KARNATAK UNIVERSITY, DHARWAD

Regulations

For

MASTER OF SCIENCE

CHOICE BASED CREDIT SYSTEM (M.Sc. Zoology– CBCS)

2019-2020 & Onwards

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For

MASTER OF SCIENCE

CHOICE BASED CREDIT SYSTEM (M.Sc. Zoology– CBCS)

From

2019-2020 & Onwards

KARNATAK UNIVERSITY, DHARWAD

Regulations concerning Master Degree Programme

Faculty of Science, from 2019-2020

Master Degree Programme in Zoology (M.Sc.Zoology-CBCS)

Regulations Governing the Post-Graduate Master Degree Programmes under Choice Based Credit System (KU-CBCS), framed under Section 44(1)(C) of K.S.U. Act, 2000.

MASTER OF SCINECE
CHOICE BASED CREDIT SYSTEM (CBCS)

Title:

These Regulations shall be called "Karnatak University Regulations Governing Post-Graduate under the Choice Based Credit System" for Master Degree programmes.

Commencement:

These Regulations shall come into force from the academic year 2019-2020.

Definitions:

In these Regulations, unless otherwise mentioned:

a) "University" means Karnatak University:
b) "Post-Graduate Programmes" means Master's Degree Courses.
c) "Compulsory Course" means a fundamental paper which a student admitted to a particular Post-Graduate programme should successfully complete to receive the Post-Graduate Degree in the concerned subject.
d) "Specialization Paper" means an advanced paper due to departmental choice for students wanting to receive Degree in the specialization area:
e) "Open elective" means a course offered by Department for students of other Departments in the same Faculty. Students have freedom to choose from a number of optional courses offered by other Department/s to add to their credits required for the completion of their respective programmes: however, if in a P.G.Centre there is only one Department for the time being, the students of that Department should study that open elective course.
f) "Credit" means the unit by which the course work is measured. For this Regulation, one Credit means on hour of teaching work or two hours of practical work per week. Normally a Semester is of 16 weeks duration in any given academic year. As regards the marks for the courses, 1 credit is equal to 25 marks, 2 credits is equal to 50 marks, 3 credits is equal to 75 marks and 4 credits is equal to 100 marks as used in conventional system.
g) "Grade" is an index to indicate the performance of a student in the selected course. These Grades are arrived at by converting marks scored in each subject by the candidate after completing his/her Internal Assessment and Semester end Examinations. Each course carries a prescribed number of the marks of credits. These

grades are awarded for each subject after conversion of the marks and after completion of the examinations in each semester.

h) "Grade Point Average" of GPA refers to an indication of the performance of the student in a given semester. GPA is the weighted average of all Grades a student gets in a given semester. The GPA depends on the number of courses student takes and the grades awarded to him/her for each of the subjects so chosen.

i) "Cumulative Grade Point Average" or CGPA refers to the cumulative Grade Point Averages weighted across all the semesters and is carried forward. The calculations of the GPA, CGPA is shown at the end of this regulation.

Minimum Eligibility for Admission:

The students who have successfully completed the three year/four-year Degree course or any other Degree course of this University or of any other University recognized as equivalent there to by this University shall be eligible for admission to the Post Graduate Programmes under the KU-CBCS Programme provided they also satisfy the eligibility conditions like percentage of marks etc., as may be prescribed by the University and as per Ordinance of the course.

Entrance Test

Candidate seeking admission to the course shall be required to appear for entrance test conducted by the University, for the 1st Semester.

Selection for Admission

The selection of students shall be made on merit in each category of reservations as per the University rules for 1st Semester.

Intake

The total number of candidates to be admitted to the course would be 52 only for the 1st semester. Seve seats are allocated to other University candidates of which one for other University within the state 6 and one for Outside state. Fifteen seats are under enhanced fee. Total Seats is 52.

Course of Study:

The courses of study for M.Sc. Zoology degree shall comprise of Theory and Practicals as noted in the syllabus.

Note: Specification of Degrees as per UGC notification dated March 2014 published in the Gazette of India, 5thJuly 2014 (Part III Section 4).

Duration of the Programme:

The programme of study for the Post-Graduate Master Degree shall normally extend over a period of two academic years each academic year comprising of two semesters, and each semester comprising of sixteen weeks of class work.

Medium of Instruction

The medium of instruction and examination is English.

