CHOICE BASED CREDIT SYSTEM (CBCS)

SYLLABUS FOR THE

MASTER OF SCIENCE

IN

ZOOLOGY

TWO YEAR FULL-TIME PROGRAMME

DEPARTMENT OF ZOOLOGY

FACULTY OF SCIENCE
DEEN DAYAL UPADHYAYA, GORAKHPUR UNIVERSITY,
GORAKHPUR-273009
2019

Semester Courses of M.Sc. Zoology Based on CBCS

The course of M.Sc. Zoology will be spread in two years previous and final. Each of which will have two semester examinations and therefore will be four semester examinations.

Programme Specific Outcomes of Zoology

1. Developing deeper understanding of key concepts of biology at biochemical, molecular and cellular level, physiology and reproduction at organismal level, and ecological impact on animal behavior.

2. Developing the concept of animal adaptation by exploring the diversity of functional characteristics of various kinds of organisms which is closely related to evolutionary processes and environmental changes.

3. Understanding of Mendel's principle, its extension and chromosomal basis; chromosomal anomalies and associated diseases; developing concepts of regulation of gene activity in prokaryotes and eukaryotes of transcriptional and post transcriptional level.

4. Development of an understanding of animal science for its application in entomology, apiculture, aquaculture, agriculture and modern medicine.

5. Develop an information about and basic concept of developmental biology elucidation of early embryonic development and organogenesis of invertebrates and vertebrates, explanation of embryonic stem cells and their application.

6. To understand the basic components of computers, software (operating system) and application of software used in biological and statistical studies.

7. Development of theoretical and practical knowledge in handling the animals and using them as model organism.

8. By the theoretical project work is aimed to in calculate ability to develop a research question, organize relevant available literature and development of technical writing skill.

9. To understand the impact of chemicals on biodiversity of microbes, animals and plants; Bioindicator and biomarkers of environmental health. Biodegradation and bioremediation of chemicals; competition and existence; intraspecific and interspecific interactions.

10. Maintenance of high standards of learning in animal sciences.

M.Sc. Previous (Zoology)

(Effective from session 2019-20)

The M.Sc. Previous (Zoology) examination will consist of two semesters, called as first and second semesters. Their examinations will be held in the months of December and May respectively. In each of these semester examinations, there will be five compulsory papers. Each paper will be of three hours duration and 5 credit (maximum marks 70), except where stated otherwise. There will be 30% internal evaluation in each paper based on:

1. Attendance 10 Marks
2. Class Test/Assignment 10 Marks
3. Seminar 10 Marks

Format of the Question Paper:

There will be one compulsory question consisting of 4 parts of short answer type question based on the whole course, out of which all parts will have to be answered. Besides this, there will be 8 questions from four units (two from each unit), out of which 4 questions will have to be answered (one from each unit). Thus in all 5 questions will have to be attempted and 9 questions will have to be set. A questions will carry equal marks, except stated otherwise.

M.Sc Final Zoology

(Effective from session 2020-2021)

The M.Sc Final Zoology will consist of two semesters, called as third and fourth semesters. Their examinations will be held in the months of December and May respectively. In each of these semesters examinations there will be three compulsory papers and two elective papers to be selected from each group of optional papers. Each paper will be of three hours duration and of 5 credit (maximum marks 70), except where stated otherwise. There will be 30% internal evaluation in each paper based on:

1. Attendance 10 Marks
2. Class Test/Assignment 10 Marks
3. Seminar 10 Marks

Format of the Question Paper:

There will be one compulsory question consisting of 4 parts of short answer type question based on the whole course, out of which all parts will have to be answered. Besides this, there will be 8 questions from four units (two from each unit), out of which 4 questions will have to be answered (one from each unit). Thus in all 5 questions will have to be attempted and 9 questions will have to be set. A questions will carry equal marks, except stated otherwise.

(ZOOLOGY)

TWO-YEAR FULL-TIME PROGRAMME

AFFILIATION

The proposed programme shall be governed by the Department of Zoology, Faculty of Science, DDU Gorakhpur University Gorakhpur

PROGRAMME STRUCTURE

The M.Sc . Programme is divided into two parts as under. Each part will consist of two semesters as given below

		Semester-odd	**Semester-Even**
Part-I	First Year	Semester-1	Semester-2
Part-II	Second Year	Semester-3	Semester-4

Each semester would consist of four papers (course) and one practical course (based on all four papers, two credits for each paper). Semesters I and II (Part I) would have core papers (courses) to be studied by all students of the M.Sc. Zoology programme. Semesters III and IV (Part II) would comprise optional papers from which each student would have to select four papers in Semester III and three papers of his/her choice in Semester IV. Selection of papers in Semester III and IV would be based on merit (performance in the part I examiners), choice and other specific guidelines as outlined below. It is mandatory for each student to complete a dissertation, assigned at the end of semester II and goes on until Semester IV. It would be theoretical and not involve any laboratory components. The schedule of papers prescribed for various semesters shall be as follows.

Part-I Semester-1

1.	ZOOL 101	Non-Chordata
2.	ZOOL 102	Tool and Techniques in Biological Science
3.	ZOOL 103	Comparative Animal Physiology
4.	ZOOL 104	Biological Chemistry
5.	ZOOL 105	Practicals

Part-I Semester-2

1.	ZOOL 201	Chordates-Origin and Evolution
2.	ZOOL 202	Systematics, Biodiversity and Evolution
3.	ZOOL 203	Genetics and Cytogenetics
4.	ZOOL 204	Developmental Biology
5.	ZOOL 205	Practicals

Part-II: Semester-3

- Two papers ZOOL 301 and ZOOL 302 (Interdisciplinary) are compulsory.
- Two optional papers are to be selected by each student
- One paper from ZOOL 303, ZOOL 304 or ZOOL 305.
- One paper from ZOOL 306, ZOOL 307 or ZOOL 308.

1	ZOOL 301	Principle of Ecology	Open Elective
2	ZOOL 302	Biostatistics and Computational Biology	
3	ZOOL 303	Biology of Parasitism	Elective Course
4	ZOOL 304	Applied Zoology	
5	ZOOL 305	Epigenetic and Chromatin Biology	
6	ZOOL 306	Structure and Function of Genes	Elective Course
7	ZOOL 307	Animal Behaviour	
8	ZOOL 308	Molecular Endocrinology	
9	ZOOL 309	Practical	

Part-II: Semester-4

Student will select any one of the four streams, each stream consisting of three papers (courses). Besides this, each student will complete a dissertation, which would be theoretical and not involve any laboratory components.

Stream 1: Entomology		
1	ZOOL 4101	Insect Morphology, Physiology & Development
2	ZOOL 4102	Ecology, Evolution & Taxonomy
3	ZOOL 4103	Economic Entomology
4	ZOOL 4104	Dissertation
5	ZOOL 4105	Practicals
Stream 2: Fish Biology		
1	ZOOL 4201	Morphology, Physiology & Development of Fishes
2	ZOOL 4202	Taxonomy & Ecology of Pisces
3	ZOOL 4203	Applied Ichthyology
4	ZOOL 4204	Dissertation
5	ZOOL 4205	Practicals
Stream 3: Cell Biology		
1	ZOOL 4301	Cytological Techniques
2	ZOOL 4302	Cellular organization & Fundamental Processes
3	ZOOL 4303	Cell Regulation-Cell communication
4	ZOOL 4304	Dissertation
5	ZOOL 4305	Practicals

Stream 4: Environmental Biology & Toxicology

1	ZOOL 4401	Wild Life Biology
2	ZOOL 4402	Environmental Chemistry
3	ZOOL 4403	Environmental Monitoring & Toxicoloogy
4	ZOOL 4404	Dissertation
5	ZOOL 4405	Practical

COURSE NO.		Credits
Semester 1		
ZOOL 101	Non Chordata	4
ZOOL 102	Tool & Techniques in Biological Science	4
ZOOL 103	Comparative Animal Physiology	4
ZOOL 104	Biological Chemistry	4
ZOOL 105	Practical	8
	Seminar	1
Semester 2		
ZOOL 201	Chordates-Origin and Evoultion	4
ZOOL 202	Systematics, Biodiversity and Evoultion	4
ZOOL 203	Genetics and Cytogenetics	4
ZOOL 204	Developmental Biology	4
ZOOL 205	Practical	8
	Seminar	1

Semester 3

(Any Two combination: one from ZOOL 303-ZOOL305 and one from ZOOL306-ZOOL 308)

ZOOL 301	Principles of Ecology	4
ZOOL 302	Biostatistics and Computational Biology	4
ZOOL 303	Biology of Parasitism	4
ZOOL 304	Applied Zoology	4
ZOOL 305	Epigenetic & Chromatin Biology	4
ZOOL 306	Structure & Function of Genes	4
ZOOL 307	Animal Behaviour	4
ZOOL 308	Molecular Endocrinology	4
	Practical	8
	Seminar	1

Semester 4 (Any one stream from 1-4)

Stream 1 Entomology

ZOOL 4101	Insect Morphology Physiology & Development	4
ZOOL 4102	Ecology, Evolution & Taxonomy	4
ZOOL 4103	Economic Entomology	6
ZOOL 4104	Dissertation	6
ZOOL 4105	Practical	6
	Seminar	1

Stream 2 Fish Biology

ZOOL 4201	Morphology, Physiology & Development of Fishes	4
ZOOL 4202	Taxonomy & Ecology of Pisces	4
ZOOL 4203	Applied Ichthyology	4
ZOOL 4204	Dissertation	6
ZOOL 4205	Practical	6
	Seminar	1

Stream 3 Cell Biology

ZOOL 4301	Cytological Techniques	4
ZOOL 4302	Cellular Organization & Fundamental Processes: Cell structure	4
ZOOL 4303	Cell Regulation-Cell Communication & Differentiation	4
ZOOL 4304	Dissertation	6
ZOOL 4304	Practical	6
	Seminar	1

Stream 4 Environmental Biology & Toxicology

ZOOL 4401	Wild Life Biology	4
ZOOL 4402	Environmental Chemistry	4
ZOOL 4403	Environmental Monitoring & Toxicology	4
ZOOL 4404	Dissertation	6
ZOOL 4404	Practical	6
	Seminar	1

- Interdisciplinary courses may be taught by Zoology or Botany or Guest Faculty.
- Assigned at the end of semester II and goes until Semester IV. It would be theoretical and not involve any laboratory components.

ZOOL 101 NON- CHORDATA

THEORY

Unit-1: Nutrition and reproduction in protozoa: origin of Metazoa; organization and affinities of Porifera; Polymorphism and Colony formation in Cnidaria; Coral reefs.
Unit-2: Life cycle patterns in helminthes parasaties; outlines of ecology of soil nematodes; segmental organs in Annelida; Adaptive radiation in Annelida.
Unit-3: Organization and affinities of Onychophora; Larval forms in Crustacea; Parasitism in Torsion in gastropods, its effect and significance.
Unit-4: Larval forms in Echinodermata; Affinities of Echinodermata and Hemichordata; Brief outlines of the structure and affinities of minor phyla with special reference to ctenophore, Rotifera, Acanthocephala, Sipunculoidea and Echiuroidea

Suggested Literature:

1. A life of invertebrates by W.D. Russel-Hunter, MacMillan Publishing Co. inc.,New York.
2. Advances in invertebrates' reproduction by K.G. Adiyodi and R.G. Adiyodi, Peralam-Kenoth Kerivellur, Kerala.
3. Biology of the invertebrates by Jan Pechenik, William C. Brown Publishers, Dubuque, lowa.
4. Invertebrates zoology by A. Kaestner, Interscience Publishers.
5. Invertebrates zoology by Alfred Kaestner, H.W.Levi & L.R. Levi, John Wiley & Sons Inc.
6. Invertebrates (Protozoa to Echinodermata) by Ashok verma, Narosa Publishing house, New Delhi.
7. Invertebrates Learning by W.C. Corning and J.A.Dayal.
8. Invertebrates Structure and Function by E.J.W.Barrington, The Camolet Press, Great Britain.
9. Invertebrates Zoology by P.A. Meglitsch & F.R. Schram; Oxford University Press.
10. Invertebrates Zoology by R.D. Barnes, V Edition. Holt Saunders International edition.
11. Principles of Comparative Anatomy of Invertebrates by W.N. Bekiemishev, University of Chicago Press.
12. Principles of Comparative Anatomy of Invertebrates by Dr J.M. Mac Lennon; Z. Kabata, Oliver and Boyd Edinburgh.
13. Textbook of Invertebrate Zoology by G.S. Sandher; H. Bhaskar, Campus book International.
14. The Invertebrates by L.H. Hymen, McGraw-Hill Book Company.
15. The Invertebrates: A New Synthesis by R.S.K Barnes, P. Calow, P.J.W. Olive, D.W. Golding, and Spicer,J.I, III Edition, Blackwell Science.

