

COURSES OF STUDY
FOR
M.Sc. (ANNUAL SYSTEM)
2 YEAR PROGRAMME
IN
ZOOLOGY



**GOVERNMENT COLLEGE UNIVERSITY,
FAISALABAD.**

Website: www.gcuf.edu.pk

**DEPARTMENT OF ZOOLOGY,
GOVERNMENT COLLEGE UNIVERSITY, FAISALABAD.**

INTRODUCTION:

Department of Zoology was established in 1990 for the teaching of graduate and post graduate courses affiliated with Punjab University, Lahore, then took a mature turn after the up-gradation of Govt. College Faisalabad as Govt. College University, Faisalabad in 2002. Later on launching of MPhil, PhD and Honors programs added to its status and it has come forth as one of the academically sound Department of the country. The high profile motivated faculty loaded with initiative and drive is key strength of the Department. The fully equipped laboratories, well-furnished class rooms and update spacious library provide the best possible facilities to the students in their academic pursuits.

All the faculty members under the dynamic leadership of Dr. Farhat Jabeen are striving hard and exercising their potentialities to the maximum extent focusing the activity based learning. University industry linkage program for the joint research ventures have been initiated. For this purpose the Department has established a linkage through signing MoU with Newcastle University UK, WASA and Punjab Fisheries Department with an objective of sharing research facilities for educational and career development of the students coherent with professional requirement. The Department believes in its uplifting at world recognized level through imparting outstanding teaching and research by awarding degree in academic programs of BS, MSc, MS /MPhil and PhD in Zoology.

Recently department has recruited foreign qualified PhD faculty members to broaden the teaching and research horizon to face the modern challenges in the field of Science and Technology. Entomology, Fish Nutrition and Wet labs have been established to extend its infrastructure. Department has research project under INSPIRE Program (British council-Higher Education Commission funded project) and its two extension programs SPEKE and TNE on its credit. Moreover various other projects funded by Pakistan Science Foundation (PSF) and Higher Education Commission are being running in the Department.

COURSE OUTLINE FOR M.Sc. ZOOLOGY (ANNUAL SYSTEM)

Summary of Courses for Part-II

PART-II

Paper #	Title	Theory*	Practical*	Total
I	Environmental Biology	70	30	100
II	Evolution and Principles of Systematic Zoology (weightage 60:40)	70	30	100
III	Zoogeography and Principles of Palaeontology	70	30	100
IV	Thesis or	70	30	200
	Special Paper A	70	30	100
	Special Paper B	70	30	100
V	Elective/Supporting Paper	70	30	100
	Total:			600
	Grand Total:			1200

*Theory and practical are independent parts of each course. Student must pass in both parts independently to qualify in the course. Failure in any part will require re-appearance in both to qualify the course.

SPECIAL PAPERS

List of Special Paper A and Special Paper B (i.e., two papers for non-research students)

Paper #	Title	Marks
1	Entomology A (Morphology, Physiology and Ecology)	70
	Lab. Entomology A	30
2	Entomology B (Classification of Insects and Pest management)	70
	Lab. Entomology B	30
3	Endocrinology A (General and comparative endocrinology)	70
	Lab. Endocrinology A	30
4	Endocrinology B (Molecular and clinical endocrinology)	70
	Lab. Endocrinology B	30
5	Physiology A (Physiology of Coordination)	70
	Lab. Physiology A	30
6	Physiology B (Physiological systems and adaptations)	70
	Lab. Physiology B	30
7	Parasitology A	70
	Lab. Parasitology A	30
8	Parasitology B	70
	Lab. Parasitology B	30
9	Microbiology A (General Microbiology)	70
	Lab. Microbiology A	30
10	Microbiology B (Applied Microbiology)	70
	Lab. Microbiology B	30
11	Fisheries A (Principles of Fish Biology)	70
	Lab. Fisheries A	30
12	Fisheries B (Fish Physiology and Breeding)	70
	Lab. Fisheries B	30
13	Wildlife A (Principles of Environmental Health)	70
	Lab. Wildlife A	30
14	Wildlife B (Ecosystem Health Dynamics)	70
	Lab. Wildlife B	30

ELECTIVE / SUPPORTING PAPERS

List of Elective / supporting papers

Paper #	Title	Marks
1	Integrated Pest Management	70
	Lab. Integrated Pest Management	30
2	Physiology of reproduction	70
	Lab. Physiology of reproduction	30
3	Physiological systems and adaptations	70
	Lab. Physiological systems and adaptations	30
4	Comparative vertebrate endocrinology	70
	Lab. Comparative vertebrate endocrinology	30
5	Animal behavior	70
	Lab. Animal behavior	30
6	Principles of Toxicology	70
	Lab. Principles of Toxicology	30
7	Fish Disease and Health Management	70
	Lab. Fish Disease and Health Management	30
8	Mammalogy	70
	Lab. Mammalogy	30
9	Vector Biology	70
	Lab. Vector Biology	30
10	Helminthology	70
	Lab. Helminthology	30
11	Comparative anatomy and biology of vertebrates	70
	Lab. Comparative anatomy and biology of vertebrates	30
12	Human Embryology and Teratology	70
	Lab. Human Embryology and Teratology	30
13	Cell and Tissue culture	70
	Lab. Cell and Tissue culture	30
14	Apiculture	70
	Lab. Apiculture	30

M.Sc. Part-II
(COMPULSORY SUBJECTS)

I. ENVIRONMENTAL BIOLOGY

Theory

Concept of physical environment:

Origin of Solar System and Earth; Climate variation; Origin of Atmosphere; Origin of Oceans

Concept of living environment:

Life in water: History, Hydrologic cycle; Life on land: Biosphere I; Geography of biome; Biosphere II; A microcosm of earth

Global Ecosystems:

Atmosphere; Hydrosphere; freshwater, saltwater and marine; Lithosphere; role in biogeochemical cycle; Ecosphere; impact of industrialization on it; Urban Ecosystem; natural habitat destruction/shelter for endangered species; Disturbance in Ecosystem; modern/mechanized agriculture, industrialization

Interaction in Ecosystem:

Competition; Exploitation; predation, herbivory and parasitism; Mutualism;

Concept of Energy Flow:

Energy sources; Energy limitations; Allocation of energy

Concept of Primary Production:

Aquatic primary production; Terrestrial primary production; Consumer influence; Trophic levels

Concept of Food Web:

Community web; Keystone species; Exotic predators

Biogeochemical Cycles:

Nitrogen, Phosphorus, Sulphur, water, carbon, nutrient cycles

Environmental Resources and Conservation:

Mineral resources; Agriculture and Forestry; Agriculture land use; Range management; Desalination and weather modification

Succession and Stability:

Community change during succession; Ecosystem change during succession; Mechanism of succession; Community and ecosystem stability

Environmental Pollution:

Primary and secondary pollutants, point and non-point source pollutants, Air Pollution sources: Origin, dispersion. Impact of air pollutants viz. Sulphur oxides; Nitrogen oxides and Volatile organic compounds; Carbon oxides, Ozone, Smog. NH₃, PAN, PAH, smoke, water vapors, pollen grains and fungal spores on human crops and forest; MTBE (methyl tertiary butyl ether) and CFCs (chlorofluorocarbons); Noise pollution; sources, units, health damage from noise, control of noise; Water pollution; Sources of water pollutants; Composition and properties of water pollutants, Fate of water pollutants; Domestic and industrial effluents; Heavy metals and their impact on aquatic life; Water purification in nature; Waste water treatment plants; Wetland sewage treatment plants; cleaner, cheaper, and prettier water; Land Pollution; Pesticides (pollutants made to kill); Inorganic pesticides; Synthetic organic pesticides; Biochemicals (bacterial toxins and synthetic hormones); Chemical pesticides (non-target toxicity); Chlorine, dioxin and PCBs (polychlorinated biphenyls); Advantages and disadvantages of pesticides; Thermal pollution, global warming;; Warm water drainage from

nuclear reactor; Radioactive pollution; Radiations, unites, types, causative effects and leakage from nuclear reactor

Population Ecology:

Population dynamics; Pattern of survival and dispersion; Age of distribution, sex ratio; Dispersal; Population growth; Geometric and exponential population growth; Logistic population growth; Environmental limits on population growth

Population Ecology of man:

Community studies, Environmental management; Ecocrises; Environmental laws; Environmental ethics and politics; Environmental Economics; Chemical and biological warfare

Contemporary environmental themes:

Ozone depletion; Green house gases and their effects; Acid rain; Desertification; Deforestation, Range management.

Practical

Methods and analysis of population dynamics; Quadrature method; Determining frequency of different species; Determining density of species in habitat; Measurement of pollutants levels; In atmosphere (NO₂, SO₂, O₃ and comparison with rural air); In soil (toxic chemical, fertilizer, insecticides, pesticides, herbicides); In plants and animals; Analysis of polluted and freshwater for various pollutants like heavy metals, DO, CO₂, Chloride, -CO₃, -HCO₃, BOD, COD, pH, EC, total soluble and suspended solids, total acidity; Impact of radiation on microbes and plants; Effects of noise on animal behaviour

Books Recommended:

1. M.L. McKinney. 2007. Environmental Science: *System and Solution*. 4th Edition. Jones and Bartlett Publication, Boston, USA
2. G. Tyler Miller, Jr. 2002. Living in the Environment. Principles, Connections and Solutions. Book/Cole Thomson Learning, USA
3. Peter Stilling, 2002. Ecology. 4th Edition. Prentice Hall Publication, New Jersey, USA
4. Krebs. 2000 Ecology: The experimental analysis of distribution and application.
5. J.L. Chapman and M.J. Reiss, 1997. Ecology. Cambridge University Press, UK.
6. M.C. Molles. 1999. Ecology: *Concepts and applications* WCB/McGraw Hill, New York
7. C.E. Mason. 1996. Biology of Freshwater Pollution. Longman Publication, UK
8. E.P. Odum. 1996. Ecology: A Bridge between science and society.
9. R.K. Singh. 1998. Human Ecology.
10. R. Lloyd.1992. Pollution and Freshwater. Fishing News Books
11. Smith, 1988. Ecology and Field Biology. National Book Foundation, Islamabad.
12. E. P. Odum. 1976. Fundamentals of Ecology National Book Foundation, Islamabad.