Minimum Credits and Maximum Credits:

a) There shall be two categories of courses viz., Compulsory course and Open Elective Course. Compulsory course should be from the concerned department only. The Open Elective are the courses offered by other Departments in the same Faculty.
b) Each course shall have a definite course objective, Eligibility criterion for taking the course, scheme of Evaluation including the components of Internal Assessment (IA) marks, Projects (if any), the number of contact hours, type of practical and the prescribed credits.
c) The credits for each of compulsory course may vary from 4 and 2 credits- theory and practical respectively. In case of Open Elective Course, it shall be 4 credits for each paper.
d) A student shall register for minimum of 18 credits and a maximum of 30 credits per semester. However, to qualify for the degree in any Department under any school and faculty, he/she should have registered and cleared a minimum number of credits, which vary from course to course.

Course Structure:

a) The students of Post-Graduate Programme shall study the courses as may be approved and prescribed by the Academic Council of the University from time to time.
b) A typical Master Degree program consists of a number of courses. This number varies from discipline to discipline. The term course is used to indicate a logical part of a subject matter of the programme (also referred to as paper). In essence the courses are of three types:

    i. Compulsory Course
    ii. Open Elective Course.

c) Each programme shall have a set of compulsory course that a student must complete to get the degree in the concerned Department. These are distributed in each semester. There could be a minimum of such papers for each semester depending on the department.
d) The students shall also choose a minimum number of specializations Course offered within the department. Each department will offer at least one specialization paper in the third and fourth semester. The Department, BOS and the Faculty may also have spell out the number of such specialization courses a student will have to take for the specialization. The Department offering of specialization course shall provide the flexibility in the system so that the student can opt for a variety of programmes depending upon their interest.
e) Each department shall offer at least two Open Elective courses for the II and III Semester for students from other department. Student from the same department are generally not allowed to opt the courses offered as Open Elective course in the same department.
f) Each course (paper) in this system is designed carefully to include lectures / tutorial/ Laboratory work/ seminars/ Project work/ practical training/ report writing/ Viva-voce

etc., to meet effective teaching and learning needs and the credits are assigned suitably.

g) Master Degree Programmes are essentially semester system Programmes. There shall be 4 semesters in each Programme. There shall be two semesters for each year of the Programme. Each of the Semester will be of 16 weeks duration including evaluation and grade finalization period. The academic session in each semester will provide 90 teaching days with 48 hrs of teaching / learning periods in six days session per week.

h) The normal calendar for the semester would be as follows:
   i. I and III semester - August to November
   ii. II and IV Semester - January to April

Attendance

a. Each paper shall be taken as a unit for the purpose of calculating the attendance.
b. Each student will have to sign and mark his attendance for every hour of teaching of each paper. At the end of every month all teachers shall notify the attendance of every student on the Notice Board of the department during 2nd week of every month. Chairman shall certify the fulfilment of required attendance of every candidate in the Examination form.
c. Certain proportion of the marks in Internal Assessment shall be awarded based on attendance as an incentive to the student for regularity in attendance.
d. A student shall be considered to have satisfied the requirement of attendance for each paper, if he/she has to attend not less-than 75% of the number of classes held up to the end of the semester including tests, seminars, group discussions, practical, tutorials, etc.
e. However, if a student represents his/her institution, University, State or Nation in sports, NCC, NSS of Cultural of any other officially sponsored activities, he/she shall be eligible to claim the attendance for the actual number of days participated subject to a maximum of 20 days in a semester based on the specific recommendation of the head of the Department.

Course Outline for the M. Sc. Zoology

SEMESTER – I Theory

Paper Code	Title of the Paper	Max. Marks	Internal Assessment	Total Marks	Credits	Teaching Hrs.
	Compulsory Papers					
PG87T101	Biosystematics	75	25	100	4	4 Hrs / week
PG87T102	Biology of non-chordates	75	25	100	4	4 Hrs / week
PG87T103	Biology of chordates	75	25	100	4	8 Hrs / week
PG87T104	Environmental Biology	75	25	100	4	4 Hrs / week

SEMESTER - II

Paper Code	Title of the Paper	Max. Marks	Internal Assessment	Total Marks	Credits	Teaching Hrs.
	Compulsory Papers					
PG87T201	Molecular Genetics	75	25	100	4	4 Hrs / week
PG87T202	Molecular Cell Biology	75	25	100	4	4 Hrs / week
PG87T203	Animal Physiology	75	25	100	4	8 Hrs / week
	Open Elective Paper					
PG87T204A	Animal Behavior	75	25	100	4	4 Hrs / week