Course Outcomes-After the course the students will be able to understand the basics of this course. Larval forms in Echinodermata; Affinities of Echinodermata and Hemichordata; Brief outlines of the structure and affinities of minor phyla. Get benefit of this course in various competitive examinations.

ZOOL 102: TOOL & TECHNIQUES IN BIOLOGICAL SCIENCE

THEORY

UNIT-1: Principles and uses of analytical Instruments; Balances, Flame Photometry, Spectrophotometer, Spectroflurophotometer, Atomic Absorption Spectrophotometer.

UNIT-2: Microbial technique:- Media preparation and sterilization, Inoculation and growth monitoring, use of fermentation, Microbial Assays.

UNIT-3: Seperation and identification of biomolecules by Chromatography: Paper and thin layer Chromatography, Gel exclusion Chromatography, High performance Liquid Chromatography (HPLC), Affinity Chromatography.

UNIT-4: Electrophoresis techniques: General principles, Support media; Electrophoresis of proteins and nucleic acid; capillary Electrophoresis, Principles of differential and density centrifugation.

Suggested Literature:

1. Essential Laboratory Techniques by S.R. Gallagher, E.A. Wiley.
2. An introduction to Practical Biochemistry by D.T. Plummer.
3. Techniques in Live Sciences by D.B. Tembhare.
4. Principles and Techniques of Biochemistry and Molecular Biology, 6th Edition by Keith Wilson and John Walker, Cambridge University Press.
5. Light Microscopy in Biology: A practical Approach, 2nd Edition by Alan J. Lacey, Oxford University Press.
6. Electron Microscopy: Principles and Techniques of Biologist by John J. Bozzola, Lonnie D. Russell, Jones & Bartiett Publ.
7. Tools and Techniques of Biotechnology by Mousumi Debnath, Pointer Publishers.

Course outcomes- To get the ideas of the media preparations and sterilization, Inoculation and growth monitoring, use of fermentation, microbial Assays and separation and identification of bimolecular by Chromatography: Paper and thin layer Chromatography, Gel exclusion Chromatography. This course is useful in various competitive exams like CSIR-NET etc.

ZOOL 103: COMPARATIVE ANIMAL PHYSIOLOGY

THEORY

UNIT -1: Modes of nutrition, types of digestion and absorption of food; Neurons, neuroglial cells, irritability, Sodium-Potassium ATPase pump, ion channels; Mechanism of conduction and transmission of nerve impulses; Nernst equation, ionic basis of resting and spike potential, electrical potential, types of synapse, synaptic transmission and neurotransmitters.

UNIT-2: Osmotic conformity and role of membranes in ionic regulation: Stenohaline, Euryhaline animals, Hypo and Hyper environment and terrestrial life; General characteristics of stimulus and response reaction: Chemoreceptors, photoreceptors, phonoreceptors, mechanoreceptors, equilibrium reception; Respiration: Oxygen and Carbon dioxide transport, factors affecting oxygen dissociation: Respiratory adaptation to low oxygen tension, regulatory process in respiration.

UNIT-3: Thermoregulation in animals: Temprature relationship in poiklotherms , homeotherms, endotherms and heterotherms, thermal acclimatization; Circulation: Types of circulation, physiological categories of heart, conduction system, cardiac cycle, electrocardiogram; Body fluids, blood coagulation; hematological abnormalities, effectors organs; Types of muscles, its composition, muscle contraction.

UNIT-4: Pattern of nitrogen excretion in different animals: Types of excretory products, Pattern of excretion, excretory devices in invertebrates and vertebrates; Biosynthesis of urea and uric acids; Comparative study of endocrines organs and their hormonal secretion in non chordates and chordates

Suggested Literature:

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

Course outcomes- To study the osmotic conformity and role of membranes in ionic regulation: Stenohaline, Euryhaline animals, Hypo and Hyper environment and terrestrial life and pattern of excretion in different animals. After the course the students get able to get benefit of this course in various national and international competitive examinations.

ZOOL 104: BIOLOGICAL CHEMISTRY

THEORY

Unit I: Chemical equilibrium, Law of Mass action; Elimentary thermodynamic system; Calculation of free energy change during biological redox reactions, Acid base amphoteric, Zwitter ions.
Unit II: Kinetics of enzyme of reaction; kinetic of enzyme– catalyzed reactions, order of enzyme reaction, rate equations, two substrate reactions; Temperature Coefficient, Activation Energy; Enzyme Inhibition, Competitive and non competitive inhibitors ; Applications of enzyme inhibition techniques in pest control, Allosteric Enzyme.
Unit III: Structure and function of vitamins and coenzymes; aerobic and anaerobic energy production from carbohydrates, lipids and amino acids,(Glycolysis, HMP Shunt, Beta oxidation of fatty acids, deaminations, and trans animation of amino acids (Phenyl alalanine, Tryptophan, Aspartate, Proline and Threonine)
Unit IV : Biosynthesis of amino acids (Phenyl alalanine, Tryptophan, Aspartate, Proline and Threonine), Nucleotides , glycogen and urea ; Inmoblized enzymes and their applications .

Suggested Literature

1. Biochemistry by J.M berg J.L.Tymoczko, W.H.Freedman Plagraue Macmillon
2. Biochemistry by Zubey; Styrer
3. Self physiology and Biochemistry by W.D. McElory , Prentice Hall of INDIA Pvt. LTD
4. Comparative biochemistry by K.A Munday, Pergmon Press Oxford London
5. Essentials of Biochemistry by Srivastva; Lal; N.Singh, Rekha Publications
6. Essentials of Biological chemistry by Fairley Kil gour, Affiliated east -west Press
7. Harper's Biochemistry by R.K. Murray, D.K Granner, A long medical book.
8. Introduction to biochemistry by J. Awapra, Printice Hall of INDIA Pvt. LTD
9. Lehninger Principles of biochemistry D.L Nelson, M.M .Cox W.H. Freedman Company

Course outcomes- To study the Kinetics of enzyme of reaction and kinetic of enzyme catalyzed reactions, order of enzyme reaction, rate equations, two substrate reactions; Temperature Coefficient, Activation Energy; Enzyme Inhibition, Competitive and non competitive inhibitors ; Applications of enzyme inhibition techniques in pest control, Allosteric Enzyme. This course is useful in various competitive exams.

ZOOL 105: PRACTICAL COURSE OF THEORY COURSES ZOOL 101-105

Distribution of Marks: **Time: 8 hours of two sitting**

Exercise
Technique/ Instrumentations
Biochemistry Exercise
Physiology Exercise
Spotting (10 spots)
Viva voce
Total Mark

Course ZOOL101: General characters and classification of the non- chordates phyla (Protozoa to Echinodermata) with the help of museum specimens and slides.

Protozoa: Vital staining and staining preparation of *Paramecium ;* Study of cyclosis and trichocysts in *Paramecium;* Permanent preparation of *Ceratium, Noctiluca,Paramecium, Vorticella,* Study of prepared slides: *Balantidium,Nyctotherus,Opalina.Paramecium* conjugation / binary fission,*Entamoeba histolytica ,Giardia, Trypanosoma, Leishmania, Trichomona.*

Porifera: Permanent preparation of gemmules, sponging fibres and different kinds of spicules, Study of museum specimens specimens/models; *Lecuosolania , Sycon , Grantia, Euplectella, Hyalonema, Oscarella, Chondrilla, Chliona, Chalina, Spongilla, Spongia, Hippospongia.*

Cnidaria and Ctenophora: Study of nematocycsts of *Hydra,* Permanent preparation of *Hydra; Obelia and* other hydrozoan colonies and *Obelia* Medusa ; Study of museum specimens/ models : *Tubularia , Bougainvillia, Pennaria, Hydractinia, Sertularia, Campanularia, Millepora, Stylaster, Physalia, Porpita, Valella, Aurelia, Rhizostoma, Tubipora, Alcyonium, Gorgonia, Corallium, Pennatula, Zoanthus, Metridium, Adamsia, Cerianthus, Fungia, Madrepora, Cestum .*

Helminths: Permanent preparation of selected soil and plant nematodes , cestode and trematode parasites of cattle and poultry , and different larval stages of liver fluke, Study of museum specimens/ whole mounts : *Convoluta, Dugesia, Bipalium, Fasciola , Paramphistomum, Schistosoma, Taenia, Moniezia , Echinococcus, Trichuris, Trichinella, Heterodera, Enterobius, Ascaris, Ancylostoma, Dracunculus,Wuchereria;study of prepared slides :Scolex of tape worm ,mature and gravid proglottid of tape worm;Study of cysticercus larva, hydatid cyst, larval stage of Fasciola .*

Annelida: Study of museum specimens*/models:Aphrodite, Tomopteris, Glycera, Chaetopterus, Arenicola ,Sabella, Amphitrite, Serpula, Tubifex, Branchiobdella, Eisenia, Metaphire, Placobdella,pontobdella Branchellion, Polygordius,:Study of prepared slides:T.S*. of body of leech passing through various places.

Arthropoda: Study of museum specimen: *Limulus, Palamnaeus, Lycosa, Apus, Argulus,Balanus, Sacculina, Mysis, Gmmarus, Squilla*, Prawn, Lobster, true crab, hermit crab, *Julus, Scolopendra, Scutigerella, Lepisma, Mantis,* stick insect, grass hopper, *termites ,Forficula,Pediculus, Ranatra, Dysdercus, Musca* ,Lady bird beetle, butterfly, wasp, *Xenopsylla,* life history of honey bee, lac insect and silk moth; Study of prepared slides: Mouth parts of mosquitoes, house fly, honey bee, butterfly , *Sarcoptes, Ixodes, Cimex, Daphnia, Cypris, Cyclops, Pediculus, Pthirus.*

Mollusca : Study of museum specimen/models : *Chiton, Dentaliun, Pila, Aplysia, Baccinum, Doris, Lymnaea, Mytilus, Patella, Pecten, Limax,* pearl oyster*, Teredo, Nautilus, Loligo, Sepia, Octopus.* Study of prepared slide: Radula, T.S of shell of *Unio*, T.S of gill lamina *of Unio,* T.S of body of *Unio* passing through middle region; Larvae of molluscs.

Echinodermata: Study of museums specimen/ models: *Astropecten, Asterias, Ophio*thrix, *Opiura, Echinus, Clypeaster, Echinocardium, Thyone, Holothuria, Antedom*; Study of prepared slides: Larvae of echinoderms: Aristotle's lantern.

Hemichordata : Study of museum specimens: *Balanoglossus, Cephalodiscus: Tornaria* larva,

Minor phyla: Representative specimens of Onychophora (*Peripatus*), Sipunculida *(Sipunculus*), Echiurida(*Bonelia)*

Course ZOOL 102: Basic principles and functioning of Microtomy, Spectrophotometry, Flame photometry, Atomicabsorption, Spectrophotometry, Paper and thin layer chromatography, Centrifugation.

Course ZOOL 103: Comparative study of total count of erythrocyte and leukocytes of fish bird, and rat. Comparative study of different leukocyte count of fish, bird and rat Colorimetric estimation of heamoglobin content of the blood, colour index and mean corpuscular haemoglobin in fish, bird and rat. Determination of haemetocrit in fish, bird and rat. Determination of respiratory rat of rat in relations to size and sex; Respiration rate in fish and different temperatures.

Course ZOOL104: Isolation and colorimetric determination of glycogen content of rat liver ; demonstration of effect of epinephrine on the glycogen yield from the liver; Estimation of nucleic acids in testis of rat. Comparative estimation of protein content of fat body of cockroach and liver of fish and rat. Quantitative estimation of total free amino acid in tissues of cockroach and paper chromatographic separation of these amino acids; Kinetic essay of salivary amylase and study of effects of time temperature and pH; Study of effect of substrate concentration on ureas activity ; Inhibition of cholinesterase activity in rat brain by organophosphate; estimation of total lipid in fat body of cockroach and liver of fish and rat.

ZOOL 201: CHORDATA: ORIGIN, EVOLUTION AND COMPARATIVE ANATOMY

THEORY

Unit–1: Origin of chordates: characteristic of Ostractoderms (cephalaspida , Anaspida , pteraspida , Coelolepida) and placodermi (Rhenanida , Acanthothoraci , Petalichthyida , Arthrodira , Ptyctodontida, Phyllolepida , Antiarchi , Brindabellaspida); Inter- relationship among ostracoderms and Placodermis.

Unit–2: General organisation (external character, endoskeleton alimentary canal , respiratory organ, blood vascular system sense organ, urinogenital system) of Holocephali ; Affinities of Holocephali, Dipnoi and crosspterygii ; origin of paired fins in teleosts; origin of tetrapoda from (lungs fishes , bichirs and rosspterygians).

