neil Patterson, 1989
3. Mahler & Cordes: Textbook of Biological Chemistry, Harper, 1966.
4. Nelson et al: Lehninger Principles of Biochemistry (3rd Ed.), MacMillan Worth, 2000
5. Berg et al.: Biochemistry (5th Ed.), Freeman, 2002 6. Mathews et al.: Biochemistry (3rd Ed.), Pearson, 2004

Course Code: ZOO-403 A (Elective)

Course Title: Special Paper: Fish and Fishery Biology-II

Credit: 6

Course Outcome:

CO1: To understand the different system of freshwater aquaculture-monoculture, composite pisciculture, sewage fed fish culture, raft, raceway, pen and cage culture, and paddy cum fish culture; extensive, intensive, semi-intensive and traditional system of fish farming. To understand the management aspect of fish ponds (Nursery, rearing and stocking ponds). Pre and post stocking management of nursery pond.

CO2: To understand the importance of Air breathing fish and its importance in fishery. To understand the different Fisher Technology in northeast India.

CO3: To understand the Economic importance of fish and fishery in relation to human health. To understand the Exotic fish culture: selection of species, invasive species and its impact on natural fisheries.

CO4: To understand the concept of management of fishery: Fish health management: and Fish environment. To understand the Principles and method of processing and preservation of fish by refrigeration and freezing, drying, salting, canning, smoking and pickling.

CO5: To understand the Fish by products of their economic importance. To understand the Fish endocrinology, reproduction, genetics and biotechnology.

Contents

Unit-I : Freshwater aquaculture

Aquaculture: definition, scope and importance, concepts of different system of freshwater aquaculture- monoculture, composite pisciculture, sewage fed fish culture, raft, raceway, pen and cage culture, and paddy cum fish culture; extensive, intensive, semi-intensive and Integrated Fish farming System. Fish related aquatic microphytes of Northeast India. Macrophytes and their roles in aquaculture. Management aspect of fish ponds (Nursery, rearing and stocking ponds). Pre and post stocking management of nursery pond. Air breathing fish and its importance in fishery.

Unit-II:

Fishery Technology. Fishing gears: nets and crafts of Northeast India, selection of fishing gears, types of fishing gear used in different freshwater bodies. Economic importance of fish and fishery in relation To human health. Exotic fish culture: selection of species, invasive species and its impact on natural fisheries.

Unit-III.

Fishery management Fish health management: Diseases in aquaculture, parasitic and non-parasitic: bacterial, viral and fungal pathogens of fish. Fish pathology: prophylaxis and therapy. Fish environment: relationship between environment and fisheries, pollution of water pollution and impact on fisheries. Physical and chemical characteristics of water and soil. Fish processing and preservation: Principles and method of processing and preservation of fish by refrigeration and freezing, drying, salting, canning, smoking and pickling. Fish by products of their economic importance.

Unit-IV. Fish endocrinology, reproduction, genetics and biotechnology Endocrine glands:

Pituitary gland, thyroid gland and parathyroid gland, islet of Langerhans, Epiphysial gland etc., structure and functions. Reproduction: Functional morphology of gonads, types and modes of reproduction. Induced breeding: hypophysation, natural and synthetic hormones, bundh breeding. 2. Heredity and variation in fishes, chromosomes in fishes, sex determination in fishes. Fish biotechnology: Gynogenesis, androgenesis and polyploidy. Hybridization, Transgenic fishes: merits and demerits.

Recommended Books:

1. Brown, M.E. Physiology of fishes, Vols. 1 and 2, Academic press, 1957
2. Evans, D.H. Physiology of Fishes, II Edn.
3. Hoar, W. & Randall, Fish Physiology, Vol I-XV., Acad. Press.
4. Vishwanath, W., P. C. Mahanta, S. Debajit & N. Anganthoibi. 2011. Coldwater fishes of India—an atlas. Directorate of Coldwater Fisheries Research (Indian Council of Agricultural Research), Bhimtal.
5. Jayaram, K.C. 2008. Fishes of the Indian Region. Narendra Pub., New Delhi
6. Kitab Mahal, 1985 22. Lagler, K. F., Bardach J.E., Miller R.R. and May Passino, D.R. Ichthyology, John Wiley.

Course Code: MSC-403 B (Elective)

Course Title: Special Paper: Entomology-II: Insect Physiology and Economic Entomology

Credit: 6

Course Outcome:

CO1: To understand the digestive system of insect, insect nutrition and absorption.

CO2: To understand the Organs of Respiration, Mechanism of Gaseous Exchange, Respiration in Aquatic Insects, Physiology of Gill and Plastron Respiration, Respiration in Terrestrial insects- different types of spiracles and their structure, opening and closing mechanism of spiracles, trachea and tracheoles, Respiration in Entomophagus, Endoparasites.

CO3: To understand the Circulatory system of insects, Accessory Pulsatile Organs, Phagocytic organs, The haemolymph, Chemical composition of haemolymph, different types of haemocytes and their functions. To understand the Excretory system of Insects and in relation to understand the accessory organs of Excretion.

CO4: To understand the Nervous system of Insect: The Sympathetic Nervous System and nerve impulse transmission. To understand the Male and female reproductive System, Hormonal control of reproduction and types of Reproduction.

CO4: To understand the classification of pest, pest of Medical importance and Forest pest. To understand the mechanism of pest Control and the importance of Biological pest control. CO5: To understand the concept of Forensic Entomology.

