


UNIVERSITY OF SARGODHA, SARGODHA

NOTIFICATION

No. UOS/Acad/2893

Dated: 06.06.2011

On the recommendation of the Board of Studies in Zoology, the Vice-Chancellor has, in exercise of the powers vested in him under section 13(3) of University of Sargodha Ordinance, 2002, on behalf of the Academic Council and Syndicate, been pleased to approve the syllabus of M.Sc Zoology (annual system) for implementation in affiliated colleges from the academic session 2010-11. Approved syllabus is annexed herewith.


(Ch. Farooq Ahmad)
Assistant Registrar (Acad)
for Registrar

Distribution:-

- The Chairman
Department of Biological Sciences
- Controller of Examinations
- Principles of all affiliated colleges concerned
- Web Developer (for uploading on university website)
- Notification File

C.C:

- Secretary to the Vice-Chancellor
- P.A. to Registrar

No-637
13/06/2011

1. DCE (C)
2. DEET (C)
3. ASES
M. Ahmad
13/06/11
13/06/11

DEPARTMENT OF BIOLOGICAL SCIENCES
UNIVERSITY OF SARGODHA
SARGODHA

M.SC ZOOLOGY ANNUAL SYSTEM (2010-12)

TWO YEARS PROGRAMME

SCHEME OF STUDIES

Part-I:

Course #	Title	Marks	Theory	Practical
Paper 1	BIOCHEMISTRY	100	75	25
Paper 2	DEVELOPMENT BIOLOGY	100	75	25
Paper 3	BIostatISTICS	100	75	25
Paper 4	CELL AND MOLECULAR BIOLOGY	100	75	25
Paper 5	ANIMAL PHYSIOLOGY	100	75	25
Paper 6	GENETICS	100	75	25

Total Marks: 600

Part-II:

Course #	Title	Marks	Theory	Practical
Paper 7	WILDLIFE AND FISHERIES	100	75	25
Paper 8	ANIMAL ECOLOGY	100	75	25
Paper 9	EVOLUTION & PRINCIPLES OF SYSTEMATICS	100	75	25
Paper 10	PRINCIPLES OF TOXICOLOGY	100	75	25
Paper 11	ZOOGEOGRAPHY AND PALEONTOLOGY	100	75	25
Paper 12*	OPTIONAL / THESIS*	100	75	25
Paper 13*	OPTIONAL / THESIS*	100	75	25

* In lieu of thesis two optional courses will be offered from the list attached depending upon resources of the department and thesis would be of 200 marks in place of paper 12 & 13.

Note:- Each Theory papers will carry 75 marks, whereas each practical paper will carry 25 marks, wherever applicable.

List of optional papers

Sr.No	Title	Marks
12	Animal Behavior ✓ 2015	100
13	Bioinformatics	100
14	Microbiology	100
15	Immunology	100
16	Fundamental of Hematology ✓ 2012	100
17	Human embryology and teratology ✓ 2012	100
18	Advances in insect pest management ✓ 2015	100
19	Statistical Ecology	100
20	Fish Physiology and Breeding ✓ 2013	100
21	Biology of Spiders	100
22	Ornithology ✓ 2013	100

BIOCHEMISTRY**COURSE CONTENTS**

General Animal Biochemistry

- 1) Techniques in Biochemistry: Macromolecular separation techniques in biochemistry; ion exchange chromatography; isoelectric focusing; density gradient centrifugation.
- 2) Amino acids, peptides and proteins: Amino-acids definition acid base properties proteinous and non-proteinous importance. structure and classification; of proteinous amino acids. Definition, classification, functions and importance of proteins in life. Peptide bonding, primary, secondary, tertiary and quaternary protein structures with examples.
- 3) Enzymes: introduction; important characteristics of enzymes; immobilized enzymes; how enzymes work; example of enzymatic reaction; enzyme kinetics, enzyme rate of reaction and substrate concentration, how pH and temperature effect enzyme activity; kinetics of bi-substrate and multi-substrate reactions.
- 4) Carbohydrates: classification, types, important characteristics and structure of carbohydrates; monosaccharides; and disaccharides their types structure and function; polysaccharides, storage and structural types; structure and major functions of polysaccharides.
- 5) Lipids: fatty acids- types and characteristics; storage lipids, acylglycerols; waxes; terpenoids and steroids. Structural lipids of cellular membranes; major functions of lipids; lipoproteins, their types and major functions.
- 6) Vitamins and cofactors: occurrence, structure and biochemical function of vitamins a, b-complex group, c, d and e.
- 7) Bioenergetics: concept of free energy; standard free energy change: energy rich compounds.

Metabolism

- 8) An aerobic catabolism: detailed description of glycolysis and catabolism of hexoses; regulation and bioenergetics of glycolysis. Anabolic role of glycolysis; fate of pyruvate under aerobic and anaerobic conditions, lactate, acetyl CoA and ethanol formation; alcoholic fermentation; gluconeogenesis, its regulation and significance in the tissues; feeder pathways in glycolysis; utilization of other carbohydrates in glycolysis; phosphorylation of glycogen and starch; regulation of glycogen metabolism; utilization of dietary polysaccharides (starch) and disaccharides (sucrose and galactose). Biosynthesis of glycogen, starch and sucrose.
- 9) Citric acid (TCA) cycle: conversion of pyruvate to acetyl CoA, pyruvate dehydrogenase, a multi-enzyme complex; detailed description of citric acid cycle; bioenergetics and conservation of energy produced in the cycle. Anabolic or biosynthetic role of citric acid cycle intermediates; replenishing or anaplerotic reactions and their role; regulation of citric acid cycle.
- 10) Lipid metabolism: oxidation of fatty acids; digestion, mobilization and transport of fats; biosynthesis of triacylglycerol; utilization of triacylglycerol; activation of fatty acids and their transportation to mitochondria; beta-oxidation; bioenergetics of beta-oxidation; oxidation of unsaturated and odd chain fatty acids; omega oxidation pathway; biosynthesis of saturated fatty acid, supply of raw material for palmitic acid synthesis; fatty acid synthetase (FAS) multienzyme complex; biosynthesis of unsaturated fatty acids. Ketone bodies their biosynthesis, utilization and role in the tissues; cholesterol metabolism: cholesterol biosynthesis and its regulation; steroid hormones.
- 11) Nitrogen metabolism: metabolic fate of amino acids; catabolism of amino acids; deamination and transamination; nitrogen excretion and urea cycle; regulation of urea cycle; Biosynthesis of some amino acids; incorporation of ammonia in glutamate and glutamine.