Unit–3: Rhynchocephalia , origin and evolution of reptiles (seymouria , cotylosaurs , captorhinomorphs , diadetomorphs plesiosaurs and ichthyosaurs , archosaurs , saurischia, bronotosaurs and diplodocus , ornithischia) and birds (Jurassic, birds, cretaceous birds , cenozoic birds); Aerodynamios in birds (modification in skeleton and musculature aspects ratio , take off , gliding and soaring flapping flight, slow and fast flight , perching mechanism, hovering ; landing); origin and evolutionary of mammals; Diagnostic character of mammals and reptiles with mammalian features (Seymouriamorph ,Captorhynomrph, Theromorphs) cynognathus lctidosours ,conversion stage of reptiles in mammals; first , mammals, adaptive radiation in Eutheria .

Unit–4: Comparative study of heart in different classes of vertebrates , e.g. fish , amphibians reptiles, birds and mammals ; arterial and venous channel in different vertebrate group ; compratrive study of urinogenital system in different group , e.g amphibian , reptile, birds and mammals .

Suggested Literature:

1. Comparative Anatomy of vertebrates by Herbert W. Rand , Harverd University Press
2. Comparative Anatomy of Vertebrates by M.D.L. Srivastava
3. Evolution of the vertebrates, E.H.Colbert.
4. Introduction to vertebrates by T.C. Majupuria , s. Nagin Company
5. Text book of Comparative Anatomy of Vertebrate by Saurav Singh , Centrum Press
6. Text book of Zoology: Vertebrates by T.J. Parker & W.Haswell , modified by A . J . Marshal.
7. The life of vertebrates: J. Z .Young.
8. The origin of vertebrates by N.J.Berrill , Oxford at The clarendon Press
9. The vertebrates Body, A.S. Romer.
10. Vertebrate life by McFaland; Pough ; code ; Heiser, Macmillian and Collier Publisher
11. Vertebrate Palenotology . A.S.Romer.

Course outcomes- After the course the students will be able to understand the basics of this course. To understand the applications of this course in different field of Science and Technology Think and develop new ideas in this subject, benefit of this course in various national and international competitive examinations

ZOOL 202: SYSTEMATICS, BIODIVERSITY & EVOLUTION

THEORY

Unit-1: Definition and basics concept of biosystematics & Taxonomy: Historical resume of systematic and its important and application in biology; trends in biosystematics: concepts of different conventional and newer aspects – chemotaxonomy, cytotaxonomy, ethotaxonomy, molecular taxonomy, DNA fingerprinting & Molecular markers for detection evaluation of polymorphism, RFLP, PAPD, etc and numerical taxonomy.

Unit-2: Dimensions of speciation and taxonomic characters: type of lineage changes, production of additional lineage, species concepts – species category, different species concepts, subspecies and infra-specific categories, theories of biological classification hierarchy of categories taxonomic and non-taxanomic character

Unit-3: Procedure in taxonomy: collection preservation identification, taxonomic keys- different kinds of taxonomic keys their merits and demerits, systematic publications. Different kinds of publications, type of concept – different zoological types, international code of zoological nomenclature (ICZN) –its operative principles, interpretation andf application of important rules, zoological nomenclature, formation of scientific names of various taxa.

Unit-4 : Darwinian and pre-darwinian concepts of evolution : Birth of concept of organic evolution; Lamarckian theories , Darwin's theory of natural selection : merits and demerits , Neodarwinian concepts and sources of variation : post – Darwinain concepts of evolution: Gradualistic vs. Nongradualistic theories, Mayr,s Founder Principle , Gould,s punctuated equilibrium theory , Kimura's neutral theory , Endo sysmbiotic theory of Margulis contemporary views ; Neo- Lamarkism , Neo – Darwinism's synthetic of evolution. Isolation and speciation; Genes in population; Hardy Weinberg Law and sewell wright effect, micro evolution, macro evolution and mega evolution, Evolution in action

Suggested Literature:

1. Biology Systematics by A. Mielli, Chapmon and Hall
2. Evolution by Hall and Hallgrimsson , johnsn and Bartlett publisher
3. Evolution by mark ridley . Blackwell science
4. Evolution by barton n.H briggs, D.E.G., Eisen J.A., Goldstein , A.E. Ptel , N.H., cold spring Harbor Laboratory press new York , U.S.A.
5. Evolution by futuyma , D.J. , sinauer associates inc., sunderland , USA
6. Evolution by Hall , B.K. and Hallgrimsson , B..Jones and Bartlett publisher, Sudbury, USA
7. Evolution analysis by Freeman and Herron , Person /prentice hall
8. Methods and principle of systematic Zoology by E.Mayer , E.G.Linsley , R.L. vsinger, McGraw – Hill Book Company , ICN
9. Numerical Taxonomy by joseph felsentein , springer – verlag Berlin Heidelberg New York
10. Procedure in Taxonomy by E.T.Schenk and J.H.Mc.Masters , Standford University Press Standford , California
11. Taxonomy ; A text and reference book by r.e,blackwelder , john wiley and sons , INC
12. What evolution is by mayr E. Basic Books , new York , USA

Course outcomes- The study of the DNA fingerprinting & Molecular markers for detection evaluation of polymorphism, RFLP, PAPD etc and numerical taxonomy, for useful to student for

research methodology and further study of research work in different topics. This course is useful in various competitive exams like CSIR-NET etc.

ZOOL 203: GENETICS & CYTOGENETIC

THEORY

Unit-1 : Mendel's Law and their chromosomal basis ; extension of Mendel's principles; Allelic variation and gene function incomplete dominances and co- dominances , allelic serie , testing , gene mutation for allelism ; gene action – form genotype to phenotype – penetrance and expressivity , gene interaction , epistasis pleiotropy ; Interaction of gene .

Unit-2 : Cytoplasmic inheritance : environment and heredity : lethal genes; sex – linked inheritance ; chromosomal Mapping

Unit-3 : Sex chromosome : sex determination ; multiple allelism; Numerical and structure chromosome aberrations and their significance ; DNA replication , Transposable elements in prokaryotes and eukaryotes ; Role of transposable elements in genetic regulation

Unit-4 : Microbial genetics : Bacterial transformation , transduction , conjugation , Bacterial chromosome , Bacteriophages; Molecular cytogenetics techniques (FISH , GISH, DNA Fingerprinting , Flow cytometry and chromosome painting) ;Elements of Eugenics ; Imprinting of genes , chromosomes and gene , gene therapy .

Suggested literature:

1. Development genetics of higher organisms by George M. Malacinski , Maxmillan
2. Embryology by M.P.Arora , Himalaya publishing house
3. Fundamantal of human genetics by sanjay madsal , new central book agency , landon
4. Fundaments of genetics by G.S.Migalani , norsa publishing house
5. Genetics by P.K gupta , Rastogi publication
6. Genetics by E. Conrad , apple academics press
7. Grenetics by ursila goodenough , hotl-saumders international edition
8. Genetics by j. Russwll , Benjamin- cummings publishing company , san Francisco , colifornia.
9. Modern genetics analysis : intergrating genes and genome , by Griffiths J.F.,Gelbart ,M., Lewontin,c,and miller , w.h freeman and company , new York , USA
10. Molecular genetics by guther s. Stent Richard colendar . cbs publication and distributors
11. Principles of genetics by snustad and simmons (4^{th} ED.2005), john wiley & sons. USA

Course outcomes- To study the students get ideas of this course including sex chromosome, sex determination, multiple allelism, Numerical and structure chromosome aberrations and their significance, DNA replication, Transposable elements in prokaryotes and eukaryotes ; Role of transposable elements in genetic regulation Microbial genetics Imprinting of genes , chromosomes and gene , gene therapy for help in to the research work. Students get benefit to this course in various competitive examinations.

ZOOL 204: DEVELOPMENTAL BIOLOGY

THEORY

Unit-1: Basic concepts of development biology – cellular differentiation, signalling , patterning ; Role of genes in embryonic development of *Drosophila;* pattern regulation in insect imaginal discs; development pattern in Zebra fish; chicken and rat; identification of Development genes: mutant screening development mutations in *Drosphila* . Determination of polarity and symmetry.

Unit-II: Early embryonic development of vertebrates and invertebrates; Gametogensis , structure of the gametes – the sperm and eggs , its types; function of vitellogenins yolk and egg membrans ; Hormonal control of ovulation ; fertilization , mechanism and types , capacitation , aerosome formation , fertilizimg and antifertilizin reactions, amphimixis, patterns of cleavages in different types of animals eggs. Role Yolk in egg organization planes of cleavage, morulation and blastulation , types of blastulae.

Unit-III: Fate maps and cell lineages ; gastrulation ; axes and germs layers; morphogenesis, morphogenetics movement ; cell adhesion , cleavages and formation of blastula , gastrulation , neural tube formation , cell migration ; tabulation , exogastrulation delamination , fate of germinal layers , notogenesis and mesogenesis;axis specification on Drosophila ; origin of anterior – posterior and dorsal – ventral patterning – role of maternal genes ; Growth and differentiation its regulation at the level of chromosome ;

Unit-IV: Introduction and organizer concept ; stems cells types its biomedical application , EMB transformation, tetraogensis, neoplasia, tumerogrnesis , allometric growth ; nucleocytoplasmic interaction , regulation of tissue generation amd gradients in development system in Hydra and an amphibian , transplantation ; ageing and cellular death ; theories and age related changes at molecular level , biological ageing effect of various nutrients and harmones secretion on ageing ; transgenic animal methods of formation , gene targeting , production and biomedical application of transgenic animals , mosaics , chimeras , knock out animals , metamorphosis in insect and amphibians , role of harmones and temperature

Suggested Literature:

1. A survery of embryology by F.G.Gilchirst , McGraw –Hill Bokk company
2. An interoduction to embryology by B.l Balansky , CBS college publishing
3. An introduction to embryology by B.L. Balinsky; Dr. Biol.Sci , sunders college publishing
4. Analysis of biology development by kathoff , McGraw –hill science , new delhi , india.
5. Altas of development embryology by emil . s. Szebenyi , faireigh Dickinson university press
6. Development biology by N.J.Berrill , tata McGraw – Hill publication
7. Development biology by scott F. Gillbert , siauer Associated INC publication
8. Deveploment bology by Gillbert ,Sinauer Associates Inc, Massachusetts, USA
9. Experiment embryology by Robert rogh , burgess publishing company
10. Foundation of embryology by Bradley M.Bopdwmer ,Holt Rinerhart and Winston , INC
11. Modern embryology by Charles w. Bopdwner, holt Rinehart and Winston, INC
12. Principle of development by Wolpert , Beddington , Brockes , jessell, Lawrence , meyerowitz.(3rd ED., 2006), oxford University press, new delhi , india
13. Regeneration in vertebrate by C.S thornton, the university of Chicago press

Course outcomes- After studying this course the student will be able to understand the basic of this course and think and develop new ideas in this course to know introduction and organizer concept;

stems cells types its biomedical application, EMB transformation, tetraogensis, neoplasia, tumerogrnesis , allometric growth ; nucleocytoplasmic interaction.

