

Ch. Charan Singh University, Meerut Campus
M.Sc. Zoology (Choice Based Credit System) Syllabus

Effective from session 2016-17

Distribution of marks in different courses

I Semester	Course Title	Credits	Total Marks (Int.+Ext.)
Core Compulsory Theory I/CH-1562	Animal Taxonomy and Economic Zoology	4	40+40
COURSE II/CH-1563	Evolutionary Biology	4	40+40
COURSE III/CH-1564	Non-Chordata	4	40+40
COURSE IV/CH-1565	Cell and Molecular Biology	4	40+40
PRACTICAL-CH-562	Based on Courses I-IV	2+2+2+2	80
Open Elective I		4	100
	Total Credits/marks	28	500

II Semester	Course Title	Credits	Total Marks
COURSE V/CH-2562	Genetics & Biostatistics	4	40+40
COURSE VI/CH-2563	Biotechnology & Bioinformatics	4	40+40
COURSE VII/CH-2564	Mammalian Physiology	4	40+40
COURSE VIII/CH-2565	Biochemistry	4	40+40
PRACTICAL-CH	Based on Courses V-VIII	2+2+2+2	80
Open Elective II CO-6606	Poultry Science and Management	4	100
	Total Credits/marks	28	500

III Semester	Course Title	Credits	Total Marks
COURSE IX/CH-3562	Chordata	4	40+40
COURSE X/ CH-3563	Developmental Biology	4	40+40
COURSE XI/ CH-3564	Environmental Biology	4	40+40
COURSE XII/CH-3565	Animal behaviour	4	40+40
PRACTICAL-CH-762	Based on theory courses IX-XII	2+2+2+2	80
Open Elective III		4	100
	Total Credits/marks	28	500

	Course Title (Core Elective Courses (A Set of four courses each from any group))	Credits	Total Marks
	GROUP A : Parasitology		
Course XIII A: CH- 4562	Biology of Parasites – I (Protozoa, Trematoda and Cestoda)	4	40+40
Course XIV A: CH- 4563	Biology of Parasites – II (Nematoda and Arthropoda)	4	40+40
Course XV A: CH- 4564	Physiology and Biochemistry of Parasites	4	40+40
Course XVI A: CH- 4565	Immunoparasitology	4	40+40
	Practical based on XIII-XVI (20 marks each)		80
	Open Elective IV		100
	GROUP B: Fish and Fisheries		
Course XIII B: CH- 4569	General Fish Biology	4	40+40
Course XIV B: CH- 4570	Morphology and Physiology	4	40+40
Course XV B: CH- 4571	Fish Culture and Limnology	4	40+40
Course XVI B: CH- 4572	Applied Fisheries	4	40+40
	Practical based on XIII-XVI (20 marks each)		80
	Open Elective IV		100
	GROUP C: Endocrinology		
Course XIII C: CH- 4570	General Endocrinology	4	40+40
Course XIV C: CH- 4571	Neuro Endocrinology	4	40+40
Course XV C: CH- 4572	Vertebrate Endocrinology	4	40+40
Course XVI C: CH- 4573	Reproductive Physiology	4	40+40
	Practical based on XIII-XVI (20 marks each)		80
	Open Elective IV		100
	GROUP D: Cytology & Cytogenetics		
Course XIII D: CH- 4574	Advanced Cell Biology	4	40+40
Course XIV D: CH- 4575	Chromosome and Genomic Organization	4	40+40
Course XV D: CH- 4576	Genomic Analysis and Immune Genetics	4	40+40
Course XVI D: CH- 4577	Human and Microbial Cytogenetics and Molecular Biology	4	40+40
	Practical based on XIII-XVI (20 marks each)		80
	Open Elective IV		100
	Group E: Entomology		
Course XIII E: CH- 4578	General Insect Biology	4	40+40
Course XIII E: CH- 4579	Anatomy and Physiology of Insects	4	40+40
Course XIV E: CH- 4580	Applied Entomology I	4	40+40
Course XV E: CH- 4581	Applied Entomology II	4	40+40
	Practical based on XIII-XVI (20 marks each)		80
	Open Elective IV		100
	Group E: Chronobiology		
Course XIII F: CH- 8562	Chronobiology	4	40+40
Course XIII F: CH- 8563	Photoperiodism and Seasonal Breeding	4	40+40
Course XIV F CH- 8564	Neuroendocrine Control of Behavior	4	40+40
Course XV F: CH- 8565	Applied Chronobiology	4	40+40
	Practical based on XIII-XVI (20 marks each)		80
	Open Elective IV		100

- Each core (compulsory and elective) course will have 4 hours theory and 4 hours practical in each week, equaling 4+2=6 credits. In each semester there will be one open elective of 4 credits each. A minimum of 108

credits are required to be earned for successful completion of the Master's degree including a minimum of 72 credits of Core Compulsory, 24 credits of Core elective and 12 credits of open elective courses.

- All regulations of CBCS courses as provided by the University ordinances and modified from time to time will become effective from the given dates.
- A minimum of 30% marks separately in internal and external assessment of each course and an aggregate of 40% marks in all the courses (including practical) is required for passing. In case of failing to obtain 30% marks in internal assessment of any paper, the candidate will not be eligible to appear in external examination of that course.
- Every student will be given two specializations based on qualifying the optional sets of papers (Core electives) in 4th semester.
- Internal assessment will be based on :
- Quizzes -2: (from first Unit) Each for 5 marks Tests-2: for 10 marks each (based on 2 units each) Seminar/ Term Paper: 10 marks in each paper
- Eligibility for admission to the course: B.Sc. (Bio)/B.Sc. (CBZ)/B.Sc. (Life Sc.)/Hons. with minimum 55% marks and Intermediate with minimum second division (45%) or with 50% aggregate marks in B.Sc. and Intermediate both. In the subject itself minimum 50% marks are necessary for eligibility.
- CBCS Regulations and grade card as per University Ordinance will be followed with any changes introduced here after.

Note: Practical in each semester will be of 5 hours duration. PG Students should be encouraged to attend the workshops/conferences/symposia/seminars and field visits.

FIRST SEMESTER

Course I: ANIMAL TAXONOMY AND ECONOMIC ZOOLOGY CH-1062

Unit 1

- a. Science of taxonomy- Definition, concepts, history, scope and application of biosystematics
- b. Principles of Zoological Classification – Theories of biological classification their history, hierarchies of categories and the higher taxa

Unit 2

- a. Concept of Species – Species category, different concepts and intraspecific categories
- b. Modern trends in taxonomy- Behavioral taxonomy, cytotaxonomy and molecular taxonomy

Unit 3

- a. Procedures in taxonomy – Taxonomic collections, process of identification, procedure of classifying, description and publication.
- b. Principles and application of Zoological nomenclature – origin of code. Rules of Zoological nomenclature (ICZN), interpretation of rules of nomenclature

Unit 4

- a. Animals products – Fish products, dairy products, piggery, pearl, leather and wool
- b. Domestic animals – Poultry, Cattle and Aquaculture, duck and goat farming

Unit 5

- a. Economic insects – General principles and products of Apiculture, Sericulture, Lac culture; pests of common crops like paddy, cotton, wheat, sugarcane, brinjal, cauliflower, mustard etc.
- b. Integrated Pest Management-Chemical and biological Control

Recommended Books:

1. A Handbook of Economic Zoology by A Jawaid & SP Sinha. Publisher: S. Chand Group Publ.
2. An Introduction to Taxonomy by TC Narendaran: Publisher : ZSI, India- free online on <http://faunaofindia.nic.in/PDFVolumes/spb/041/index.pdf>
3. Carp and Pond Fish Culture by Horvath, L., Tamas, G., Seagrave, C., Wiley-Blackwell
4. Economic Zoology by KR Ravindranathan. Publisher: Dominant Publishers & Distributors
5. Economic Zoology by GS Shukla & VB Upadhyay. Publisher: Rastogi Publications
6. Economic Zoology 1st Edition by BS Jangi. Publisher: CRC
7. Modern Trends in Biology & Economic Zoology by HC Nigam. Publisher: Vishal Publ. Co.
8. Principles of Animal Taxonomy by GG Simpson. Publisher: Columbia University Press
9. Principles of Systematic Zoology by [Ernst Mayr](#) & [AD Peter](#). Publisher: McGraw-Hill
10. Theory and Practice of Animal Taxonomy by VC Kapoor. Publisher: [Oxford & IBH Publishing Co Pvt. Ltd.](#)

Unit 1

- a. Pre-biotic environment. Abiotic and Biotic Evolution. Theories of Organic Evolution, Emergence of Evolutionary Thoughts
- b. Origin and evolution of economically important microbes

Unit 2

- a. Distribution of Animals: Distribution with Space and Time. Rise of Dinosaurs and their extinction
- b. Dispersal of Animals: Means & Barriers

Unit 3

- a. Micro and Macro Evolution, Phylogenetic Gradualism
- b. Molecular Evolution: Concepts of neutral evolution, molecular divergence and molecular clocks; molecular tools in phylogeny; origin of new genes and proteins; gene duplication and divergence

Unit 4

- a. Mechanism of Evolution: Isolating Mechanism. Speciation, Convergent Evolution, Sexual Selection, Co-evolution, Natural Selection
- b. Adaptation – Introduction, Adaptive Radiation and Modification, Coloration & Mimicry

Unit 5

- a. Fossil & Fossilization
- b. Evolution of Horse and Elephant

Recommended Books:

1. Evolution: Principles & Processes by Brian Hall. Publisher : Jones & Bartlett
2. Evolution: Above the species level by Rensch. Publisher : Columbia University
3. Evolution by MW Strikberger. Publisher : Jones & Bartlett
4. Introduction to Evolution by PA Moody. Publisher : Riper & Brothers
5. Organic Evolution by RS Lull. Publisher: The Macmillan Co.
6. Origin of Adaptation by Vern Grant. Publisher: Columbia University Press
7. Text book of Palaeontology by KAV Zittel – 2 volumes. Publisher: The Macmillan Co.
8. The Major Features of Evolution by GG Simpson. Publisher: Columbia University Press
9. The Material Basis of Evolution by Richard Goldsmith. Publisher: Yale University Press
10. Vertebrate Palaeontology by AS Romer. Publisher : University Chicago Press

Unit 1

- a. General Organization and classification of Non chordate phyla up to order level
- b. Coelom formation, body symmetry and metagenesis in non-chordates

Unit 2

- a. Protozoa: locomotion and reproduction in protozoa
- b. Porifera: skeleton and regeneration in sponges
- c. Cnidaria:, skeleton in coelenterates and coral reefs

Unit 3

- a. Ctenophora: Affinities.
- b. Helminths: Parasitism and parasitic adaptations
- c. Annelida: Polymorphism and excretory system

Unit 4

- a. Arthropoda: Exoskeleton, Respiratory system and larval forms in crustaceans
- b. Mollusca: Torsion and detorsion in gastropod
- c. Echinodermata: Skeleton and larval forms and their evolutionary significance

Unit 5

- a. Minor non coelomate phyla: Affinities of phylum Rotifer and Acanthocephalan
- b. Minor coelomate phyla: Affinities of Chaetognaths, Onychophora, Pogonophora, Phoronida and Brachiopoda.
- c. Hemichordata: Affinities

Recommended Books:

1. A Biology of Higher Invertebrates by WD Russel-Hunter. Publisher: McMillan Co. Ltd., London.
2. Animal Parasitism by CP Read. Publisher : Prentice Hall Inc., New Jersey
3. Invertebrate structure and function by EJW Barrington. Publisher: Thomas Nelson & Sons Ltd., London
4. Invertebrates Zoology, III Edition by RD Barnes. Publisher : WB Saunders Co. Philadelphia
5. Student text book of Zoology. Vol. I, II & III by AA Sedgwick. Publisher : Central Book Depot, Allahabad
6. Text book of Zoology by TJ Parker & WA Haswell. Publisher : Macmillan Co., London
7. The Invertebrates smaller coelomate groups, Vol. V. by LH Hyman. Publisher: Mc.Graw Hill Co., New York
8. The invertebrates, Vol. 1 Protozoa through Ctenophora by LH Hyman. Publisher: McGraw Hill Co., New York
9. The Invertebrates. Vol. 2 Platyhelminthes and Rhynchocoela by LH Hyman. Publisher: McGraw Hill Co., New York
10. The Invertebrates. Vol. 8 Environmental Adaptations by LH Hyman. Publisher: McGraw Hill Co., New York

Unit 1

- a. Introduction to the cell, cell theory, ultrastructure of prokaryotic and eukaryotic cells, organization of eukaryotic cells
- b. Cell organelles – origin, structure and function of mitochondria, endoplasmic reticulum and ribosomes, Golgi complex, endosome, (lysosomes, peroxisomes, centrosome)
- c. Nucleus – Nuclear envelope, nucleolus. Chromosomes (type, structure chemical composition and functions)

Unit 2

- a. Bio membrane – Ultrastructure and functions, Transport across membrane
- b. Cytoskeleton, structure and dynamics of microtubules, action filaments (microfilaments), intermediate filaments, cilia & flagella
- c. Cell division – Mitotic & meiotic cell division, the central cell cycle control system, feedback signals. Biology of cancer

Unit 3

- a. Prokaryotic and eukaryotic genome, fine structure of DNA, DNA Replication, DNA repair
- b. Transcription & post transcriptional modifications, translation & post translational modifications, regulation of gene expression, genetic code, protein targeting, transposones

Unit 4

- a. Cell adhesion & cell junctions: cellular affinity, cell adhesion molecules (CAMs), Ca⁺⁺ dependent cell-cell adhesion, Ca⁺⁺ independent cell-cell adhesion, cadherins, selectins, integrins, cell junctions
- b. Cell communication: cell – cell signaling, cell surface receptors, second messenger system, kinase pathways, signaling from plasma membrane to nucleus (signal transduction)

Unit 5

- a. Cytometry, flow cytometry, cell fractionation; Light, Electron and Phase contrast microscopy
- b. x-ray diffraction, autoradiography, Gram staining

Recommended Books:

1. Cell & Molecular Biology by De Robertis. Publisher: EDP
2. Cell & Molecular Biology by Gerald Karp. Publisher: John Wiley
3. Cell Biology by T. D. Pollard and W. C. Earnshaw, Saunders-Elsevier Publisher: Elsevier
4. Essential of Molecular Biology by GM Malacinski. Publisher: Jones & Bartlett
5. Molecular Biology of Cell by Bruce Albert. Publisher: Taylor & Francis Inc.
6. Molecular Biology of Cell by Wilson John. Publisher: Tim Hunt
7. Molecular Biology of the Cell by Keith Roberts. Publisher: Garland Science
8. Molecular Biology of the Gene by JD Watson. Publisher: Baker Bell
9. Molecular Biology: Genes to proteins by BE Tropp. Publisher: Jones & Bartlett
10. Molecular Cell Biology by David Baltimore. Publisher: WH Freeman & Co.