BOOKS RECOMMENDED

1. David L. Nelson, and Michael M. Cox, 2000. Lehninger Principles of Biochemistry, 3rd Edition, Macmillan Worth Publishers, New York.
2. Murray, R.K., Granner, D.K., Mayer, P.A. and Rodwells, V.W., 2000. Harper's Biochemistry, 25th Edition, McGraw-Hill Book Company, New York.
3. Voet, D., Voet, J.G., and Pratt, C.W., 1999. Fundamentals of Biochemistry. John Wiley and Sons, Inc., New York.

PRACTICALS

- 1) Tests for detection of carbohydrates in alkaline and acidic medium.
- 2) Tests for detection of Disaccharides.
- 3) Detection of Non-Reducing sugars in the presence of Reducing sugars.
- 4) Demonstration of Acid Hydrolysis of Polysaccharide.
- 5) Separation and identification of various types of sugars, fatty acid and amino acid through chromatographic techniques.
- 6) Biochemical tests for detection of different amino acids.
- 7) Separation of various protein fractions by precipitation method.
- 8) Demonstration of differential solubility of lipids in various solvents.
- 9) Quantitative analysis of Amylase activity from blood serum or liver.
- 10) Studies on the effects of temperature pH, and substrate concentrations on the enzymatic rate of reaction.

Marks : 100 (75 + 25)

DEVELOPMENTAL BIOLOGY

COURSE CONTENTS

1. Introduction: Principal features of development, origin of sexual reproduction, developmental patterns; Spermatogenesis; Oogenesis.
2. Fertilization: Recognition of sperm and egg, fusion of gametes, activation of egg metabolism, rearrangement of egg cytoplasm.
3. Cleavage: Patterns of embryonic cleavage, mechanism of cleavage.
4. Gastrulation: Fate maps, gastrulation in sea urchin, amphibians, birds and mammals.
5. Early Vertebrate Development: Early differentiation, Axis formation. formation of ectoderm, mesoderm and endoderm, Neurulation. Origin and Migration of Germ Cells in Vertebrates.
6. Cellular Basis of Morphogenesis: Differential cell affinity, cell adhesion molecules.
7. Mechanism of Cellular Differentiation: RNA processing, translational regulation of developmental process, cell-fate by progressive determinants, autonomous cell specification by cytoplasmic determinants, establishment of body axes and mechanism of teratogenesis; Secondary Induction.
8. Normal Growth and Oncogenesis- Controlling. Factors
9. Hormones as Mediators of Development
10. Metamorphosis and Vertebrate Regeneration.
11. Abnormal developments and teratogens

BOOKS RECOMMENDED

- 1) Gilbert, S. F., 2008. *Developmental Biology 8th-edition*; Sinauer Associates, Sunderland, MA.
- 2) Balinsky, B. I., 1985. *An Introduction to Embryology*, Saunders.
- 3) Saunders, J. W. 1982. *Development Biology*, McMillan.
- 4) Oppenheimer, S.S., 1984. *Introduction to Embryonic Development*, Allen and Bacon.
- 5) Ham, R. G. and Veomett, M. J., 1980. *Mechanism of Development*. C. V. Mosby Co.
- 6) Berril, N. J. and Karp, G., 1978. *Development*. McGraw Hill.

PRACTICALS

- 1) Study of structure of gametes in some representative cases, i.e., frog, fish, fowl and mammal.
- 2) Study of cleavage and subsequent development from prepared slides and/or whole mounts in various animals i.e., frog, chick etc.
- 3) Study of fertilization, early development of frog through induced spawning under laboratory conditions.
- 4) Preparation and study of serial sections of frog or chick embryos. Application of microsurgical techniques on chick embryos *in vitro*. Preparation and staining of histological slides.

COURSE CONTENTS:

Introduction and scope, use of statistics in biology. Concepts of population and samples. Types of data and methods of data collection. Measure of central tendency computation of means, median and mode from grouped and ungrouped data. Measures of dispersion, computation of variance, standard deviation, standard error and their coefficients. Probability rules. Binomial, poisson and normal distributions. Hypothesis testing, types of t-tests, Chi-square test, Analysis of variance, correlation and regression, experimental design, planning of an experiment, estimation of species richness, diversity, evenness, principal component analysis, correspondence analysis and cluster analysis. concepts

PRACTICALS:

Fields surveys to collect different animals or plants from different habitats and application of above mentioned statistical analyses on the collected data.

RECOMMENDED BOOKS:

1. Geoffery, R. Norman and David L Streiner, 2000. Biostatistics: The Bare Essentials. B.C. Decke Inc.
2. Gerry, P. Quinn and Mechael J. Keough, 2002. Experimental design and data analysis for biologists. Cambridge University press.
3. Ludwig, J. A. and Reynolds, J. F., 1988. Statistical Ecology: A Primer on

Cell and molecular Biology

Marks = 100 (75 + 25)

Course Content:

Introduction to prokaryotic and eukaryotic cells: Plasma membrane, its chemical composition structure and functions: of plasma membranes, cell permeability, active transport, endocytosis, phagocytosis.

Cytoskeleton: Microfilaments, Microtubules, Intermediate filaments.

Cytoplasmic Organelles: Membrane system (structural and functional commonalities). Ultrastructure, chemical composition and functions of Endoplasmic Reticulum with special reference to their role in protein synthesis and drug metabolism), Golgi Apparatus (with reference to its role in synthesis of glycoprotein), Mitochondria (with reference to its role in cellular respiration, and its significance as semi-autonomous organelle), Lysosome (with reference to its diverse roles due to hydrolytic activity of enzymes), peroxisome (with reference to metabolism of hydrogen peroxide), glyoxysome (with reference to glyoxylic acid cycle).

Nucleus, chromatin, heterochromatin, euchromatin, chromosome structure with reference to coiling and nucleosome during different phases of cell cycle, Replication (mechanism, DNA replication in prokaryotes specially with reference to variety of DNA polymerases and other proteins involved. DNA replication in Eukaryotes with special reference to DNA polymerases, concept of Replicons etc.), Transcription (variety of RNA and their characteristics, synthesis of mRNA, rRNA and tRNA with special reference to enzymes, involved, RNA splicing, split genes, concept of Ribozymes and posttranscriptional processing), RNA transduction, Genetic code, point mutations, Translation (with reference to the specific role of Ribosomes, various factors, and posttranslational processing). Control of Gene expression in Prokaryotes.