ZOOL 205: PRACTICAL COURCES OF THEORY COURSES ZOOL 201 – ZOOL 204

Distribution of marks: Time: 8 hour of two sittings

Exercise
Cytogenetics exercise
Ecology exercise
Embryology exercise
Spotting (10 spots)
Viva-voce
Total marks

Courses ZOOL 201 -202: General character and classification of chordate phyla.
Urochordata : study of museum specimens/ whole mount *: oikopleura, Herdmania , Ascidia ,pyrosoma , doliolum, salpa.*
Cephalochordate: study of museum specimen: Branchiostoma .
Cyclostomata : study of museum specimens /models : *peltromyzon ,Myxine; Ammocoete* larva.
Pisces: study of museum specimens/ models :*sphyrna(hammer – headed shark), Trygon,(string –rays) , pristis , Raja (skate), Torpedo(electric –rays), chimaera, polypterus, Acipener, polydon , Amia, Lepidosteus, hilsa,harppodon , notopyerus, labeo, catla, cyprinus,cirrhina, ariys , heteropneustes,clorias, wallago, mystus, Anguilla, exocoteus, hippocampus, channa ,amphipinous, ansbas,synaptura, echeneis,neoceratodus, protopterus, lepidosiren;study of disarticuklated bone of carp.*
Amphibia: Study of museum specimen /models *:Ichthyophis, uraeotyphlus,cryptobrunchus,ambystoma,axolotl, latrva , salamandra, amphiuma, triturus, proteus,Necturus , siren,alyles,bufo, hyla, rhacophorus, study of adisarticulated bone to frog*
Reptilia *:* Study of museum specimen/models chelone*, kachuga, sphenodon , hemidactylus, calotes, draco , phrynosoma , lguana, heloderma , varanus , ophisarus, typhlops, python, natrix , ptyas, dendrophis, bungarus , naja , russlle's viper, pit viper, hydrophis , cerotalus, crocodilus , alligator , gavialis, ichthyosarus, dimentron , brontosarus , tyranosarus, stegosarus, study of disarticulated bones of varanus*
Aves : Study of museum specimens */ models :Arhaeopterys,Milvus(kite), gyps(vulture). Pavo(peacock), Columba (pigeon), eudynamys (koel) , psittacula (parrot) , bubo (owl), coracias (nilkanth), dinopium (woodpecker), house sparrow , corvus (crow) ; study of disarticulated bones of fowl .*
Mammalians : study of museum specimens / models : echidna , ornithorhynchus , macropus , erinaceus , shrew, pteropus , bat , loris , manis , hystrix, funambulus, rattus, oryctologus or lepus, herpestes, lutra, (otter), civet cat , macacar ,study of disarticulated bones of rabbit , skull of dog .
Course ZOOL 203 : Study of mitosis in onion root tip and meiosis in testis of grasshopper or any other insect with the acetocarmine squash method ;study of the salivary gland chromosomes of *Drosophila* and *chironomus.*
Course ZOOL204 : Experiments on artificial ovalutation , insemination in study of the life history stages of frog and insects ; mounting of egg and embryos of snail; study of hormonal control of amphibian metamorphosis ;incubation and mounting of chick embryos;study of prepared slides of the embryology of frog , chick and mammals and mammalian plcantation microtomy of embryonic stages of chick embryonic ; application of window techniques for in –situ study of chick embryo with special reference to marphogenetic movement ; determination of the effect of temperature on the embryonic

development of chick; study of the development of selective organs through preserved specimen and prepared slides;Experiment on regeneration in earthworm ; regeneration of lizards.

ZOOL 301: PRINCIPLES OF ECOLOGY THEORY

Unit-1: Environment: meaning definition and environmental perception in vedic literature (air,fire, Bearth, water, sun in Vedas); Environmental ethics and global imperatives; Environmental factors (Abiotic) ' medium, substrate, solid, water and humidity, light, temperature, currentand pressure, atmospheric gases (O 2, CO2, and N2), pH, nutrients and their importance and. role: Climate of India and Indian monsoons,

Unit-II: Structure and composition of atmosphere, hydrosphere, lithosphere and biosphere;Terrestrial and aquatic (fresh water and marine) habitat;E nvironmental (biotic factors; population and community ecology, parasitism and prey-predator relationship ; Ecosystem definition, type, structural components of ecosystem (pond ecosystem)- autotrophs and Hetrotrophs (producer consumers,decomposers and transformers); Ecological pyramids on numbers biome and energy, Concept of productivity and standing cropsecotonw,ecotype Ecological indicators,;Edge effect

Unit-III: Biogeochemical cycle L's, concept of stress and strain ; Acclimation & acclimazation, adaptation, ecological habitats and niche, concept of limiting factors, Liebig's law of the minimum; Shelford law of tolerance; ecological succession; Concept of Homeostasis and feedback Concept of model and ecosystem modeling; Ecological indicator, Conservation of natural resources; Wetlands,

Unit-IV: Ecological succession, mass and energy transfer access to various interfaces; Material balance; Energy flow; First and second law of thermodynamics; Heat transfer processes Demography: population size and density, life table, generation time, reproductive rate, dispersion. age structure, survivorship. population growth, natality, mortality, biotic potential, population interaction,; Life history structures, evolution of sex and mating System, Concept of r and k selection.

Suggested Literature:

1. Basic concepts of Ecology by Clifford B. Knight, The Macmillan Company, New York
2. Basic Ecology by E.P. Odum, Oxford and IBN Publishing Co., New Delhi
3. Ecological Modeling by Grant, W.E. and Swannack , T.M.,(2008) , Blackwell.
4. Ecology and Applied Environmental Science by Kimon Hadjibros, cro Press.
5. Ecology and Margaret Brown, Apple Academic
6. Environmental Law by Gurkirat kaur, Shree Publishers and Distributors, New Delhi
7. Field Biology and Ecology by Benton and Werner , McGraw-Hill Book Company
8. Field Sampling: Principles and Practices in Environmental Analysis by Conklin A.R. Jr(2004), CRC Press
9. Fundamental processes in Ecology: An Earth system Approach by Wilkinson, D.M.;(2007),Oxford University PRESS , UK,
10. Fundamentals of Ecology by E.P. Odum,
11. Principles and standards for Measuring Primary Production by Fahey, T.J .and Knapp,A.K., (2007),Oxford University press, UK.

Course outcomes- Demonstrated an understood of ecological relationships between organisms and their environment. A Presented an overview of diversity of life forms in an ecosystem. Explained and identified the role of the organism in energy transfers, Described the habitat ecology and resource ecology. To understood the Environmental Pollution and their management.

ZOOL 302: BIOSTATISTICS AND COMPUTATIONAL BIOLOGY

UNIT I

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

UNIT II

Sampling technique: methods of sampling, choices of sampling methods, sampling and non-sampling errors: tabulation and graphic representation of data; frequency distribution, tabulation, bar diagram, histogram, pie diagram; and their significance and limitations; measures of dispersion: interquartile ranges, variance and standard variation, coefficient of variation, measures of skewness, coefficient of skewness, kurtosis; probability : theorems on probability, application of permutation and combination, coitional probability; probability or theoretical distributions: (a) binominal distribution : mean, variance, conditions for application, pascal's triangle, characteristics of binominal distribution; (b) Poisson distribution: condition under which it is used, mean and variance and binominal approximation to Poisson distribution: (c) normal distribution : properties and applications of binominal distribution.

UNIT III

Probit analysis, correlation covariance, correlation analysis, correlation of coefficient, spearman's rank, correlation coefficient, graphical method of presentation; regression; regression analysis, fitting of lines of regression, regression coefficient and its properties, coefficient of determination; standard error of a statistic, estimation theory, confidence limit testing of hypothesis; test of significance of mean (large sample), of difference between, two means(large sample); students' t-test: assumption for t-test, properties and application of t-distribution, computation of t-statistics (t values). Tests of significance of a single mean (small samples), of difference between two means (small sample) ; paired t-test to difference of means.

UNIT IV

The square test: degree of freedom. Properties and uses of chi-square, conditions for using the chi-square; analysis of variance – one way and two of classification, f-test; types of non- parametric tests, its advantage/disadvantage and use, sign-test for paired data, Mann- Whitney U-tests, Spearman's rank correlation test; experimental design : basic concepts and principles, completely randomized design; Duncans multiple range test randomize block design; Tukey's tests of additivity. Simple lattice design, Leslie matrix model, point source stream, pollution model, box model, Gaussian plume model.

Suggested literature:

1. Biostatics by P N Arora and P.K Malhan, Himalaya publishing house
2. Principles of Biostatistics by Pagano M. Gauvreau, K (2000), Duxbury press, USA
3. Fundamental of Biostatics by I A Khan and A Khanam, Ukaaz publication, Hyderabad

Course Outcomes- Introduction to basic components of computers, Software (operating systems) and application software used in biological and statistical studies. An overview of databank search data

mining, data management and interpretation. An introduction and learning of Probit Log Analysis for interpretation of toxicity data.

ZOOL 303: BIOLOGY OF PARASITISIM

THEORY

UNIT 1: Introduction to parasitology: Animal associations and host – parasite relationship : Distribution of diseases and zoonosis caused by animal parasites, morphology, lifecycle , mode of infection of *Plasmodium*, molecular biology of *Plasmodium*- drug target, mechanism of drug resistance, vaccine strategies and proteomic approaches.

UNIT 2: Morphology, lifecycle and mode of infection of *Leishmania,* molecular biology of *Leishmania* - drug targets, drug resistance and vaccine strategies,: morphology, lifecycle , mode of infection of *Entamobia and Giardia* , morphology, biology, lifecycle and mode of infection of gastrointestinal, nematodes (*Ascaris lumbrisoides, Ancylostoma duodenale, Enterobius vermicularis*) *and Wuchereria bancrofti*

UNIT 3: Morphology biology, lifecycle and mode of entry of *Fasciola, Taenia and Schistosoma* : molecular biology of nematodes, cestodes and trematodes and vaccine strategies.

UNIT 4: Pathology of helminth infections ; immune response and self defense mechanisms, immune evasion and biochemical adaptation parasites ; parasites of veterinary importance ; parasites of insects and their significance, host parasite interactions.

Suggested Literature

1 Ecology of Parasites by A.P Diwan , A.K Arora , Anmol Publications , New Delhi
2 Foundations of Parasitology by Roberts L.S. and Janovy J; M.c Graw – Hill Publishers, New York U.S.A
3 Mordern Parasitology : A Textbook of Parasitology by F.E.G.Cox ., Wiley- Blckwell, U.K.

Course outcome- A study of the immune response to parasite and self-defense mechanisms, immune evasion and biochemical adaptations of parasites and description of parasites of insects and their significance, nematode parasites of plants and host parasite interaction. This course is useful in various competitive exams.

ZOOL 304: APPLIED ZOOLOGY

THEORY

Unit 1: Aquaculture; marine, reverine and lacustrine fishes; Some food fishes of India: *Wallago , Anquilla , Harpodon, Notopterus, Stromateous , Channa , Clarias, Labeo, Catla, Cirrhinus, Barbus*: Fish culture in India: Indian Aquaculture: Culture of Carps, Culture methods, Prawn culture exotic fishes ; Importance of pearl culture; methods of pearl culture,; status of pearl industry in India.

Unit 2: Domestic animals- Animal husbandry and Poultry: Important breeds of cattle in India, Exotic breeds, cattle breeding, artificial insemination, feeding and management of dairy stock , dairy product and chemistry of milk.: Position of goat/ Pig production industry in India, breeds of goat/ pig ; common cattle diseases ; poultry industry in India, important poultry breeds, poultry farming, disease of fowl.

Unit 3: Apiculture : importance of Bee keeping, Apiculture*, Apis* species, bee hive, social life of honey bee, properties of honey: Lac culture, Lac insect and its biology, rearing of Lac insects, collection and processing of Lac: Sericulture : Mulberry and non mulberry Sericulture (tasar , munga and eri sericulture) ; lifecycle of silk moth; physical and chemical properties of silk.

Unit 4: Vermiculture: Introduction, ecology and distribution of earthworms: Vermiculture and vermicomposting methods : chemical composition of waste based vermicompost: Economics of vermiculture and vermicomposting : species of earthworms for vermicomposting ; In situ application of vermiculture and crop productivity; use of earthworm in land improvement and reclamation.

Suggested literature:

1 Bee keeping in India by A.M. Wadhwani
2 Poultry Husbandry by Morley A. Jull.
3 Domestic Water Buffalo by M.Fahimuddin
4 Life stock and Poultry Production by Harbans Singh and E.N.MOORE
5 Textbook of dairy chemistry by M.P. Mathur, D.D Roy, P.Dinaker

Course outcome- To understand concept of fisheries, fishing tools and site selection and introduction to basic concepts of Aqua culture systems, induced breeding techniques, post harvesting techniques. To understand the various concepts in lac Cultivation and also to know the economical importance of lac cultivation, sericulture and apiculture. To study the methods of Vermiculture and Vermi-composting and economic value of vermiculture and vermi-composting. Uses of earthworm in land improvement and reclamation.

ZOOL 305: EPIGENETICS AND CHROMATIN BIOLOGY

THEORY

Unit 1: Chromatin structure- basic organization of a eukariyotic genome; histone- structure and function; nucleosome as fundamental particle; 30 nm chromatin fiber, high order structure of chromatin , chromatin territories; intra nuclear spatial organization of chromatin: MARs and SARs and their importance.

Unit 2: Epigentics- from phenomenon to field, a brief history of epigentics- overview and concepts: chromatin modifications and their mechanism of action, concept of ' Histone- code' hypothesis, epigenetics in *Saccharomyces cerevisiae* , position effect variegataion heterochromatin formation, and gene silencing in D*rosophila* , fungal models for epigenetic research: *Schizosaccharomyces pombe* and *Neurospora crassa* ; epigentics of ciliates; RNAi and heterochromatin assembly, role of non coading RNAs; epigenetic regulation in plants.

Unit 3: Chromatin structure and epigenetic marks – transcriptional silencing by polycomb group proteins, transcriptional regulatin by trithorax group proteins, histone variants and epigenetics, epigenetic regulation of chromosome inheritance, epigenetic regulation of the X chromosomes in Caenorhabditis elegans, dosage compensation in *Drosophila,* dosage compensation in mammals; types mechanism ofchromatin remodeling.