II. EVOLUTION AND PRINCIPLES OF SYSTEMATIC ZOOLOGY

Evolution:

Origin of life: Panspermia and Chemical theory; The causes of micro-evolution; Hardy-Weinberg equilibrium, Mutation, Gene flow, Genetic drift, Nonrandom breeding, and natural selection. Types of natural selection, its measurement. Causes of polymorphism in populations. The general selection model: (one locus and two locus), Genetic load, Cost of selection, Hitchhiking, Linkage disequilibrium and shifting balance theory. Fitness and its measurement, Dependence of fitness on frequency of individual. Concept of phenotypic variation: Polygenic traits and Heritability. Explanation for adaptation, genetics of adaptation, reasons of imperfect adaptation. The Units of selection (allele, cell line, organisms, kin group and group). Sexual selection, Theories of sexual selection; Darwin, Fisher and Zahavi. Macroevolution: Evolutionary developmental biology: allometry, heterochrony, species selection, Evolutionary innovation and origin of higher taxa. Rates of evolution; Evolutionary trends and laws, Gradualism and punctuated equilibrium. Coevolution and co adaptations.

Systematics:

Contribution of systematics to biology. Concepts of taxon, phenon and category. Species concepts and its problems (Typological, Nominalistic, Biological, Evolutionary, Mate recognition, Genetic cohesion, Phylogenetic and Phenetic concepts). Subspecies concepts, Clines and hybrid zones, Polytypic species, superspecies. Modes of speciation. Intrapopulational variation. Different kinds of taxonomic characters. Weightage of taxonomic characters. Classification and its types: Phenetic, cladistic and Evolutionary classifications. Difference between types of classification. Taxonomic collections and the process of identification. Types of taxonomic publications, major features of taxonomic articles. The rules of zoological nomenclature (interpretation and application of the code (Stability, priority, first reviser principle), range of authority of code, concept of availability, type method, formation of specific names, synonym, homonym.

Practicals:

Experiments that simulate the effects of natural selection and adaptation in changing environments, genetic drift, and the importance of population size in natural population. Discussion on evidences of evolution and their problems. The study of a group of organisms while utilizing Key. Collection, preservation, labeling and identification of a group of specimen according to expertise available in the institute. Preparation of bracket and indent key. Biometry Rationale, collection of data, statistical analysis (F test, t test, Z test, analysis of variance, regression and correlation) and interpretation. Phylogeny Reconstruction. Application of phenetic (similarity and dissimilarity matrix and unweighted pair group method) and cladistic (compatibility method) analysis to a group of mock "organisms."

Text Books:

1. Ridley, M. 2004. Evolution, 3rd Ed.. Blackwell Science.
2. Mayer, E. and Ashlock, P. D. () Principles of Systematic Zoology. McGraw Hill, New York.

Books Recommended:

1. Bell, G. 1997. Selection: the mechanism of evolution. Chapman and Hall, NY.
2. Dawkins, R. 1986. The blind watchmaker. Longman Scientific and Technical. Essex, England.
3. Dawkins, R.. 1978. The selfish gene. Oxford University Press, NY.
4. Freeman, S. and Herron, J. C. 2004. Evolutionary analysis, 3rd ed. Pearson Prentice Hall.
5. Futuyma, D. J. 1997. Evolutionary Biology, 3rd ed. Sinauer Associates, Inc. Sunderland, Massachusetts.
6. Gould, S. J. 1977. Ever since Darwin. W. W. Norton and Company, NY.
7. Ridley, M. 2000. Genome. New York: Perennial. Great reading.
8. Stearns, S. C. and Hoekstra, R. F. 2000. Evolution, an introduction. Oxford University Press.
9. Strickberger, (3rd or latest Ed.) Evolution. Jones and Barrett Publishers.
10. Freeman Dyson, (1999). Origin of life, Cambridge University press.
11. Simpson, G, G. (latest Ed.). Principle of animal taxonomy. Columbia University Press, New York.
12. Sokal R., and Sneath P.H. A. (latest Ed.). Principles of numerical taxonomy. W.H. Freeman and company, London.

III. ZOOGEOGRAPHY AND PRINCIPLES OF PALAEOLOGY

Zoogeography **Theory**

Branches of zoogeography (Descriptive, chorology, Faunistics, systematic, biocoenotic, causal, ecological, historical, experimental and applied zoogeography); Animal distribution (Cosmopolitan distribution, discontinuous distribution, isolation distribution, bipolar distribution and endemic distribution); Barriers and dispersal (Barriers and means of dispersal in marine, fresh water and terrestrial environments); Zoogeographical regions (division, geographic ranges, physical features, climates, faunas and affinities of Holarctic (Palaeartic and Nearctic regions), Oriental, Ethiopian, Australian and New tropical Regions); Insular fauna [Continental islands (British Isles, Borneo, Java, Japan, Formosa and Philippines and Sri Lanka islands)] [Oceanic Islands, (Azores, Bermuda, Galapagos, St. Helena and Karakatau Islands) Ancient Islands (New Zealand and Madagascar Islands)]; Palaeogeography (Theories of permanence of continents, Land bridges, Continental drift and Plate tectonics).

Books Recommended:

1. Darlington, 1963. Zoogeography. John Wiley & Sons, New York.
2. Allee, Schmidh and Hesse, 1951. Ecological Animal Geography. John Wiley & Sons, Ltd., New York.
3. De Beaufort, 1951. Zoogeography of the Land Inland Waters. Sidgwick & Jackson, Ltd., London.
4. Ekman, 1953. Zoogeography of the sea. London, Sedgwick and Jackson, Ltd London.
5. Lillies, 1974. Introduction to Zoogeography. By Joachim lilies. Translated by WD Williams. London: Macmillan.

6. Muller, 1974. Aspects of Zoogeography. Hague, Dr. W. Junk Publishers
7. Jafri, 1977. Land Zoogeography of World.
8. Ali, S.S., 1999. Palaeontology, Zoogeography and Wildlife Management.

Principles of Palaeontology

Theory

The history of life; Earth, Shells of earth (Atmosphere, hydrosphere, biosphere and lithosphere); Rock, types of rocks (Igneous rocks, sedimentary rocks and metamorphic rocks); Fossil, types and uses of fossils, Nature of fossils, Processes of fossilization (Study of process of dying and what processes occur to animals after their death, Geological concepts of fossilization); Geological time scale; Pre-Cambrian life, Post-Cambrian life (Paleozoic life, Mesozoic life, Cenozoic life); A brief history of the Siwaliks; Geochronometry (Uranium/Lead dating, radiocarbon dating, Fission track dating and palaeomagnetism); Evolutionary histories of camels, horses, elephants and man.

Books Recommended:

1. Young J.Z., 1950. (3rd edition). Life of vertebrates. London, Oxford Univ. Press.
2. Dunbar C.O., 1960. Historical Geology. John Willey and Sons Inc. New York.
3. Brouwer, A., 1977. General Palaeontology, Oliver and Boyed, London.
4. Gilbert, Colbert, E.H., 1980. Evolution of vertebrates, John Willey and Sons Inc. New York.
5. Moore, R.C. Lalicker, G.C., Fisher, A.G., 1952. Invertebrate Fossils. McGraw-Hill, New York.
6. Steven M. Stanley, 2008. Earth system History. 3rd addition.
7. Ali, S.S., 1999. Palaeontology, Zoogeography and Wildlife Management.
8. Michael Foote and Arnold I. Miller, 2007. Principles of Palaeontology (3rd Ed.) Freeman and Company.

Practicals

Zoogeography and Principles of Palaeontology

Study of rocks (Igneous, sedimentary and metamorphic rocks); Identification and classification of vertebrates and invertebrate fossils; Study of molds, casts, pseudomorphs, petrified fossils, imprints, foot prints and coprolites; Study of vertebrate fossils of evolutionary importance e.g. Horses, Elephants, Primates and Camels etc; The classification of vertebrate animals up to species and their zoogeographical distribution.

IV. THESES/SPECIAL PAPERS

SPECIAL SUBJECTS

IV-1A. ENTOMOLOGY A (Morphology, Physiology and Ecology)

Theory

General characteristics of insects. Relationship with other Arthropoda, splitting up into different evolutionary lines. Reasons for success of the insects in diverse environments.

Hard Parts: General segmentation, Tagmatosis and organization.

Cuticle: Detailed structure along with its biochemistry. Epidermal layer; its structure and function. Basement membrane. Colours of insects. Cuticular outgrowths and appendages sclerotization.

Head: Cephalization, Sclerites, Modifications. Antennae: Different modes of ingestion and types of mouth parts.

Neck: Sclerites.

Thorax: Sclerites: legs, their different modifications and functions.

Wings: Origin: Different regions. Development. Basal attachments. Main veins and their branches (generalized insects). Wing coupling.

Abdomen: Secondary appendages and external genitalia. Flight: types of flight. Aerodynamics. Fuels.

Endoskeleton: Head, thorax and abdomen.

Soft Parts: Muscular system: Basic structure. Types of muscles. Muscle contraction and its energetics. Comparative structure of all the systems, e.g., digestive, excretory, respiratory, incubatory, and nervous system and their physiology. Sense organs: sound and light producing organs. Nutritive requirements: Fat body. Exocrine and Endocrine glands including pheromones and their functions.

Reproduction: Reproductive organs and different types of reproduction in insects. Egg fertilization and maturation.

Development: Embryology up to dorsal closure. Different types of metamorphosis. Apolysis and ecdysis and the role of endocrine secretions.

Ecology: Carrying capacity 'r' and k selection. Food chains. Predation and competition. Insect defences and adaptations. Diapause insect population and community studies. Insect communication.

Practicals

Preparation of permanent slides. All the hard parts (terminal segments, wings, antennae, legs, mouth parts and genitalia). Different systems, especially digestive, reproductive of the following insects. American cockroach, Gryllus, grasshopper, housefly, butterfly, mosquito, any common beetle. Red cotton bug. Wasp and honey bee. Sympathetic nervous system of cockroach and gryllus. Salivary glands of cockroach, red cotton bug and honey bee.

Books Recommended

1. GENERAL TEXT BOOK OF ENTOMOLOGY. Imm. Richards and Davies, Vol.1.
2. THE INSECTS: STRUCTURE AND FUNCTION, 2000. Chapman.
3. INSECT PHYSIOLOGY. Wiggles Worth.
4. INSECT PHYSIOLOGY. Pattons.
5. INSECT ECOLOGY. Price.
6. ECOLOGY: THE EXPERIMENTAL ANALYSIS ABUNDANCE. Krebs.
7. MODERN ENTOMOLOGY, 1997. Tembhare.
8. ECOLOGICAL METHODS, 1978. T.R.E. Southood.
9. ELEMENTS OF INSECT ECOLOGY, 1997. S.S. Yasbani and M.L. Agarwal.