Books Recommended:

1. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K. and Watson, J.D. MOLECULAR BIOLOGY OF THE CELL, 1989. Garland Publishing Inc., New York.
2. Damell Jr. J., Lodisch, H. and Balimore, D. MOLECULAR CELL BIOLOGY, 1990. Scientific American Inc. N.Y.
3. De Robertis, E. D. P. and De Robertis Jr. E. N. F. CELL AND MOLECULAR BIOLOGY, 1987. Lea & Febiger, New York.
4. Karp, J. CELL AND MOLECULAR BIOLOGY, CONCEPTS AND EXPERIMENTS, 2005. Jhon Wiley and Sons, INC.
5. Geoffrey M.C., Robert E.H. THE CELL: A MOLECULAR APPROACH, 2007. Sinauer Associates, INC.

Practicals:

1. Detection and quantitative determination of chromosomal DNA and RNA.
2. Cultural and staining of bacteria and yeast.
3. Identification of different type of blood cells in human blood through smear technique.
4. Counting of prokaryotic cells (bacteria) and blood cells by using haemocytometer.
5. Isolation and characterization of proteins on polyacrylamide gel electrophoresis (native and sub-unit molecular weights).
6. Separation of different sized DNA fragments on agarose gel.

Animal physiology

Marks = 100 (75+25)

Course Contents:

Central themes in Physiology: Structure-function relationship, Adaptations, Homeostasis, Conformity and Regulation.

Physiological basis of Membrane Function: Mechanisms in resting membrane potentials: Electrogenic ion pump, Donnan equilibrium, Diffusional potentials, Ion channels, Ionic mechanisms in action potentials: Roles of ion channels, Properties of action potential. Propagation of action potential in neurons; Synaptic transmission; Structure and function of electrical synapse structure and function of chemical synapse; Neurotransmitters; Synaptic receptors; Excitatory postsynaptic potentials; Inhibitory postsynaptic potentials; Presynaptic inhibitions; Integration at synapses: Facilitation, Posttetanic Potentiation.

Receptors Physiology: Transduction; Sensory coding; Range fractionation; Sensory adaptations; Mechanoreception: Hair cell mechanism particularly in acoustico-lateralis system of vertebrates; Cutaneous receptors; Cellular and molecular mechanisms in taste and olfactory reception; Photoreception: Ultrastructure of photoreceptors, Photochemistry, Phototransduction and physiological basis of color vision; Physiological mechanisms in electroreception.

Chemical Messenger and Regulators/Endocrine Physiology: Types and functions of secretions. An overview of invertebrate endocrine structures, their hormones and physiological roles. An overview of hormones, their chemistry and physiological roles of Hypothalamus, Pituitary, Thyroid, Parathyroid and associated structures, Endocrine pancreas, Gastropancreatic system, Adrenal medulla (Chromaffin Tissue), Adrenal cortex, Ovary, Testis and Placenta. A generalized model account of hormone synthesis, storage and secretion (a peptide hormone model and steroid hormones); Hormonal interactions in metabolic and developmental function; Water and electrolyte balance and reproduction. Integrated endocrine and neural responses in glycemia and calcium homeostasis and reproductive cycles; General account of hormonal regulations, hormonal turnover, recognition; Mechanisms of action in hormones involving membrane receptors and nuclear modulated gene expression; Endocrine functions of kidneys, heart and pineal gland.

Movements and Muscles: Structural basis of muscle contraction: molecular structures of contractile components and their interaction, sarcoplasmic reticulum, calcium and membrane mechanisms in regulation of contraction.

Cardiovascular Mechanisms: Electrical activity of heart: Automaticity, Rhythmicity, Electrocardiography, Kymography; Hemodynamics, Blood flow, pressures and resistance and their interrelationships. Control of cardiac activity (cardiac output) and peripheral circulation.

Exchange of Gases: Transport of O_2 and CO_2 between respiratory surface (the lungs) and body cells. Regulation of lungs respiration; Gas transfer in water (gills) and its regulation; Respiratory responses in extreme conditions as hypoxia; Hypercapnia in air breathing divers.

Excretion and Osmoregulation: Osmoregulation in aquatic and terrestrial environment. Vertebrate nephron as osmoregulatory organ: Physiological anatomy, Glomerular filtration, Tubular absorption and secretion; Nitrogenous waste products; Patterns of nitrogenous excretion and their phylogenetic development.

Nutrition: Regulation of digestive secretions; Physiological anatomy of digestive tract (mammalian model), Absorption of water, ions and nutrients; Potential and Movements in gastrointestinal tract; Control of motility.

Temperature Relations: Temperature classification of animals; Temperature relation of ectotherms in freezing and cold and warm and hot environment; Costs and benefits of ectothermy; Temperature relations of heterotherms and endotherms; Dormancy: Sleep, Torpor, Hibernation, Estivation.

Books Recommended:

1. Randall, D., Burggren, W., French, K. and Fernald, R. ECKERT ANIMAL PHYSIOLOGY: MECHANISMS AND ADAPTATIONS, 5th Edition. 2002. W.H. Freeman and Company, New York
2. Bullock, J., Boyle, J. and Wang, M.B. PHYSIOLOGY, 4th Edition. 2001. Lippincott, Williams and Wilkins, Philadelphia.
3. Berne, R.M. and Levy, M.N. PRINCIPLES OF PHYSIOLOGY, 3rd Edition. 2000. St. Louis, Mosby.
4. Guyton, A.C. and Hall, J.E. TEXTBOOK OF MEDICAL PHYSIOLOGY, 10th Edition. 2000. W.B. Saunders Company, Philadelphia.
5. Withers, P.C. COMPARATIVE ANIMAL PHYSIOLOGY. 1992. Saunders College Publishing, Philadelphia.
6. Schmidt-Nelsen, K. ANIMAL PHYSIOLOGY, ADAPTATION AND ENVIRONMENT, 5th Edition. 1997. Cambridge University Press, Cambridge.
7. Bullock, J., Boyle, J. and Wang, M.B. PHYSIOLOGY, 4th Edition. 2001. Lippincott, Williams and Wilkins, Philadelphia.