SEMESTER - III

Paper Code	Title of the Paper	Max. Marks	Internal Assessment	Total Marks	Credits	Teaching Hrs.
	Compulsory Papers					
PG87T301	Developmental Biology	75	25	100	4	4 Hrs / week
PG87T302	Evolutionary Biology	75	25	100	4	4 Hrs / week
PG87T303	Animal Biotechnology	75	25	100	4	4 Hrs / week
	Open Elective Paper					
PG87T304A	Economic Zoology	75	25	100	4	4 Hrs / week

SEMESTER – IV

Paper Code	Title of the Paper	Max. Marks	Internal Assessment	Total Marks	Credits	Teaching Hrs.
	Compulsory Papers					
PG87T401	General and Comparative Endocrinology	75	25	100	4	4 Hrs / week
PG87T402	Biology of Reproduction	75	25	100	4	4 Hrs / week
PG87T403	Applied Zoology	75	25	100	4	4 Hrs / week
PG87PW404	ZCPJ-4.7 Project work	75	25	100	4	4 Hrs / week

Internship

Nil

Submission of Dissertation

a) M.Sc. III semester students shall have to choose a topic for dissertation and preliminary preparation be carried out under the guidance of a teacher.
b) M.Sc. –IV semester students shall have to submit the dissertation on the chosen topic, before the commencement of the theory examination.
c) Candidates keeping terms but not appearing for the theory and practical papers and not submitted the dissertation within the prescribed time, may appear for respective examination and submit the dissertation within the prescribed time.
d) Candidates appearing for the examination under the provision of (c) will be not eligible for the award of any rank, prize, medal etc.

Evaluation:

a. Each Course has two components, the first being Internal Assessment Marks and the second being the Semester End Exams. The Internal Assessment (IA) marks are based on continuous Internal Assessment. The total marks for the Internal Assessment would be based on the total credit awarded to the Course. For instance, if a Compulsory Course has a Credit award of 4, then the total max marks would be 100 for the subject.
b. The marks shall be displayed on the Notice Board of the Department also. The tests shall be written in a separately designated book and after evaluation; the same should be shown to students.
c. In case of candidates who wish to appear in improvement examinations, if any, the marks obtained in the Internal Assessment shall not be revised. There is no improvement for internal assessment.
d. To encourage the students for the regular participation in academic curricula following break-up for attendance has been recommended.

Attendance	Marks Allotted
91 to 100%	3
81 to 90%	2
75 to 80%	1

e. Students seeking the condoning of attendance after representing the University have to produce attendance certificates from the concerned authority and that attendance period to condone of shall be considered for the allotment of marks as under.
f. There shall be one end semester examination of 3 duration (for 75 marks/ paper). Each answer scripts of the semester end examination (theory and project report) shall be assessed by two examiners (one internal and another external). The marks awarded to that answer script shall be the average of these two evaluations. If the difference in marks between two evaluations exceeds 20% of the maximum marks such a script shall be assessed by third

external examiner. The marks allotted by the third examiner shall be average with nearer mark of the two evaluation

Completion of Course:

a. A candidate is expected to successfully complete P.G. Master Degree course in two years from the date of admission.
b. Whenever the syllabus is revised, the candidate reappearing shall be allowed for PG Degree examinations only according to the new syllabus.

Declaration of Results:

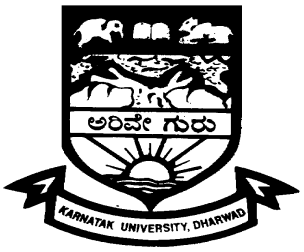
a. Minimum for a pass in each paper shall be 40% of the total 100 marks including both the IA and the semester end examinations. However, candidate should obtain at least 40% of the marks in the Semester End Examination. There is no minimum in the IA marks. However, after adding the IA and the semester end examination, the candidates should score a minimum of 40 % of the maximum marks for the subject.
b. The candidates, seeking improvement of their results shall submit a representation along with a permissible fee to the Registrar (Evaluation) and surrender the degree certificate/ provisional pass certificate /original marks card of that semester within 15 days of announcement of result.