Unit 4: Epigentics and genome imprinting – DNA methylation in mammals, genomic imprinting in mammals, germ line and pluripotent stem cells, epigenetics control of lymphopoiesis, nuclear transplantation and the reprogramming of the genome, epigenetic and human disease, epigenetic determinants of cancer.

Suggested Literature:

1. Epigentics by C.David Allis and Thomas Jenuwein, (2007) Cold spring Harbor Laboratory PRESS, New York. USA
2. Molecular biology oF gene by Watson at.al(5^{th}.E.d 2004), Pearson Education Delhi India

Course outcome- Detailed understands of chromatin structure and different levels of its organization. Awareness of brief history of epigenetics and key concepts. Detailed knowledge chromatin modifications and their mechanism of action, concept of 'histone code' hypothesis in the phenomenon of epigenetics. Developing skill in describing chromatin structure and epigenetics marks, dosage compensation and mechanism of chromatin remodeling. Learning of epigenetics and genome imprinting and the reprogramming of the genome.

ZOOL 306: STRUCTURE AND FUNCTION OF GENES

THEORY

Unit 1: Strcture of nucleic acid, folding motifs, conformation flexibilities, denaturation, renaturation kinetics of hybridization, super-coiling of DNA, packaging of DNA in the nucleus, structure of chromatin, chromatin territories. Genetic material and its evolution structure and function relationships, evolution of genetic material, genes and genomes.

Unit 2: DNA replication, recombination and repair-energetics of nucleic acid polymerization, accuracy during flow of genetic information, DNA polymerases proof-reading activity, errors and damage in the DNA, mechanism of DNA repair; genome instability, transcriptional control of gene expression - positive and negative regulations, RNA polymerase, promoters and regulatory sequences, activators and repressors of transcription, transcription mitiation by RNA polymerases, regulation of transcription-factor activity, elongation and terimination of transcription.

Unit 3: Post-transcriptional gene control and nuclear transport- types of introns and their splicing, evoultion of introns, catalytic RNA, alternative splicing and proteome diversity, regulation of Pre-mRNA Processing, micro RNA and other non coding RNAs, degradation of RNA.

Unit 4: Transport across the nuclear envelope and stability of RNA- structure of nuclear membrane and nuclear pore complexs, processes of nuclear import and export and their regulation, degradation of RNA, Translation machinery and translational control-energetics of amino acid polymerization, tRNAs and their modifications, aminoacyl tRNA synthetases, accuracy during aminoacylation of tRNA, regulation of initiationof translation in eukaryotes, elongation and its control, inhibitors of translation.

Suggested Literature

1. Genes by Lewin,(9th Edition 2008), Jones and Bartlen Publishers, Boston, USA
2. Genetics (Analysis of genes and Genomes) by Denial L.Hartl, Jones and Bartlett publishers.
3. Molecular biology of The Cell by Bruce Alberts, Garland Science Taylorand Francis Group
4. Molecular Biology of the Gene by Watson et.al. (5th Ed. 2004), Pearson Education, Delhi INDIA
5. The Cell *A Molecular Approach* by Geoffrey M. Cooper, Sinauer Associates, INC.

Course outcome- An introduction to structure of nucleic acids, folding motifs, conformation flexibilities, denaturation, renaturation, kinetics of hybridization, super-coiling of DNA, packaging of DNA in the nucleus, structure of chromatin, chromatin territories used for the students for further study. regulation of Pre-mRNA Processing, micro RNA and other non-coding RNAs, degradation of RNA. Description of transport across the nuclear envelope and stability of RNA, processes of nuclear import and export and their regulation, degradation of RNA. This courses useful in various competitive exams like CSIR-NET etc.

ZOOL 307: ANIMAL BEHAVIOUR

THEORY

Unit-I: Introduction, definition, historical out line, pattern of behavior, objective of behavior, mechanism of behaviour, asking questions; Reflexes and complex behavior; orientation; primary and secondary orientation kinesis-orthokinesis and klinokinesis, taxis-different kinds of taxis; sun compass orientation dorsal-light reaction.

Unit-II: Eusociality, social organization in honey bee, polyphenism and its neural control, flower recognition, displacement and translocation experiment, various types of communications, production of new queen and hive, swarming, honey bee as super organism; fixed action pattern; mechanism, deprivation experiment, controversies; FAP characteristic and evolutionary feature; learning and instincts, conditioning, habituation, sensitization.

Unit-III: Innate releasing mechanism; key stimuli, stimulus filtering, supernormal stimuli, open and closed IRM; mimetic releaser, code breaker, Homeostasis and behavior; motivational system, physiological basis of motivation, control of hunger drive in blow fly and thirst drive in goat, role of hormone , motivational conflict and decision making, displacement activity, models of motivation, meaning motivation, Hormones and pheromones influencing animal behavior.

Unit-IV: Pattern of communication (chemical, visual, light, audio, species specificity of songs, evolution of language with respect to primates). Social behavior with reference to insects and primates; Sexual behavior; Courtship, sexual selection, mating patterns, parental care, migratory behavior of fishes and birds; territorial behavior, Behavioual genetics.

Suggested Literature:

1. An Introduction to Animal Behaviour by Manning and MS Dawkins Cambridge University Press, UK.

2. Animal Behaviour by John Alcock, Sinaer Association, INC.

3. Animal Behaviour in the Laboratory by P. Silverman, London. Chapman and Hall.

4. Introduction to Animal Behaviour by Rishikesh and Niraj, Campus Bools.

5. Mechanism of Animal behavior by Peter Marter and J Hamilton. John Wiley & Sons, USA.

6. Perspective on Animal Behaviour by Goodenough, Mc Gure and Wallace. John Wiley & Sons, USA.

7. Principles of Animal behavior by Lee Alan Dugatkin, W.W Norten an Co. New York.

8. Text Book of Animal Behaviour by FB Mannl PH learning Pvt.

Course outcome- An introduction to behavior and mechanisms of behavior, various types of communications. This course also helpful for the study of learning and instincts, conditioning, habituation, sensitization. The Sexual behavior of different species, Courtship, sexual selection, mating patterns, parental care, migratory behavior of fishes and birds; territorial behavior and Behavioual genetics. This courses useful in various competitive exams like, UGC-NET, CSIR-NET, Civil service examinations etc.

ZOOL 308: MOLECULAR ENDOCRINOLOGY

THEORY

Unit 1: Discovery of harmones as chemical signals for control and regulation of physiological processes: Natrue of harmonal actions; Major questions in biology o hormones; Techniques for quantization of hormones; Desgin and develoment of hormonal asseys.

Unit 2: Structure of peptide and protein hormones; Purification and characterization of hormones; Structure-Function relationships in different hormones; Phylogenic analysis of hormonal structure and functions; Biosynthesis of protein hormones; Stroage and secretion of hormones; Molecular mechanisms of regulation; Transcriptional and post-transcriptional mechanisms of hormone biosynthesis and secretion; Regulation of biosynthesis and secretion; Inhibitors of hormone biosynthesis and their use.

Unit 3: Nature of hormonal effects and actions; Discovery of receptors in target tissues; Mechanisms of hormone action and signal attenuation; Signal discrimination, Signal transduction and signal amplification in hormone regulated physiological processes; Structure requirements for successful hormone-receptor interactions; Receptor antagonists and their applications; Metabolism of hormones by target and non-target tissues; Pharmacokinetics of hormones; Hormones behaviour - cellular and molecular actions of semiochemicals.

Unit 4: Hormones as therapeutic agents; Current developments in desgin and production of hormonal contraceptive, Recombinant protein hormones-production and application in regulation of fertility in farm animals and humans; Evolution of chemical communication in animal systems; Unsolved problems in hormonal biology.

Suggested Literature:

1. Molecular Biology of steriod and Nuclear Hormone receptors by L.P. Freedom, Bickhauser,Boston.USA
2. Biochemical actions of Hormones *by ed.*G.Litwack, Academic press, New York,USA
3. Comparative Vertebrate Endocrinology by P.J.Bentlay

Course outcome- Understanding the nature of hormonal action and its experimental methods of evaluation elucidation of biosynthesis of protein hormones and molecular mechanisms of regulation. Knowledge of signal discrimination, signal transduction and signal amplification in hormone regulated physiological processes. To Developing know how of pharmacokinetics of hormones and behavior.

ZOOL 309: PRACTICAL COURSE OF THEORY COURSES ZOOL 301 – 308

Distribution of marks: Time: 8hours of two sittings

Exercise
Ecology exercise (2)
Statistical Exercise
Exercise for parasitism (2)
Exercise for applied zoology (2)
Exercise for epigenetics and chromatin biology (2)
Exercise for structure and function of gene (2)
Exercise for animal behavior (2)
Exercise for Molecular endocrinology (2)
Viva voce
Total

Course ZOOL 301: Study of different structural adaptation of animals to ecological conditions ; Study of micro and macro fauna of soil by froth floatation method; Comparative estimate of physicochemical eco factor of in different localities; Temperature , pH , Carbonate, sulphate , nitrate, and turbidity , in fresh water sample; moisture contenting soil sample; Study of seasonal variation in plankton population demonstration of parallax vision and height perception ; Analysis of plant community and biodiversity and biomass ; Study of seasonal in plankton population both qualitative and quantitative

Course ZOOL 302: Use of excel sheet for data processing. Designing simple experiment for testing mean differences, test of significance (Chi-square test), extra.

Course ZOOL 303: Study prepared slides and museum specimen of selected parasites of representative groups of protozoans, helminthes, and arthropods; demonstration of in vitro and in vivo, infection of *Fasciola* in snails and mammals by histopathology and immune reactions. Culturing insect parasitic nematodes and their life-cycle. Culturing and an insect parasitoid and studying their infection on an insect host; survey of vector born diseases in local and adjoining areas.

Course ZOOL 304: Field study at different Government/ Non Government farm houses/ apiaries/ dairies/ poultries/ seri culture in local areas and project has to be submitted.

Course ZOOL 305: Isolation of nuclei (as a source for studies on structure of chromatin) from rat/mouse liver by discontinuous sucrose density gradient centrifugation; Isolation of total histones and resolution on SDS-PAGE, Studies on modifications of histones (such as acetylation, methylation etc) by western blotting using modification specific- anti bodies; Expression and purification of recombinant histones ; isolation and characterization of total nuclear proteins Digestion of nuclei by MNase and calculation of ' repeat-length' of nucleosomes. Digestion of nuclei by DNase-I, and studies of DNA super helicity in the nucleosomes; Preparation and characterization of soluble chromatin(10 and 30 nm chromatin fibres); Purification of and characterization of mono nucleosomes; reconstitution of nucleosome-core PCR-Amplified synthetic DNA ; chromatin immuno precipitation (ChiP)

Course ZOOL 306: Familiarization with sterile handling techniques for growth of bacteria, such as sterilization, growth media types of culture etc. Isolation of genomic DNA from bacteria and mouse/rat liver, measurement of absorption spectrum of DNA, RNA and nucleotides ; study of denaturation of DNA and determination of Tm and calculation of G:C content ; Studies on stability of DNA and RNA towards

alkali; Study on growth curves of *E.coli* in synthetic medium and calculation of log phase for metabolic experiments ; Studies on induction of *lac* operon : Studies on catabolite repression of *lac* operon and role of cAMP ; Generation and selection of mutants for *lac* operon, calculation of mutation frequency.

Course ZOOL 307: STUDY OF Taxis; Kinesis; Habituation; Trial and error learning; Visual discrimination; Feeding behavior , Pheromonal communication with reference to sexual/special behavior. To study the responses of wood lice to hygrostiluli. To study the geotaxis behavior of earthworm; to study the orientation responses of first instar noctuid larvae to photo stimuli. To study the median threshold concentration of sucrose solution in eliciting feeding responses of housefly ; To study the orientation responses of larvae to volatile and visual stimuli.

Course ZOOL 308: Isolation of protein horonstration of bio-activity in an in vivo bio-assay (e;g: FSH); Immunocytochemical localization of a pituitary hormone using light or electron microscopy (e.g; Prolactin), In vivo bio-assay for estrogen; In vivo Bio-assay for testosterone; vivo bio-assay for luteinizing hormone; In vitro biochemical assay for a hormone (LH or PRL); Effect of hCG on poly A rich RNA content in ovary; Quantification of specific transcript (mRNA) after ovarian stimulation by hCG or FSH; affinity purification of bobine/bubaline pituitary TSH; Preparation and characterization of hormone-enzyme conjugate, ELISA for any one hormone and estimation of plasma level; Estimation of cAMP in a rat tissue (example adipose) with and without hormone stimulation; Streptozotocin administered rat model for diabetes; Demonstration of phosphlipase C action; Molecular cloning of a protein hormone (eg., buffalo prolactin); Expression of recombinant buffalo prolaclin in *E.coli*.