Practicals:

Muscle and Neuromuscular Activity: Nerve muscle preparation, Muscle twitch, Comparison of muscle and nerve irritability, effect of

stimulus strength, effect of stimulus frequency (tetany), effect of load or stretch, effect of prolonged activity (fatigue), neuromuscular fatigue, stimulation of motor points in human.

Excitability, Sensation and Behaviour: Recording of action potential by oscilloscope and demonstration of its various features. Experiments to demonstrate characteristic of reflex arc. Experiment in human (students themselves) to demonstrate some aspect of sensory physiology.

Cardiovascular Activity: Normal cardiac activity, effect of temperature, effect of drug, heart block, tetanization of heart. Measurement of blood pressure.

Respiration and Exercise: Oxygen consumption in fish and effect of temperature (by dissolved oxygen meter) and terrestrial animal (mouse). Oxygen consumption (by respirometer), heart rate, blood pressure glycemia altered by exercise.

Endocrine and Reproductive Mechanisms: Effect of insulin on glycemia, study of stages in estrous cycle.

Books Recommended

1. Tharp, G. and Woodman, D. EXPERIMENTS IN PHYSIOLOGY, 8th Edition. 2002. Prentice Hall, London.

GENETICS

Marks: 100 (75+25)

Course Contents :

Classical genetics – multiple alleles, genetics of blood groups, chromosomal basis of inheritance, interaction of genes, chromosomal changes (euploidy, aneuploidy, structural changes), sex-determination and sex-linkage, linkage, recombination and chromosome mapping in eukaryotes, quantitative inheritance, gene concept (classical and modern), genetics of viruses, bacteria, transposons.

Molecular genetics – analysis and techniques of molecular genetics (elements of genetic engineering), genetic basis of cancer, genetic control of animal development, the genetic control of the vertebrate immune system, complex inheritance patterns.

Population genetics – Hardy-Wienberg equilibrium, systematic and dispersive pressures, inbreeding and heterosis.

Books Recommended:

1. Snustad, D.P. and Simmons, M.J. PRINCIPLES OF GENETICS. 3rd Edition, 2003. John Wiley and Sons Ins. New York, USA.
2. Lewin, B. GENE-VIII. 2000. Oxford University Press. UK.
3. Tamarin, R.H. PRINCIPLES OF GENETICS. 7th Edition, 2001. WCB publishers USA.
4. Gardener, E.J., Simmons, M.J. and Snustad, D.P. PRINCIPLES OF GENETICS. 1991. John Wiley and Sons Ins. New York, USA.
5. Strickberger, M.W. GENETICS. 1985. McMillan, New York. USA.

Practicals:

1. Mitosis (Onion root tips.)
2. Meiosis (Grass hopper testes)
3. Blood groups.
4. Salivary gland Chromosomes of *Drosophila melanogaster*
5. General morphology of *Drosophila melanogaster*
6. Human Pedigree analysis problems
7. Human Genetics problems
8. Probability problems. Tossing of coins X^2 test
9. Study of transformed bacteria on the basis of antibiotic resistance.

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COURSE CONTENTS:

Aquaculture: the concept; mariculture, substrate system, seawater ponds, cages, enclosure, tanks; aquaculture in fresh and brackish waters. Aquaculture in practice. General characteristics of fish: size, shape and external features. Freshwater fishes of Pakistan. Freshwater fishing methods. Food and feeding habits of fish: feeding types. Pond fish culture: types of fish ponds, planning and construction of fish ponds, water quality variables. Requisite conditions suitable for fish culture. Culturable species of fish, procurement of stocking material, preparation and management of rearing fish ponds. Brief account on Mono-poly and composite fish culture systems. Fertilization of fish ponds: their application and impact on fish growth and water quality. Fish feed and feeding: feed ingredients and feed conversion efficiency. Fish diseases and their control. Aquatic resources of Pakistan.

Wildlife of Pakistan, identification, distribution, status, conservation and management (population estimate technology) of fishes, reptiles, birds and mammals of major importance in Pakistan. Philosophy and significance of wildlife conservation. Biodiversity and sustainability of wildlife. Wildlife rules and regulations in Pakistan. National and International agencies involved in conservation and management of wildlife. Sanctuaries, Game Reserves and National Parks in Pakistan. Ramsar convention, wetlands, endangered species of Pakistan.

(Note: The teacher is suggested to provide blank maps of Pakistan in the theory class to the students to indicate the distribution of the animals. Similar blank maps should be attached with the question paper, if distribution of animals is asked from the student in the theory paper).

Books Recommended:

1. Bailey, J.A. PRINCIPLES OF WILDLIFE MANAGEMENT, 1986. John Wiley and Sons..
2. Ali S. and Ripley S.D. A HANDBOOK OF BIRDS OF INDIA & PAKISTAN, 1973. Oxford University Press, London.
3. Roberts, T. J. THE BIRDS OF PAKISTAN, (Vol. I). 1992. Oxford University Press.
4. Roberts, T. J. THE BIRDS OF PAKISTAN, (Vol. II), 1998. Oxford University Press.
5. Roberts, T.J. MAMMALS OF PAKISTAN. 1977. Ernest Benon Ltd, London.
6. Robinson, W.L. and Bolen, E.G. WILDLIFE ECOLOGY AND MANAGEMENT. 1984. McMillan, Cambridge.
7. Magon, C.F. BIOLOGY OF FRESHWATER POLLUTION. 1988. Longman and Scientific Publication.
8. Boyd, C.E. and Tucker, C. S. POND AQUACULTURE AND WATER QUALITY MANAGEMENT. 1998. Boston, Kluwer Publishers Alabama.
9. Ali, S.S. PALEONTOLOGY, ZOOGEOGRAPHY & WILD-LIFE MANAGEMENT. 1999. Nasim Book Depot. Hyderabad, India

PRACTICALS:

1. Study of morphological characters of a typical fish. Dissection of a bony fish to expose its various systems. Species identification based on fin formula and scale counting etc.
2. Practical demonstration of induced breeding. Artificial feeds and their constituents. Aquatic plants, aquatic insects.
3. Visit to hatchery and fish farm.