Marks and Grading

The grading of successful candidate at the examination shall be as follows:

Percentage	GPA/CGPA	Letter	Class
75.00 to 100.00 %	7.50 to 10.00	A	First Class with Distinction
60.00 to 74.90%	6.00 to 7.49	B	First Class
50.00 to 59.94%	5.00 to 5.99	C	Second Class
40.00 to 49.94%	4.00 to 4.99	D	Pass
Less than 40.00%	Less than 4.00	F	Fail

KARNATAK UNIVERSITY, DHARWAD



SYLLABUS

For

MASTER OF SCINECE

CHOICE BASED CREDIT SYSTEM

(M.Sc. – CBCS)

PROGRAMME SPECIFIC OUTCOMES (PSOS)

After successfully completing of M. Sc. Zoology Program, the students will be able to:

- Develop in-depth knowledge about the concepts of Zoology from the organism level to the molecular level. Understand the significance of animal taxonomy and systematics.
- Comprehend and interpret the evolutionary relationships among different animal groups.
- Learn the skills of handling various scientific equipment and perform the experiments.
- Explore various applied fields with the knowledge of sericulture, apiculture, fisheries, poultry, vermiculture and dairy farms etc.
- Communicate the importance of ecosystem, biodiversity its conservation and awareness about pollution control to the society.
- To acquire knowledge on the various aspects of Zoology including Molecular Cell Biology, Molecular Genetics, Physiology, Developmental Biology, Evolutionary Biology, Comparative Endocrinology, Biology of Reproduction, and Animal Biotechnology.
- Develop theoretical and practical knowledge in handling the animals and using them as model organisms.
- Develop skill in effective data presentation and dissertation writing.

Semester-I

Paper Code and Name	PG87T101Biosystematics

COURSE OUTCOMES (COs)

After completion of Biosystematics paper students will be able to:

- Understand the different species concepts, trends and approaches of taxonomy.
- Study different collection, preservation and identification methods in animal science.
- Understand the components and category classification, construct phylogenetic tree and its analysis.
- Understand the fundamental principles of animal systematic and their analysis.
- Classify animals according to their characters and understand the theories for classification.
- Highlight the importance of International rules of nomenclature and classification of animals.

PARTICULARS	Teaching Hours (Max. 48)
Unit I: Science of Biosystematics	
Concept of Biosystematics, Terms used in systematic biology, Historical review of taxonomic philosophies, Future of taxonomic studies, Stages in taxonomy, Tasks of taxonomist, Systematics as a profession, Significance of taxonomy.	04
Unit II: Species concept	06
Historical perspective of species concept (typological, nominalist, biological), kinds of species- sibling, sympatric, allopatric, syntopic, ring species, polytypic and monotypic species. Intraspecific groups (variety, morphs, subspecies, temporal subspecies, race and clines).	
Unit III: Taxonomic Collection, Preservation and Identification	10
Collection - Purpose, value, scope of collection, content of collection, significance of museum collections, legal aspects of collecting animals, post collection processes. Preparation and packaging of specimen for posting. Preservation - Methods, taxidermy, plastination, factors responsible for the deterioration of museum specimens. Curating of collections - museum collection policy, preparation of material for study, housing and cataloging, exchangeable and expendable materials and loans.Identification - Systematic process of sorting and labelling, procedure of identification; identification services	

Unit IV: Trends and Approaches in Taxonomy	(08)
Morphological - General external structures, anatomy, special structures, Embryological and Cytogenetic, Ecological – Habitats and hosts, food, parasitism, seasonal variations. Behavioural – Ethological isolating mechanisms, courtship and behavioural patterns, Biochemical – Serological proteins, metabolic factors. Molecular – Major rRNA genes, Cytochrome B, Cytochome C, Cytochrome C oxidase and other conserved sequences; Numerical approaches.	
Unit V: Classification and Phylogenetic Analysis	(10)
Components of classification; Procedure of classification (phenetic and cladistic), presentation of classification - Linnaean/Taxonomic hierarchy, ways of constructing a phylogenetic tree. Phylogenetic analysis - Purpose, terminology, methods of phylogenetic analysis (Phenetic method, dendrogram method, pairwise distance; Cladistics method, parsimony, maximum likelihood); phylogenetic lineages.	
Unit VI: Application of Zoological Nomenclature	(10)
Taxonomic keys and their significance, taxonomic publications, International rules of nomenclature – Historical and contemporary situation; International Code of Zoological Nomenclature (ICZN); DNA bar coding, the taxonomic bottle neck, digitization of taxonomic data/ Bioinformatics.	