ELECTIVE COURSES

STREAM: ENTOMOLOGY

ZOOL 4101: INSECT MORPHOLOGY, PHYSIOLOGY AND DEVELOPMENT

THEORY

Unit-I : The integumentry system: histology of the integument, physical property and chemical composition of cuticle, sclerotization, colouration and moulting, Morphology of the head, tentorium, antenna and mouth parts and their modification; thorax, tergites, legs and their modifications, wing structure and venation, their modifications coupling mechanism and abdomen, pregenital abdominal appendages, external genitalia

Unit II: Nervous system : the neurons, central visceral and peripheral nervous system. Sensory mechanisms ; mechanoreceptors (tango reception ,proprioception, sound perception), chemoreception, thermoreception , hygroreception and photoreception (compound eyes, image formation , stemmata , ocelli); Bioluminescence and sound production.

Unit III: Alimentary system : nutrition, feeding behavior, morphology of the gut and physiology of digestion and absorption, Circulatory system: dorsal vessel, accessory pulsating structures, sinuses and diaphragms mechanism of circulation, composition and function of haemolymph : respiratory system structure of trachea, tracheoles, air sacs , spiracles, physiology of respiration, respiratory adaptation of aquatic and parasitic insects; Excretory system : Malpighian tubules and its arrangements, physiology of excretion (nitrogenous excretion, salt and water balance)

Unit IV: Reproductive system: male and female: development, post embryonic development ,metamorphosis , types of larvae and pupae. Exocrine glands: structure and function, pheromones, Endocrine glands: structure and function of non neural, neural and peptide hormones, regulation of general body function and metabolic activities, moulting, polymorphism and diapauses.

Suggested Literature:

1. A text Book of Entomology by R. Mathur, Campus books
2. A text book Entomology by Patnaik, D.D (2013), Dominant Pbl.
3. Biochemistry of insects Rockestein , M(1978), Academic Press, New York
4. College Entomology by Essig, E.O.(1942) Macmillan, New York
5. Comprehensive insect Physiology, Biochemistry and Pharmacology by kerkut, GA and B.I Gilbert (1985) volume 1-13, Pergamon press Oxford New York
6. Elements of Entomology by Singh, R(2015) Rastogi publ.MERRUT
7. Entomology Ecology and Biodiversity by Tyagi B.K.(2011), Scienctific Publishers (India)
8. Fundamentals of Entomology by Elzinga, R.J (2004) 6^{TH} edition. Publication. Prentice Hall
9. Fundamental s of insect physiology by Blum, M.S(1985) , Wile and sons , New York
10. General and applied Entomology by Nayar, K.K,.T.N. Ananthkrishnana & B.V. David (1979), Tata McGraw Hill publication Co Ltd., New Delhi
11. General Entomology by Mani, M.S (1982) Oxford and IBH publishing Co. Pvt. LTD. New Delhi
12. General text book of Entomology by Kuzman H.,Apple academics
13. Imm's General text book of Entomolgy By Richerds, O.W. and R.G Davis (1977) Vol I (structure, physiology, and development), 10^{th} Edition, Chapman & Hall, London, New York
14. Insect Biology A text Book of Entomology by Evans.H.E,. (1984) Addison Wisley publishing company, Reading EGKFOKY
15. Insect physiology and Anatomy by Pant, N.C and S.Ghai(1981), ICAR , New Delhi
16. Insect physiology by W.Hening, John Wiley and Sons
17. Insect plant Relationships by Van Emden, Hf (1972) Black Well, London

18. Introduction to comparative Entomology by Fox.R.M. and Fox.J.W. (1964), Van Nostrand Reinhold, New York
19. Pest control by van Emden , H.F.(1992) 2nd Edition Cambridge University Press, New York
20. Principles of insect Morphology by Snod Grass, R.E (1935) , McGraw , Hill, New York
21. Text book on Agricultural Entomology by Pruthi, H.S (1969), ICAR New Delhi
22. The Insects : An Outline of Entomology by P.J. Gullan, Wiley-Blackwell
23. The Insects : An Outline of Entomology by P.J. Gullan and Cranston. P.(2010)4TH Ed.,Wiley-Blackwell Press.584 pp
24. The Insects Structure and Function by Chapman. R.F.(1998), 4th Edition, Cambridge University Press.
25. The Principles of Insect physiology by Wigglesworth.V.V (1982), Chapman & Hall, London
26. The Science of Entomology by Romoser,. W.S. and J.G. Stoffolano(1994), 3rd Edition, Wm.C.Brown Publisher, USA.

Course outcome- To the value of wildlife, field observations sign and foot prints, locomotory pattern in tetrapods. Understand the management practices required to achieve a healthy ecosystem for wildlife population along with emphasis on conservation and restoration. Sociobiology of wild animals, migratory and breeding behavior and their sociobiological importance. Description of reason for wild life depletion and wild life ecotourism management measures for wild life conservation.

(ZOOL4102) ECOLOGY, EVOLUTION AND TAXONOMY

UNIT 1

Insects and the abiotic environment: effect of temperature, moisture and light on insect population; insect plant interaction; plant and insect herbivore relationship; primary and secondary metabolic plant products. Host selection by insects; chemical defence in plants; allocation of protective chemicals, primary role of toxic chemicals; response of insects to chemical defence; temporal avoidance of chemical semiochemicals.

UNIT2

Insect origin and evolution: Ancestry of insect origin and evolution of insects, relationship between entogonathous and ectogonathousapeterygotes, outline classification of insects: classification, characters, economic importance and examples of following: Entognatha (proturan, collembola, dipluran); Thysanura (Lepismatidae); Palaeoptera(Ephemeroptera, odonata) Orthoptera (schizodactylidae, tettigoniidai, gryllidae, gryllotalpidae, acrididae), phasmida (phasmidae, phyllidae); Dictyoptera (blattaria, Mantodea) Isoptera (kalotermitidae, Termitidae); Phthiraptera (Mallophaga, Anopluara- Haematopinidae, Pediculidae)

UNIT 3

Classification, characters, economic importance, and examples of following : Hemiptera (Fulgoridae, Lophopidae, Cicadidae, Membracidae, Cicadellidae, Psyllidae, Aleyrodidate, Aphidadae, Margarodidae, Kerridae, Pseducoccidae, Coccidae, Diaspididae , Redividae, Cimicidae, Anthocoridae, Lygaeidae, Pyrrociridae, Coreidae, Scutelleridae, Pentatomidae,Gerridae, Notonectidae. Belostomatidae, Nepidae); Thysanoptera (Terebrantia—Thritidae, Tubulitera); Neuroptera (Chrysopidae); Coeoptera (Carabidae, Cicindellidae, Dytiscidae,Gyrinidae. Hydrophilidae, Lucanidae, Scaribaeide. Buprestidae, Elateridae,Lampyridae. Dermestidae.Coccinellidae, Tenebrionidae, Meloidae. Cerambycidae, Chrysomelidae,Bruchidae, Curculionidae.)

UNIT 4

Siphonophera:(Pulicidae,Ceratophyllidae);Diptera(pschodidae,Culicidae,Simulidae,Chironomidae,Bibionidae,Myctophilidae,Cecidomyidae,Tabanidae,Asilidae,Bombyliidae,Syrphidae,Agromyzidae,Drosophilidae,Gasterophilidae,Muscidae,Calliphoridae,Hippoboscidae);Lepidoptera (tineidae, Psychidae, Plutellidae, Nymphalidae,Pieridae, Papilonidae, Geomrtridae, Bombycidae, Sphingigae, Arctiidae, Noctuidae); Gelechidae; Pyrialidae; Hymenoptera (tenthredinidae, ichnegumonidae, Braconidae, Evaniidae,Cynipidae, Chalacidae , Eulophidae, Trichogrammitidae, Scoliidae, Formicide Vespidae, Sphecide, Xylocopidae, Aphidae)

Suggested literature:

1. Elements of Entomology by Singh.R, (2015), Rastogi Publ, Meerut.
2. Dynamics of Insect-Plant Interaction by Ananthkrishnana, T N & A Raman(1988). Oxford & IBH Publishing Co Pvt. Ltd., New Dehli.
3. Navel aspects of insect plant interaction by Barbosa. P.& D.K. Letoumeau (1988). John Wiley & Sons New York.

4. Arthropoda Phylogeny by Boudreaux, B.H (1997), with special reference to insects, Wiley and Sons , New York, pp. 320.
5. Evolution of the insects by Grimaldi . D &Engel .M.(2005), Cambridge University Press, New York and Cambridge, pp. 755.
6. Arthropoda Phylogeny by Gupta , A.P. (1979), Van Nostrand reinhold, New York.
7. insectEcology by Price, P.W 1984, 2nd edition, John Wiley & Sons, New York.

Course outcome- By biological evolution we could understand that many of the organisms that inhabit the Earth today are different from those that inhabited it in the past Explained adaptation, providing examples from several different fields of biology explained how the molecular record provides evidence for evolution Understood the Human origin and evolution.

(ZOOL4103) ECONOMIC ENTOMOLOGY

UNIT 1

Beneficial insects: biology of beneficial insects (Apis, Bombyx , Kerria), Insect products, use of insects in medicines, insects in biological Research, Pollination by insects, insects as consumers, Scavengers and as food, torensic entomology. Harmful insects: life history, damage caused and control measuresof following insects pests: household insects: insect injurious to man (aedes, Anopheles, Culex, Phlebotomus, Cimex, Xenopsylla, Pediculus) and life stock (Simulium, Tabanus, Hypoderma, Cochliomyia, Hippobasca), insects transmitting viral diseases in plants : pests of cotton (Aphis gossypii,Earius spp., PectinophoraGossypiella, Dysdercuskoenigi, Myllocerusundecimpustulants, Amrascahigullula), pests of sugarcane (Scirpophagaexcerptali, Chiloinfuscatellus,Emmaloceradepresella,Pyrillaperpusilla,Aleurolobusborodenis.)

UNIT 2

Life history, damage caused and control measures of following insects pests, pest of cereal crops (Leptocorsiaacma, Scirpophagaincertulus, ChlioSuppressalis, Hieroglyphus banian, Dicladispaarmigera, Nephotettixspp,Sesamiainferens); pest of pulses (Hehcoverpaarmigera), pests of vegetables (Aulacophoraindica, Leucinodesorbanalis, Bactroceracucurbitae, Henosepilachna spp., Phthorimaeaoperculella, Pieris brasiccae); pests of oilseeds(Amsactaspp.,Lipaphispseudobrassicae, Athalialugensproxima, Bagradahilaris). Pests of fruits and fruit trees (Quadraspidiotus pernicious, Eriosomalanigerum. Amritodesatkinsoni,Oryctesrhinoceros,Papillodemoleus); pests of stored commodities: Sitophilus oryzae,Trogodermagranarium,Tribolium spp., Callosobruchuschinensis, Corcyra cephalinica, sitotrongacereaiella).

UNIT 3

Methods of pest managemenrt: physical conrol measures (temperature,electromagnetic fields and ionizing radiations,temperature); mechanical control measures(handpicking of infested plants and their destruction, netting,bagging and dislodging insect pests, trenching, insect barriers, insect traps,destruction of crops residues, weeds and trash); cultural control measures (selected of quality

seeds,clean cultivation, destruction/provision of alternative/trap plants, crop rotations, tillage operations, timing of planting/harvesting, nutrient/water management).

UNIT 4

Chemical control measures: insecticides: classification, properties, synergistic,repellants, attractions: feeding deterrents: feeding deterrents; formulations, biopesticides; benefits and risks of chemical control; application; modes of action of insecticides, developments of insect resistance against insecticides; biocontrol measures(organisms used in biocontrol , inoculation,augumemtation and conservation of natural enemies – pathogens, predators and parasitoids; selected criteria of a promising natural enemy). Feasibility of biocontrol: genetic control measures(sterile- male techniques, artificial manipulation of genecompostion of pest insects; breeding of insect-resistant host plants); legal control measures (enactment and enforcement of quarantines); concept of integrated pest management (IPM) in agro-ecosystem; ticks and Mites of Economic importance.

Suggested literature:

1. Integrated pest management by Abroi,D.P.(2014). Acadmic press, USA.
2. Atextbook of Agricultural entomology by Alford, D.V.(1990), Wiley –Blackwell.
3. Agriculture pests of South asia and their Management by Atwal, A.S. &Dhalwal, G.S (1997), Kalyani Publishers, New Dehli.
4. Agricultural pests and their control by Awasthi, V.B (2001), Scientific Publishers, New Dehli
5. Elements of economic entomology by David, B.V (2000), Popular Book Depot, Chennnai

Course outcome- To study the methods of pest management physical control measures mechanical control measures elected of quality seeds, clean cultivation, destruction of alternative/trap plants, crop rotations, tillage operations, timing of planting/harvesting, nutrient/water management.