ANIMAL ECOLOGY

Marks: 100 (75+25)

Course Contents:

An overview of concepts of ecosystem with emphasis on interaction and homeostasis. Basic global ecosystems (atmosphere, hydrosphere, lithosphere, ecosphere). Biogeochemical cycle: nitrogen, phosphorus, sulphur, water, carbon, nutrient. Limiting factors: basic concepts, temperature, soil, water and humidity, light, fire. Energy: laws of thermodynamics, primary and secondary productions, trophic levels and energy variation with increasing trophic levels, energy flow, food chains and food webs. Population ecology: basic population characters, growth and growth curves, population dynamics and regulations. Community ecology: basic concepts, community analysis, ecotones, inter-population interactions. Ecological niche: basic concepts and types. An overview of

nitrogen oxide, carbon monoxide, ozone, smog and PAN, MTBE & CFCs); land pollution (pesticides, bacterial toxins, synthetic hormones); noise pollution. Radiation. Space biology. Contemporary environmental themes: (ozone depletion, acid rain, greenhouse effect and global warming, desertification, deforestation, exotic and invasive species, radioactivity leakage, environmental laws).

Books Recommended:

1. Odum, E. P. 1994. FUNDAMENTALS OF ECOLOGY. 3rd Edition W.B. Saunders Philadelphia.
2. Molles, M.C. 2005 Ecology: CONCEPTS AND APPLICATIONS. 6th Edition, McGraw Hill, New York, USA.
3. Dondson, S.I., Allen, T.F.N., Carpenter, S.R., Ives, A., Jeanne, R.L., Kitchell, J.F., Langston, N.E. and Turner, M.G., 1998. ECOLOGY: Oxford Univ. Press, UK.
4. Slingsby, D. and Cook, C., 1986. PRACTICAL ECOLOGY. McMillan Education Ltd. UK.
5. Chapman, J.L. and Reiss, M.J. 1997. ECOLOGY: PRINCIPLES AND APPLICATIONS. Cambridge Univ. Press, UK.
6. Smith, R.L. 1980. ECOLOGY AND FIELD BIOLOGY, Harper and Row.
7. Newman, I. 1993. APPLIED ECOLOGY. Black Well Scientific Publications Oxford. UK.
8. Cox, C.B and Morre. D. 2000. BIOGEOGRAPHY: AN ECOLOGICAL AND EVOLUTIONARY APPROACH, 6th Edition. Life Sciences King's College, London, UK.

Practicals:

Measurement of environmental factors on land, water and air. Study of different ecosystems: pond, agricultural or grassland, forest. Community analysis through different sampling techniques (quadrat, Transect). Population dynamics of grasshoppers. Adaptive features of animals in relation to food and environment. Food chain studies through analysis of gut contents. Analysis of polluted and fresh water for biotic and abiotic variations. Field visits for study of selected terrestrial habitat and writing notes. Development of an ecological management plan of some selected area.

EVOLUTION AND PRINCIPLES OF SYSTEMATICS

Marks: 100 (75+25)
~~100~~

Course Contents:

Evolution: The nature and origin of life. Evidences of evolution. (molecular, embryological & paleontological). Theories to explain the diversity of life - Modern synthetic theory.

Factors initiating elementary evolutionary changes (micro-evolution) by changing gene frequencies, mutation pressure, selection pressure, immigration and crossbreeding, genetic drift. Role of isolation in evolution. Factors of large evolutionary changes (macro/mega evolution) - allometry, orthogenesis, adaptive radiation.

Modern concept of Natural Selection: Levels of selection, selection patterns, laboratory and field example regarding action of Natural Selection. Action of Natural Selection leading to convergence, radiation, regression and extinction, Batesian mimicry, Mullerian mimicry. Sexual selection: Darwin's concept, Fisher's view, Zahavi's handicap theory. Recapitulation theory. Trend and rates in evolution.

Systematic Zoology: Contribution of systematics to Biology: History of Taxonomy (Downward classification, upward classification, impact of the origin of species, population systematics, current trends); Microtaxonomy, phenon, Taxon; Taxonomic categories: specific category, infraspecific category, higher categories; species concepts (Typological concept; nominalistic concept, Biological concept, evolutionary concept), species mate recognition concept; non-dimensional species concept; Multidimensional species concept; Cohesion species concept; Difficulties in the application of biological species concepts; polytypic species, subspecies, super species, sibling species; study of major type of variation within a single population. Speciation and taxonomic decision, various types of characters, cladistic analysis, Macrotaxonomy; different kinds of taxonomic characters: Taxonomic collection and identification; definitions of Synonym, Homonym, Keys; Evolution of the theory of Nomenclature; interpretation and application of the code (stability, priority, first revisor principle) range of authority of code; concept of availability, type method formation of specific

Books Recommended:

1. Ridley, M. EVOLUTION. 1993. Blackwell Scientific Publications.
2. Dobzhansky, T., Ayala, F.J., Stebbins, G.L. and Valentine, J.W. EVOLUTION. 1973. W.H. Freeman and Company.
3. Dobzhansky, T. GENETICS AND THE ORIGIN OF SPECIES, 1951. Columbia University Press, New York.
4. Mayr, E. POPULATIONS, SPECIES AND EVOLUTION, 1965. Harvard University Press.
5. Moody, P.A. INTRODUCTION TO EVOLUTION, 1989. Harper and Row Publishers, New York.
6. Strickberger. M.W. EVOLUTION. 2000. Jones & Barrett Publishers

PRINCIPLES OF TOXICOLOGY

Marks: 100 (75+25)

COURSE CONTENTS:

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 Dysfunction 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 Edition (International), McGraw-Hill, Health Professions Division, New York.
2. Timbrel, J.A., 1995. Introduction to Toxicology, 2nd Edition 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 Edition, Raven Press, New York.

ZOOGEOGRAPHY AND PALEONTOLOGY

Marks: 100 (75+25)

Course Contents :

Zoogeography: 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. Zoogeographical regions (division, geographic ranges, physical features, climates, faunas and affinities of Holarctic (Palaeartic, Nearctic regions), Oriental, Ethiopian, Australian, and New tropical Regions. Palaeogeography (Theories of Continental drift and Plate tectonics).

Principles of Paleontology: 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. Geological time scale. Pre-Cambrian life. Post Cambrian life (Palaeozoic life, Mesozoic life, Cenozoic life). Geochronometry (Uranium/Lead dating, radiocarbon dating, methods), evolutionary history of man, elephant, horse and camel, Paleoecology, Paleomagnetism.