IV-1B: ENTOMOLOGY B (Classification of Insects and Pest Management)

Theory

A general account including classification of insect orders: Collembola, Orthoptera, Dictyoptera, Isoptera, Hemiptera, Lepidoptera, Diptera, Hymenoptera, Coleoptera. Only diagnostic characters of the remaining insect orders: Thysanura, Diplura, Protura, Ephemeroptera, Odonata, Plecoptera, Grylloblattoidea, Phasmida, Dermaptera, Embioptera, Zoraptera, Psocoptera, Mallophaga, Siphunculata, Thysanoptera, Neuroptera, Mecoptera, Tricoptera, Siphonaptera, Strepsiptera, Insects of economic importance.

Brief account of biological control, chemical control and integrated pest management: common sampling techniques in insect pest management, concept of economic levels, economic damage and economic boundary, economic injury level and economic threshold. Household pests and their management.

Practicals

1. Collection, preservation and identification of insects upto families (except for the identification upto species of a few pests of great economic importance), with the help of keys/literature.

Books Recommended:

1. Pedigo, L.P., 1991. Entomology and Pest Management. Maxwell MacMillan.
2. Richards, O.W. and Davies, R.J., 1977. *Imm's General Textbook of Entomology*. Vol-2
3. Metcalf, C.L. and Flint, W.P., 1962. *Destructive and Useful Insects*, McGraw-Hill.

IV-2A. ENDOCRINOLOGY A (General & Comparative Endocrinology)

Theory

An overview of general concepts and principles of endocrinology: The endocrine system; Type of hormones; Endocrine and nervous system relationship; General principles in function, interaction, nature, synthesis, transport of hormones; General concept of feed back, biorhythms, pathology and assessment of endocrine function; Evolution of endocrine system.

Hypothalamus and pituitary: Hypothalamic hormones: Origin, chemistry and actions; Anterior pituitary and hormones: Hypothalamic pituitary regulation, General chemistry, Physiological action and metabolism of prolactin-growth hormone family, glycoprotein hormone family,

corticotrophins and other pro-opiomelanocortin peptides; posterior pituitary: Release, regulation and actions of vasopressin and oxytocin.

Thyroid gland: Anatomy and histology of gland; Formation and secretion of thyroid hormones; Thyroid hormones in peripheral tissues, Regulation and factors affecting thyroid function.

Calcitropic and Mineral Metabolism Hormones: Chemistry, physiological actions and metabolism of parathyroid hormone, calcitonin and calciferols; Homeostasis of calcium, phosphate and magnesium.

Pancreatic Hormones and Regulatory Peptides of the Gut: Anatomy and histology for sources of the hormones; Chemistry, physiological roles and mechanism of action of insulin and glucagon; Physiological roles of gut peptides.

Adrenal Medulla and Catecholamines: Chromaffin cell and organization; Structure of adrenal medulla; Biosynthesis, storage, release and metabolism; Adrenergic receptors.

Adrenal Cortex: Steroid biochemistry; Physiological actions of corticoid hormones; Regulation and metabolism of glucocorticoids, mineralocorticoids and adrenal sex steroids.

Testes: Androgenic tissue: Structure and chemistry; Transport, metabolism and mechanism of action.

Ovaries: Ovarian hormones: Steroid biochemistry and biosynthesis; Transport, metabolism and mechanism of action.

Endocrinology of Pregnancy: Hormones in conception and implantation; Hormonal actions and adaptation in pregnancy and parturition.

Endocrinology of Lactation: Hormones in lactation.

Endocrinology of Heart, Kidney, Immune system: Growth and pineal gland.

Functional Diversity of Hormones in Vertebrates.

Overview of Endocrine Mechanisms in Invertebrates.

Practicals

Demonstration of endocrine glands and associated structures in dissections, transparencies, computer projections etc; Histological and ultrastructure features of endocrine glands; Experiments to demonstrate physiological roles of hormones of different endocrine glands; Experiments to demonstrate regulation of hormones' releases. Experiments to demonstrate functional diversity of hormones in different vertebrates. Experiments on endocrine mechanism in vertebrates.

Books Recommended:

1. Greenspan, F.S. and Stewler, G.J., 2002. Basic and clinical endocrinology, 5th Ed.. Prentice Hall International Inc., London.
2. Wilson, J.D., Foster, D.W., Kronenberg, H.M. and Larsen, P.R., 1998. Williams textbook of endocrinology, 9th Ed.. W.D. Saunders Company, Philadelphia.
3. DeDroot, L.J., Jameson, J.L. *et al.*, 2001. Endocrinology, Vol.I, II and III, 4th Ed.. W.B. Saunders, Philadelphia.
4. Giffin, J.E. and Ojeda, S.R., 2000. 4th Ed.. Textbook of Endocrine Physiology. Oxford University Press, Oxford.
5. Neal, J.M., 2000. Basic Endocrinology: An interactive approach. Blackwell Science Inc., London.

IV-2B. ENDOCRINOLOGY B (Molecular and Clinical Endocrinology)

Theory

General Mechanisms in Molecular Endocrinology: Subcellular structure of cells secreting protein hormones; Process of hormone secretion; Transcription factors in developmental organisms in endocrine systems. Recombinant DNA technology and molecular genetics in diagnosis and treatment of endocrine diseases. Measurements of hormones: Radioimmunoassay, immunoradiometric, immunochemiluminometric and radioreceptor assays and their statistical procedures.

Mechanisms of Action of Hormones: Hormone systems and intracellular communication; Hormones acting at cell surface: Properties of hormone receptor interaction, structure, biosynthesis and turnover of membrane receptors; Hormones acting in transcription regulation: Biochemistry and molecular interaction of steroid receptor, gene expression, messenger RNA stability and metabolism in hormone action.

Functional Pathology in Endocrine Glands: Neuroendocrine disorder of gonadotrophin, prolactin, growth hormone, corticotrophin regulation; Pituitary Disorders: Prolactinomas, acromegaly, Cushing's syndrome. Diabetes insipidus, hypo- and hyper-tonic syndromes; Thyroid Diseases of excess and deficient hormones and autoimmunity; Adrenal cortex: Disorders of cortical hypo and hyper function; Disorders of Adrenal Medullary Function; Disorders of Ovarian Function and Hormonal Therapy; Abnormalities of Testicular Functions and Hormonal Therapy.

Fuel Homeostasis: Glucose Homeostasis and Hypoglycemia; Diabetes Mellitus; Disorders of Lipoprotein Metabolism; Eating Disorders: Obesity, anorexia nervosa and bulimia nervosa.

Development and Growth: Disorders of growth and puberty.

Endocrine Hypertension

Polyendocrine Syndromes.

Hormones and Cancers: Hormones Effect on Tumors, Breast and Prostate Cancer; Endocrine Therapy; Humoral Manifestation of Malignancy.

Geriatric Endocrinology: Endocrine and Associated Metabolism in aging: Specifically thyroid, glucose and calcium homeostasis.

Practicals

Studies on recognition and response of receptors; Studies of disorders of pituitary by observing anatomical and histological features; Studies of thyroid status in deficient and excess hormone functions; Studies of type 1 and type 2 diabetes mellitus: Epidemiology of the types in population, studies of management of the type 2; Model studies of disorders of Ovarian and Testicular disorders; Model studies of obesity and anorexia; Studies of hormonal status in puberty and aging.

Books Recommended:

1. Greenspan, F.S. and Stewler, G.J., 2002. Basic and clinical endocrinology, 5th Ed.. Prentice Hall International Inc., London.
2. Wilson, J.D., Foster, D.W., Kronenberg, H.M. and Larsen, P.R., 1998. Williams textbook of endocrinology, 9th Ed.. W.D. Saunders Company, Philadelphia.
3. DeDroot, L.J., Jameson, J.L. *et al.*, 2001. Endocrinology, Vol. I, II and III, 4th Ed.. W.B. Saunders, Philadelphia.

4. Giffin, J.E. and Ojeda, S.R., 2000. 4th Ed. Textbook of Endocrine Physiology. Oxford University Press, Oxford.
5. Neal, J.M., 2000. Basic Endocrinology: An interactive approach. Blackwell Science Inc., London.

IV-3A. PHYSIOLOGY A (Physiology of Coordination)

Theory

Physiological Mechanisms at Cell: Cellular membrane and transmembrane transport; resting membrane potentials; Generation and conduction of action potentials; synaptic transmission; Membrane receptors, Second messenger and signal-transduction pathways.

Nervous System: Organization of nervous system; General sensory system; Visual, Auditory, Vestibular and Chemical sensory system; Motor system with brainstem, Cortical, Cerebellar and basal ganglia control of posture and movements; Autonomic system and its control; Higher functions of nervous system including state of consciousness, learning, memory.

Muscle and Movements: Molecular basis of contraction; Muscles activity on skeleton; Adaptation of muscles for various activities; Muscles in the walls of hollow organs.

Endocrine System: General principles of endocrine physiology; Hormones in homeostasis of metabolism; Endocrine regulation of metabolism of calcium and phosphate; Parathyroid gland, Calcitonin and Cholecalciferol; Hypothalamus and Pituitary: Hypothalamic regulation of pituitary, pituitary gland hormone in physiological coordination; Thyroid gland: Functional anatomy, biosynthesis, regulation and roles in physiological functions, mechanism of thyroid hormones action; Adrenal cortex: Hormones biosynthesis, physiological roles and control; Adrenal medulla: Hormones biosynthesis, physiological roles, and hypothalamic-pituitary-adrenocortical axis, adrenal medulla and sympathetic nervous system together integrate responses to stress; Endocrine function of kidney, heart and pineal gland; General reproductive mechanisms: Energetics of reproduction; Functional anatomy, synthesis and regulation of gonadal steroids, secretory pattern of gonadal steroid at different stage of life; Male reproduction: Roles of androgen, biology and regulation of spermatogenesis, male puberty; Female reproduction: Roles of ovarian steroids, biology and regulation of oogenesis, female puberty, cyclic changes and adaptations in gestation, parturition, lactation and menopause.

Practicals

Recording of action potentials on oscilloscope and effects of various factors on its characters; Study of synaptic activity with neuromuscular preparations; Sciatic nerve compound action potential. Demonstration of nervous system organization while studying brain, cranial nerve, spinal cord and spinal nerves. Experiments on sensory organs study. Experiments on characteristics of skeletal muscle contractions; Responses of intestinal muscles and effect of drugs. Demonstration of endocrine glands in a mammal (mouse). Effect of hormones on glycemia and calcemia; Effect of thyroxine on oxygen consumption; Effect of androgen on

accessory sex organs and of estrogens on target tissues; Study of estrous cycle and effects of the hormones.