SECOND SEMESTER

COURSE V

GENETICS AND BIostatISTICS

CH-2562

Unit 1

- a. Mendelian principles – Fine concept of gene, mendelism and deviations from mendelian inheritance
- b. Methods of genetic transfer – Transformation, conjugation, transduction, bacteriophages-types: structure and morphology of T₄ phage

Unit 2

- a. Chromosomes – structural and numerical alterations of chromosomes, Molecular anatomy of eukaryotic chromosomes, heterochromatin and euchromatin, giant chromosomes, polytene and lampbrush chromosomes, sex chromosomes
- b. Gene-mapping- Concept of recombination, linkage map, cytogenetic map, physical maps, molecular maps, levels of genome mapping, significance of genome mapping

Unit 3

- a. Population genetics – Gene pool and gene frequencies, Hardy-Weinberg law of genetic equilibrium and changes in gene frequencies
- b. Somatic cell genetics – cell fusion and hybrids-agents and mechanism of fusion heterokaryon
- c. Genetic disorders – chromosomal disorders, inborn errors of metabolism, tay-sachs disease, albinism, phenylketonuria, lesch-nyhan syndrome

Unit 4

- a. Biostatistics – Basic concepts. Fundamentals of measurement. Qualitative & Quantitative Variables, Collection, Classification, Tabulation & Presentation of data
- b. Mean, Median, Mode, Dispersion, Standard Deviation and their merits & demerits

Unit 5

- a. Chi-square test & ‘t’ test. Analysis of variance, Probability Distribution and normal distribution (Gaussian Distribution)
- b. Correlation Analysis – Importance of Correlation Analysis. Types and measures of Correlation. Regression Analysis. Regression of Y on X and X on Y

Recommended Books:

1. An Introduction to Modern Genetics by GH Waddington. Publisher: George Allen and Unwin Ltd., London
2. Basic Statistics by Mary B Harris. Publisher: Allyn & Becon, London Sydney
3. Genetics by MW Strickberger. Publisher: Phi Learning
4. Genetics by PK Gupta. Publisher: Rastogi Publications
5. Genetics by RJ Brooker by RJ, Mc Graw Hill Book Co., Inc., NY
6. Genetics: a conceptual approach by BA Pierce. Publisher: Mc Milan
7. Principle of Genetics by EW Sinnott, LC Dunn & T Dobzhansky. Publisher: Mc Graw Hill Book Co., Inc., NY
8. Principles of Genetics by EJ Gardner. Publisher: Wiley Eastern (Pvt.) Ltd., New Delhi
9. The Elements of Genetics by Darlington and Mathew. Publisher: Allan & Unwip Ltd., London
10. Understandable statistics: Concept & Methods by CH Brase & CP Brase. Publisher: Cengage Learning

Unit 1

- a. Basic concepts of genetic engineering, vectors, cell & tissue culture.
- b. DNA recombination expression in bacterial cell, DNA finger printing.

Unit 2

- a. Molecular techniques – DNA isolation, Electrophoresis, Microinjection, Electroporation, Hybridization technology, Cloning, PCR, DNA sequencing, FISH, GISH, Chromosome walking, microarray
- b. Application of Biotechnology

Unit 3

- a. Bioinformatics – Introduction. Components of Computer, Number System, Logic Gates, Flow Chart, Comprehension of C & its programming.
- b. Basics for operating system (Windows), MS-Word, Power Point, Introduction of Data Base Management System (DBMS)
- c. Internet – Basics for Biologists (Electronic mail, Electronic Mail Servers, Downloading files with anonymous File Transfer Protocol, Gopher, WWW, Mosaic).

Unit 4

- a. Primary & Secondary Databases. Sequence Databases (European Molecular Biology Laboratory, Gene bank).
- b. DNA Data Base of Japan (DDBJ), SWISS-PORT, Protein Information Resource, TREMBL, Protein Family/Domain Databases (Prosite, Pfam & Prints).
- c. Submitting sequence to Database and information retrieval through ENTREZ.

Unit 5

- a. Collecting & Storing Sequences, Local alignment,
- b. Global Alignment, BLAST (BLASTP, BLASTN, BLASTX, TBLASTN, TBLASTX).
- c. Phylogenetic Prediction, Gene Prediction & Analysis.

Recommended Books:

1. Bioinformatics Basics by Hooman Rashidi and Lukas K. Buehler. Publisher: CRC Press /Taylor & Francis Group
2. Bioinformatics Sequence & Genome Analysis by Davit W Moont. Publisher: Cold Spring Harbor Laboratory Press
3. DNA Cloning – A Practical approach by DM Glover & BD Hames. Publisher: Oxford University Press, UK
4. Double Helix by [Nancy Werlin](#). Publisher: Puffin Books
5. Genomes by TA Brown. Publisher: BIOS Scientific Publishers Ltd.
6. Introduction to Bioinformatics by Arthur M Lesk. Publisher: Oxford University Press
7. Molecular Biotechnology by Bernard J. Glick, Jack J. Pasternak and Cheryl L. Patten. Publisher: ASM Press, Washington DC
8. Molecular Cloning – a laboratory manual (Vol. 1-3) by J Sambrook and DW Russell. Publisher: Cold Spring Harbor Laboratory Press, NY
9. Principles of Gene Manipulation & Genomics by Primrose and Twyman. Publisher: Blackwell Publishing, Oxford & Australia
10. The Biotech Century by Jeremy Rifkin. Publisher: Penguin Publishing Group

Unit 1

- a. Digestive physiology, Digestion, absorption, energy balance, BMR.
- b. Respiratory system: Comparison of respiration in different species, anatomical considerations, transport of gases, exchange of gases, waste elimination, neural and chemical regulation of respiration.

Unit 2

- a. Blood and circulation: Blood corpuscles, hemopoieses and formed elements, plasma function, blood volume, blood volume regulation, blood groups, hemoglobin, immunity, homeostasis.
- b. Cardiovascular System: Comparative anatomy of heart structure, myogenic heart, specialized tissue, ECG-its principle and significance, cardiac cycle, heart as a pump, blood pressure, neural and chemical regulation of all above.

Unit 3

- a. Excretory system: Comparative physiology of excretion, kidney, urine formation, urine concentration, waste elimination, maturation, regulation of water balance, blood volume, blood pressure, electrolyte balance, acid-base balance.
- b. Nervous system: Neurons, action potential, gross neuroanatomy of the brain and spinal cord, central and peripheral nervous system, neural control of muscle tone and posture. Sense organs: Vision, hearing and tactile response.

Unit 4

- a. Reproductive Physiology- Menstrual cycle, ovulation, pregnancy, lactation, reproductive processes,
- b. Endocrine glands, basic mechanism of hormone action, hormones and diseases; neuroendocrine regulation.

Unit 5

- a. Thermoregulation: Comfort zone, body temperature-physical, chemical, neural regulation, acclimatization, Stress and adaptation.
- b. Type and Structure of Ig, Immune response, Vaccines, Immunoelectrophoresis, ELISA, RIA

Recommended Books:

1. BRS Physiology by Linda S. Costanzo. Publisher: Lippincott Williams and Wilkins
2. Comparative Animal Physiology by CL Prosser and FA Brown. Publisher: W.B. Sanders Co.
3. Endocrine Physiology by CR Martin. Publisher: -Oxford University Press
4. Fundamentals of Human Physiology by Stuart Ira Fox. Publisher: McGraw-Hill Education - Europe
5. Ganong's Review of Medical Physiology by Brooks, Boitano and Barman. Publisher: Mc Graw Hill
6. General & comparative Endocrinology by EJW Barrington. Publisher: Oxford, Clarendon Press
7. Guyton & Hall Textbook of Medical Physiology by V Hall & R Kurpad. Publisher: Elsevier
8. Principles of Human Physiology, Davson and Eggleton. Publisher: J & A. Churchill, London
9. Text Book of Endocrinology by RH Williams. Publisher:-W.B. Saunders
10. Textbook of Medical Physiology by John E Hall. Publisher: Elsevier - Health Sciences Division

Unit 1

- a. Structure of atoms, molecules and chemical bonds, Stabilizing interactions (Vander Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc.).
- b. Composition, structure and function of biomolecules (carbohydrates, lipids, proteins, nucleic acids and vitamins).

Unit 2

- a. Conformation of proteins (Ramachandran plot, secondary, tertiary and quaternary structure; domains; motif and folds), Stability of protein and nucleic acid structure.
- b. Conformation of nucleic acids (A-,B-,Z-,DNA), t-RNA micro-RNA).

Unit 3

- a. Principles of catalysis, enzymes and enzyme kinetics, enzyme regulation, mechanism of enzyme catalysis, isozymes.
- b. Principles of biophysical chemistry (pH, buffer, reaction kinetics, thermodynamics, colligative properties).

Unit 4

- a. Bioenergetics, oxidative phosphorylation, coupled reaction, group transfer, biological energy transducer.
- b. Catabolism of carbohydrates, lipids, amino acids and nucleotides.

Unit 5

- a. Glycogenesis, gluconeogenesis, fatty acid synthesis, cholesterol synthesis, nucleotide synthesis, synthesis of essential amino acids
- b. Chromatography (paper, thin layer, ion exchange, GLC, HPLC), spectrophotometry, ultracentrifugation, amino acid sequencing, enzyme immobilisation

Recommended Books:

1. A Biologists Guide to Principals and Techniques of Practical Biochemistry by K Wilson & KH Goulding
2. Basic Concepts in Biochemistry: A Student's Survival Guide by Hiram F. Gilbert. Publisher: McGraw Hill Professional
3. Biochemical Calculations by IH Segal. Publisher: John Wiley and Sons
4. Biochemistry by D Voet and JG Voet. Publisher: John Wiley & Sons.
5. Essentials of Molecular Biology. by George M Malacinski; David Freifelder: Publisher: Boston : Jones and Bartlett Publishers
6. Grisham. Biochemistry by RH Garret & CM Saunders. Publisher: College Publishers
7. Physical Biochemistry by DWH Freifelder. Publisher: Freeman & Co.
8. Practical Physiological Chemistry by PB Hawk. Publisher: P. Blakiston's Son & Co
9. Protein Structure and Molecular Properties by TEWH Creighton. Publisher: Freeman & Co.
10. Tools of Biochemistry by TG Cooper. Publisher : Wiley

THIRD SEMESTER**Course IX****CHORDATA****CH-3062****Unit 1**

- a. **Protochordata:** Origin & Evolution of Chordate, General Organization & Affinities of Larvacea, Thaliacea and Cephalochordate
- b. **Vertebrate Ancestry:** Introduction. Origin and Evolution of Vertebrates
- c. General and Comparative Account of Integumentary System and Endoskeleton System

Unit 2

- a. **Fish:** General and Special Characters. General Organization and Affinities of Ostracoderm & Coelacanthiformes
- b. **Amphibia:** General and Special Characters. Parental Care, Neoteny

Unit 3

Reptiles: General and Special Characters. Adaptive radiation, skull, General Organization of Chelonia

Unit 4

Birds: General and Special Characters. Flight Adaptation, Migration and Territorial Behavior

Units 5

- a. **Mammals:** General and Special Characters. Organization & Affinities of Prototheria
- b. **Mammals:** General Organization and Affinities of Marsupialia
- c. **Mammals:** Aquatic Mammals and their adaptations with reference to Cetacea

Recommended Books:

11. Analysis of vertebrate structure. IV. Ed by Milton Hilderbrand. Publisher : John Wiley and Sons Inc., NY
12. Biology of vertebrates by HE Walter & LD Sayles. Publisher: MacMillan & Co. New York
13. Chordata Morphology by Malcom Jollie. Publisher: East – West Pres Pvt. Ltd., New Delhi.
14. Comparative anatomy of vertebrates by CG Kent. Publisher: McGraw Hill, NY
15. Evolution of Chordate Structure by H.S. Smith. Publisher: Hold Rinchart and Winstoin Inc. New York.
16. Life of vertebrates by JZ Young. Publisher: The Oxford University Press, London
17. Outlines of Comparative Autonomy of Vertebrates by JS Kingsley. Publisher: Central Book Depot. Allahabad
18. Structure and Habit in Vertebrate Evolution by GS Carter. Publisher: Sedgwick and Jackson, London
19. Students Text Book of Zoology, Vol.II by AA Sedgwick. Publisher : BiblioLife
20. Vertebrate Body, IIIrd Ed. by AS Romer. Publisher: W.B. Saunders Co., Philadelphia

Unit 1

- a. **Introduction**-History background and theories of development, theory of preformation. epigenetic theory, theory of pangensis, recapitulation theory, germplasm theory, mosaic theory, regulated theory, gradient theory and theory of organizers. Regulation in sea urchin egg and *C. elegans*
- b. **Parthenogenesis**-Natural parthenogenesis, arrhenotoky, thelytoky, accidental parthenogenesis, rudimentary parthenogenesis, artificial parthenogenesis, parthenogenesis in human being, gynogenesis. androgenesis and significance of parthenogenesis
- c. **Basic concepts of development:** Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages: stem cells: genomic equivalence and the cytoplasmic determinants; imprinting mutants and transgenics in analysis of development

Unit 2

- a. **Gametes and fertilization**-Spermatogenesis, oogenesis and fertilization
- b. **Early development**- Cleavage and blastula, Pattern of cleavage, laws of cleavage, types of cleavage, effect of yolk on cleavage, physiology of cleavage, morula and blastula

Units 3

- a. **Gastrulation**-Process of gastrulation. invagination, involution, infiltration, delamination and mechanisms, accessory processes of gastrulation concrescence and convergence

Unit 4

- a. Body axis formation in *Drosophila*, *Xenopus* and Chick, metamorphosis in insects and amphibians, biochemical and morphological metamorphic changes and hormonal control of metamorphosis
- b. **Regeneration**- Regenerative potentials in different animal groups, mechanism of regeneration in amphibian and *Planaria*

Unit 5

- a. **Aging**- Introduction, consequences of aging, causes of aging, control of aging through genes and aging of cells in vitro, Carrel's immortal cells
- b. Abnormal development
 - i. **Teratology**- Causes of abnormal development therapeutic drugs as teratogens drug testing, experimental teratology
 - ii. **Neoplasia**- Etiology, growth and differentiation of tumor cells, cell growth and oncogenesis, loss of homeostatic control, growth and invasiveness of placenta

Recommended Books :

1. Biological Physics of the Developing Embryo by [Gabor Forgacs](#). Publisher : Cambridge University Press
2. Coming to Life: How Genes Drive Development by [Christiane Nusslein-Volhard](#). Publisher : Kales Press
3. Developmental Biology by [Scott F. Gilbert](#). Publisher: Sinauer Associates Inc.,U.S.
4. Developmental Biology by Scott F Gilbert. Publisher: Sinauer Associates Inc.
5. Embryology at a Glance by Samuel Webster. Publisher : John Wiley & Sons
6. First the Egg by [Laura Vaccaro Seeger](#). Publisher : Roaring Brook Press
7. From DNA to Diversity 2 ed by [Sean B. Carroll](#). Publisher: Wiley-Blackwell
8. The Triumph of the Embryo by [Lewis Wolpert](#). Publisher : Oxford University Press
9. Vertebrate Embryology by Milnes Marshall. Publisher : G. P. Putnam's sons, NY
10. Vertebrate Embryology by Richard M. Eakin. Publisher : University of California Press

Unit 1

- a. **The Environment:** Physical environment; biotic environment; biotic and abiotic interactions
- b. **Habitat:** and niche: Concept of habitat and niche: niche width and overlap fundamental and realized niche, resource partitioning; character displacement
- c. **Biogeography:** Major terrestrial biomes; theory of island biogeography, biogeographical zones of India

Unit 2

- a. **Populations Dynamic:** Characteristics of a population; population growth curves; population regulation: life history strategies (*r*- and *K*- selection): concept of metapopulation-demes and dispersal, interdemec extinctions, age structured populations
- b. **Community ecology:** Nature of communities, community structure and attributes: levels of species diversity and its measurement: edges and ecotones

Unit 3

- a. **Ecosystem ecology:** Structure and function: energy flow and biogeochemical cycle (CNP&S): primary productivity and decomposition, ecological energetic, Major Indian ecosystems:- terrestrial (forest, grassland) and aquatic (fresh water, marine, estuarine)
- b. **Ecological successions:** Types: mechanisms: changes involved in succession; concept of climax

Unit 4

- a. **Environmental Pollution ecology:** Environmental pollution; global environmental change; sustainable development
- b. Biodiversity status, monitoring and documentation; major drivers of biodiversity change; biodiversity management approaches

Unit 5

- a. **Conservation biology:** Principles of conservation, Environmental Impact Assessment (EIA), Environmental Management Plan (EMP), Environmental Auditing (EA), Indian case studies on conservation/management strategy (Project Tiger, Biosphere reserves)
- b. Remote sensing, Geoinformatics and GPS technology; NASA, IIRS, history and applicability of remote sensing in India

Recommended Books :

1. Animal Physiology: Mechanism and Adaptation by R Eckert. Publisher : W.H. Freeman and Co., New York
2. Baumgartner, population Biology by BD Elseth & KM Van. Publisher : Nostrand Co., New York
3. Ecological Applications by [Colin R. Townsend](#). Publisher : Wiley
4. Ecological Concepts by JM Cherrett. Publisher : Blackwell Science Publication, Oxford, U.K.
5. Ecological Methodology by CJ Krebs. Publisher : Harper and Row , New York
6. Ecology by CJ Krebs. Publisher : Harper and Row, New York
7. Essentials of Ecology by Colin R. Townsend, Michael Begon & John L. Harper. Publisher : Blackwell
8. Fundamentals of ecological modelling by SE Jorgensen. Publisher: Elsevier, New York.
9. Sampling Design and Statistical Methods for Environmental Biologists by RH Green. Publisher : John Wiley & Sons, NY
10. The Future of Life by Edward O. Wilson. Publisher : Abacus

Unit 1

- a. **Introduction:-** Ethology as a branch of biology, Animal psychology, classification of behavioural patterns, analysis of behaviour (ethogram), Evolution and ultimate causation: Inheritance behaviour and relationships, Genetic and environmental components in the development of behaviour.
- b. **Stereotyped behavior-** Taxes, reflexes, instinct and motivation
- c. **Individual behavioral patterns-** Conflict behavior

Unit 2

- a. **Learning and memory-** Definition, forms, development and mechanism of learning, neural basis of learning, memory in animals
- b. **Communication-** Study of communication, messages and their meanings, the forms of signals, Evolution of language

Unit 3

- a. **Environmental perceptions-** Electrical, chemical, olfactory, auditory and visual
- b. **Biological rhythms-** Circadian and circannual rhythms, biological clocks, migration, orientation and navigation

Unit 4

- a. **Neural and hormonal control of behavior-** Neural structures, general pattern of nervous system in animals, hormones in relation to different behavioral patterns
- b. **Pheromones and behavior-** Introduction, definition, classification and role of hormones behavioral patterns

Unit 5

- a. **Neuroendocrine control of behavior-** Endocrine secretions, neuro-endocrine control mechanism in some behavioral patterns. Mechano receptor, Photo receptor, Phono receptor, Chemo receptor, Equilibrium receptor
- b. **Social behavior-** Social structures, social dominance, domestication, advantages of groupings, group selection, kin selection, altruism, reciprocal altruism, inclusive fitness, foraging, social organization in insects and primates

Recommended Books :

1. An Introduction to Animal Behavior by Aubrey Manning & Marian Stamp Dawkins. Publisher : Cambridge University Press
2. Animal Behavior: A synthesis of Ethology and Comparative Psychology by Hinde. Publisher : McGraw-Hill, NY
3. Animal behavior: An evolutionary approach by J Alcock. Publisher: Sinauer Assoc., Sunderland, Mass. USA
4. Behavioral Ecology by JR Krebs and NB Davies. Publisher : Blackwell, Oxford, U.K
5. Perspectives on Animal Behavior By Judith Goodenough, Betty McGuire, Elizabeth Jakob. Publisher: [John Wiley & Sons](#).
6. Principles of Animal Communication by Bradbury & Verhrencamp. Publisher: Sinauer Assoc., Sunderland, Mass. USA
7. Sociobiology: The New Synthesis by EO Wilson. Publisher: Harvard Univ. Press, Cambridge, Mass. USA
8. The Evolution of Communication by M Hauser. Publisher : MIT Press, Cambridge, Mass. USA
9. The evolution of Parental Care by TH Clutton-Brock. Publisher: Princeton Univ. Press, Princeton, NJ, USA
10. The Mechanisms and Evolution of Behavior by JL Gould. Publisher : Norton

FOURTH SEMESTER

GROUP- A: PARASITOLOGY

COURSE XIII A BIOLOGY OF PARASITE-I (Protozoa, Trematoda and Cestoda)

Unit 1

- a. **Animal Associations & Categories:** Introduction. Basic Principles & Concepts. Symbiosis, Parasitism, Commensalisms. Types of Parasites
- b. **Parasitic Adaptation:** Evolution of Parasitism, Fate of Parasites. Adaptation to Parasitism

Unit 2

Host parasite Relationship: Host specificity: (I ectoparasite; i. Larval stages parasitic & adult free living, ii. Adult parasitic & larval stages free living, iii. Both larva & adult parasites), (Endoparasite: 1. Larval stages parasitic & adult free living: ii. Adult parasitic & larval stages free living)}- Action of Parasite upon their Host- (Effects of parasites upon invertebrates, Effects of parasites upon Vertebrates)

Unit 3

Parasitic Protozoa: Introduction, General Classification; *Trypanosoma gambiense*. *Leishmania donovani*.

Unit 4

- a. **Trematoda:** Introduction, General Classification, Types of Trematodes, Larval forms
- b. **Trematoda:** *Paragonimus westermani*
- c. **Trematoda:** Blood flukes (*Schistosoma haematobium*, *S. mansoni* & *S. japonicum*)

Unit 5

- a. **Cestoda:** Introduction, General Classification
- b. **Cestoda:** Larval forms
- c. **Cestoda:** *Echinococcus granulosus*, *Hymenolepis nana* & *H. diminuta*

Recommended Books

1. *Biochemical Adaptation in Parasites* by C Bryant & C Behm. Publisher: Chapman & Hall, NY
2. *Biology of Echinococcus and Hydatid Disease* by RCA Thompson. Publisher : George Allen & Unwin, London
3. *Biology of Eucestoda* by C Armes & PW Pappas. Publisher : Academic Press London
4. *General Parasitology* by TC Cheng. Publisher Orlando : Academic Press
5. *Handbook of Medical Protozoology* by CA Hoare. Publisher : Bailliere, Tyn dall & Cox, London
6. *Perspective in Trypanosomiasis Research* by JR Barker. Publisher: John Wiley, UK
7. *Systema Helminthum I: Digenetic Trematodes* by S Yamaguti. Publisher : Interscience Publishing Co., NY
8. *Systema Helminthum II: The Cestodes of Vertebrates* by S Yamaguti. Publisher : Interscience Publishing Co., NY
9. *Systema Helminthum IV: Monogenea & Aspidogastrea* by S Yamaguti. Publisher : Interscience Publishing Co., NY
10. *The Biology of Trematoda* by DA Erasmus. Publisher : Edward-Arnold, London
11. *The Biology of Trypanosoma & Leishmania* by DH Moleneux & RW Ashford. Publisher : Taylor & Francis, London

COURSE XIV A BIOLOGY OF PARASITE-II (Nematoda and Arthropoda)

Unit 1

- a. General, Organization, Classification & General Pattern of life cycle of Nematodes (animals, plant parasitic & Entomopathogenic), Parasitic Adaptation
- b. **Introductory:** Nematology: Introduction, General Morphology, Economic importance, Types of Plant nematodes, Host Range, Biology

Unit 2

- a. **Family-** Strongyloidea: *Strongyloides stercoralis*
- b. **Family -** Ancylostomatidae: *Ancylostoma duodenale*
- c. **Family-** Filaridae: *Wuchereria bancrofti*

Unit 3

- a. **Techniques in Nematology:** Methods of sampling (soil & plant samples), Methods of extracting nematodes from soil & plant samples, Methods of processing nematodes for observation
- b. **Plant Nematode Relationship:** Host parasite relationship, Mechanism involved in injury & histopathology of

infected tissue, Interaction with other microorganism
Brief Structure. Life Cycle. Epidemiology. Pathogenicity and Control of Root knot and Cyst Nematodes.