Books Recommended:

Zoogeography:

1. Darlington, P. J. Jr. ZOOGEOGRAPHY, 1963. John Wiley and Sons.
2. DeBeaufort, L. F. ZOOGEOGRAPHY OF THE LAND AND INLAND WATERS. 1951. Sidgwick and Jackson.
3. Ali, S.S. PALAEONTOLOGY, ZOOGEOGRAPHY AND WILDLIFE MANAGEMENT. 1999. Nasim Book Depot, Hyderabad, India

Paleontology:

1. Dunbar C.O. HISTORICAL GEOLOGY, 1969. John Wiley and Sons Inc. New York.
2. Brouwer, A. GENERAL PALAEONTOLOGY, 1977. Oliver and Boyed, London.
3. Gilbert, L. I. and Colbert, E.H. EVOLUTION OF VERTEBRATES, 1980. John Wiley and Sons Inc. New York.
4. Ali, S.S. PALAEONTOLOGY, ZOOGEOGRAPHY AND WILDLIFE MANAGEMENT. 1999. Nasim Book Depot, Hyderabad, India.

Practicals:

1. Study Of fauna of various zoogeographical regions.
2. Study of mould, cast, pseudomorph, coprolite, petrified fossils of plants and animals.
3. Study of invertebrate fossils of coelenterates, trilobites, ammonite, brachiopods, molluscs and echinoderms.
4. Study of vertebrate fossils e.g. horse/elephant/camel/bovids.
5. Study and identification of Igneous, Sedimentary and Metamorphic rocks
6. Map work for identification of various zoogeographical regions of the World.

OPTIONAL SUBJECTS

ANIMAL BEHAVIOR

Marks: 100 (100+0)

Course Contents:

Mechanism of behavior : mechanism of behavior, nervous system and behavior, hormones and behavior, biological rhythm, development of behavior, learning behavior, communication.
Social organization: conflict, sexual reproduction, parental care, social system.

BOOKS RECOMMENDED:

1. Goodenough, J., McGuire, B. and Wallace, R.A. 2001. Perspective on Animal Behavior. John Wiley & Sons, New York.

BIOINFORMATICS

Marks: 100 (75+25)

COURSE CONTENTS:

1. Overview of Bioinformatic: The scope of Bioinformatics, Bioinformatics and internet. Useful Bioinformatics sites on the WWW.
2. Data Acquisition: Sequencing DNA, RNA and proteins, Determination of protein structure, Gene and protein expression data, Protein interaction data.
3. Database – Contents, Structure and Annotation: File formats, Annotated sequence databases, Genome and organism-specific databases, Miscellaneous databases.
4. Retrieval of Biological Data: Data retrieval with Entrez and DBGET/LinkDB, Data retrieval with SRS (sequence retrieval system).
5. Searching Sequence Databases by Sequence similarity Criteria: Sequence similarity searched, Amino acid substitution matrices, Database searched (FAST and BLAST), sequence filters. Interactive database searches and PSI-BLAST.
6. Multiple Sequence Alignment- Genes and Protein Families: Multiple sequence alignment and family relationships, protein families and pattern databases, protein domain families.
7. Phylogenetics: Phylogenetics, cladistics and ontology, Building phylogenetic trees, Evolution of macromolecular sequences.
8. Sequence Annotation: Principles of genome annotation, Annotation tools and resources.
9. Structural Bioinformatics: Conceptual models of protein structure, relationship of protein three-dimensional structure to protein function, The evolution of protein structure and function, Obtaining, viewing and analyzing structural data, Structural alignment, classification of proteins of known three-dimensional structure: CATH and SCOP, Introduction to protein structure prediction by comparative modeling, secondary structure prediction, advanced protein structure prediction and prediction strategies.
10. Microarray Data Analysis: Analysis methods, tools and resources, sequence sampling and SAGE.
11. Proteomic Data Analysis: Analyzing data from 2D-PAGE gels, analyzing protein spectrometry data.
12. Higher-order System: Modeling and reconstructing molecular pathways, protein interaction informatics, Higher-order models.
13. Chemoinformatics in Biology: Conventions for representing molecules, Chemoinformatics resources.
14. Bioinformatics in Pharmaceutical industry: Bioinformatics and drug discovery. Pharmainformatics resources.
15. Basic Principles of Computing in Bioinformatics: Running computer software, Computer operating systems, software downloading and installation, Database management.

RECOMMENDED BOOKS:

1. Gibas, C. and Jambeck, P. 2001. Developing Bioinformatics Computer Skills. O'Reilly publishers, ISBN 1-56592-644-1.

4. Baxevanic, A.D. and Ouellette, B.F.F. 2004. Bioinformatics: A practical Guide to the analysis of Genes and Proteins, 3rd Ed. O'Reilly publishers.
5. Krane, D.E. and Raymer, M.L. 2002. Fundamental concepts of Bioinformatics. Benjamin Cummings.
6. Moody, G. 2004. Digital Code of life: How bioinformatics is revolutionizing science, Medicine, and Business. John Wiley and Sons.
7. Orengo, C.A., Jones, D.T. and Thornton, J.M. 2003. Bioinformatics: Genes, Proteins and Computers (Advanced Text). Routledge.
8. <http://www.ncbi.nlm.nih.gov>
9. <http://www.ebi.ac.uk>
10. <http://foldoc.doc.ic.ac.uk/foldoc/index.html>
11. <http://wit.integratedgenomics.com/GOLD/>

MICROBIOLOGY

marks, 100 (75+25)

COURSE CONTENTS:

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.

Microbial evolution, systematics and taxonomy; Characterization and identification of microorganisms. Nomenclature and Bergey's manual.

Viruses: Bacteriophages and phages of other protists. 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.

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.

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.

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

Microbial Ecology: Microorganisms in nature, Microbial activity measurements, Aquatic habitats, Deep-sea microbiology, Terrestrial environments, Hydrothermal vents, Rumen microbial ecosystem, Microbial leaching, Biogeochemical cycles; Trace metals and mercury, Biodegradation of Xenobiotics.

Microbial metabolism: Fuelling reactions in aerobic and anaerobic heterotrophs and autotrophs.

Microbial metabolism: Biosynthesis, polymerization, assembly: Methods of studying biosynthesis, synthesis of Nucleotides, Amino acids, Lipids, Porphyrins, Proteins, Polysaccharides and peptidoglycan polymerization of building blocks, Assembly of biopolymers into cellular components.