Books Recommended:

1. Randall, D., Burggren, W., French, K. and Fernald, R., 2002. Eckert Animal Physiology: Mechanisms and Adaptations, 5th ed. W.H. Freeman and Company, New York
2. Bullock, J., Boyle, J. and Wang, M.B., 2001. Physiology, 4th ed. Lippincott, Williams and Wilkins, Philadelphia.
3. Berne, R.M. and Levy, M.N., 2000. Principles of Physiology, 3rd Ed.. St. Louis, Mosby.
4. Guyton, A.C. and Hall, J.E., 2006. Textbook of Medical Physiology, 11th Ed.. W.B. Saunders Company, Philadelphia.
5. Withers, P.C., 1992. Comparative Animal Physiology. Saunders College Publishing, Philadelphia.
6. Schmidt-Nelsen, K., 1997. Animal Physiology, Adaptation and Environment, 5th Ed.. Cambridge University Press, Cambridge.
7. Tharp, G. and Woodman, D., 2011. Experiments in Physiology, 101th Ed.. Prentice Hall, London.

IV-3B. PHYSIOLOGY B (Physiological Systems and Adaptations)

Theory

Cardiovascular System: Blood and homeostasis; Physiology of cardiac muscles; Automaticity and rhythmicity in heart activity and cycle; Electrocardiography; Regulation of heart activity; Hemodynamics; Arterial system; Microcirculation and lymphatics; Control of cardiac output; Special circulations: Cutaneous, skeletal, coronary, cerebral, fetal.

Respiratory System: Overview of respiratory system; Pulmonary and bronchial circulations; Mechanical aspects of breathing; Transport of oxygen and carbondioxide; Regulation of ventilation; Respiratory responses in extreme conditions.

Renal System: Elements of renal function; Tubular function in nephron; Control of body fluid volume and osmolality; Potassium, Calcium and Phosphate homeostais; Role of kidney in acid-base balance.

Gastrointestinal System: Gastrointestinal secretions and their control: Salivary, gastric, pancreatic and liver; Digestion and Absorption of carbohydrates, proteins, lipids, vitamins, ions and water; Motility of gastrointestinal tract: Functional anatomy, regulation and motility in various segments.

Osmoregulation: Problems of osmoregulation; Obligatory exchange of ions and water; Osmoregulators and osmoconformers; Osmoregulation in aquous and terrestrial environments.

Environmental Challenges: Temperature and animal energetics; Temperature relation of Ectotherms, Heterotherms and Endotherms; Dormancy: Special metabolic state; Body rhythms and energetic; Energy, environment and evolution.

Practicals

Experiments on the study of heart in prepared frogs; Study of blood pressure in various physiological states; Study of electrocardiograms; Blood coagulation study. Determination of oxygen consumption in fish and mouse and effects of factors; Demonstration of respiratory volume and pulmonary function tests. Experiments on digestion on nutrients by enzymes and effects of factors; Study of exocrine secretion in stomach or pancreas and effects of factors. Experiments on kidney regulation of osmolality; Urine analysis; Study of osmoregulatory adaptations in animals inhabiting various environments; Demonstration of effect of temperature on several physiological responses; Study of animals in various types of dormancy.

Books Recommended

1. Randall, D., Burggren, W., French, K. and Fernald, R., 2002. Eckert Animal Physiology: Mechanisms and Adaptations, 5th ed. W.H. Freeman and Company, New York
2. Bullock, J., Boyle, J. and Wang, M.B., 2001. Physiology, 4th ed. Lippincott, Williams and Wilkins, Philadelphia.
3. Berne, R.M. and Levy, M.N., 2000. Principles of Physiology, 3rd Ed.. St. Louis, Mosby.
4. Guyton, A.C. and Hall, J.E., 2006. Textbook of Medical Physiology, 11th Ed.. W.B. Saunders Company, Philadelphia.
5. Withers, P.C., 1992. Comparative Animal Physiology. Saunders College Publishing, Philadelphia.
6. Schmidt-Nelsen, K., 1997. Animal Physiology, Adaptation and Environment, 5th Ed.. Cambridge University Press, Cambridge.
7. Tharp, G. and Woodman, D., 2011. Experiments in Physiology, 10th Ed.. Prentice Hall, London.

IV-4A. PARASITOLOGY A

Introduction to parasitology. Relationship to other sciences, parasitology and human welfare. Parasites of domestic and wild animals. Camers in parasitology. Some basic definitions.

Basic principles and concepts. Parasite ecology and evolution.

Basic principles and concepts. Immunology and pathology. Susceptibility and resistance, innate defence mechanisms. Acquired immune response in vertebrates. Immunity in invertebrates. Immunodiagnosis, pathogenesis of parasitic infections. Accommodation and tolerance in the host-parasite relationship.

Parasitic protozoa, form, function and classification.

Kinetoplasta, trypanosomes and their kin, forms of trypanosomatidae.

Other flagellated protozoa, order Retortamonadita, order Diplomonadida, order Trichomonadida, order Opalinida.

The Amoebas. Order Amoebida, order Schizopyrenida.

Phylum Apicomplexa, Gregarines, Coccidia and related organisms. The apical complex, class Gregarinaea, class Coccidea.

Phylum Apicomplexa, Malana, organisms, and pyroplasms, order Haemospondea, order Pyroplasmida.

Phylum ciliophora, ciliated protistan parasites, class Spirotoichea, class Litostomitea, class Oligohymenophorea.

Phyla Microspora and Myxozoa. Parasites with polar filaments. Phylum Microspora, Phylum Myxozoa.

The Mesozoa, pioneers or Degenerates. Class Rhombozoa, class orthonectida, Phylogenetic position, physiology and Host parasite relationship. Classification of Phylum Mesozoa.

Books Recommended:

1. FOUNDATION OF PARASITOLOGY, 2000, 6th ed. Roberts, L.S. and Janovy, J. McGraw Hill Book Co.
2. PROTOZOOLOGY, 1996, 2nd ed. Hausman, K. and Hulsmann, N. Thieme Medical Publishers, Inc. New York.

Practical

- 1 Study of the prepared slides of Protozoan Parasites
 1. *Giardia lamblia* (Cyst and trophozoite)
 2. *Eimeria tenella* (Cyst and trophozoite)
 3. *Endolimax nana* (Cyst)
 4. *Entamoeba histolytica*
 5. *Histomonas meliagridis*
 6. *Leishmania*
 7. *Opalina*
 8. *Plasmodium falciparum*
 9. *Plasmodium vivax*
 10. *Schistosoma mansoni*
 11. Trophozoite of *Giardia lamblia*
 12. *Trypanosoma cruzi*
 13. *Trypanosoma gambiense*
 14. *Neglaria fowleri*
 15. *Monocystis lumbrici*
- 2 Culturing of protozoa (*Entamoeba*, *histomonas meliagridis*)
- 3 Establishing infection studies of *Eimeria tenella* in chicken
- 4 Study of malarial parasite in thick and thin blood films.
- 5 Effects of coccidiosis on hematological parameters of chicks
- 6 Macroscopic and microscopic observation of lesions caused by protozoan parasite infection in host tissues (histopathology of infected tissue)

Books Recommended:

1. Chaudhri SS and Gupta SK. 2003. *Manual of General Veterinary Parasitology*. International Book Distr. Co.
2. Sterling CR. and Adam RD. 2004. *The Pathogenic Enteric Protozoa*. Kluwer Academic Press.
3. Durr P & Gatrell A. 2004. *GIS and Spatial Analysis in Veterinary Science*. CABI. Ministry of Agriculture, Fisheries and Food (MAFF). 1986. *Manual of Veterinary Parasitological Laboratory Techniques*. 3rd Ed. Tech. Bull. 18, HMSO.
4. Rathore VS & Sengar YS. 2005. *Diagnostic Parasitology*. Pointer Publ.

IV-4B. PARASITOLOGY B

Theory:

Systematics, biology, pathology, host parasite relationships and control of parasitic Helminths with particular reference to Helminths of Medical and Veterinary importance.

Systematics, morphology and biology of Arthropods causing disease or those responsible for transmission of disease. Chemical and non-chemical control of Arthropods of Medical and Veterinary importance.

Practicals

Methods of collection, preservation and transportation of parasitic material. Qualitative and quantitative faecal examination for helminth ova. Collection, preservation and preparation of slides of local helminthes and their identification. Identification of insects of medical and veterinary importance.

Books Recommended:

1. Noble and Noble, 1982. Parasitology. The Biology of animal parasites. 5th Ed.. Lea and Febiger.
2. Beck, J.W. and Davies, J.E., 1981. Medical parasitology. 3rd Ed.. The C.V. Mosby Company, Toronto, London.
3. Cheesbrough, M., 1987. Medical Laboratory Manual for Tropical Medicine. Vol.I. University Press Cambridge.
4. Smyth, J.D., 1994. Introduction to Animal Parasitology. Cambridge University Press.
5. Roberts, L.S. and Janovy, J. Jr., 2001. Foundations of Parasitology. 5th Ed.. Wm Brown Publishers, Chicago, London, Tokyo, Toronto.
6. Urquhart, G.M., Hucan, J.L., Dunn, A.M. and Jennings, F.W., 2000. Veterinary Parasitology. Longman Scientific and Technical publications, Longman Group, U.K.

IV-5A. MICROBIOLOGY A (General Microbiology)

Theory

History and Introduction of Microbiology: The beginnings of Microbiology; Discovery of the microbial world; Discovery of the role of microorganisms in transformation of organic matter, in the causation of diseases, development of pure culture methods. The scope of microbiology.

Characterization, Classification, and Identification of Microorganisms: Microbial evolution, systematics and taxonomy; Characterization and identification of microorganisms. Nomenclature and Bergey's manual. **Morphology and fine structure of bacteria:** Size, shape and arrangement of bacterial cells, Flagella and motility, Pili, Capsules, sheaths, Prosthecae and stalks, structure and chemical composition of cell wall, cytoplasmic membrane, protoplasts, spheroplasts, the cytoplasm, nuclear material. **The Cultivation of Bacteria:** Nutritional requirements, nutritional types of bacteria, bacteriological media, physical conditions required for growth, choice of media, conditions of incubation. **Reproduction and growth of bacteria:** Modes of cell division, New cell formation, Normal growth cycle of bacteria, synchronous growth, continuous culture, quantitative measurement of bacterial growth; Direct microscopic count, Electronic enumeration of cell numbers, the plate count method, Membrane-filter count, Turbidimetric method, Determination of nitrogen content, Determination of the dry weight of cells, The selection of a procedure to measure growth, Importance of measurement of growth.