Unit 4

Acanthocephala - General Organization and Classification

Units 5

- a. **Medically Important Insects** : Arthropods and sectors of human diseases (mosquitoes, lice, flies and ticks); Mode of transmission of pathogens by vectors. Chemical, biological and environmental control of anthropoid vectors
- b. Insects carrying Vesication. Urtricatino and Venomenization

Recommended Books:

1. *Handbook of Parasitology* by AK Awasthi and BD Patnaik. Publisher : Dominant *Publishers & Distributors* India
2. *Veterinary Parasitology* by MA Taylor and R. L. Coop & RL Wall. Publisher : John Wiley & Sons, USA
3. *Modern Parasitology: A Textbook of Parasitology* by FEG Cox. Publisher : John Wiley & Sons, USA
4. *Arthropod Born Diseases* by Carlos Brisola Marcondes (ed.). Publisher : Springer
5. *Tylenchida: Parasites of Plants and Insects* by [Mohammad Rafiq Siddiqi](#). Publisher : CABI Publishing, UK
6. *Imm's General Textbook of Entomology* by OW Richard & RG Davies. Publisher : Chapman & Hall, London
7. *An Ecological Approach to Acanthocephalan Physiology* by DWT Crompton. Publisher : Cambridge University Press
8. *Nematode Parasites of Domestic Animals and man* by Norman D Levine. Publisher : Burgess Publishing Co., London
9. *Plant Nematology*: , 2nd Edition by Roland N Perry, Maurice Moens. Publisher: CABI
10. *Entomopathogenic Nematology* by Randy Gaugler. Publisher: CABI

COURSE XV A

PHYSIOLOGY AND BIOCHEMISTRY OF PARASITES

Unit 1

- a. **Nutrition**-Uptake and digestion in protozoa, trematoda, cestoda and nematode, Metabolism- Carbohydrate, metabolism and energy
- b. **Parasitic reproduction**- Asexual, sexual, reproduction, Synchronization of parasite with host reproduction, in vitro cultivation of parasites
- c. **Nucleic acids in parasites**- Composition, synthesis and catabolism

Unit 2

- a. **Parasitic reproduction**- Asexual, sexual, reproduction, synchronization of parasite with host reproduction, in vitro cultivation of parasites
- b. **Egg shell**-formation in helminthes, of egg shell formation, role of mehli's glands

Unit 3

Excretion- Nitrogen excretion and water and ionic regulation in parasites

Unit 4

- a. **Parasite transmission**-Mechanism of host selection, penetration and circadian rhythm.
- b. **Ecology of parasitism**-How parasite find their host, host selection and its consequences. negative interaction, problems of escape and dispersal, problem of mate finding, niche biology, population dynamics
- c. **Growth and establishment of parasite**- Hatching, establishment, site selection. migration

Unit 5

Nervous system and sense organs- Morphology of nervous system and sense organs nervous transmission and neurosecretion and behavioral coordination

Recommended Books

1. *Advances in Parasitology* by B Dawes. Publisher: Academic Press, NY
2. *Biochemical Parasitology* by G Cooms & M North. Publisher : Taylor & Francis, London
3. *Biochemistry and Molecular Biology of Parasite* by JJ Marr & M Muller. Publisher: Academic Press, NY
4. *Biochemistry of Parasites* by Th Von Brand. Publisher : Academic Press NY
5. *Chemical Physiology of Endoparasitic Animals* by Th Von Brand. Publisher : Academic press, NY

6. Digestive System Physiology by PA Sanford. Publisher : Edward-Arnold, London
7. Physiology of Gastrointestinal Tract by LR Jonston. Publisher : Raven Press NY
8. Physiology of Parasite by [Leslie H. Chappell](#). Publisher: Springer US
9. The Physiology & Biochemistry of Cestodes by JD Smyth & DP McManus. Publisher : Cambridge University Press.
10. The Physiology of Trematodes by JD Smyth & DW Halton. Publisher : Cambridge University Press.

COURSE XVIA

IMMUNOPARASITOLOGY

Unit 1

- a. **Introduction:** Early theories of immunity, historical prospective, recognition, kinds of immunity, normal immune response
- b. **An overview of immune system:** innate immunity, acquired immunity (Humoral & cell mediated immunity)
- c. **Cells of immune system:** Lymphoid cells (T-lymphocytes, B-lymphocytes), null cells, mononuclear cells, granulocytic cells, mast cells, basophils, dendritic cells. MHC molecules and compliments

Unit 2

- a. **Immune system:** Lymphoid organs of the body, thymus, bone marrow, lymph nodes spleen. GAIT. MALT. CAIT
- b. **Immunoglobulin:** Basic structure of immunoglobulin. fine structure of IgG, IgM. IgA, IgE, monoclonal antibodies, parasite antigen
- c. **Antigen antibody interactions:** Strength of antigen-antibody interactions, cross reactivity, precipitation reaction, agglutination reaction

Unit 3

Immunobiology of Protozoans: Malaria (Host response against Plasmodium infection, design of malaria vaccine). African sleeping sickness

Unit 4

Immunobiology of trematodes: General considerations, immunological problems of trematode infection, immunological response against trematode infection, Schistosomiasis, fascioliasis, immunodiagnosis of trematodes

Unit 5

- a. **Immunobiology of cestodes:** General consideration, immunity to adult cestodes, immunity to travel cestodes, immuno-diagnosis
- b. **Vaccines:** Passive immunization active immunization, designing of vaccines for active immunization, whole organism vaccines, recombinant vector vaccines. DNA vaccines synthetic vaccines

Recommended Books

1. Fundamental of Immunology by [William E. Paul](#). Publisher: Lippincott Williams & Wilkins
2. How helminthes alter immunity to infection by William Horsnell. Publisher: Springer
3. How the Immune System Works 4th Edition by L Sompayrac. Publisher : Willey Blackwell.
4. Immunoparasitology by Phillip Scott. Publisher: Blackwell Munksgaard
5. Immunity to Parasites: How Animal Controls Infections by D Wakelin Publisher : Edward Arnold, London
6. Immunoparasitology by André R.G. Capron. Publisher: Saunders, Philadelphia
7. In vitro cultivation of Parasitic Helminths by JD Smyth. Publisher : CRC Press, Boca Raton, USA
8. Introductory Immunology by [Jeffrey K. Actor](#). Publisher: Academic Press
9. Malaria Immunology by P Perlmann & M Troye-Blomberg. Publisher: Karger
10. Parasite Antigens in Protection, Diagnosis and Escape by R.M.E. Parkhouse. Publisher: Springer Science & Business Media

GROUP A: PARASITOLOGY

H-862 P

Course XIII A: Biology of Parasites – I (Protozoa, Trematoda and Cestoda)- H-4062

Course XIV A: Biology of Parasite – II (Nematoda and Arthropoda)- H-4063

Course XV A: Physiology and Biochemistry of Parasites- H-4064

Course XVI A: Immunoparasitology- H-4065

Practical based on above

Practical class/field visit record file evidences of the following to be maintained by the students and submitted at the time of practical examination for evaluation by the examiners.

1. Biology of Parasites – I (Protozoa, Trematoda and Cestoda)
2. Biology of Parasite – II (Nematoda and Arthropoda)
3. Physiology and Biochemistry of Parasites
4. Immunoparasitology
5. Field visit report and collection etc.

Marks Distribution

Duration: 5 hrs

M.M.: 100 Marks

- | | | | |
|-----------|---|---------|-----------------|
| 1. | Host examination (01) | | 15 Marks |
| 2. | Lymphoid organs of host (01) | | 10 Marks |
| 3. | Mounting(01) | | 05 Marks |
| 4. | Numerical exercise on Population Dynamics (01) | | 05 Marks |
| 5. | Spotting (1-10) | | 20 Marks |
| | <u>Specimens: (04)</u> | | |
| | <u>Prepared Slides: (02)</u> | | |
| 6. | Microtomy- Histological study | | 10 Marks |
| | a. Sectioning and stretching of tissues (02) | 5 Marks | |
| | b. Staining of pre-stretched tissue (02) | 5 Marks | |
| 7. | Field Visit/Collection/Ornamental fish management | | 15Marks |
| | a. Visit report of laboratory /institute | 5 Marks | |
| | b. Collection & preservation of parasites | 5 Marks | |
| | c. Parasitology museum/laboratory setting and maintenance | 5 Marks | |
| 8. | Viva-voce | | 10 Marks |
| 9. | Practical Class Record | | 10 Marks |

FOURTH SEMESTER
GROUP-B: FISH AND FISHERIES

COURSE XIIB GENERAL FISH BIOLOGY

UNIT I:

- a. Classification of Fishes with special emphasis on Berg's Scheme.
- b. Origin, Affinities, General characters and important examples of Cyclostomata, Elasmobranchii, Bradyodonti, Actinopterygii, Crossopterygii and Dipnoi.
- c. Geographical distribution of fishes, Freshwater and marine fish fauna of India.
- d. Outline classification of local Ichthyofauna

UNIT II:

- a. Migration in Fishes- Types of migration with examples, courses of migration, Homing, territorial behavior and schooling
- b. Locomotion in fishes- Locomotory muscles, red and white muscle types, organization of myonemes, types of swimming and hydromechanics of propulsion, significance of swim bladder in swimming and buoyancy

UNIT III:

- a. Body form and its diversity – Types of fins, origin of unpaired and paired fins, modifications and functions of fins
- b. Integument and exoskeleton – Types and modifications of Scales

UNIT IV:

- a. Endoskeleton and musculature – Vertebral column, Types of Jaw suspension in fishes, Structure, arrangement and homology of Weberian ossicles, lateral musculature and respiratory musculature
- b. Coloration- Chromatophores, types of chromatophores. Morphological, physiological and biological significance of coloration in fishes

UNIT V:

- a. Adaptation in Fishes – Deep sea adaptations, cave adaptations, hill stream fishes, freezing avoidance, symbiosis and Parasitism.
- b. Fish venoms – Poisonous Fishes, venom apparatus, Pharmacology & Toxicology of fish venoms

Recommended Books

1. Leo.S.Berg Classification of fishes (fossilized & Recent)
2. C.B.LShrivastava, Fish Biology.
3. K.S.Mishra: An aid to classification of Fishes.
4. B.Qurashi: Identification of fishes.
5. A.J.K.Mainan: Identification of fishes.

COURSE XIVB MORPHOLOGY AND PHYSIOLOGY OF FISHES H-4067

UNIT I:

- a. Food, digestion and nutrition – Food and Feeding habits of different groups of fishes. Methods of determining food and feeding habits, Analysis of Gut content, alimentary canal in fishes, physiology of digestion
- b. Blood vascular system – Heart and circulatory vessels, Blood and blood forming organs, Body temperature

UNIT II:

- a. Respiratory system- Structure and function of gills, morphology of the gill epithelia, gaseous exchange at the gill surface, fish blood as gas carrier, water and ion transport across the gills.
- b. Air Breathing Fishes – causes, adaptation for air breathing, accessory respiratory organs, morphology and function of Pseudo branch

UNIT III:

- a. Excretion- Structure and function of kidney, Osmoregulatory and excretory organs, excretory products, endocrine control of excretion and Osmoregulation
- b. Nervous System & Sense Organs: Brain and Spinal Cord, Cranial and Autonomic nervous system, supporting tissues of CNS and sense organs in fishes

- c. Reproduction & development – Types of reproduction, Reproductive system, reproductive cycles and breeding season and spawning, Parental care and development

UNIT IV:

Endocrine Glands in Fishes – Pituitary, Thyroid, Gonads, adrenal, Corpuscles of stannous, Pancreas, Ultimobranchial gland, Cells and tissues of fish immune system

UNIT V:

- a. Electric organs in fishes – Types of electric fishes, origin, structure and function of electric organs. Location of electric organs, evolution of electroreceptors and electric organs
- b. Luminescent organs in Fishes – Location, structure and control of luminescent organs, physiological and biological significance of luminescence

Recommended Books

COURSE XV B

FISH CULTURE AND LIMNOLOGY

H-4068

UNIT I:

- a. Introduction and history of fishery science in India, Inland, Marine, capture and culture fisheries, Indian fisheries. World fisheries
- b. Cultivation of fish – Freshwater fish culture in India. Types of culture systems. Bionomics and Culture of Indian major carps (Rohu, *Catla*, Mrigal), Exotic carps (common carp, Grass carp, Silver carp) Tilapia. Culture of air breathing fishes (*Heteropneustes*, *Clarias*, *Channa* and *Anabas*)

UNIT II:

- a. Riverine Fisheries – Ecology and fisheries of the major river systems of India, Production and Potential of Riverine Fisheries.
- b. Reservoir Fisheries – Ecology of lakes and reservoirs, development, exploitation and management of reservoir fisheries

UNIT III:

- a. Cold water Fisheries – Ecology of high altitude streams, lakes and reservoirs, important cold water fisheries, present status and scope of development in India
- b. Marine capture Fisheries – Capture fisheries of Sardines, Mackerel: Bombay duck, ribbon fish, Pomfret, Tuna and Sole. Culture of pearl Oyster and Bivalves. Present status and potential of mariculture in India
- c. Crustacean Fisheries – Prawn Fisheries, lobster fisheries and crab fisheries, development and exploitation of Crustacean fishery resources

UNIT IV:

- a. Ecology and Productivity – of a freshwater, pond lake and river, Biota, algal blooms, benthos, macrovegetation, nutrient cycle and productivity
- b. Pollution of aquatic ecosystems, effects of water pollution on fishes
- c. Methods of Fishing – Fishing effort, crafts and gears used in India for fishing, Recent advances in fishing methods – electrical fishing, light fishing, fish finders (echosounder and sonar) and their uses

UNIT V:

- a. Limnology - History and scope of Limnology – past, present and future
- b. Distribution of inland waters and their origin; Morphology and morphometry of inland waters
- c. Light conditions, factors influencing light penetration, color, transparency and turbidity and its causes
- d. Thermal properties; annual temperature cycle in inland waters. Thermal stratification, its terminologies and modifications; thermal classification of inland waters and heat budget

Recommended Books

1. Francis day Vol I & II Fishes of India.
2. Gopalji Shrivastava: Indian of fishes of U.P. & Bihar.
3. W.D.Rusell: Aquatic Productivity.