PRACTICALS:

Study of bacteria, yeasts and 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. Culturing of microorganisms: Preparation and sterilization of culture media, agar slope, agar slab, streak plates, pour plates methods. Isolation of a bacterial culture. 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. MICROBIOLOGY, 1986. Pelczar Jr., Chan, E.C.S. and Krieg, M.R. McGraw Hill, London.
3. BROCK BIOLOGY OF MICROORGANISMS, 1997. Madigan, M.T., Martinko, J.M. and Parker, J. Prentice-Hall, London.
4. THE MICROBIAL WORLD, 1986. Stainier, R.Y., Ingraham, J.L., Wheelis, M.L. and Painter, R.R. Prentice Hall, London.

IMMUNOLOGY

Marks: 100 (75+25)

COURSE CONTENTS:

Overview of the immune system Historical perspective, innate and acquired immunity. Cells and organs of immune systems Hematopoiesis, lymphoid cells, Mononuclear cells Dendritic cells, primary lymphoid organs, leukocyte recrudescences. Antigens; immunologic properties of Antigens factors affecting antigenicity, epitopes, Heptend, and study of antigenicity, ucal and bacterial antigens, milogens. Immunoglobulin structure and function basics structure, sequencing studies, fine structure, receptor complex, Antigenic determinants, Isotype and super family. Antigen antibody interactions strength, cross reactivity, precipitant, agglutination reaction RIA and ELISA, western blotting, immuno-flourescence. Organization and expression of immunoglobulin genes genetic modal compatible with immunoglobulin structure. Multigene organization of Ig genes variable region rearrangement, regulation of Ig gene transcription, generation of Ab diversity, class switching among constant region genes. Expression of Ig genes. Major histocompatibility complex (MHC). General organization and inheritance of MHC. Class I MHC molecules and genes. Polymorphism of class I and II MHC genes, class III MHC molecules, mapping of MHC and its expression. Antigen processing and presentation; self MHC restriction of T-cells roll of Ag presenting cells. T-cell receptor organization and rearrangement of TCR genes T-cell receptor complex, TCR (i) 3 T-cell accessor membrane molecules TCR-MHC-Antigen interaction. Cytokines; General properties discoverage and purification, structure and function, receptors, antagonists, recreation and Biological activity of TH I and TH-2 subsets. Generation of humoral immune responses. Kinetics, experimental systems, identification of cells required for induction of humoral immunity. Cell mediated immunity. Direct and delayed type cytotoxic and hypersensitivity responses. Transplantation immunology graft reflection. Immunodeficiency diseases. Classification, phagocytic humoral, cell mediated and combined humoral and cell mediated deficiencies, complement mediated deficiencies.

PRACTICALS:

Detection of Ab. Primary immune response. Secondary immune response. Demonstration of Ab specificity. Estimation of antibodies. Separation of various types of immunoglobulins. Microscopic study of various organs of immune system. Immune responses in stress. Estimation of globulins. Demonstration of enzyme linked immunosorbent assay. Demonstration of radioimmuno assays.

BOOKS RECOMMENDED:

1. KUBY'S IMMUNOLOGY, 2002. 4th ed. Richard, A., Goldsby, Thomas, J. Kindt and Barbara: A. Osborn. W.H. Freeman & Company, New York.
2. CELLULAR AND MOLECULAR IMMUNOLOGY, 1994. 2nd ed. Abbas Lichtman & Pober, W.B. Saunders Co.

COURSE CONTENTS:

Introduction to Blood and its formed elements, erythrocytes, leucocytes, and thrombocytes with size and shape, Blood plasma and its composition; blood sampling; techniques and sites of sampling; sites of blood formation at various stage of life; Anticoagulants.

Bone marrow and its types, Haemopoiesis, Normocytic erythropoiesis, Megalocytic erythropoiesis, Regulation and control of erythropoiesis, Leucopoiesis and its types and regulation, thrombopoiesis, Haemoglobin, its structure, types and synthesis; Other respiratory pigments; erythrocytic inclusions; Gas transport Blood coagulation and its mechanisms; Introduction to anaemia and its types; Introduction to Leukemia and its types and white blood cells disorders. variation in shape of erythrocytes, and bone marrow transplantation;

PRACTICALS:

1. Total erythrocyte count by use of improved neubar hemocytometer
2. Counting of leucocytes by the use of hemocytometer
3. Differential leucocytes counting by using Giemsa stain
4. Study of lymphoid organism among mammals
5. Estimation of haemoglobin by use of spectrophotometer through cyanomethaemoglobin
6. Demonstration of packed cell volume/haematocrit by use of centrifuge machine through haematocrit tubes.
7. Estimation of different blood indices.

Books Recommended:

1. Dacie, M.S., Bates, I and Bain, B.J. Practical Haematology by Dacie and Lewis 10th Edition 2006 Churchill Livingstone Philadelphia
2. Hoffbrand, A.V and Pettit, J.E. Essential Haematology 4th Edition 2001 Blackwell Science Ltd. Malden, USA
- Riot, M Essentials of Haematology 1983 by McGraw Hill.

HUMAN EMBRYOLOGY AND TERATOLOGY

Marks : 100 (75+25)

COURSE CONTENTS:

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 plan. Placenta and extra embryonic membranes, developmental disorders: causes mechanisms and patterns. Brief description of development of various body systems.

PRACTICALS :

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

BOOKS RECOMMENDED:

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

COURSE CONTENTS:

Introduction, approaches and objectives, past and present, theoretical foundation of pest control, opportunities and challenges for insect pest control in developing countries, concept of economic threshold level, economic injury level, economic damage and economic boundary, major threats to the natural enemies, ranking of natural enemies, concept of classical biological control, effects of different agronomic practices and habitat structure on the population dynamics of predators, relationship of biological control to the sustainable agriculture, augmentation and inoculation of natural enemies, conservation of existing natural enemies, limitation of biological control and modern trends to overcome this problem.

PRACTICALS:

Collection and identification of important pests and their enemies, techniques to culture and maintain selected natural enemies of insect pests in the laboratory and in the fields.

RECOMMENDED BOOKS:

1. Bradford, A. H. & Howard V. C, 2008. Theoretical Approaches to Biological Control. Cambridge University Press, New York.
2. DeBach, P., 1991, *Biological Control by Natural Enemies*, 2nd edition, Cambridge University Press, Cambridge, MA.
3. Dent, D., 1991. Insect pest management. C.A.B International Wallingford, Oxon. UK.
4. Pedigo, L.P., 1991. Entomology and pest management. Maxwell MacMillian.
5. Van Driesche, R.G. and T.S. Bellows, Jr., 1996, *Biological Control*, Chapman and Hall, International Thomson Publishing Co.