(ZOOL4104) DISSERTATION

Subject of the Dissertation will be assigned to each student at the end of Semester II and goes until Semester IV. It would be theoretical and not involve any laboratory components.

PRACTICAL COURSE OF THEORY COURSES ZOOL4101- ZOOL4103

Distribution of marks: **time: 8 hours of two sittings**

Exercise
Major Dissection
Minor Dissection
Taxonomy (identification of two insects)
Physiology Exercise
Spotting (10 spots)
Viva-voice
Total

1. Detailed study of the external features of grasshopper
2. Dissection of different systems of Gryllotalpa, Dysdercus, Housefly/Calliphora, Moth/butterfly/Catterpillars/Wasp, honey bee, Dung beetle, Water beetle.
3. Permanent preparation of testis of Coxkroach, salivary gland of dysdercus , ovary, spermatheca and accessory gland of house fly.
4. Sting apparatus of wasp/ honey bee.
5. Spiracles of the caterpillar and wing scales of a lepidopteran insect.
6. Legs of tresterrial and aquatic insects showing simple adaptation concerning locomotion.
7. Study of prepared slides of : T.S / L.S. of integument and the various region of gut, ovary, testis and brain.
8. Whole mounts of thoracic/ abdominal spiracles, different types of antennae, legs, moth parts , wings and sting apparatus of honey bee/ wasp.
9. Determination of pH of insects guts and haemolymph .
10. Qualitative assay of free amino acids and haemolymph and fat body.
11. Quantitative estimation of glycogen, protein and lipid.
12. Qualitative determination of uric acid from fat body/ Malpighian tubules.
13. Determination of the rate of passage of food through gut.
14. Collection of different kinds of larvae and pupae of insects.
15. Collection, preservation and identification of locaaly available insects.
16. Permanent preparation of mouth parts, antennae, wings, legs, Spiracles and external genitalia of insects from different groups.
17. Identification of various insects pests, their life -history and materials damaged by them.
18. Study of various groups of insecticides and equipment's used for insecticide application.
19. To study histology and to demonstrate the presence of lipid and glycogen in microtomy sections of suitable material.
20. Study of life -history of beneficial insects and their products.

ELECTIVE COURSES

STREAM 2: FISH BIOLOGY

(ZOOL4201) Morphology, Physiology and Development of Fishes

THEORY

UNIT 1

Structure and function of ear-air bladder; connection with Weberian apparatus; different types of caudal fins; specialized organs in fishes(electric organ, sound producing organs, light producing organs, poison glands); sense organs and nervous system in fishes.

UNIT 2

Different types of feeding habits in fishes and their adaptation in elementary tract; physiology of digestion,respiration, osmoregulation (freshwater and marine fishes); structure of kuidney of freshwater and marine fishes and physiology of excretion.

UNIT 3

Structure of reproductive organs and physiology of reproduction; embryogenesis; process og gastrulation, neurilation, organ formation, larval development and metamorphosis in freshwater fish.

UNIT 4

Structure of pituatatry gland, thyroid, adrenal glands, corpuscles of stnnius and urophysis in fishes: hormones, secreated by theses glands and their physiological significance.

Suggested literature:

1. Behaiviour of teleost fishes by Tony J. Pitcher, Chapman and hall.
2. Ecology of freshwater by Bria mass , Willey Blackwell
3. Fish and fisheries by S.S Khanna.
4. Fish by C.B. L. Srivastava
5. Fish life Environment and diversity by N.B. Marshal, agrobios(india)
6. Fish physiology edited by W.S Hoar & D J Randall Vol I and II academic press INC.

Course outcomes- Study of the physiology of fish structure and function of ear-air bladder; connection with Weberian apparatus; different types of caudal fins; specialized organs in fishes (electric organ, sound producing organs, light producing organs, poison glands); sense organs and nervous system in fishes. Understand the basic of this course and think & develop new ideas in this course.

(ZOOL4202) TAXONOMY AND ECOLOGY OF PISCES

THEORY

UNIT 1

Characteristics of fishes: classification by berg, romer, bertin and niambourg, and greenwood; modern classification of fishes: detail taxonomic studies of following orders of fishes of U.P. and Bihar upto families: clupeiformes, cypriniformes, beloniformes, cyprinidontiformes, mugiliformes, ophiocephaliformes, symbranchiformes, perciformes, mastacembaliformes and tetradontiformes.

UNIT 2

Adaption to different modes of life with special reference in hill stream and deep sea fishes: relation between fishes and their abiotic and biotic environment; influence of following abiotic factors on life of fishes, e.g. density and pressure, temperature, salt content in water, light, sound, electric current , bottom deposits and particle suspended in water.

UNIT 3

Influence of biotic factors on life of fishes; interspecific and intraspecific interrelationship among fishes with different other organisms- paratisims, commensalisms, mutualisms, predatorisms and cannibalisms

UNIT 4

Plankton in relation to fish production: sewage fed fisheries and its importance; pollution affecting fishery water with special reference to oil spills, domestic pollution, industrial water pollution, radio-active waste; bio-accumulation and bio-magnifications.

Suggested Literature:

1. Behaiviour of teleost fishes by Tony J. Picher, Champman and Hall.
2. Comparative Vertebrate Endocrinology by P.J. Bentlay
3. Ecology of fishes by G.V. Nikolsky, Academy press, London.
4. Ecology of fresh waters by Bria Mass, Willey Blackwell
5. Fish and fisheries by S.S Khanna
6. Fish by C.B.L Srivastava.

Course outcomes- Students to know the study of the influence of biotic factors on life of fishes; interspecific and intraspecific interrelationship among fishes with different other organisms- parasitism, commensalisms, mutualisms, predations and cannibalisms for help to prepare competitive examinations.

(ZOOL4203) APPLIED ICHTHYOLOGY

UNIT 1

Marine, freshwater estuarine reservoir and cold water fisheries of india: fish culture- nutritional requirements of craps, siluroids and murreis , crap cultivation in india; spawning, collection, hateheries, rearing, shocking, transport and mortality of fish fry.

UNIT 2

Fertilization and management of fishery pond. Composite fish culture, cage culture and culture of exotic fishes; induced breeding: methods of fishing in India with particular refernce to U.P. preservation, processing, transport and Marketing of fish. Food value and flavours of different fishes.

UNIT 3

Larvivorus fishes and public health, common enimies and symptoms, etiology and treatment of diseases of food fishes; fish culture in paddy fields and reservoir ; integrated fish farming with prawn, pig, duck and poultry.

UNIT 4

Development of fisheries in india: fish- based industry and their by products: culture of asexual or sterile fish; homosex culture; hybridisation, gynogenesis and androgenesis; transgenic fish; fish conservation of threatened fresh water fishes (in situ, ex situ), techniques of Cryopresevation.

Suggested Literature:

1. Aquaculture and fisheries biotechnolog Genetic Approaches, Dunha, R.A, CABI publishing USA.
2. Handbook of fishery technology by V.M. Novikov, A.M Erindublishng company.
3. Fish and fisheries of india by V.G. Jhingra, Hindustan publication corporation.
4. Fisheries Science by Rounsefell and Evarhart, international books and periodical supply service.
5. Aquaculture principles nad practices, Pillay T.V.R.. Blackwell publicsing , USA

Course outcomes- Learnt the general classification of fishes, economically important marine and freshwater fishes, migrations and fishery products. Described recent concepts in fisheries management, endangered species management and Came to know the various aquaculture systems. Understood the type of hatchery, brood stock, larval production, feed management water quality and disease management in cultivable species, live feed production.

(ZOOL4204) DISSERTATION

Subject of the Dissertation will be assigned to each student at the end of Semester II and goes until Semester IV. It would be theoretical and not involve any laboratory components.

PRACTICAL COURSE OF THEORY COURSES ZOOL4101- ZOOL4103

Distribution of marks: **time: 8 hours of two sittings**

Exercise

Major Dissection of edible/culturable fish
Taxonomy (identification of two fishes)
Physiology Exercise
Ecology excercise
Spotting (10 spots)
Viva-voice
Total

1. Study of organ system of Sc*oliodon, labeo* and *wallago*; study of accessory respiratory organs and their blood supply in *heteropneusus*. *Clarias, Channa* and Amphibians: Study of air bladder and ear connection in Notopterus and Gudusia or Hilsa; Morphology of olfactory organs and their innervations on teleosts: preparation of a skeleton and an alizarine mount of fish, Study of prepared microslides: Osteolosy of *Wallago*.
2. Quantitative estimation of liver glycogen and blood sugar; demonstration of color change.
3. Systematics of marine and freshwater fishes with special reference to identification of local forms; structural adaptations in fishes.
4. Qualitative and quantative study of freshwater plankton; estimation of Dissolved oxygen, free carbondioxide, alkanity in a local fish pond; oxygen consumption in local fish sin different habitats.
5. Study of food and structural modifications due to feeding habits, gills and gill-rackers, mouth eye alimentary canal, olfactory organs etc: Study of age and growth in fishes; Study of amphibians, exotic poisonous, venomous larvivorous and sound producing fishes.
6. Study of common aquatic vegetation and aquatic insects: study of fishing gears, with particular reference to Uttar Pradesh: soil factors; estimation of hydrobiogical parameters temperature, pH, conductivity, salinity, dissolved oxygen, primary productivity, ammonia, nitrite, nitrate, phosphate, biological oxygen demand, chemical oxygen demand, of nursery rearing, shocking nad breeding ponds.
7. Estimation of ovarian egg counts: culture of live food organisms and assay of nutritional quality of live food; estimation of popular density of live food organisms; decapsulation and hatching of *Artemia* cysts for use in hatcheries; Demonstration of breeding pools and hatcheries. Induced breeding of Indian major carps and catfishes. Identification of eggs, spawn, fry and fingerings of cultivable fishes of india.
8. Collection and identification of aquatic weeds and aquatic insects: Study of feeding habits of fishes by gut content analysis, isolation and estimation of fish immunoglobulins; Molecular techniques in fish health management: Aquarium design and maintenance formulation and

preparation of artificial fish food for Indian major carps and Prawns; Analysis of proximate composition of fish and processed products.

9. Visit to freshwater marine fish farm.

ELECTIVE COURSES

STREAM 3: CELL BIOLOGY

(ZOOL4203) CYTOLOGY TECHNIQUES

UNIT 1

Microscopy : basic principles of light microscopy, magnification, numerical aperture, resolution, stereo microscopy, principles and instrumentation of phase contrast, interference , polarisation (bireferingant object, plane polarized light, Nicole prism), Fluorescence microscopy; principles and instrumentation of electron microscopy(transmission electron microscope (TEM), Scanning electron microscopy(SEM)); different fixation and staining techniques for electron microscope. Freeze -etch and freeze-fracture methods for EM; image processing methods in microscopy

UNIT 2

Basic principles of freeze drying technique (Lyophilization) and their uses; X-ray diffraction; basic principle of X-ray diffraction methods and instrumentation uses of X-ray diffraction study in cell biology; Autoradiography: basic principles of Autoradiography and their uses in cell biology; detection and measurement of different types of radioisotopes used in biology; safety aspects; methods of cell culture and cell line establishment, media preparation.

UNIT 3

Chemical basis of fixation of ethanol, methanol, acetone, acetic acid, trichloroacetic acid, picric acid, mercuric chloride, formaldehyde, chemistry of cytochemical localization of glycogen by periodic acid-Schiff method; protein by coupled tetrazonium reaction method; lipid by Sudan Black B method; nucleic acid by Feulgen and methyl green- pyronin; acid and alkaline phosphatase by method Gomori's lead phosphate and Azo-dye coupling method; oxidases by diphenyl amine and nathoquinone.

UNIT 4

Purification and fractionation of nucleic acid, nucleic acid hybridisation, enzymatic replication of DNA by PCR- optimize reaction component, cycling parameters. DNA template, primers, bivalent and monovalent cations, cot analysis, taq and thermostable DNA Polymerases, enhancers; DNA micro-arrays, GISH and FISH.

Suggested Literature:

1. Cell and molecular biology, D. Roberties
2. Cell bilogy, Saunders
3. Molecular cell biology, Albert Brucee et al
4. The cell nad molecular approach, G.M Cooper
5. Cell biology, Gerald Karp.

Course outcomes-After the course the students will be able to Purification and fractionation of nucleic acid, nucleic acid hybridisation, enzymatic replication of DNA by PCR- optimize reaction component, cycling parameters. Course is useful in various competitive examinations.

(ZOOL4203) CELLULAR ORGANIZATION AND FUNDAMENTAL PROCESSES: CELL STRUCTURE

UNIT 1

The nucleus (the nuclear envelop and traffic between the nucleus and cytoplasm), internal organization of the nucleus, the nucleolus; plasma membrane structure and chemical composition; movements of substances across the membrane.