Paper Code and Name	**PG87T102Biology of non-chordates**	**Teaching Hours (Max. 48)**
COURSE OUTCOMES (COs)		
After completion of Biology of non-Chordata paper students will be able to: • Understand the evolution of body plan and design in invertebrates. • Study the systematic position and phylogeny of few invertebrate minor phyla. • Learn the morphological adaptations with respect to different physiological functions in invertebrates. • Understand special features, organs, life history and significance		
Unit I: Coelom, Body plan and Phylogeny		(8)
Symmetry and evolution of bilateria; Evolution and significance of coelom; evolution and significance of metamerism; Protostomia and Deuterostomia.Phylogeny and systematic position of Ctenophora, Entoprocta, Sipunculida and Ectoprocta.		
Unit II : Locomotion and Nutrition Amoeboid, Ciliary and Flagellar movements in Protozoa; Ultrastructural aspects of flagella; Principle of hydrostatic skeleton; hydrostatic movement in Annelida; Flight movement in insect. Nutrition in Protozoa and lower Metazoan; Filter feeding in Polychaeta, Mollusca, Crustacea and Echinodermata; Feeding patterns in insects.		(12)
Unit III: Respiration and Circulation Respiratory organs in invertebrates – gills, lungs and trachea; Respiratory pigments - hemoglobin, hemocyanin, hemerythrin and chlorocruorin Circulation – Patterns (open and closed types) with suitable examples		(10)
Unit IV: Excretion Excretory organs – Flame cells, coelomoducts, nephridia and Malphigian tubules – Morphology and mechanisms.		(6)
Unit V: Nervous System Trends in neural evolution: Primitive nervous system in Cnidaria and Echinodermata; Advanced nervous system in Annelida, Arthropoda and Mollusca; Brief review of sense organs in different phyla.		(7)
Unit VI: Reproduction Asexual, sexual and parthenogenetic modes of reproduction and their significance; Larval forms and		(5)

their significance. **Practicals**	

Paper Code and Name	PG87T103Biology of chordates	Teaching Hours (Max. 48)
	COURSE OUTCOMES (COs)	
	After completion of Biology of Chordata paper students will be able to: Understand the systematic and phylogenetic position of protochordates and their general organization. • Get an insight idea of origin, evolution and adaptive radiations of early vertebrates such as Cyclostomes and Pisces. • Trace out the origin and evolution of Amphibia, Reptilia, Aves and mammalia and their adaptive radiations. • Understand the adaptive radiations and the nature of endoskeleton in mammals. • Describe the comparative anatomy of integument and its derivatives, brain, kidney, heart and aortic arches in different vertebrates. • Discuss the different modes of adaptations in vertebrates. • To impart the knowledge with respect to taxonomic status of the entire chordates and the evolutionary model of the group, ecology of some important fishes, amphibians reptiles, birds and mammals. • Compare the structures of heart, aortic arches, kidney, balancing organ, hearing organ, thyroid, respiratory organs, brain of different animals.	
	UNIT I: Phylogeny, systematic position and organization of Protochordates Phylogeny and systematic position of Urochordata and Cephalochordata. General organization in urochordates-ascidians, thaliaceans and larvaceans; General organization in amphioxus. Retrogressive metamorphosis.	(6)
	UNIT II: Origin, evolution and adaptive radiations in early vertebrates Origin of chordate; origin, evolution and adaptive radiations in cyclostomata; origin, evolution and adaptive radiations in Pisces – ostracoderms; placoderms; chondrichthyans; acanthodians; actinopterygians and sarcopterygians.	06
	UNIT III: Origin, evolution and adaptive radiations in Amphibia, Reptilia and Aves Origin, evolution and adaptive radiations in Amphibia – Early labyrinthodonts – stegocephalians, temnospondyls and lepospondyls; Lissamphibians. Origin, evolution and adaptive radiations in Reptilia – stem reptiles, pelicosaurs and therapsids. Origin, evolution and adaptive radiations in Aves.	(8)
	UNIT IV: Zoogeography, Adaptive radiations and Endoskeleton of Mammals Zoogeography, origin and evolution of monotremes, marsupials and placentals, adaptive radiations in marsupials; dentition in mammals. Overview of skull - cranium, jaws and hyoid apparatus; Axial skeleton – vertebrae, centra and ribs. Appendicular skeleton – pectoral girdle, pelvic girdle and organization of limb bones	(12)
	UNIT V: Comparative anatomy Comparative anatomy of integument and its derivatives – organization of dermis and epidermis in vertebrates; teeth, feathers, hair, scales, mammary glands, nails, claws and hooves. Heart and aortic arches in anamniotes and amniotes; Anatomy of Brain in different vertebrates. Kidney in vertebrates – archinephric, pronephric, mesonephric and metanephric kidneys and their ducts.	(10)
	UNIT VI: Adaptations	(6)

	Aquatic, aerial and terrestrial adaptations; Aerodynamics and mechanism of flight in birds (wing as flight surface).	