Pure cultures and cultural characteristics: Natural microbial populations, selective methods; Chemical methods, Physical methods, Biological methods, Selection in nature, Pure cultures; Methods of isolating pure cultures, Maintenance and preservation of pure cultures, Culture collections, Cultural characteristics; Colony characteristics, Characteristics of broth cultures.

Prokaryotic diversity Bacteria: Purple and green bacteria; cyanobacteria, prochlorophytes, chemolithotrophs, methanotrophs and methylotrophs, sulfate and sulfur-reducing bacteria,

homoacetogenic bacteria, Budding and appandaged bacteria, spirilla, spirochetes, Gliding bacteria, Sheathed bacteria, Pseudomonads, Free living aerobic nitrogen fixing bacteria, Acetic acid bacteria, Zymomonas and chromobacterium, Vibrio, Facultatively aerobic Gram-negative rods, Neisseria and other Gram-negative cocci, Rickettsias, Chlamydias, Gram-positive cocci, Lactic acid bacteria, Endospore forming Gram-positive rods and cocci, Mycoplasmas, High GC Gram-positive bacteria; Actinomycetes, Coryneform bacteria, propionic acid bacteria, Mycobacterium, Filamentous Actinomycetes.

Eukaryotic Microorganisms: Algae: Biological and economic importance of algae; Characteristics of algae; Lichens. Fungi: Importance of fungi; Morphology; Physiology and reproduction, Cultivation of fungi. Protozoa: Ecology and importance of protozoa. Classification of protozoa.

Viruses: Bacteriophages; Replication of bacteriophages. Viruses of animals and plants; History, structure and composition; classification and cultivation of animal viruses. Effects of virus infection on cells. Cancer and viruses.

Practicals

Study of bacteria, yeasts, molds and protozoa. Staining of microorganisms: Simple stains, positive staining; negative staining. Demonstration of special structures by stains: Spore stain, Flagella stain. Differential stains: Gram stain, Metachromatic granule stain, Acid fast stain. The culture of microorganisms: Preparation and sterilization of culture media, agar slope, agar slab, streak plate and pour plate methods. Isolation and pure culturing of bacteria. Quantitative plating methods. The turbidimetric estimation of microbial growth. Study of bacterial viruses.

Books Recommended:

1. MICROBIAL APPLICATIONS (complete version) LABORATORY MANUAL IN GENERAL MICROBIOLOGY, 1994. Benson, H.J. WMC Brown Publishers, England.
2. Pelczar Jr., Chan, E.C.S. and Krieg, M.R. 1986. Microbiology, McGraw Hill, London.
3. Madigan, M.T., Martinko, J.M. and Parker. 1997. Brock's Biology of Microorganisms, J. Prentice-Hall, London.
4. Stainer, R.Y., Ingraham, J.L., Wheelis, M.L. and Painter. 1986. The Microbial World, R.R. Prentice Hall, London.

IV-5B: MICROBIOLOGY B (Applied Microbiology)

Theory

Control of microorganisms: Control by physical agents: High Temperatures, Low Temperatures, Desiccation, Osmotic Pressure, Radiations, Filtration. **Control by chemical agents:** Characteristics of an ideal antimicrobial chemical agent, Selection of a chemical agent for practical applications, Phenol and Phenolic compounds, Alcohols, Halogens, Heavy metals and their compounds, Dyes, Quaternary ammonium compounds, Aldehydes, Gaseous agents, Evaluation of Antimicrobial Chemical Agents, **Antibiotics and other chemotherapeutic agents:** Antibiotics, Fleming and Penicillin, Modes of Action of Antibiotics, Antifungal antibiotics, Antiviral Chemotherapeutic agents, Synthetic chemotherapeutic agents, Development of resistance to antibiotics, Microbiological assay of antibiotics, Microbial susceptibility to chemotherapeutic agents, Nonmedical uses of antibiotics, **Microorganisms and diseases:**

Microbial Flora of the Healthy Human Host: Origin of the normal flora, Normal flora and the human host, distribution and occurrence of the normal flora, **Host-microbe interactions:** The **Process of Infection:** Pathogenicity virulence and infection, Microbial adherence, Penetration of epithelial cell layers, Events in infection following penetration, Microbial virulence factors, **Resistance and Immunity:** **Natural Resistance and Nonspecific Defense mechanisms:** Natural resistance, Internal defense mechanisms, Nonspecific defense mechanisms. **Basic and Theoretical Aspects of the Immune Response:** The immune response, The immune system, Hypersensitivity. **Epidemiology of Infectious Diseases:** Epidemiological techniques, Role of the host in infectious diseases, Airborne transmission, Waterborne transmission, Foodborne transmission, Transmission by direct contact, Arthropod-borne transmission. **Air, food and water-borne infections:** Human contact diseases. Infectious diseases of animals. **Environmental microbiology:** **Aquatic microbiology:** Natural waters, The aquatic environment, Distribution of microorganisms in the aquatic environment, Techniques for the study of aquatic microorganisms, Aquatic microorganisms, The role and importance of aquatic microbial ecosystems, Productivity of aquatic ecosystems, Biogeochemical transformations. **Soil microbiology:** Physical characteristics of soil, Microbial flora of soil, Interactions among soil microorganisms, Biogeochemical role of soil microorganisms, Biochemical transformations of nitrogen and nitrogen compounds, The nitrogen cycle, Biochemical Transformations of carbon and carbon compounds The carbon cycle, Biochemical transformations of sulfur and sulfur compounds The Sulfur cycle. Biodegradation of herbicides and pesticides. **Microbiology of domestic water and sewage:** Water purification, Determining sanitary quality, Swimming pools, Water pollution, Wastewater, Wastewater treatment and disposal, wastewater-treatment processes, Microorganisms and wastewater-treatment procedures, Efficiency of wastewater-treatment procedures, The pollution problem. **Microbiology of foods:** Microbial flora of fresh foods, Microbial spoilage of foods, Microbiological examination of foods, Preservation of foods, fermented foods, Microorganisms as food, single-cell protein. **Industrial Microbiology:** Scope of industrial microbiology in food production, control of insects, human therapy, petroleum, mining and bioremediation. Biotechnology and its role in modern human comforts.

Practicals

Bacteriological examination of water. Isolation and identification of coliform bacteria and enteric pathogens. Isolation of pathogenic *Staphylococci*. Normal throat flora and reaction on blood agar. Enumeration and identification of microorganisms in urinary tract infections. Isolation and identification of microorganisms from the diseased ear. Inhibition and destruction of microorganisms by physical agents. Action of disinfectants on bacteria. Bacteriostatic action of certain dyes and drugs. Bacterial sensitivity tests. Bacterial examination of food and raw milk. Surveys of microorganisms' activities based industries.

Books Recommended:

1. MICROBIOLOGY: A HUMAN PERSPECTIVE , 2001. Eugene W. Nester, Denise, G., Anderson, Martha, T., Nester, C., Evans Roberts, Nancy, N. McGraw Hill Higher Education.
2. MICROBIOLOGY PRINCIPLES AND EXPLORATIONS, 2001. Jacquelyn, G.G. Wiley John and Sons Inc.

3. MICROBIOLOGY, 1986. Pelczar Jr., Chan, E.C.S. and Krieg, M.R., 1986. Mc-Graw Hill, London.
4. MICROBIAL APPLICATIONS: LAB MANUAL IN GENERAL MICROBIOLOGY, 1994. Benson, H.J. WMC Brown Publishers, England.

IV-6A. FISHERIES A (Principles of Fish Biology)

Theory

What fish are. How and where fish live. Major groups of living fishes. Characterization of living fish groups, major groups of extinct fishes. Relationships of the major groups of fishes, primitive fishes, early jawed fishes, sharks and their relatives bony fishes. Representative of families of living fishes.

Systematics and nomenclature; Introduction. Suitability of fishes to systematic studies. Historical background, taxonomic concepts. The data of classification. Study of collections, zoological nomenclature.

Fish morphology; Fish body form, body covering, appendages, openings. Head and mouth, upper lip lower lip, barbules. Scale, its types, arrangement, colour, scalesless fishes. Fin rays, fin spines (Pectoral, Pelvic, Dorsal, and caudal and Anral fin).

Fish Anatomy; (comparative account in three major groups of living fishes, Cyclostomes, chondrichthyes, osteichthyes). Skeleton. Types of skeleton (membranous, axials, appendicular skeleton). Notochord, Skull, backbone, spines; Brain and spinal cord, carnial nerves, spinal nerves; Olfactory organ, eye, organs of hearing and balance. Gills (no, size, arrangements). Fish blood, vital organs, Heart, Liver, Kidney; Viscera and mesenteries (Swimbladder, stomach, spleen. Pancreas, Intestine, reproductive glands-gonads).

Feeding groups of fishes; Herbivore, planlton eater, larvivore, carnivore, omnivore, voracious

Ecology of fishes; Definitions, organic productivity in aquatic ecosystem. Ecological classifications of fishes, ecological factors, marine ecosystem, estuarine, ecosystem freshwater ecosystem.

Practicals

Identification of freshwater fish species with the help of key. Collection and preservation of freshwater fish (optional). Study of different organs of various fish species. Study and survey of various fish collections present in museums like Natural History Museum at Islamabad; Govt. College University Museum, Lahore and Punjab University Museum, Lahore.

Textbook:

1. Ichthyology (2nd Ed.) By Lagler et al., 2003. John Wiley and Sons (Text Book).

Books Recommended:

2. Textbook of Fish and Fisheries. 2005. Sandhu, G.S. 1st Ed. Dominant publishers, New Delhi.
3. Textbook of Fish culture: Breeding and Cultivation. 1986. By M. Hute. Fishing News Books, UK.
4. Catfishes of India 2006. Jayram K.C. Narendra Publishing House, Delhi.
5. A Hatchery Manual for the Common Chinese and Indian Major carps. Jhingran and Rullin 1986. Asian Development Bank, Manila, Philippines.

6. A key to the fishes of the Punjab by Mirza and Sharif. 1996. Ilmi Kitab Khana, Lahore.

IV-6B: FISHERIES B (Fish Physiology and Breeding)

Theory

Fish nutrition: Digestive system, Stomach less fishes, Stomach fishes, Digestion and absorption; Fish food of plant and animal origin; Feeding; Fresh food, dry concentrates and pelleted food

Transportation: Blood composition, Blood cells (Erythrocytes, differential leukocytes and plasma). Circulation; Arterial and venous systems, blood capillaries, Transport of food material

Respiration: Gills, Lungs, Skin, Swimbladder, Homeostasis

Excretion: Kidneys, structure and function of teleost's kidney, osmoregulation

Reproduction: Gonads, maturation, oogenesis, spermatogenesis, reproductive cells.