UNIT 2

Protein shortening and transport endoplasmic reticulum (the endoplasmic reticulum and protein sectreation, the smooth ER and lipid synthesis, export of protein and lipids from the ER), The Golgi apparatus (organization of the Golgi, protein glycosylation within the Golgi Lipid and polysaccharide metabolism to the Golgi, protein sortening and export from the Golgi apparatus).

UNIT 3

Lysosomes. Types, ultrasound and functions, lysosomal enzymes, endocytosis and lysosome formation, phagocytosis and autophagy; lysosomal storage disorders.

UNIT 4

Bioenergetics and metabolism (mitochondria-organizaton and function, mechanisms of oxidative phosphorylation, peroxisomes- functions of peroxisomes); types of ribosomes, its ultrastructure; functions and biogenesis in eukaryotes and prokaryotes.

Suggested Literature:

1. Biochemistry of lipids and membranes by D.E Vance; J E Vance, the Benjamin/Cummimge Co.
2. Cell & Molecular biology, D Roberties.
3. Molecular cell biology, Albert Brucee et al
4. The cell nad molecular approach, G.M Cooper
5. Cell biology, Gerald Karp.
6. Cell biology by Thomas D. Pollard, Saunders.

Course outcomes- Understood about the transmission, distribution, arrangement, and alteration of genetic information and how it functions and is maintained in populations. Bioenergetics and metabolism. Course is useful to further study of the students.

(ZOOL4303) CELL REGULATION-CELL COMMUNICATION &DIFFERENTIATION

UNIT 1

Cell signalling: general principles of cell signalling, forms of signalling, classes of cell surface receptors protein, signalling of steroid and thyroid hormones through intercellular receptors, signalling via – G-protein linked cell surface receptors; interferon; the cell division cycle; the general strategy of cell cycle, regulation of the cell cycle by cell growth an extra circular signals, cell cycle check points, regulation of cell cycle progression.

UNIT 2

Circular mechanism of development: mechanisms of cell diversification in the early animal embryo, cell memory, cell determination and the concept of positional values; differentiated cells and their maintenance: maintenance of the differentiated state , tissues with permanent cells, renewal by simple duplication. Renewal by stem cells, epidermis, renewal by pluripotent stem cells: Apoptosis and natural cell death.

UNIT 3

The immune system: the cellular basis of immunity, antien& antibody interactions. The functional properties of antibodies. The fine structure of antibodies, production & Synthesis of Polyclonal and monoclonal antibodies. T-cell receptors and subclasses, AIDS, MHC(major histocompability cells), molecular and antigen presntation onto T cells, Cytoxic T cells, Helper T Cells and T cells and T cell activation, Selection of the T cells repertone.

UNIT 4

Cancer : cancer as a micro-evolutionary process, causes and types of cancer, properties, properties of cancer cells, Molecular diagnoss, prevention and treatment, Molecular genetics of cancer; controlling gene expression : An overview of gene control, promoter and operator genes. Hormone regulation or gene control, DNS binding motifs in gene regulatory proteins. Working of genetic switches, post transcriptional controls.

Suggested Literature:

1. Cell & Molecular Biology, D. Roberties.
2. Cell bilogy, Saunders
3. Molecular cell biology, Albert Brucee et al
4. The cell nad molecular approach, G.M Cooper
5. Cell biology, Gerald Karp

Course outcomes- Outline the key components of the innate and adaptive immune responses. To describe about cell types and organs which are involved in an immune response, described the Infectious diseases, hypersensitivity, autoimmune disorders, immunodeficiency diseases and Understood the microbial diversity, ultra structure, culture techniques of microbes.

(ZOOL4304) DISSERTATION

Subject of the Dissertation will be assigned to each student at the end of Semester II and goes until Semester IV. It would be theoretical and not involve any laboratory components.

PRACTICAL COURSE OF THEORY COURSES ZOOL4101- ZOOL4103

Distribution of marks: **time: 8 hours of two sittings**

Exercise
Cytochemical localization
Vital staining
Microtomy
Isolation of nucleic acid
Spotting (10 spots)
Viva-voice
Total

1. Handling and use of phase contrast microscope.
2. Quantitative estimation of DNA, RNA, alkaline phosphate.
3. Cytochemical localization of phosphatases, RNA, DNA, proteins, lipids and glycogen.
4. Study of chromosomal behavior during cell division, using squash preparations of animal (testes of rat and grasshopper; bone morrow of rat) tissues and plants (onion root tip) tissues.
5. Prepared slides of chromosomes behavior during cell division.
6. Study of salivary gland chromosomes of drosophila and/or Chironomus larvae.
7. Identification and study of mutant forms of drosophila.
8. Druxoplnla culture technique.
9. Cytochemical localization of golgi complex, mitocohondria, acids and alkaline phosphatases and glycogen.
10. Supravital staining of Nissl bodies, mitochondria and Cytoplasmic organells and inclusion.
11. Study of prepared slides of various cytoplasmic organells and inclusion.
12. Study of prepared slides of various stages during mitotic, and meiotic cell divisions. Bacterial culture techniques. Isolation of nucleic acids.

ELECTIVE COURSES

STREAM: ENVIRONMENTAL BIOLOGY TOXICOLOGY

(ZOOL4401)Wildlife Biology

THEORY

UNIT I

Value of Wildlife, field observation, study of sign and symptoms, footprints; locomotory patterns in tetrapod; types of movement; tiger pug marks, footprints of other animals, feeding sign, animal dropping, wildlife photography.

UNIT 2

Wildlife Census Method (water hole survey point count and line transect methods, pug mark count methods, kings census method); major wildlife habitat biomes, tropical and temperate habitat; components of wildlife habitat (cover, food, water, space) common flora and fauna of India.

UNIT 3

Socio biology of wild animals, terrestrial behaviour, migratory behaviour, breeding behaviour, visual, acoustic and olfactory communication and their socio biological importance; India wildlife (introduction, distribution of wildlife in ecological sub division of India); IUCN categories, cinctures, biosphere, reserves, national parks, sanctuaries and zoos in India; gene -pool, habit, habitat and breeding biology of a representative wildlife and weaverbird.

UNIT 4

Reasons for wildlife depletion (habitat, distribution, commercial wildlife exploitation, overgrazing etc); wildlife ecotourism management, measures for wildlife conservation (policies and programme); special projects for endangered species (project Tiger, Gir Lion Sanctuary, project, crocodile breeding project, project Hangul)

Suggested literature

1. Wildlife ecology, A.N. Moen.
2. Wildlife ecology and management, E.G. Balen
3. Indian wildlife, Ramesh Bedi
4. Wildlife management, Rajesh Gopal.

Course Outcomes-Distribution of wildlife in ecological sub division of India); IUCN categories, cinctures, biosphere, reserves, national parks, sanctuaries and zoos in India; gene -pool, habit, habitat and breeding biology of a representative wildlife and weaverbird. This course is useful in various competitive exams like CSIR-NET, IAS PCS.

(ZOOL4402) ENVIRONMENTAL CHEMISTRY

THEORY

UNIT I

Fundamentals of environmental chemistry: stereochemistry, Gibbs energy, chemical potential, chemical equilibrium, acid base reaction, solubility product, solubility of gases in water, carbonate system, unsaturated and saturated hydrocarbon, radio-nuclides.

UNIT 2

Chemical components of air: classification of elements, chemical speciation particles ions and radicals in the atmosphere, chemical processes for information of inorganic and organic particulate matter, thermo chemical and photo chemical reaction in the atmosphere, oxygen and ozone chemistry of air pollutants, photochemical smog.

UNIT 3

Water chemistry: chemistry of water concepts of D.O. BOD, COD. Sedimentation coagulation filtration. Redox potential, soil chemistry, inorganic and organic components of solid nitrogen pathways and NPK in soils.

UNIT 4

Toxic chemicals in the environment: pesticides in air, water and soil: biochemical aspects of Lead, Mercury, Cadmium, Arsenic, carbon monoxide, O3 and PAN: MIC, carcinogens

Suggested literature

1. Environmental chemistry, Ian Williams
2. Environmental chemistry, Colin Baird. M.Cann
3. Environmental chemistry, F. Helmet
4. An introduction to environmental chemistry, J.E. Andrews
5. An introduction to environmental chemistry, Andrews et al.
6. Chemistry of the environment, T.G. Spiro, W.M. Stigliani

Course Outcomes- Fundamentals of environmental chemistry: stereochemistry, Gibbs energy, chemical potential, chemical equilibrium, acid base reaction, solubility product, solubility of gases in water, carbonate system, unsaturated and saturated hydrocarbon, radio-nuclides Toxic chemicals in the environment. Get benefit of this course in various competitive examinations.

(ZOOL4403) ENVIRONMENTAL MONITORING AND TOXICOLOGY

THEORY

UNIT I

Air pollution monitoring: air quality standards, sampling methods, instruments, duration of sampling period. Location of sampling sites, Air sampler operation, stack sampling techniques, control of gases contaminants combustion. Adsorption, Adsorption recovery system. Features of Ganga action plan.

UNIT 2

Physiochemical and bacteriological sampling and analysis of water quality. Waste treatment, primary, secondary, and tertiary treatment, criteria for the application of aerobic and anaerobic biological treatment. Types of biological treatment, treatment for various industrial effluents with reference to distillery, paper and pulp, textile and dyeing wastes, industrial pollution abatement.

UNIT 3

Pollution control in petroleum refineries and petro-chemical unit. Odours and their control. Threshold concentration oxidation, water supply management: introduction, demand of water, need of water supply. Treatment of ground water, pollution, control in petroleum refineries and petrochemical unit, oil spills. Sources and generation of solid-waste and its control. Sewage treatment, physico-chemical and bacteriological samplings as analysis of soil quality, control of soil pollutants, remedial measures of soil pollutants, protection and control from radiation, disposal of radio-active wastage, control of thermal pollution

UNIT 4

Toxicology: introduction, basic concept o toxicology, toxicants of health hazards (Lead, Mercury, Cadmium, Arsenic, Vanadium, Cyanide, Cobalt, Iron), Xenobiotics, (absorption, transport and execution of chemicals). Biological magnification, biomonitoring of toxic chemicals, bioindicators.

Suggested literature

1. Toxicology, Earnest Hodgson.
2. Environmental pollution and management, G.R. Pathade, P.K. Goel.
3. Pollution, A.D. Stern
4. Pollutants and their determination, Gryson
5. Assessment and Management of Carbon, Nitrogen and Sulphur, P.A. Debarry.
6. Toxicology and risk assessment principles. Methods and application by Anna M Fan, Louis W Chang, Marcel Dekker, inc, New York.

Course Outcomes- Study is useful to **p**hysiochemical and bacteriological sampling and analysis of water quality. Types of biological treatment, treatment for various industrial effluents with reference to distillery, paper and pulp, textile and dyeing wastes, industrial pollution abatement for useful to the student applied work.

(ZOOL4404) DISSERTATION

Subject of the Dissertation will be assigned to each student at the end of Semester II and goes until Semester IV. It would be theoretical and not involve any laboratory components.

PRACTICAL COURSE OF THEORY COURSES ZOOL4101- ZOOL4103

Distribution of marks: **time: 8 hours of two sittings**

Exercise

Exercise For wildlife biology (2)

Exercise (2) For environmental monitoring

Exercise Environmental toxicology

Viva-voice

Total

1. Study of wildlife of local and suburban areas and submission of the report.
2. Study on wild life in adjoining area with biodiversity of wild flora & fauna.
3. Study on wild animals and their behaviour
4. Comparison of dissolve oxygen (D.O) in water samples from different sources.
5. Determination of the chloride demand and chloride residue.
6. Estimation of chemical oxygen demand.
7. Estimation of biological oxygen demand.
8. Estimation of free carbon dioxide demand.
9. Estimation of chloride concentration.
10. Determination of turbidity.
11. Estimation of pH
12. Effect of UV radiation on animals
13. Demonstrations of vectors of different diseases
14. Determination of temperature, colour, odour.
15. Determination of conductivity.
16. Determination of total solids in water samples.
17. Determination of alkalinity
18. Determination of total kjedol nitrogen and sulphate.
19. Determination of gas pollution in different localities of the city.
20. Measurement of humidity by hair hygrometer.
21. Measurement of temperature by Max. Min thermometer
22. Study on environmental awareness in different group of society
23. Estimation of LC50, LC10, LC90, measurement of selected toxicant for selected organisms. Determination of upper and lower confidant limits, slope with value of each study
24. Study of selected biological effect of selected pollutants, especially on the behaviour on animals
25. Effect of toxicant on enzyme acetyl cholinesterase (AchE) and alkaline phosphatase (ALP) in the nervous tissues of aquatic animals of different groups.