COURSE XV B

APPLIED FISHERIES

H-4069

UNIT I:

- a. Pisciculture – Objectives in South east Asia & India
- b. Fish Breeding and Hatchery technology – Induced Breeding and its significance in Aquaculture. Methods of Induced breeding.
- c. Types of Hatchery and their operation
- d. Types of ponds and their management

UNIT II:

- a. Significance of age and growth studies; methods of age determination; types and methods of determining fish growth
- b. Length weight relationship and condition factor
- c. Fecundity: determination of absolute and relative fecundity, variations in egg production potential
- d. Characteristics of Fish eggs
- e. Marking and tagging and its significance, information derived, types of tags and materials used for preparation, evolution of performance of marks/ tags

UNIT III:

- a. Fish Pathology: Symptoms, etiology, Prophylaxis and treatment of common diseases of cultivable fishes. Viral, Bacterial Fungal and algal infections and their control: epizootic ulcerative syndrome. Disease caused by protozoan and helminth parasites and methods of their control
- b. Immunostimulants in Aquafarming
- c. Fish Processing Technology – Methods of Preservation of Fish and Prawn (Chilling, Freezing, Quick freezing, Salting drying, freeze drying, smoking, canning. Rigor mortis in Fish, Fish spoilage – bacterial & chemical
- d. Quality Assurance – Value added products (Fish fingers, fish flakes, soup powder) By products (Fish meal, Fish oil, surgical sutures.)

UNIT IV:

- a. Fish Genetics and Biotechnology: Genetic improvement (Inbreeding and cross breeding), Chromosome manipulation, Transgenic fish and shell fish. Cryopreservation; Fish Genomics/ Nutrigenomics of some important Indian aquaculture species.
- b. Fish Cell Lines/ Outlines of whole genome of Tor tor, Labeo rohita and Clarius batrachus.
- c. Fish Transgenics for therapeutic, ornamental and marine extremophiles.
- d. Fish Nutrition and Feed technology: feed formulation strategies and methods, types of feed and their ingredients. Formulation of feed for larvae, fry, fingerlings, adults and brood stock; Formulation of nutritionally balanced and cost effective diets
- e. Ornamental fishes: Types of ornamental fishes
- f. Types of Aquarium and their accessories, Aquarium maintenance

UNIT V:

- a. Fish Transport and marketing: Handling and transportation of freshwater fish whole sale and retail markets. Fishery Cooperatives
- b. Fishery education and management: Objectives and function of Central Institute of Fisheries education (CIFE, Mumbai), Central Inland Captured Fisheries Research Institute (CICFRI), Central Institute Of Freshwater Aquaculture (CIFA), Central Marine Fisheries Research Institute (CMFRI, Kochi)
- c. EEZ, Indian Antarctic Expedition and relevance to Fishing
- d. Fisheries legislation for resource management

Recommended Books

1. The Perfect Aquarium: Complete Guide to Setting Up and Maintaining an Aquarium
2. Leo.S.Berg Classification of fishes (fossilized & Recent)
3. Francis day Vol I & II Fishes of India.
4. C.B.LShrivastava, Fish Biology.
5. K.S.Mishra: An aid to classification of Fishes.
6. Gopalji Shrivastava: Indian of fishes of U.P. & Bihar.
7. B.Qurashi: Identification of fishes.
8. W.D.Rusell: Aquatic Productivity.

9. A.J.K.Mainan: Identification of fishes.
10. K.F.Lagler: Ichthyology.
11. N.R.Rao: An Introduction of fishes.
12. J.F.Norman: An History of fishes.
13. S.S.Khanna: An Introduction of fishes.
14. R.L.Rath: Fresh water Aquaculture.
15. H.R.Singh: Advance in fish Biodiversity.
16. H.D.Kumar: Sustainability & Management of Aquaculture & Fisheries.
17. Arugun & Natarajan: Fresh water Aquaculture.
18. Arugun & Natarajan: Santanu-Costal Aquaculture.
19. R.Sanatham: A manual of fresh water Aquaculture.

GROUP B: FISH & FISHERIES

H-862 P

Practical based on above

I. General Fish Biology

- a. Collection and identification of local fish fauna
- b. Osteology of a fresh water teleost
- c. Mounting of different types of Scales, Scale showing Lateral Line, chromatophores
- d. Museum specimens & prepared slides of fishes having special characters, economically important food fishes, aquarium Fishes and larvivores Fishes etc.
- e. Study of adaptive radiation in fishes of common/different habitat
- f. Visit to fish biology laboratory/institute

II. Morphology and Physiology of fishes

i. Major Dissection

Cranial Nerves of *Wallago/ Clarias* and *Labeo/ Catla*

ii.Minor Dissection

- a. Biometry and General anatomy of any local food fish
- b. Accessory respiratory Organs of *Clarias* or *Heteropneustes*
- c. Weberian ossicle of *Wallago*
- iii. Preparation and observation of fish Blood film for different blood constituents
- iv. Calculation of Gonado-somatic index and Gastro-somatic index
- v. Screening of gut for food content
- vi. Estimation of Muscle Protein, Serum Protein / glucose / Lipids
- vii. Estimation of hemoglobin in fish blood / Counting of erythrocytes/ RBC in fish blood
- viii. Differential count of corpuscles
- ix. Location of electric and luminescent organs in fishes
- x. Location of endocrine glands in fishes
- xi. Identification of stages of life cycle of fishes

III. Fish Culture and Limnology

Analysis of Different parameters of soil and water and equipment used for analysis; Identification of planktons in different samples of water; Experimental culture of Phyto - and zooplanktons; Different crafts and gears used in capture fisheries; Sampling equipment of water, plankton and benthic organisms

IV. Applied Fisheries

Aquarium fabrication, setting and maintenance of ornamental fishes in it on different diet formulations; Determination of fish fecundity, ova diameter and maturity stages of fishes; Study of length –weight relationship and condition factor of fish; Screening of gut and other organs for protozoan and helminth parasites; Determination of age with the help of scales
Survey of fish resources at coastal regions/fresh water system/fish market/fish landing centers/hatcheries/fish farms/culture ponds

Practical class/field visit record file evidences of the following to be maintained by the students and submitted at the time of practical examination for evaluation by the examiners.

1. General Fish Biology
2. Morphology and Physiology of fishes

3. Fish Culture and Limnology
4. Applied Fisheries
5. Field visit report and collection etc.

Marks Distribution

Duration: 5 hrs

M.M.: 100 Marks

- | | |
|---|-----------------|
| 1. Major Dissection (01) | 10 Marks |
| 2. Minor Dissection (01) | 05 Marks |
| 3. Mounting (01) | 05 Marks |
| 4. Water/Soil analysis (01) | 05 Marks |
| 5. Spotting (1-10) | 20 Marks |
| <u>Specimens: (04)</u> | |
| <u>Prepared Slides: (02)</u> | |
| <u>Bones (02)</u> | |
| <u>Fishing Nets and Gears: Through models (01)</u> | |
| <u>Identification Of Fish Parasites-</u> Through prepared slides (Nematodes/ Cestodes/ Monogenea/ Acanthocephala) (01) | |
| 6. Identification of Local Ichthyofauna (02) (1 Cyprinid & 1 Silurid) | 05 Marks |
| 7. Fish Physiology/ Biochemistry (01) | 05 Marks |
| 8. Microtomy- Histological study of tissues Intestine/ Liver/ Kidney/ Gills etc. | 10 Marks |
| a. Sectioning and stretching of tissues (02) | 5 Marks |
| b. Staining of pre-stretched tissue (02) | 5 Marks |
| 9. Field Visit/Collection/Ornamental fish management | 15Marks |
| a. Visit report of effluent treatment plant/aquafarm/hatchery/ laboratory /institute (01) | 5 Marks |
| b. Collection and submission of local fish fauna (specimens/amateur photographs & videos etc.)/endoskeleton of fish/scientific news reports/ Microtomy slides (stained/stretched) and blocks (Raw/trimmed) etc. | 5 Marks |
| c. Aquarium fabrication, setting and maintenance | 5 Marks |
| 10. Viva-voce | 10 Marks |
| 11. Practical Class Record | 10 Marks |

Book ISBN: 9780123948151; eBook ISBN: 9780123964656) – Main Textbook

8. Hormones (2014, 3rd Edition) by Anthony W. Norman & Helen L. Henry, Academic Press (Print Book ISBN: 9780123694447; eBook ISBN: 9780080919065

Course XV C: Invertebrate and Vertebrate Endocrinology CH- 4572

Unit 1: General idea of invertebrate Neuroendocrine systems: Insects, Crustaceans and Mollusca. Juvenile hormone.

Unit 2: Structure and function of endocrine glands-I: thyroid and parathyroid glands- T₃, T₄ and catecholamines. Adrenal gland- glucocorticoids, mineralocorticoids adrenaline noradrenaline.

Unit 3: Structure and function of endocrine glands-II: Structure and function of pancreas- Insulin, Glucagon, leptin, Ghrelin, somatostatin. Diabetes Mellitus, Structure and function of pineal and melatonin hormone.

Unit 4: Hormone hyper/ hypo secretions and related disorders: thyrotoxicosis, goiter, hypothyroidism, Graves' disease, Hashimoto's thyroiditis Hormone based effects of stress on homeostatic systems. obesity, sports “doping”.

Unit 5: Principles and application of techniques in endocrinology: Spectrometry, ELISA, Electrophysiology, immunocytochemistry, *in situ* hybridization, autoradiography.

Suggested reading:

1. Endocrinology, 6th ed., Mac E. Hadley, Prentice Hall, ISBN: 0131876066
2. Vertebrate Endocrinology, 4rd ed., David O. Norris, Academic Press, ISBN 0-12-088768-1
3. Human Anatomy & Physiology, 8th ed., Elaine N. Marieb, Benjamin Cummings, ISBN: 0321694155

Course XVI C: Reproductive Physiology CH- 4573

Unit 1: Comparative anatomy of male reproductive organs: Structure, and function of non-mammalian and mammalian testes, Spermatogenesis, maturation of sperm

Unit 2: Comparative anatomy of female reproductive organs: Structure, and function of non-mammalian and mammalian ovary, Oogenesis, ovulation, graafian follicle, Role of progesterone, Prostaglandins; luteolysis,

Unit 3: Reproductive cycles: Estrous cycles, menstrual cycles and their hormonal regulation, Puberty, menopause

Unit 4: Fertilization & Implantation: Fertilization, Implantation, Placenta, Types of placenta; parturition, lactation, Gestation; Contraception. methods of assisted fertility, cloning and sperm banks, family planning devices.

Unit 5: Mammary glands: Physiology of nursing; milk and its production; endocrinology of nursing hormonal effects on maternal-infant bonding; effects of nursing on spacing of births.

Suggested readings:

1. Ganong: Review of Medical Physiology (22nd Ed 2005, Lang Medical Publications)
2. Guyton and Hall: Text Book of Medical Physiology (11th Ed 2006, W.B. Saunders)
3. General & Comparative Physiology 2nd Edition; William S. Hoar
4. A Text Book of Animal Physiology; R. Nagabhushnam
5. Principle of Animal Physiology; D. Moyes
6. General & comparative endocrinology; E.J.W. Barrington
7. An introduction to invertebrates endocrinology; A S Tombes
8. Comparative endocrinology; U.S. Von Euler

PRACTICAL

1. Dissect and display of Endocrine glands rat (virtual)
2. Study of the permanent slides of all the endocrine glands
3. Compensatory ovarian/ adrenal hypertrophy *in vivo* bioassay in laboratory bred rat
4. Demonstration of Castration/ ovariectomy in laboratory bred rat
5. Estimation of plasma level of any hormone using ELISA
6. Designing of primers of any hormone

FOURTH SEMESTER
GROUP-D CYTOLOGY AND CYTOGENETICS

COURSE XIII D ADVANCED CELL BIOLOGY H-4074

Unit I Cell organization

- a. Hierarchy in organization of cells
- b. Cellular organization of prokaryotes, Gram +ve and Gram –ve cell wall
- c. Cell Membrane in prokaryotes- structure, composition, transport, quorum sensing and its importance

Unit II

- a. Cytology of microflora of thermophilic, thermoacidophile, halophilic and psychrophilic bacteria, bacteriorhodopsin, signal transduction, prebiotics
- b. Cellular organization of eukaryotes, chemistry of Bio membrane, transmembrane proteins, channel protein, pump and receptors

Unit III

- a. Electron transport system, oxidative phosphorylation, endosome, peroxisome, vesicular transport
- b. Cell-cell interaction, cell adhesion (Ca⁺⁺ independent cell-cell adhesion, Cadherins, selectin and integrin etc.)
- c. Cell junctions, cell-cell communication and its importance, Circadian rhythms in cells, i.e. from human supra chiasmatic nucleus and peripheral oscillators and cyanobacteria.