Statistical Ecology:**COURSE CONTENTS:**

Introduction to ecological parameters, experiments and experimental design, review of ANOVA, assumptions of ANOVA, ANOVA models, mixed model ANOVA, Nested ANOVA, Factorial experiments & Repeated Measures, linear regression & multiple-regression, MANOVA, estimation of species richness, diversity, evenness, principal component analysis, correspondence analysis, discriminate functional analysis, cluster analysis, redundancy analysis, concepts of niche overlap and resource partitioning, distribution models, interspecific association, interspecific covariation, association analysis, non linear ordinations, resemblance function, quadrat variance methods and distance methods.

PRACTICALS

Fields surveys to collect different arthropods from different habitats and application of above mentioned statistical analyses on the collected data using statistical softwares.

BOOKS RECOMMENDED

1. *Multivariate Statistical Methods: a primer*. Manly, B.F.J. 2004. Chapman and Hall.
2. *Multivariate Statistics for Wildlife and Ecology Research*. McGarigal, K., S. Cushman, and S. Stafford. 2000. Springer.
3. *Statistical Ecology: A Primer on Methods in Computing*. Ludwig, J. A. and Reynolds, J. F. 1988. John Wiley and Sons, New York.
4. *The interpretation of ecological data: a primer on classification and ordination*. Pielou, E.C. 1984. Wiley-Interscience.

COURSE CONTENTS

Fish nutrition: Digestive system; Stomach less fishes; Stomach fishes; Digestion and absorption; Food; Plant origin; Animal origin; Feeding; Fresh food; Dry concentrates; Pelleted food; Transportation: Blood; Blood cells (Erythrocytes, leukocytes, platelets and plasma); Circulation; Arterial system; Venous system; Capillaries; Transport of food material; Respiration: Gills; Lungs; Skin; Swimbladder; Homeostasis; Excretion: Kidneys; Hypo-osmotic urine; Hyper-osmotic urine; Osmoregulation; Reproduction: Gonads; Testes and ovaries; Maturation; Reproductive cells (egg and sperm); Artificial fertilization of sex cells; Breeding: Natural (seasonal); Artificial; Hormonal induced breeding; Temperature & photoperiod; control induced breeding. Growth: Extensive culture (due to the consumption of natural food); Semi-intensive culture (due to natural & artificial food); Intensive culture (due to only dry concentrates); Fish health: Water quality; Hygiene of fish culture facilities; Hygiene of equipments used in fish culture; Diseases and their control: Viral; Bacterial; Fungal; Parasitic; Protozoan; Helminths (trematodes, cestodes, nematodes, acanthocephalons); Crustaceans (cladocera); Annelids (leeches); Arthropods (water ticks, water flea, water mites) Fish migration: To nursery ground; To maturation grounds; Freshwater to marine water; Marine water to freshwater; Fish behaviour: Learning and memory; Light response for maturation; Courtship behaviour; Aquarium fish behaviour 66

PRACTICALS

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 (GnRH) on fish maturation. Diagnosis of bacterial infection in infected fish, Study of fish parasites, Visit to various fish seed hatcheries during breeding seasons

BOOKS RECOMMENDED

1. Kestin Farmed Fish Quality (2001) Multiline Books
2. Ruth Freshwater Aquaculture (2000) Multiline Books
3. Saksena Ichthyology: *Recent research advances* (1999) Multiline Books
4. Woo Fish Diseases and Disorder: *Protozoan and Metazoan Infections* (1995) Pak Book Corp.
5. Brenabe Aquaculture, Vol. I & II (1992) Fishing News Books Ltd, England
6. Maseke Fish Aquaculture (1987) Pergamon Press, Oxford
7. M. Huet Text Book of Fish Culture: *Breeding and Cultivation* (1986) Fishing News Books Ltd, England
8. Hoars Fish Physiology
9. Hoars Fish Reproduction
10. Matty Fish Endocrinology (1985)
11. Gorbman Comparative Endocrinology (1983)

Biology Of Spiders:

Marks: 100 (75+25)

COURSE CONTENTS

An Introduction to Spiders: Mygalomorphae, chelicerae, spinnerets, Functional Anatomy: prosoma, chelicerae, opisthosoma, Metabolism: hemolymph, book lungs, hemocyanin, Neurobiology: neuropil, subesophageal ganglion, Cupiennius, Spider Webs: cribellum, linyphiids, spider silk, Locomotion and Prey Capture: Callilepis, bombardier beetles, Argyiope, Reproduction: palps, Haplogynae, cocoon, Development: autotomized, cheliceral, molting, Ecology: ant mimicry, stridulation, Argyrodes, Phylogeny and Systematics: synapomorphies, cribellum, Mygalomorphae

PRACTICALS

Collection, Preservation and Identification of Spiders. preparation of slides of genitalia, measurements, drawings and description. study of various systems.

BOOKS RECOMMENDED

1. *Biology of Spiders*. Foelix, R. F. 1996. Oxford University Press, US.
2. *A Spider's World: Senses and Behavior*. Barth, F.G. and Biederman-Thorson, A. 2001. Springer Verlag, Berlin, Heidelberg, New York.
3. *Spiders in ecological webs*. Wise, D.H. 1995. Cambridge University Press.
4. *Spiders of India*. Sebastian, P. A. and Peter, K. V. 2009. Universities Press (India) Pvt. Ltd.

Ornithology:

Marks: 100 (75+25)

Course Contents:

Introduction, The contributions of ornithology to modern biology. The Diversity of Birds
The design of a flying machine--The Evolution of Birds and Adaptations for flight .Adaptive radiations-- Birds of the world – Orders and Families .Form and Function: Anatomy and Physiology .Reproduction and Development - the amazing egg. Annual cycles/Molt/Migration,Migration/Navigation,Navigation/behavior
Demography and Conservation .Social behavior .Communication – Vocalizations.Song and song learning

PRACTICALS:

FIELD TRIPS

RECOMMENDED BOOKS:

1. *Ornithology*. Gill, F. 3rd Edition
2. *Manual of Ornithology*. Proctor, N.S. and Lynch, P.J. Yale University Press. New Haven. Connecticut. 1993
3. *Sibley's Birding Basics*. Sibley, D.A. and Knopf, A.A. 2002, New York.
4. *The Sibley Guide to Bird Life & Behavior*. Sibley, D.A. and Knopf, A.A. 2001. New York.

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