Endocrine glands: Pituitary, thyroid, adrenal and pancreas in fishes, endocrine hormone regulation in reproduction.

Breeding: Natural (seasonal), Artificial, Hormonal induced breeding, Temperature and photoperiod control induced breeding

Development: Fertilization, cleavage, gastrulation and organogenesis.

Growth: Extensive culture (due to the consumption of natural food), Semi-intensive culture (due to natural and artificial food), Intensive culture (due to only dry concentrates)

Fish migration and behaviour: Anadromous, Catadromous, Amphidromous, Oceanodromous, potamodromous and diadromous fishes. Learning and memory, Courtship and feeding behaviour, Aquarium fish behaviour

Practical

Study of gut contents, Study of feeding modification and adaptation in fish, Study of respiratory adaptation in fish, Study of blood cells and their counts in normal and diseased fish, Study of water quality parameters (DO, NH₃, hardness, alkalinity, turbidity, transparency, temperature, salinity), Study of various forms of swimbladder as hydrostatic organ, Study fecundity of various fish species, Study the effects of reproductive hormone on fish maturation, Visit to various fish seed hatcheries during breeding seasons

Books Recommended

1. A. N. Shukla, 2009. **Physiology of Fishes**. Discovery Publishing House Pvt. Ltd. New Delhi, India.
2. S. M. Hadi Alvi et al., 2008. **Fish Spermatology**. Alpha Science International, Oxford Business Park, Oxford, UK
3. G. S. Sandhu, 2001. **An Introduction to Fishes**. Campus Book International, New Delhi, India.
4. Keshav Kumar Jha, 2010. **Aquaculture**. Daya Publishing House, New Delhi, India
5. Brenabe. 1992. **Aquaculture vol. II**. Blackwell Scientific Publications Ltd. London
6. Maseke, C. 1987. **Fish Aquaculture**. Pergamon Press, Oxford, England
7. Huet, M., 1986. **Text Book of Fish Culture: Breeding and Cultivation**. Blackwell Scientific Publications Ltd. London
8. Lagler et al. 2003. **Ichthyology**. 2nd Edition. John Wiley & Sons. Inc. Pvt. Ltd., Singapore

9. Matty. 1983. **Fish Endocrinology**
10. Hoar, et al., 1983. **Fish Physiology: Reproduction**. Academic Press, New York

V. ELECTIVE PAPERS

1. INTEGRATED PEST MANAGEMENT

Theory

Brief account of integrated pest management. Concept of economic damage and the damage boundary. Economic injury level (EIL), Economic threshold (ET), dynamics of economic injury level, environmental EILs. Pest management history, insecticide era, evolution of pest management. The concept of Pest management : definition, strategies and tactics, kinds of pests (sub economic, occasional, percnial and severe) and likely management strategies. Management with natural enemies. Biological control, numerical and functional response of biocontrol agents; types of biological control agents and their working, practice of biological control (introduction, augmentation and conservation). Ecological management; definition, procedures of ecological management. Role of sanitation, tillage, water management, crop spacing, crop rotation, trap crop, inter cropping and host tolerance in ecological management.

Chemical management: insecticides, classification according to application and chemical composition (Pyretheroids, carbamates, organophosphate, Neonicotinoids, insect growth regulators, fumigants). Types of insecticides formulation, good and bad effects of insecticides; Genetic control: Sterile insect techniques, methods of sterilization and utilization of specimens. Management with resistant plants, insect and host plant relationship, mechanisms of resistance, application in the integration programme. Integration of all these management methods.

Practicals

- Surveillance and sampling techniques (any five for collection of insect pests).
- Population estimation of insect pests using different methods.
- Calculation of economic decision levels (EIL and ET).
- Development of a pest management programme (using any important Pest of the area.
- Collection, preservation and identification of insect pest.
- Effect of insecticide on insect population in the field utilizing any pest and sampling techniques.
- Effects of tillage and intercrop on insect population in the field.

Textbook:

1. Pedigo, L.P., 1991. Entomology and Pest Management. Maxwell MacMillan.

Additional Readings:

2. Richards, O.W. and Davies, R.J., 1977. *Imm's General Textbook of Entomology*. Vol-2
3. Metcalf, C.L. and Flint, W.P., 1962. *Destructive and Useful Insects*, McGraw-Hill.

4. De Bach P., 1964. Biological control of insect pests and weeds. Chapman and Hall, London (Latest edition).
5. Flint, M.L. and Gouveia, 2001. IPM in practice principles and methods of Integrated Pest Management.

2. PHYSIOLOGY OF REPRODUCTION

Theory

Introduction: Overview of structure, at different levels, of reproductive systems and developments in gametes formation.

Sex Determination and Differentiation: Molecular aspects and chemical messengers in differentiation.

Hypothalamic-Hypophyseal-Gonadal axis in Reproduction: Hormonal and neuronal factors and their interactions in ovarian, testicular and other reproductive targets functions; The interactions in developments in estrous and menstrual cycles; The interactions in transitions from childhood to reproductive and post-reproductive states.

Reproductive Behaviors: Physiological basis of male and female sexual behavior and maternal behavior; Endocrine basis of communication in reproduction and aggression; Pheromones in mammalian reproduction; Rhythms in Reproduction.

Pregnancy: Hormonal mechanism in fertilization, zygote transport and implantation. Placental steroid and polypeptide hormones; Recognition and maintenance of pregnancy; Maternal metabolism in gestation, Hormonal mechanism in parturition.

Lactation: Hormonal mechanism in lactation; Lactogenesis, Galactopoiesis, Milk ejection.

Reproductive Senescence: Hormonal and metabolic aspects in menopause; Mechanisms in males.

Fertility Control Mechanisms: Hormonal contraceptives; Rhythmic methods, Immunologic techniques and other fertility control procedures in women; complications in their uses; Fertility control in men and search for male contraceptive.

Practicals

Study of male and female reproductive tract; physiological histology of segments of male and female reproductive tracts; Recognition of spermatogonial cells, ovarian follicles and corpus luteum in gonads; study of hormonal mechanisms in superovulation and implantation; Tests for pregnancy recognition; Experiments on role of gonads in maintenance of accessory sex gland in males and target structures in females; Study of fertility control procedures in populations.

Books Recommended

1. Knobil, E. and Neill, J.D., *et al.*, 1994. The Physiology of Reproduction, Vol.1 and 2; 2nd Ed., Raven Press, New York.
2. Wilson, J.D., Foster, D.W., Kronenberg, H.M. and Larsen, P.R., 1998. William's Textbook of Endocrinology, 9th Ed.. W.B. Saunders Company, Philadelphia.
3. Evert, B.J. and Johnson, M.H., 2000. Essential Reproduction, 5th Ed.. Blackwell Science Inc., Oxford.

Theory

Cardiovascular System: Blood and homeostasis; Physiology of cardiac muscles; Automaticity and rhythmicity in heart activity and cycle; Electrocardiography; Regulation of heart activity; Hemodynamics; Arterial system; Microcirculation and lymphatics; Control of cardiac output; Special circulations: Cutaneous, skeletal, coronary, cerebral, fetal.

Respiratory System: Overview of respiratory system; Pulmonary and bronchial circulations; Mechanical aspects of breathing; Transport of oxygen and carbondioxide; Regulation of ventilation; Respiratory responses in extreme conditions.

Renal System: Elements of renal function; Tubular function in nephron; Control of body fluid volume and osmolality; Potassium, Calcium and Phosphate homeostais; Role of kidney in acid-base balance.

Gastrointestinal System: Gastrointestinal secretions and their control: Salivary, gastric, pancreatic and liver; Digestion and Absorption of carbohydrates, proteins, lipids, vitamins, ions and water; Motility of gastrointestinal tract: Functional anatomy, regulation and motility in various segments.

Osmoregulation: Problems of osmoregulation; Obligatory exchange of ions and water; Osmoregulators and osmoconformers; Osmoregulation in aquous and terrestrial environments.

Environmental Challenges: Temperature and animal energetics; Temperature relation of Ectotherms, Heterotherms and Endotherms; Dormancy: Special metabolic state; Body rhythms and energetic; Energy, environment and evolution.

Practicals

Experiments on the study of heart in prepared frogs; Study of blood pressure in various physiological states; Study of electrocardiograms; Blood coagulation study. Determination of oxygen consumption in fish and mouse and effects of factors; Demonstration of respiratory volume and pulmonary function tests. Experiments on digestion on nutrients by enzymes and effects of factors; Study of exocrine secretion in stomach or pancreas and effects of factors. Experiments on kidney regulation of osmolality; Urine analysis; Study of osmoregulatory adaptations in animals inhabiting various environments; Demonstration of effect of temperature on several physiological responses; Study of animals in various types of dormancy.

Books Recommended:

1. Randall, D., Burggren, W., French, K. and Fernald, R., 2002. Eckert Animal Physiology: Mechanisms and Adaptations, 5th ed. W.H. Freeman and Company, New York
2. Bullock, J., Boyle, J. and Wang, M.B., 2001. Physiology, 4th ed. Lippincott, Williams and Wilkins, Philadelphia.
3. Berne, R.M. and Levy, M.N., 2000. Principles of Physiology, 3rd Ed.. St. Liou, Mosby.
4. Guyton, A.C. and Hall, J.E., 2000. Textbook of Medical Physiology, 10th Ed.. W.B. Saunders Company, Philadelphia.

5. Withers, P.C., 1992. Comparative Animal Physiology. Saunders College Publishing, Philadelphia.
6. Schmidt-Nelsen, K., 1997. Animal Physiology, Adaptation and Environment, 5th Ed.. Cambridge University Press, Cambridge.
7. Tharp, G. and Woodman, D., 2002. Experiments in Physiology, 8th Ed.. Prentice Hall, London.

V-4 COMPARATIVE VERTEBRATE ENDOCRINOLOGY

Theory

General concepts in comparative Endocrinology; Comparative Morphology of Endocrine Tissues in Vertebrates; The chemical structure, polymorphism and evolution of hormones; The life history of hormones.

Hormones and Nutrition; Hormones and the Integument; Hormones and Osmoregulation; Hormones and Reproduction.