Unit IV

- a. Cell signaling, receptor, second messenger system, signaling from plasma membrane to nucleus, receptor tyrosine kinase
- b. Ageing cells, necrosis and apoptosis (Programmed cell death), cancer biology

Unit V

- a. Principles, working and applications of flow cytometry; ultracentrifugation; Light, SEM, TEM, Phase contrast & fluorescence microscopy and Fluorescence Recovery After Photobleaching (**FRAP**)
- b. Sterilization and Gram staining

Recommended Books

1. Cell and Molecular biology De Robertis and De Robertis: Saunders College Publ
2. Cell and molecular biology, Karp Gerald
3. Cell and molecular biology, Thorpe
4. Molecular Cell Biology, Lodish et al. : Scientific American Books
5. Principles of biochemistry, Lehninger
6. The Cell, Alberts et al.: Garland Publishing, USA

COURSE XVI D CHROMOSOMES & GENOMIC ORGANIZATION H-4075

Unit I

- a. History and scope of chromosome study, Chromosomes (Ultrastructure: Nucleosome and solenoid model, nuclear scaffold).
- b. Molecular structure of telomeres (structure, synthesis and significance of telomere length) kinetochore and centromere (yeast centromere, alpha-satellite DNA, other centromere sequences).
- c. Molecular structure of euchromatin and heterochromatin, Giant Chromosome : Polytene & Lamp brush chromosome, somatic cell genetics

Unit II

- a. Genic balance theory of sex determination (*Drosophila*, *Lymantria* and *Caenorhabditis elegans*), X/A ratio, multiple numerator elements, sex linked master control genes and autosomal regulatory genes.
- b. Sex determination and sex differentiation in mammals (including human),
- c. Dosage compensation in organism with heterogametic males, Genetic imprinting

Unit III

- a. Prokaryotic genomic organization, plasmid, phage genome, chromosomal organization of genes and non-coding DNA, mobile DNA
- b. Eukaryotic genomic organization, molecular structure of a eukaryotic gene
- c. Reassociation kinetics and “Cot” curves (chemical complexity and kinetic complexity); Sat-DNA

Unit IV

- a. Concept of totipotency vis-a-genome constancy.
- b. Amphibians: Serial nuclear transplants
- c. Development significance of fluctuations in genomic DNA content (rDNA amplification)

Unit V

- a. Automated Karyotyping
- b. Chromosome banding and chromosome painting
- c. FISH, GISH

Recommended Books

1. Molecular Cell Biology, Lodish et al. Scientific American Books
2. Cell and Molecular biology De Robertis and De Robertis: Saunders College Publ
3. Molecular Biology of cell Alberts et al.: Garland Publishing, USA
4. Genetics, Strickberger : Macmillan
5. The Science of Genetics, Atherly et al.:Saunders College Publ. NY
6. Principles of Genetics, Snustad, D.P. and M. Simmons: John Wiley & Sons, NY
7. Genetics, Brooker, R.J.:Benjamin/Cummings USA
8. Genetics, Gupta P.K.: Rastogi Publ., Meerut
9. Genetics, Farnsworth: Harper & Row
10. Principles of Genetics, Gardner, E.J., M.J., Simmons & D.P. Snustad John Willey and Sons. Inc. NY

COURSE XV D GENOMIC ANALYSIS AND IMMUNOGENETICS H-4076

Unit I

- a. C-value paradox, detailed account of various models of prokaryotic genomes, viral genome and eukaryotic genomes. Organization genes in organelle genomes.
- b. Molecular analysis of genomic DNA in yeast or any other eukaryote.
- c. Transposable elements in prokaryotes and eukaryotes. Role of transposable elements in genetic regulation.
- d. Genome analysis – Microbial genomes. *Drosophila*, *yeast*.

Unit II

- a. Genetic screening, prenatal diagnosis and genetic counseling
- b. Prenatal screening methods; fetal screening: new born screening; carrier screening; pre-implantation screening.
- c. History and methods of genetic counseling; need to seek genetic counseling, ethical and legal aspects.

Unit III

- a. Choice of mapping population : Simple sequence repeat loci
- b. Molecular markers in genome analysis: RFLP, RAPD and AFLP analysis.
- c. Applications of Molecular markers in forensics, disease diagnosis, genetic counseling, germplasm maintenance and taxonomy.

Unit IV

- a. Immunoglobulin gene structure
- b. Multigene organization of Ig genes
- c. Mechanisms of DNA rearrangements and generation of antibody diversity
- d. DNA rearrangements and expression of T-cell receptors, DNA vaccines

Unit V

- a. DNA & RNA isolation, PCR, DNA sequencing, Southern and northern blotting for genome analysis
- b. Chromosome walking, microarray, DNA chips, Cloning
- c. Taq polymerase production by *Thermus aquaticus*

Recommended Books

1. Molecular Cell Biology. J. Daenell, H. Lodish and D. Baltimore, Scientific American Book, Inc., USA
2. Molecular Biology of the Cell. B. Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts, and J.D. Watson, Garland Publishing, Inc., New York.
3. Genes, VI. Lewin, B.Oxford University Press, Oxford, New York, Tokyo.
4. Biotechnology, BD Singh
5. Biotechnology, PK Gupta
6. Recombinant DNA technology, Watson

COURSE XVI D HUMAN & MICROBIAL CYTOGENETICS AND MOLECULAR BIOLOGY H-4077

Unit I

- a. Human genetics
- b. Heterokaryon-selecting hybrids and chromosome segregation
- c. Numerical and structural abnormalities of human chromosomes – implications, syndromes and its consequences

Unit II

- a. Bacterial transformation, transduction, conjugation, bacterial chromosomes.
- b. Bacteriophage- types, structure and morphology of T4phage, morphogenesis.
- c. Cytogenetic effects of ionizing and non-ionizing radiation.

Unit III

- a. RNA & DNA polymorphisms, DNA replication in prokaryotic and eukaryotic cells, DNA damage and repair
- b. Transcription in prokaryotic and eukaryotic cells, RNA processing (capping, polyadenylation, splicing)
- c. The translation machinery in prokaryotes and eukaryotes, Genetic code

Unit IV

- a. Regulation of gene expression in prokaryotes and eukaryotes
- b. Post translational modification in proteins (folding, glycosylation), protein targeting (nucleus, plasma membrane, rough endoplasmic reticulum), genetics of cell cycle and cyclin dependent kinases, molecular basis of cellular check points
- c. Mode of action and structure of Diphtheria & Cholera toxin, transposones
- d. Molecular basis of neoplasia (cancer) Oncogenes and tumour suppressor genes.

Unit V

- a. x-ray diffraction, autoradiography, NMR, AA spectrophotometry
- b. Sterilization, media preparation, SDS PAGE, Gel documentation, laminar air flow hood
- c. Setting, maintenance and precautions in cytology and cytogenetics laboratory

Recommended Books

1. Cell and molecular biology: Albert
2. Cell and molecular biology: Gerald Karp
3. Cell and molecular biology: PK Gupta
4. Cell Biology – Townsend
5. Cell physiology- Grise
6. Genes VIII: Benjamin Levi's
7. Microbiology : Prescott
8. Molecular cell biology: H. Lodish, J. Daenell, and D. Baltimore
9. Principles of Microbiology: Ronald M. Atlas and Lawrence Parks

GROUP D: CYTOLOGY and CYTOGENETICS H-862 P

Practical based on above

Marks Distribution

Duration: 5 hrs

M.M.: 100 Marks

- | | |
|---|-----------------|
| 1. Enumeration of the number of RBC/WBC by Hemocytometer | 10 Marks |
| Estimation of % hemoglobin by Haemometer | |
| 2. Numerical Problems from Genetics and Biostatistics (01+01) | 10 Marks |
| 3. Exercise from Bioinformatics (01) | 05 Marks |
| 4. Biochemical tests for proteins, Carbohydrates, Lipids and Enzymes | 10 Marks |
| 5. ECG, Electrophoresis of proteins, chromatography | 05 Marks |
| 6. Spotting (1-10) | 20 Marks |

Equipment and Apparatus: (04) Molecular models

- | | |
|--|----------------|
| 9 Field Visit/Collection/Laboratory management etc. | 15Marks |
| a. Visit report of field/laboratory /institute (01) | 5 Marks |

b. Collection of local fauna (Specimens, photographs, videos etc.)/ 5 Marks

c. Laboratory setting and maintenance 5 Marks

10. Viva 10 Marks

11. Practical Class Record 10 Marks

Practical class/field visit record file evidences of the following to be maintained by the students and submitted at the time of practical examination for evaluation by the examiners

1. Advanced cell biology
2. Chromosome and genomic organization
3. Genomic analysis and immunogenetics
4. Human and Microbial cytogenetics and molecular biology
5. Field visit report and collection etc.

FOURTH SEMESTER
GROUP E- ENTOMOLOGY

COURSE XIII E

GENERAL INSECT BIOLOGY

H-4078

UNIT I:

- a. General Principles of insect taxonomy, General characters and classification of insects up to families.
- b. Affinities of different orders of Apterygota and Pterygota with special reference to Odonata, Orthoptera, Blattaria, Mantodean, Isoptera, Thysanoptera, Hemiptera, Coleoptera, Hymenoptera, Lepidoptera and Diptera

UNIT II:

- a. Origin, Evolution and Distribution of insects in time and space
- b. Ecological Dynamics, Effect of biotic and abiotic factors on abundance and diversity of insects, dispersal and migration in insects.
- c. Phylogenetic analysis; Universal tree of life; fossil record of insects; evolution and speciation; genomes and phylogenies of insects

UNIT III:

- a. Methods of insect collection and their preservation. Maintenance of insect museum, Insect rearing

UNIT IV:

- a. Structure and function of insect integument, cuticular outgrowths, Coloration and modifications of integument, Molting

UNIT V:

- a. Head- Origin, structure and modification; types of mouthparts and antennae, cranial structure: tentorium and neck sclerites, Compound eye
- b. Thorax- Areas and sutures of tergum, sternum and pleuron, pterothorax; Wings: structure and modifications, venation; Legs: structure and modifications, Abdomen-Segmentation and appendages

Recommended Books

1. Blackwelder RE. 1967. *Taxonomy - A Text and Reference Book*. John Wiley & Sons, New York.
2. Chapman RF. 1998. *The Insects: Structure and Function*. Cambridge Univ. Press, Cambridge.
3. David BV & Ananthkrishnan TN. 2004. *General and Applied Entomology*. Tata-McGraw Hill, New Delhi.
4. Duntson PA. 2004. *The Insects: Structure, Function and Biodiversity*. Kalyani Publ., New Delhi.
5. Kapoor VC. 1983. *Theory and Practice in Animal Taxonomy*. Oxford & IBH, New Delhi.
6. Mayr E. 1971. *Principles of Systematic Zoology*. Tata McGraw-Hill, New Delhi.
7. Richards OW & Davies RG. 1977. *Imm's General Text Book of Entomology*. 10th Ed. Chapman & Hall, London.
8. Ross HH. 1974. *Biological Systematics*. Addison Wesley Publ. Co.
9. Snodgrass RE. 1993. *Principles of Insect Morphology*. Cornell Univ. Press, Ithaca.
10. Triplehorn CA & Johnson NF. 1998. *Borror and DeLong's Introduction to the Study of Insects*.

COURSE XIV E

ANATOMY AND PHYSIOLOGY OF INSECTS

H-4079

UNIT I:

- a. Anatomy and Physiology of Digestive system, Respiratory system, Circulatory system and Excretory system, Nervous system and Sense organs

UNIT II:

- a. Musculature, adaptations in insects, Wing coupling apparatus and mechanism of flight
Bioluminescence and Sound Production.

UNIT III:

- a. Exocrine Glands- structure and function.
- b. Endocrine Glands and their hormones.
- c. Neural control of Endocrine system in insects.
- d. Pheromones and their glands.

UNIT IV:

- a. Male and Female Reproductive systems and their endocrine control. Genitalia and their modifications, Vitellogenesis and hermaphroditism.