Contents

UNIT: I

1. Digestive System: The Alimentary Canal, The Salivary Gland, Insect Nutrition, Physiology of Digestion and Absorption. 2. Respiratory System: The Organs of Respiration, Mechanism of Gaseous Exchange, Respiration in Aquatic Insects, Physiology of Gill and Plastron Respiration, Respiration in Terrestrial insects, opening and closing mechanism of spiracles, trachea and tracheoles. 3. Circulatory System: Components- The haemocoel, The dorsal vessel, Accessory Pulsatile Organs, Phagocytic organs, The haemolymph, Chemical composition of haemolymph, different types of haemocytes and their functions; Mechanism of Blood circulation.

UNIT: II

1.Excretory System: Types of Excretory system, The organs of Excretion, The accessory organs of Excretion, Physiology of excretion, Malpighian tubules- Anatomy and Histology. 2.Nervous System: Different types of Neurons, The Central Nervous system, Gross anatomy and Microanatomy of Brain, The Sympathetic Nervous System and nerve impulse transmission. 3. Reproductive Reproductive

System: The male reproductive system, The female reproductive system, Egg Maturation, Specialized Reproductive Mechanism, Hormonal control of reproduction. 4. Types of Reproduction: Ovoviviparity, Viviparity, Parthenogenesis, Paedogenesis, Polyembryony, Alternation of generation.

UNIT:III

Insects Pests: Classification of Pest, Pests of major crops- Pests of paddy, Pests of Wheat, Pests of Sugarcane, Pests of Cotton and Pests of Stored grains. 2. Pests of Medical Importance: Mode of Transmission, Common Vectors Insects- The Mosquitoes, The Sand flies, The Black flies.3. Forest Insect Pest: Types of Pest, Profile of some forest insect pest of Teak, Sal and Bamboo trees. 4. Pest Control: Primary Control Measures- Mechanical measures, Physical measures, Cultural measures, Legislative measures, Quarantine measures, Drawbacks of Chemical control; Modern Trends in Pest Control- Biological Control, Autocidal control, Integrated Pest Management

UNIT-IV:

Immunity in Insects: Mechanism of Innate Immunity in Insects; Antibacterial Immunity: Signalling pathways, Insect antibacterial proteins; Antiviral immunity, Bacterial resistance to Insect immunity; The Biological significance of Immunity. 2. Forensic Entomology: Principle and Scope, Forensic Insects and Factors and Forensic Entomological Investigation Methodology.

Recommended Books

1. Alford: A textbook of Agricultural Entomology, Blackwell Science Ltd. 1999
2. Atwal: Agricultural pests of India and south-east Asia, Kalyani Publishers, New Delhi, 1986.
3. Busvine: Insects and Hygiene, Chapman and Hall, (3rded.) 1980
4. Chandler & Read: Introduction to Parasitology, Willey International, 1970 5. Chapman, R.F., 1998. The Insect Structure and Function, Cambridge University Press.

5. 6. Dhaliwal and Arora: Principals of Insect pest management, National Agricultural Technology Information Centre, Ludhiana, 1996.
6. Dhaliwal and Arora: Trends in Agricultural Insect pest Management, Commonwealth Publ., New Delhi,

Course Code: ZOO-404

Course Title: Dissertation

Credit: 3

Course Outcome:

CO1: Student understand the concept of Research.

CO2: To understand how to prepare the method and methodology for a Research work. To understand the future field of interest so that one student can extend their Research Work to Ph.D.

CO3: To understand the new findings in the Research work.

CO4: To understand the expansion of research work from the level of classroom to the field.

CO5: To accountant students how formulate a research proposal and to generate innovative thinking

Course Code: ZOO-406C (Practical)

Course Title: Fish and Fish Biology-II

Credit: 3

Course Outcome:

CO1: To understand the various physiochemical parameters of water with respect to fish biology

CO2: To understand the age determining technique in fishes.

CO3: To analyze the haematological parameters in fishes.

CO4: To analyze the fish population estimation & its fecundity and the feeding habit of fishes and plankton analysis.

CO5: To understand the various design of fish farm/hatcheries & their significance.

Contents:

1. Collection of water sample for a pond for physicochemical parameters viz. free CO₂, DO₂, hardness, turbidity and alkalinity.
2. Age determination of fishes from skeleton, scales, preparation and examination.
3. Quantitative estimation of lipid from the viscera of a fish.
4. Histology: skin, gills, liver, stomach, intestine, testis, ovary and pituitary.
5. Water sampling, plankton collection, study of primary productivity in a fish farm.
6. Planktons: Identification of common zoo- and phyto-planktons of the freshwater ponds.
7. Practical record book.
8. Viva-voce.

Course Code: ZOO-406 D (Practical)

Course Title: Entomology-II: Insect Physiology and Economic Entomology

Credit: 3

Course Outcome:

CO1: To demonstrate the Male Reproductive system of Cockroach with help of dissection.

CO2: To understand the Nervous System, demonstrating the nervous system of cockroach with help of dissection.

CO3: Demonstrating the salivary gland of Cockroach to understand the importance of salivary secretion.

CO4: Demonstrating the digestive system of cockroach by dissection so that student will understand the general overview of digestive system of insect.

CO5: To understand the Bacterial Chamber of insect, demonstrating the bacterial chamber of termites. To prepare the mounting of hepatic caeca and malpighian tubules to understand the respiratory system.

Contents:

1. Male Reproductive system of Cockroach.
2. Female Reproductive system Cockroach.
3. Nervous system of Cockroach/ Grasshopper.
4. Salivary gland of Cockroach.
5. To determine the trehalase activity in haemolymph of any insect.
6. Study of different types of insect Eggs.
7. Field observation, identification and collection of insect pest of paddy, cotton, pulses, vegetables and forest trees.
8. Field observation, identification and collection of insect damages to crops.
9. Practical Record Book
10. Viva Voce