Practicals

Demonstration of endocrine glands in representative vertebrates; Histological studies of endocrine glands in various vertebrate; Experiments on functional diversity in hormones in vertebrates; Studies in evolution of chemistry of hormones in vertebrates.

Books Recommended

1. Bentley, P.J., 1998. Comparative Vertebrate Endocrinology. Cambridge University Press, Cambridge.

V-5 ANIMAL BEHAVIOUR

Theory

The Study of Animal Behaviour: Introduction. History of Animal Behaviour. Approaches and Methods.

Behaviour Genetics and Evolution: Genes and Evolution. Behavioural Genetics. Evolution of Behaviour Patterns.

Mechanisms of Behaviour: The Nervous System and Behaviour. Hormones and Behaviour and Immunology and Behaviour. Biological Rhythms. Development of Behaviour. Learning Behaviour. Communication.

Finding Food and Shelter: Migration, Orientation and Navigation. Habitat Selection. Foraging Behaviour.

Social Organization and Mating Systems: Conflict. Sexual Reproduction and Parental Care. Mating Systems and Parental Care. Social Systems.

Practicals

Experiments on reflexes, latency, after-discharge, summation, warm up, fatigue, inhibition and feedback. Experiments on habituation, conditioned reflex type I and trial and error learning. Experiments showing hormonal involvement in behavioural responses. Study of social integration in social insects. Study of hibernation and biological rhythms.

Books Recommended:

1. Drickamer, L.C., Vessey, S.H. and Jacob, E., 2002. Animal Behaviour: Mechanism, Ecology, Evolution. 5th Ed..
2. Manning, A. and Dawkins, M.S., 1997. An introduction to animal behaviour, 4th Ed.. Cambridge University Press, Cambridge.

V-6 PRINCIPLES OF TOXICOLOGY

Theory

History and General Introduction to Toxicology; Types of Toxicology; Specialized areas in Toxicology; Classification of Toxic chemicals; Types of Exposure and Exposure responses including exposure characteristics; Spectrum of Undesirable effects; Variation in Toxic Responses; Dose Response relationship; Acute lethality; Descriptive animal Toxicity Testing; Sub-acute, sub-chronic and chronic toxicity; Developmental/Reproductive toxicity; Mutagenicity; Absorption, Distribution and Excretion of toxicants; Biotransformation/Disposition of toxicants; Phase-I and Phase II Biotransformation Reactions; Mechanism of Toxicity; Delivery, from the site of Exposure to the Target; Absorption versus prtesytemic Elimination; Distribution to and away from the Target; Excretion versus Re-absorption; Toxication versus Detoxication; Toxicity resulting from Delivery; Reaction of the Ultimate Toxicant with the Target molecule; Attribution of Target Molecules; Effects of Toxicant on Target Molecules; Cellular Dysfuntion and Resultant Toxicities; Toxicant-induced Cellular Dysregulation; Toxic alterations of Cellular Maintenance; Repair and Dysrepair.

Books Recommended:

1. KLAASSEN, CURTIS D., (1996). *Casarett and Doull's Toxicology: The Basic Science of Poisons*; 5th Ed. (International), McGraw-Hill, Health Professions Division, New York.
2. Timbrel, J.A., 1995. Introduction to Toxicology, 2nd Ed. Taylor and Francis Ltd., London.

Practicals

Determination of LD50 values of some pesticide against any insect pest. Determination of LD50 doses of any toxic compound in mammalian system. Effect of any toxicant on body weights in mice. Toxicity of some toxic compound on relative organ weights in mice. Effect of toxicant on food consumption in mice. Study of toxicity of any chemical on total leukocytic count. Effect of a toxicant on total erythrocytic count in blood of mice. Effects of any toxicant on haemoglobin level in mice. Study of inhibition of cholinesterase enzyme activity by organophosphate insecticides in mice. Study of liver function enzyme (Alanine amino transferase) activity following administration of toxic compound to experimental animals. Determination of blood glucose level following toxic exposure.

Books Recommended:

1. Hayes, A. Wallace, 1994. *Principles and Methods of Toxicology*, Third Ed., Raven Press, New York.

V-7 FISH DISEASE AND HEALTH MANAGEMENT

Theory:

Fish morphology and Biology: Brief account of Fish morphology and Biology; Warm water / cold water culturable fishes; Fish culture practices; Extensive/Semi intensive/intensive fish culture;

Fish Farm management: Brief accounts of fish pond, fish stocking, water quality; manuring, feeding and harvesting.

Fish Health Management: Introduction to fish diseases; disease process; causes of disease. Effects of diseases;

Fish Diseases: A general account of Infectious diseases; (Viral; Bacterial fungal; parasitic diseases) Noninfectious diseases. (Nutritional; Genetics; Pollution; Environmental; Physical damage)

Control of fish diseases: Prevention; Therapy, management; Methods of disease control in fishes; Treatment of fish diseases. Diagnosis to action; Types of treatment; Methods of treatment; Strategies for treatment; Chemicals and drugs for fish health.

Practicals:

Dissection of culturable carp; sampling of fish for diagnostic purpose. Study of fish for parasitic, fungal and bacterial diseases. Preparation of slides of parasites. Visit to a fish farm. Preparing a diagnostic report of diseased fish sample.

Books Recommended:

1. Post, G.W. 1988. Textbook of fish health. T.F.H. publications Inc. USA. (**Textbook**)
2. Bauer, O.N., Musselius, V.A. and Strelkov, Yu.A. 1973. Diseases of pond fishes. Keter press, Jerusalem.
3. Hool, D. et al., 2001. Diseases of carp and other cyprinid fishes. Fishing News Books, UK.
4. Legler, K.E., Bardach, J.E., Miller, R.R. and Maypassino, D.R. 2003. Ichthyology (2nd Ed.) John Wiley, UK.
5. M. Huet, 1986. Text book of Fish culture, breeding and cultivation. Fishing book news Ltd.
6. Woo, 1995. Fishes diseases and disorders, Protozoan and Metazoan infections. Pak Book corporation
7. Noga, E.J. 2010. Fish Diseases. Diagnosis and treatment. 2nd Ed. Wiley and Blackwell, USA.
8. Boyd and Tucker, 1998. Pond Aquaculture and water quality management. Springer, India.

V-8 MAMMALOLOGY

Theory

Classification of mammals (including Mesozoic mammals: Triconodonts, Symmetrodonts, Multituberculates, Docodonts and pantotheres); Mammalian characteristics; The Monotremes, Marsupials and Placental mammals; Specialization of Mammalian teeth; Mammalian molar and its origin (Tritubular Theory); Distribution, Dispersal; Territory and Territoriality; Classification of mammals according to their diet; Food and food storage in mammals; Hibernation and Aestivation; Defense and

Protection; Movement in mammals (running, leaping, fossorial, swimming, arboreal, flying and gliding mammals); Origin and evolution of mammals.

Practicals

- General survey and classification up to species of the following mammals;
- Egg-lying mammals (Echidna and Platypus).
- Marsupial mammals (Opossum, Australian cat, Numbat kangaroos, Marsupial moles, Bandicoots, Koala, Wombats).
- Placental Mammals (Elephants, Giraffes, Rhinoceroses, Tapirs, Blackbuck, Four-horned antelope, *Bos*, *Bison*, *Bubalus*, *Capra*, *Ovis*, *Boselaphus*, Camels).
- Skeleton of Mongoose, Cat, Hedgehog and Rabbit.
- The skull and teeth.
- The vertebral column and appendicular skeleton.

Books Recommended:

1. Davis, D., 1963. Principles in Mammalogy. Reinhold Publishers Corporation, New York.
2. Gelder, 1969. Biology of mammals. Reinhold Publishers Corporation, New York.
3. Miller and Harly, 2005. Zoology (6th Edition). McGraw Hill, New York.
4. Hickman, Roberts, and Larsen, 2005 & 2008. Integrated principles of Zoology (13th & 14th Editions). McGraw Hill, New York.
5. George C. Kent and Robert K. Carr, 2001. Comparative Anatomy of the Vertebrates. (9th Edition.) Boston: McGraw Hill, New York.
6. Vauchan, T.A., Ryan, J.M., Czaplenski, N.J., 2011. Mammalogy. 5th Edition, Johns and Bartlett publisher USA.

V-9 VECTOR BIOLOGY

Theory

Details studies of systematic, Biology and Ecology of some vectors of medical importance (order Diptera):

Mosquitoes; Anopheles mosquitoes, *Culicine* mosquitoes, Black flies, sand flies, biting midges, horse flies, deer flies, and clegs, tsetse flies, house flies, Myiasis producing flies, (blow flies, blue bottles, green bottles, flesh flies, warble flies and bot flies).

The study will cover following aspects: Morphology, anatomy, distribution, breeding habits, Life-cycle, pathogenesis and seasonal prevalence of the species. Brief account of diseases spread by these vectors, methods of control, modern trends in their biological and chemical control.

Practicals

Methods of identification; Dissection of selected vectors i.e. Mosquito, House fly, blue bottles, green bottles, bot flies. Study of prepared slides of parasites. Epidemiological studies of Vector borne diseases (one e.g. malaria) including field studies of control methods and parasite evaluation.

Books Recommended:

1. William A. Riley. Medical Entomology. Mc-Graw Hill book Co., Inc. London.
2. McDonald, G. The Epidemiology and Control of Malaria, London Oxford Press.
3. World Health Organization. Vector Control series, Training and information guide. The House Fly.
4. World Health Organization. Chemical methods for the control of Arthropod Vectors and pests of Public Health Importance Geneva, WHO, 1984.
5. Walker, A. 1994. Arthropods of human and domestic animals. A guide to preliminary identification. Chapman and Hall.
6. Seevicc, M.W., 1980. A guide to medical entomology. MacMillan International College Ed..
7. Herms, W.B. and James, M.T. 1960. Medical entomology. The MacMillan Company, New York.