- b. Gametogenesis, Insemination, Fertilization. Early Embryonic and Embryonic Development. Post- Embryonic Development- Growth, Metamorphosis and their neural & hormonal control.
- c. Sex determination; dosage compensation; genetic control programs

UNIT V:

- a. Insect nutrition- role of vitamins, proteins, amino acids, carbohydrates, lipids, minerals and other food constituents;
- b. Extra and intracellular micro- organisms and their role in physiology; artificial diets

Recommended Books

1. Chapman RF. 1998. Insects: Structure and Function. ELBS Ed., London
2. Duntson PA. 2004. The Insects: Structure, Function and Biodiversity. Kalyani Publ., New Delhi
3. Kerkut GA & Gilbert LI. 1985. Comprehensive Insect Physiology, Biochemistry and Pharmacology. Vols. I-XIII. Pergamon Press, New York
4. Muraleedharan K. 1997. Recent Advances in Insect Endocrinology. Assoc. for Advancement of Entomology, Trivandrum, Kerala.
5. Patnaik BD. 2002. Physiology of Insects. Dominant, New Delhi
6. Richards OW & Davies RG. 1977. Imm's General Text Book of Entomology. 10 th Ed. Vol. 1. Structure, Physiology and Development. Chapman & Hall, New York
7. Richards OW & Davies RG. 1977. Imm's General Text Book of Entomology. 10h Ed. Chapman & Hall, London
8. Saxena RC & Srivastava RC. 2007. Entomology at a Glance. Agrotech Publ. Academy, Jodhpur
9. Triplehorn CA & Johnson NF. 1998. Borror and DeLong's Introduction to the Study of Insects
10. Wigglesworth VB. 1984. Insect Physiology. 8th Ed. Chapman & Hall, New York

COURSE XV E

APPLIED ENTOMOLOGY- I

H-4080

UNIT I:

- a. Insect Population, Population change and factors affecting insect population. Symbiosis in relation to parasitism, commensalism and mutualism. Social adaptations in insects. Locust Phase theory- Monitoring and control measures.

UNIT II:

- a. **Insect - plant Interaction**-Theory of co-evolution. Phytophagous insects and host plant selection. Tritrophic interactions. Allelochemicals mediated interactions. Chemically mediated interactions.
- b. Defense mechanisms of plants against insects. Responses of insects to chemical defense. Establishment and adaptation of insect population on a plant. Insects as vectors of plant diseases.

UNIT III:

- a. Systematic position, identification, distribution, host range, bionomics, nature and extent of damage, seasonal abundance and management of insect- pests of cereals (wheat, paddy, maize), fruits (mango, guava, litchi, papaya), and vegetables (brinjal, mustard, tomato, lady's finger, spinach), sugarcane and cotton.
- b. Pests of stored grains & forests; Pests in polyhouses and protected cultivation.

UNIT IV:

- a. Pest outbreak- Type of pests; causes that make the insect as pest, and global factors causing pest outbreak.
- b. Natural control of insect pest with reference to climatic features, natural barriers & enemies and insect diseases, Gut analyses of predators
- c. History, principles and scope of chemical control; Insecticides/ Pesticides- Nature, chemistry, mode of action and their application. Insect resistance against pesticides. Insect pheromones and their role in pest control; entomophagous aspects of *Bt Cotton* and *Bt Brinjal*

UNIT V:

- a. History, principles and scope of biological control; important groups of parasitoids, predators and pathogens; Biology, adaptation, host seeking behavior of predatory and parasitic groups of insects
- b. Role of insect pathogenic nematodes, viruses, bacteria, fungi, protozoa etc., their mode of action
- c. Mass production of quality biocontrol agents- techniques, formulations, economics, field release/application and evaluation,
- d. Importation of natural enemies- Quarantine regulations

Recommended Books

1. Burges HD & Hussey NW. (Eds). 1971. *Microbial Control of Insects and Mites*. Academic Press, London
2. Butani DK & Jotwani MG. 1984. *Insects and Vegetables*. Periodical Expert Book Agency, New Delhi
3. Chapman JL & Reiss MJ. 2006. *Ecology: Principles & Applications*. iCambridge. Ed. Cambridge Univ. Press,
4. De Bach P. 1964. *Biological Control of Insect Pests and Weeds*. Chapman & Hall, New York
5. Evans JW. 2004. *Outlines of Agricultural Entomology*. Asiatic Publ., New Delhi
6. Huffaker CB & Messenger PS. 1976. *Theory and Practices of Biological Control*. Academic Press, London
7. Matsumura F. 1985. *Toxicology of Insecticides*. Plenum Press, New York
8. Price PW. 1997. *Insect Ecology*. 3rd Ed. John Wiley, New York
9. Speight MR, Hunta MD & Watt AD. 2006. *Ecology of Insects: Concepts and Application*. Elsevier Science Publ., The Netherlands
10. Van Driesch & Bellows TS. Jr.1996. *Biological Control*. Chapman & Hall, New York

COURSE XVI E

APPLIED ENTOMOLOGY II

H-4081

UNIT I:

- a. Classification of pesticides based on chemical structure, mode of entry, action, toxicity and structure activity relationship
- b. Mode of action and therapeutic methods for control of poisoning of chlorinated hydrocarbon, organophosphates, carbonates, natural and synthetic pyrethroids
- c. Systematic insecticides, phytotoxicity, compatibility, antagonism and synergism

UNIT II:

- a. Life cycle, pathogenicity and control measures of insects injurious to human beings-mosquitoes, sand flies, lice, house flies etc.
- b. Life cycle, pathogenicity and control measures of insects injurious to Livestock- Black flies, Horse flies, louse flies, Horse botflies etc.

UNIT III:

- a. Distinguishing features of lac-insect, silk worm and honey bees- their biology, management, principles, products, agricultural and industrial importance. Genetically modified disease resistant lac-insect, silk worm and honey bees. Regulatory laws related to release of genetically modified insects into the environment
- b. Insects as pollinator and bioindicators, Biological control of weeds using insects

UNIT IV:

- a. Principles of pests sampling and surveillance; database management and computer programming, simulation techniques and system analysis and modelling, Case histories of national and international programmes, their implementation, adoption and criticisms, global trade and risk of invasive pests, Genetic engineering and new technologies- their progress and limitations in IPM programmes. transgenic insects, artificial selection, transgenesis, TE vectors Para transgenesis, endosymbionts

UNIT V:

- a. Deployment of benevolent alien genes for pest management- case studies; scope and limitations of bio-intensive and ecological based IPM programmes. Application of IPM to farmers' real- time situations (IPM modules of important crops), Challenges, needs and future outlook; dynamism of IPM under changing cropping systems and climate; insect pest management under protected cultivation; strategies for pesticide resistance management.
- b. Decision making areas, cost-benefit ratio, ecological sound approaches for the insect pest control

Recommended Books

1. Dhaliwal GS, Singh R & Chhillar BS. 2006. *Essentials of Agricultural entomology*. Kalyani Publ., New Delhi
2. Flint MC & Bosch RV. 1981. *Introduction to Integrated Pest Management*. 1st Ed., Springer, New York
3. Horowitz AR & Ishaaya I. 2004. *Insect Pest Management: Field and Protected Crops*. Springer, New Delhi
4. Ignacimuthu SS & Jayaraj S. 2007. *Biotechnology and Insect Pest management*. Elite Publ., New Delhi
5. Metcalf RL & Luckman WH. 1982. *Introduction of Insect Pest management*. John Wiley & Sons, New York
6. Norris RF, Caswell-Chen EP & Kogan M. 2002. *Concepts in Integrated Pest Management*. Prentice Hall, New Delhi
7. Oakeshott J & Whitten MA.. 1994. *Molecular Approaches to Fundamental and Applied Entomology*. Springer Verlag
8. Pedigo RL. 2002. *Entomology and Pest Management*. 4th Ed. Prentice Hall, New Delhi

9. Rechcigl JE & Rechcigl NA. 1998. *Biological and Biotechnological Control of Insect Pests*. Lewis Publ., North Carolina
10. Subramanyam B & Hagstrum DW. 1995. *Integrated Management of Insects in Stored Products*. Marcel Dekker, NY

GROUP E: ENTOMOLOGY

H-862 P

Practical based on above

Practical class/field visit record file evidences of the following to be maintained by the students and submitted at the time of practical examination for evaluation by the examiners.

- 1 Study of insect segmentation
- 2 Study of various tagmata and their appendages
- 3 Preparation of permanent mounts of different body parts and their appendages of taxonomic importance including male and female genitalia
- 4 Study of Sense organs
- 5 Dissection of cockroach to study comparative anatomical details of digestive, nervous, excretory systems
 1. Types of distributions of organisms
 2. Methods of sampling insects
 3. Estimation of densities of insects and understanding the distribution parameters – Measures of central tendencies
 4. Poisson Distribution, Negative Binomial Distribution
 5. Determination of optimal sample size
 6. Learning to fit basic population growth models and testing the goodness of fit
 7. Fitting Hollings's Disc equation
 8. Assessment of prey – predator densities from natural systems and understanding the correlation between the two
 9. Assessing and describing niche of some insects of a single guild
 10. Calculation of niche breadth, activity breadth and diagrammatic representation of niches of organisms
 11. Calculation of some diversity indices – Shannon's and Avalanche Index and understanding their associations and parameters that affect their values
 12. Problem solving in ecology
 13. Field visits to understanding different ecosystem and to study insect occurrence in these systems
5. Analysis of honey and its quality control
6. Field studies of insects to understand their habit, habitat environmental impact, beneficial and harmful activities etc.
7. Study of beneficial insects, benefits derived from them and useful products
8. Study of destructive insects, damage caused by them and damaged products
9. Study of insecticidal formulations and insect control appliances
10. Experiments on insect control like LC-50 /LD-50, knock down and recovery effect, repellency/ antifeedance tests, percentage damage tests for leaf eating insects, and stored grain pests
 1. Dissection / demonstration of insect organ systems (nervous, digestive, reproductive, neuroendocrine) in insects like grasshopper, cricket, cockroach, wasp, honey bee, insect larvae.
 2. Preparation of permanent stained mounts of insects, their body parts and dissected organs.
 3. Study of permanent slides of insects, their body parts, organs and histological preparations
 4. Study of insect specimens showing coloration, mimicry, light production, polymorphism, sound production and reception and other morphological modifications
 5. Physiological experiments in insects like extirpation and implantation of endocrine organs, parabiosis, ligation of dipteran / lepidopteran larvae, preparation of isolated abdomen demonstration of digestive enzymes, excretory products etc.
 6. Microtomy of insect material
 7. Biochemical analyses like chitin test, demonstration of cuticular lipids
 8. Estimation of total proteins, SDS PAGE of hemolymph proteins

I. General Insect Biology

Insect collection and preservation for systematic studies

Identification of different insects up to orders

Identification of insects up to families of economically important insect orders

II. Anatomy & Physiology of Insects

Major Dissection:

Nervous system of Honey bee, Wasp, Grasshopper and Beetle

Nervous system and alimentary canal of cockroach

III. Applied Entomology I

Collection and identification of insects up to species: Mosquitoes, honeybees, stored grain beetles, aquatic insects, important crop and household pests

IV. Applied Entomology II

Life cycle studies of crop pests

Equipment and accessories for rearing of lac-insect, honey bee and silk worm

Marks Distribution

Duration: 5 hrs.	M.M.: 100 Marks	
1. Major Dissection: (01)	10 Marks	
2. Minor Dissection: (01)	05 Marks	
Sting apparatus of honey bee/ wasp.		
Salivary glands and mouth parts of cockroach.		
3. Mounting: (01)	05 Marks	
Different types of mouth parts, wings, antennae and legs of insects.		
Malpighian tubules and Hepatic caeca from alimentary canal of cockroach.		
Spiracles and trachea of cockroach.		
4. Spotting: (1-10)	20 Marks	
Museum specimens of insects with special features (04)		
Permanent slides of whole mounts, mouth parts, wings, antennae and legs (02)		
Histological slides (02)		
Insect collection nets & traps through models (02)		
5. Taxonomic Identification: (02)	10 Marks	
6. Written exercises based on theory courses		05 Marks
7. Microtomy: Histological study of tissues- Alimentary Canal, Malpighian tubules etc.		10 Marks
Sectioning and stretching of tissues (Ribbon) (02)	5 Marks	
Staining of pre-stretched tissue (Ribbon) (02)	5 Marks	
8. Field Visit/Collection/Museum & laboratory management	15 Marks	
9. a. Field visit report of Insectary/Lac culture, Apiculture, Sericulture Farm/		
Laboratory/Institute (01)	5 Marks	
b. Collection & preservation of local insect fauna/		
Microtomy blocks & slides	5 Marks	
c. Maintenance of museum & laboratory	5 Marks	
10. Viva-voce	10 Marks	
11. Practical Class records	10 Marks	

FOURTH SEMESTER

Group-F Chronobiology and mechanisms of behavior

This course will cover the science of chronobiology and mechanisms of behavior. Course material shall include historical perspective, and current knowledge. By the end of the semester, student should be able to critically evaluate scientific evidence and acquire scientific writing skill. Besides comprehension of state of the art of sleep, future prospect of a career in public health and sleep diagnostic centers are foreseen.

COURSE XIII F Chronobiology H-8562

Unit 1: Introduction to biological clocks: astrophysical basis; Biological clocks in animals, Historical perspective including earlier studies in plants; Evolution and adaptive significance; Types of Rhythms - Circannual, Lunar, Tidal, Circadian, Ultradian, and Infradian rhythms. Importance of rhythms 24x7 life.

Unit 2: Clock system in prokaryotes/invertebrates: Clock in bacteria with example *Cyanobacteria*. Circadian pacemaker system in invertebrates with *Drosophila* as example.

Unit 3: Vertebrate Clock System: Suprachiasmatic nucleus (SCN) and Anatomical basis of circadian clocks in mammals and their entrainment to light. Concept of central and peripheral clocks; Importance of time of eating.

Unit 4: Molecular basis of circadian rhythms: Cell autonomous clocks; core-clock and clock-controlled genes, feedback loops; TTFL and Redox rhythms

Unit 5: Melatonin, sleep and healthy aging: Sleep across animal strata; structure, synthesis, secretion, and functions of melatonin, Importance of sleep to circadian rhythms. Aging, Factors affecting aging; Introduction to neurodegeneration with brief examples of Parkinson's, Alzheimer's, psychological disorders, addiction, etc.

Suggested Readings:

1. Chronobiology Biological Timekeeping: Jay. C. Dunlap, Jennifer. J. Loros, Patricia J. DeCoursey (ed). 2004, Sinauer Associates, Inc. Publishers, Sunderland, MA, USA
1. Insect Clocks. D.S. Saunders, C.G.H. Steel, X., afopoulou (ed.) R.D. Lewis. 2002 Barnes and Noble Inc. New York, USA
2. Biological Timekeeping: Clock, Rhythms and Behaviour, Vinod Kumar (ed. 2017)

COURSE XIV F Photoperiodism and Seasonal Breeding H-8563

Unit 1: Photoreception: Eye; Vision (image and non-image forming vision); Extra-retinal photoreception and Pineal gland. Retinal ganglion cell (RGCs), Opsins and their types.

Unit 2: Photoperiod and Photoperiodic time measurement PTM: LD cycles, actograms, Phase shift, Running Period, Phase response curve (PRC). Zeitgeber, Masking and Entrainment. Models explaining PTM. PTM protocols- night break, T-cycle, and resonance cycles.

Unit 3: Seasonality and its regulation:, Concept of seasonality, Proximate and Ultimate factors. Role of photic and non-photoc cues in regulation of seasonality; Cues- principal and supplementary cues, Seasonal migration in fishes. Hibernation.

Unit 4: Circannual rhythms and migration in birds: Seasonal breeding in birds, migration and its types. An Overview and Factors Affecting bird Migration; Spring and autumn migration; Orientation and navigation.

Unit 5: Methods to study seasonal rhythms: Locomotor activity, feeding rhythm, calculation of phase, period and amplitude; calculating PRC, consequences of LAN.

Suggested Readings:

2. The Physiology of Reproduction, Vol 1 and 2, Ernst Knobil and Jimmy D. Neil, (ed), Raven Press.
3. Sturkie's Avian Physiology, 7th Ed. (Eds: Colin Scanes, Sami Dridi) eBook ISBN: 9780323853514
4. Biological Rhythms: Vinod Kumar (ed 2002) Narosa Publishing House, Delhi/ Springer-Verlag, Germany

COURSE XV F Neuroendocrine control of behavior H-8564

Unit 1: Basic neurobiology: Using terms- Neuroscience; Neuroanatomy, Neurophysiology, and Systems Neurobiology; Structure and properties of neurons; Propagation of nerve impulses; Synapses and its types; Neurotransmitters, Different types of neurotransmitters— catecholamines, amino acidergic and peptidergic neurotransmitters; Transmitter gated channels; G-protein coupled receptors and effectors, neurotransmitter

receptors; Ionotropic and metabotropic receptors.

Unit 2: Hypothalamus, Pituitary gland and hypothalamo-hypophyseal axis: Structure of Hypothalamus, Pituitary gland and hypothalamo-hypophyseal axis: Overview of releasing and release inhibiting and trophic hormones. Concepts of feed-back in regulation of hormone secretion

Unit 3: The control hormone secretion: Regulation of thyroid, adrenal and gonadal secretion. Regulation of oxytocin and vasopressin. Pancreas as exocrine and endocrine gland.

Unit 4: Hormonal regulation of behaviors: Regulation of motivational system. Control of feeding and drinking. Hormonal influence of activity behavior; neuroendocrine control of sleep..

Unit 5: Principles and application of techniques in Neuro endocrinology:

Electrophysiology, immunocytochemistry, *in situ* hybridization, autoradiography.

Suggested Readings:

1. An Introduction to Neuroendocrinology, Brown R., (1994), Cambridge University Press, Cambridge, UK
2. Psychoneuroimmunology, Ader R, Felten D.L. and edited by Nicholas C. (4th Ed., 2007), Academic Press, UK
3. John Alcock, Animal Behaviour, Sinauer Associate Inc., USA.

COURSE XVIX F

Applied Chronobiology

H-8565

Unit 1: Ambulatory methods to study rhythms in humans: Ambulatory measurement of heartbeat, blood pressure, body temperature, Actigraphy, ambient light recording; Chronotype, MCTQ questionnaire and analysis; Continuous Glucose Monitoring CGM. Time series analysis.

Unit 2: Sleep and rhythms: Molecular basis of sleep regulation, Napping, sleep disorders- excessive sleepiness, poor sleep ability, sleep apnea and other sleep disorders. Functions of sleep. REM sleep. Occupational hazards of sleep disruption- Shift work.

Unit 3: Human Lifestyle, health and metabolism: Sleep disruption; Disruption of clocks and cancer; Diabetes, Cardiovascular diseases. Preventing lifestyle disorders- Intermittent fasting.

Unit 4: Monitoring rhythms for better health: hematological analysis; Liver function test, kidney function test, thyroid function test, cardiovascular markers-lipid profile, Introduction to biomarkers.

Unit 5: Biological clocks in human welfare – Chronomedicine and importance of time of medication, Chronopharmacology and drug delivery; physiological benefits of yoga and exercise. Chronotherapy

Suggested Readings:

1. Biologic Rhythms in Clinical and Laboratory Medicine. Touitou, Yvan; Haus, Erhard (Eds.) Springer-Verlag, 1992
2. Circadian Physiology: Roberto Refinetti, CRC Press (3rded) 2016
3. Circadian Medicine: Christopher Colwell (ed.) Wiley-Blackwell (2015)

Practical based on above

Practical record file, evidences of the following to be maintained by the students and submitted at the time of practical examination for evaluation by the examiners.

1. Ambulatory study of Heart rate using ABPM
2. Oximetry
3. Study of permanent mounts of feather types,
4. Slides of endocrine glands viz. pituitary, thyroid, adrenal, pancreas, testes and ovary of mammal.
5. Study of SCN through virtual media
6. Study of Retinal ganglion cell (RGCs) through virtual media
7. Structure of Eye using virtual media
8. Measuring sleep using in-bed and out-bed timings
9. Light intensity measurement and role of light intensity at different times of day
10. Learning to use timers in daily life
11. Recording actogram, double plotting, ad interpretation through eye-fit line
12. Measurement of central tendencies and variability; ANOVA.

13. Deciding sample size in behavior studies
14. Studying different areas of hypothalamus and their functions, using virtual media
15. Ambulatory measurement of blood pressure to interpret night dipping
16. Actigraphy
17. Chronotype and MCTQ questionnaire and analysis
18. Continuous Glucose Monitoring CGM.
19. hematological analysis, hemoglobin and differential leucocyte count
20. HBA1C, and understanding Liver function tests
21. Good Laboratory Practices; Gel electrophoresis
22. ELISA
23. To study the phototaxis and geotaxis behavior of earthworm

XIII. Chronobiology

Long day plants long day animals

Durations of sleep wake, heartbeat and annual cycle of breeding (to understand circadian, ultradian and annual cycles)

work shifts in 24x7 life

XIV. Photoperiodism and Seasonal Breeding

Structure of Eye, rods and cones

image and non-image forming vision

Retinal ganglion cell (RGCs), Opsins and their types.

Locomotor activity rhythms

Illustrate PTM protocols- night break, T-cycle, and resonance cycles.

XV. Neuroendocrine control of behavior

Structure of neurons

Propagation of nerve impulses

Chemical structures of important Neurotransmitters

Areas of Hypothalamus

slides of Pituitary gland and hypothalamo-hypophyseal axis

XVI. Applied Chronobiology

Ambulatory measurement of blood pressure, body temperature,

Actigraphy

Chronotype, MCTQ questionnaire and analysis;

Continuous Glucose Monitoring CGM.

OPEN ELECTIVE PAPERS

Even Semester

Poultry Production and Management

- UNIT I** Classification of poultry, common breeds of chicken and their descriptions.
- UNIT II** Scavenging system of management raising of chicks, scavenger feed base of village. Low input technology; backyard and semi intensive unit of various sizes; their description, management and economic achievements.
- UNIT III** Mixed farming and poultry raising. Concept of self-local market unit. Brooding and rearing practices used for chicken.
- UNIT IV** Economic production of chicken and duck. Hatching and feeding norms for chicken. Marketing of poultry and poultry products. Poultry diseases : Parasitic, microbial & nutritional
- UNIT V** Setting of farms for different classes of poultry.

Recommended Books:

1. The small scale poultry flock by Haevey Ussery. Publisher: Chelsea Green Publishing Co., USA
2. Hatching and Brooding your Own Chicks by Gail Damerow. Publisher: Storey LLC, USA
3. Disease of Poultry, 13th Edition by David E Swayne et al. Publisher: USDA, Georgia, USA
4. A Pocket Guide to Poultry Health & Diseases by Paul McMullin. Publisher: Sheffield, UK
5. The Poultry Yard: Comprising of Management by WCL Martin. Publisher: Kessinger Publ., USA
6. Poultry Production by SK Das. Publisher: CBS Publisher & Distribution
7. Popular Poultry Breeds by David Scrivener. Publisher: Crowood Press Ltd., UK
8. Nutrient Requirement of Poultry. ICAR Publication, New Delhi
9. Handbook of Poultry Production and Management by NV Jadhav et al. Publisher: JB Medical publisher (P) Ltd., Bangalore
10. Poultry Diseases 6th ed by *Mark Pattison et al.* Publisher: Elsevier Ltd.

Odd Semester

Wildlife and Conservation

- UNIT I** Concept of wildlife: Role of wildlife in nature, habitat improvement, Values of Wildlife, Human-wildlife conflict: reasons and remedial measures.
- UNIT II** Sociobiology of wild animals– Territorial behavior, migratory behavior, socio- biological importance, animal learning and memory.
- UNIT III** National parks, Wildlife Sanctuaries, Zoos in India.
- UNIT – IV** Reasons for wildlife depletion (Habitat fragmentation, Habitat destruction, commercial wildlife exploitation, overgrazing, impacts of developmental projects etc.)
- UNIT – V** Wildlife conservation techniques, role of WWF, IUCN, UNEP, Red Data Book; Categories of Endangered Wildlife Species. National Projects: Project Tiger, Project elephant, Project Rhinoceros, Project Crocodiles

Recommended Books

1. Techniques for wildlife Census in India (A field manual) by W.A. Rogers; Wildlife Institute of India, Dehradun.
2. Wildlife Wealth of India by T.C. Majupuria; Tecpress Services, L.P., 487/42-SOL Wattenslip, Pratunam Bangkok, 10400, Thailand
3. Handbook of Birds of India & Pakistan 10-Vols by Ali, S. and Ripley S.D.. Publisher: Oxford University Press, Bombay.
4. The Book of Indian Animals by S.H. Prater. Publisher: BNHS Publication, Bombay.
5. Wildlife in India by V.B. Saharia. Publisher: Natraj Publishers, Dehradun.
6. E.P. Gee, The Wildlife of India. Publisher: HarperCollins India

Open Electives offered by Campus Departments from 2016-17

History:

1. Indian rituals and Karma
2. Indian Culture and heritage

Urdu:

1. Mass Media
2. Urdu Proficiency

Psychology:

1. Personality Development and Communication Skills
2. Psychology and Spirituality

Chemistry:

1. Chemistry of Life-I
2. Chemistry of Life-II

Mathematics:

1. Optimization techniques
2. Basic cryptography

Zoology:

1. Poultry Science and Dairy Management
2. Wild life and Forestry

Toxicology:

1. Chemical disaster Management
2. Forensic toxicology

Statistics:

1. Applied Statistics
2. Essential Statistics

Physics:

1. Introduction to Nanotechnology
2. Electron Microscopy

Botany:

1. Disaster Management
2. Environmental Awareness

Microbiology:

1. Food Safety and Quality Control

2. Public Health and Hygiene

English:

1. Human Society
2. Personality development and Communication skills

Hindi:

1. Functional Hindi
2. Hindi journalism

Economics:

1. Basic economics
2. Developments in Indian Economics

Genetics and Plant Breeding:

1. Crop Physiology
2. Crop Biochemistry

Sociology:

1. Rural Development: concepts and Dimensions
2. Social Change in India

Political Science:

1. Human rights
2. Constitution of India