V-10 HELMINTHOLOGY

Theory

Introduction to the phylum platyhelminthes. Trematoda, Aspidothelminthes. Trematoda, Form, Function, Life cycle and Classification of digeneans. Digeneans, strigeiformes. *Schistosoma haematobium*, *S. japonicum*, *S. mansoni* (Schistosomiasis); Digeneans Echinostomiformes: *Fasciola hepatica*, *F. gigantica*, *Paramphistomum cervi*, *Megalodiscus temperatus*. Digeneans, Plagiorchiformes and opisthorchiformes: *Paragonimus westermani*, *Clonorchis sinensis*, *Heterophyesheterophyes*, *Prosthogonimus macrochis*. Monogenea; *Polystomum integraruum*. Form, function, classification, life cycle. Cestoidea, form function, life cycle and classification of the tapeworms. Cyclophyllidae: *Taenia solium*, *Taeniarhynchus saginata*, *T. pissiformis* (Taeniasis), *Taenia multiceps*, *Echinococcus granulosus*, *E. multilocularis*, *E. vogeli*, *Hymenolepis nana*, *H. diminuta*, *Railletina* species, *Diphylidium caninum*, *Moniezia* species, *Mesocestoides* species. Phylum Nematoda, Form, Function and Classification. Nematodes, Trichurida and Dioctophymatida, enoplean parasites (*Trichuris trichiura*), *Capillaria hepatica*, *Anatrichosoma ocularis*, *Dioctophyme renale*, Nematodes, Rhabdilitida; *Strongyloides stercoralis*, Nematodes, Strongylida, bursate rhabdilitidians, *Bunostomum*, *Necator americanus*, *Ancylostoma duodenale*, *Synagamus trachea*, *Haemonchus contortus*, *Trichostrongylus* species, *Ostertagia* species, *Prostrongylus rufescens*. Nematodes, Ascaridida, intestinal large round worms; *Ascaris lumbricoides*, *Toxocara canis*, *Lagochilascaris minor*, *Heterakis gallinarum*, *Ascaridia galli*. Nematodes, oxyrurida, the pinworms; *Enterobius vermicularis*. Nematodes, Spirurida, a potpoorri, *Gnathostoma doloresi*. Nematodes, Filarioidea; the filarial worms, *Wuchereria bancrofti*, *Brugia malayi*, *Loa loa*, *Mansonella perstans*, *M. ozzardi*, *Onchocerca volvulus*, *Dirofilaria immitis*. Nematodes, camallanina, the Guinea worms and others; *Dracunculus mediensis*. Phylum Acanthocephala, Thorny headed worms. Forms, function and classifications; *Macrocanthorhynchus hirudinaceus*. Helminth Zoonoses (Trematode, Cestodes and nematode zoonoses).

Practicals

Methods for collection, transportation, fixation and preservation of flukes, tapeworms and round worms. Methods for collection and examination of faeces, urine and sputum for the presence of eggs/larvae of various helminthes. Methods for examination and staining of blood film for helminthes. Identification of important members of class Trematoda, Cestoda, Nematoda and Acanthocephala. Practical demonstration of helminthes at slaughter houses.

Books Recommended:

1. PRACTICAL EXERCISE IN PARASITOLOGY, 2001. Hatton, D.W., Behinke, M. and Marshal, I. Cambridge University Press, BSP.
2. VETERINARY PARASITOLOGY, 2000. Urquhart, G.M., Duncan, J.L., Qunn, A.M. and Jenniry, F.W. Longman Scientific and Technology, U.K.
3. PARASITIC DIAGNOSIS, 1999. Mayate, S. and Akhtar, M. UGC Govt. of Pakistan.
4. FOUNDATIONS OF PARASITOLOGY, 2000. 5th ed. Robert, L.S. and Janovy, J.Jr. W.C.B. Company, U.K.
5. INTRODUCTION TO ANIMAL PARASITOLOGY, 1994. Smyth, J.D. Cambridge Univ. Press.

V-11 COMPARATIVE ANATOMY AND BIOLOGY OF VERTEBRATES

Theory

Origin of vertebrates. Classification (excluding fossil groups) of vertebrates and characteristics of each group. Comparative anatomy of various body systems in vertebrates.

Practicals

Study of skeleton of Labeo, frog, varanus, fowl and rabbit. Dissection and study of various systems in *Rita rita*, frog, uromastix, pigeon and rabbit. General survey of vertebrates.

Books Recommended:

1. Kardong, K.V. 2002. Vertebrates, Comparative Anatomy, Function Evolution, 3rd Ed. McGraw Hills.
2. Weichert, W.C. Anatomy of the chordates. W.B. Sundres. (Recent Ed.)
3. Young, J.Z.. 1991. LIFE OF VERTEBRATES, Oxford Univ. Press.

Additional Readings

1. Romer, A.S. and Parsons, T.S. 1986. The Vertebrate Body, Saunders.
2. G.C. Kent. Comparative anatomy of vertebrates W.B. Sundres. (Recent Ed.)

V-12 HUMAN EMBRYOLOGY AND TERATOLOGY

Theory

Formation of normal and abnormal gametes and their relation to age, getting ready for pregnancy, transport of gametes and fertilization, cleavage and implantation, formation of germ layers and early derivatives, establishment of basic embryonic body plant. Placenta and extra embryonic membranes, developmental disorders: causes mechanisms and patterns. Brief description of development of various body systems.

Practicals

Study of mammalian gonates and gametes. Study of whole mounts and sections of various mammalian embryos. Experimental manipulations of live embryos.

Books Recommended:

1. **Moore, K.L. and Prasad.** 2000. THE DEVELOPING HUMAN, Saunders.
2. **Sadler, T.W. and Langman, J.** 1995. LANGMAN'S MEDICAL EMBRYOLOGY, Williams and Wilkins.
3. **Carlson, B.M.** 2000. HUMAN EMBRYOLOGY AND DEVELOPMENTAL BIOLOGY, Mosby.

V-13 CELL AND TISSUE CULTURE

Theory

An overview of background, advantages, limitations, terms and definitions, growth of attachment-dependent and suspended cells; cell lines. Biology of Cultured Cell, Culture environment, cell adhesion, cell proliferation, differentiation and evolution of cell line. Design, Layout and Equipment in Animal Cell Culture Construction, layout; essential, beneficial and useful equipment; consumable items. Aseptic Technique and Safety Objectives, element of aseptic environment, sterile handling, general safety, risk assessment, radiation and biohazard. Media and Serum-free Media Physicochemical properties, complete media, serum, selection, advantages and disadvantages of serum free media, replacement of serum, media development. Primary Culture and Cell Lines Type of primary culture cell. Isolation of tissues. Primary culture. Cloning Selection and Molecular Techniques An overview of suspension cloning, isolation of clones ,in situ molecular hybridization, production of monoclonal antibodies. Somatic cell fusion and DNA transfer. Cryopreservation and Quantification Preservation, cell banks, transporting cells. Quantification , Somatic Embryogenesis and Organogenesis, Micro-propagation,

Practicals

Isolation of Liver cells; Cell culture in vitro; Maintaining the cell lines; Primary cell culture

Text Books

1. Freshney, R.I., (2000), Culture of Animal cell: A Manual of Basic Techniques, 4th Ed., Wiley Liss.
2. Dodds, J.H., and Roberts, L.W., (1995), Experiment in Plant Tissue Culture,3rd Ed., Cambridge University Press.

Books Recommended:

1. Harrison, M.A., and Rae, I.F., (1997), General Techniques of Cell Culture, Cambridge University Press.
2. Dixon, R.A., (1985), Plant Cell Culture: Practical Approach, IRL Press.
3. Doyle, A., and Griffiths, J.B., (2000), Cell and Tissue Culture for Medical Research, John Wiley and Sons.
4. Chawla, H.S., (2002), Introduction to Plant Biotechnology, 2nd Ed., Science Publisher

V-14 APICULTURE

Theory

The significance of Apiculture; Types of honeybees and their distribution, endemic and exotic species; Honeybee structure, functions and special organs; The colony and its organization; Biology of

the honeybee, life history, placement of colonies, moving and transporting bees; Beekeeping equipment and fundamental tools for bee breeding, honey production and harvesting/ processing of honey and beeswax; Major honey flows in different ecological areas; How to start, installing a bee hive and establishment of an apiary; Inspection techniques, introducing a queen, handling queens; control of robbing; Supplemental feeding for queen breeding and stimulative brooding rearing; sources of nectar and pollen; Products from apiculture; Honey production, harvesting, processing and uses; Beeswax production, extraction, processing and its uses; Swarming, its prevention and control.

Modern and traditional methods for honeybee breeding, merits of frame hive beekeeping and top bar hives; Migratory beekeeping; Seasonal management of colonies; Integrated management of honeybees for higher honey yield; Natural enemies of honeybees, and control; American foulbrood disease of honeybee brood and its remedies; Mite diseases of honeybees and their control; Other diseases of honeybees and cures; Preparation of colonies for honeybee queen breeding, queen management, Commercial queen rearing, improvement of stock and package bees; Conservation of indigenous honeybees and issues facing apiculture; Honeybees as pollinators; Honeybee pollinated crops and fruit trees; Preparation and management of colonies for pollination.

Practicals

1. Watching for the natural nest, contents of the cells, arrangement of the nest, colour of the combs.
2. Preparation of hive with frames and top bars.
3. Wiring frames, fixing foundations.
4. Use of bee veil, smoker, hive tool and other appliances.
5. Handling bees, stings, cleaning hives and ventilation.
6. Inspection of bees: opening bee hives, organization within the colony, removing frames, handling frames, fanning and food transmission.
7. Identification of queens, workers, drones, brood comb formation/ structure, honey and pollen stores, propolis and royal jelly.
8. Transferring bees in Langstroth hives, Observation hives and nuclei.
9. Removing honey crop, uncapping, handling cappings, honey extraction modern and traditional methods and preparation of honey for market.
10. Inspection of colonies: watching for diseases, pests, predators, their diagnosis and control.
11. Supplemental/ emergency feeding and making candy for queen breeding.
12. Moving colonies: Packing hives for transportation.
13. Queen rearing: preparation of colonies and queen cells.
14. Selection an breeding, grafting larvae, dry and wet methods.
15. Requeening of colonies, caging of queens and queen introduction.
16. Uniting colonies, harvesting pollen, propolis and royal jelly.
17. Recognizing robber bees, control of robbing.
18. Production of beeswax, harvesting and processing.

Books Recommended:

1. Ahmad, R. and Muzaffar, N. 1984. Modern beekeeping (Urdu version). Pak. Agric. Res. Council, 350 pp.
2. Atwal, A.S. 2000. Essentials of beekeeping and pollination. Kalyani Publishers, India, 393 pp.
3. Blackiston, 2001. Beekeeping for dummies. Wiley Publishing Inc., USA, 303, pp.
4. Crane, E. 1976. Honey- A comprehensive survey. Inter. Bee Res. Assoe. Heinemann, London, 608 pp.
5. Dadant, C. 1986. The hive and the honeybee. Dadant and Sons, Hamilton, Illinois, USA, 740 pp.
6. Phillips, E.F. 2006. Beekeeping. Ithaca, New York Agrobios Press, India, 490 pp.