Paper Code and Name	PG87T104Environmental Biology	Teaching Hours (Max. 48)
	COURSE OUTCOMES (COs)	
	After completion of Environmental Biology paper students will be able to: • Understand and appreciate the environment and ecological services • Understand the biotic and abiotic factors of environment, biogeochemical cycle and intraspecific relationships of animals. • Acquire knowledge of ecosystem, food chain, energy flow and productivity and study pond as a model ecosystem. • Gain knowledge of habitat ecology, pollution and bioremediation of polluted environment and learn about biodiversity, its importance, conservation, and role of organizations involved in conservation of animals. • Think of climate change, the causes and its effect on the environment and biodiversity.	
	Unit I: Introduction to Environmental Biology History, definition, importance, scope, divisions and awareness of environmental biology. Ecosystem: Concept, types, structure, components and productivity and functions of different ecosystems; Biogeochemical cycles. Ecological Succession: Definition, primary and secondary succession, influence of anthropogenic activities on succession.	(10)
	Unit II: Population Growth and Regulation Types of population growth, physical and biological factors regulating population, population pyramids, population explosion.	(4)
	Unit III: Natural Resources Concept and classification of natural resources; Non-renewable resources- land, soil and mineral resources; Renewable resources- water, forest, wildlife, range lands, agriculture, livestock, aquaculture; Energy resources (renewable and non-renewable); Resource management and conservation.	(6)
	Unit IV: Animal biodiversity Global and Indian biodiversity; Levels of biodiversity- genetic, species, ecosystem diversity; Endangered species; Values of biodiversity- consumptive, productive, social, ethical, aesthetic (ecotourism) and health values; Conservation of biodiversity- ex-situ and in-situ; Mega-biodiversity centers- National parks, sanctuaries and biosphere reserves, biodiversity hotspots; Threats to biodiversity; Human-wildlife conflicts; Organizations associated with biodiversity management.	(12)
	Unit V: Climate change Composition and structure of atmosphere; Climate- catastrophes and driving forces; Human caused climate change- ozone layer depletion, greenhouse gases and global warming, acid rain; Strategies for dealing with global warming.	(6)
	Unit VI: Environment and human health **Types of environmental health hazards- infectious organisms, Toxicants-chemicals, natural and synthetic toxins, heavy metals; Bioaccumulation and bio-magnification; Toxicity measurement- animal testing;** environmental legislation and protection	(10)

	Semester-II
Paper Code and Name	**PG87T201: Molecular Genetics**

COURSE OUTCOMES (COs)

PG87T201: Molecular Genetics

After completion of Molecular Genetics paper students will be able to:

- Describe the gene regulation patterns in prokaryotes and eukaryotes.
- Understand the dosage compensation mechanisms in a few invertebrates and vertebrates.
- Explain the molecular basis of mutations and their impact.
- Describe the gene transfer mechanisms in bacteria.
- Understand the theories of classical genetics and blood group inheritance in man.
- Describe the genetic variation through linkage and crossing over, chromosomal aberrations and sex determination.
- Understand the genetic defects, inborn errors of metabolism and genetic and multifactorial diseases, counseling and role of inbreeding and outbreeding.
- Understand the molecular structure of genetic materials and the mechanism of gene expression and regulation

PARTICULARS	Teaching Hours (Max.48)
Unit I: Mendelian and Modern Genetics	
Overview of Mendelian principles and Post-Mendelian Genetics. Concept of alleles, complementation test, cistron, muton and recon. Linkage and crossing over. Non-Mendelian inheritance. DNA structure and functions: DNA as hereditary material – experiments; Watson and Crick model and alternate models of DNA, semi-conservative replication of DNA; DNA repair mechanisms; organization of prokaryotic and eukaryotic genomes. Replication: Enzymology of replication, initiation, elongation and termination; models of replication. Protein synthesis: Genetic code, colinearity hypothesis. Transcription, post-transcriptional modification. Translation: post-translational modification.	(12) Hours
Unit II: Bacterial Genetics	
Genetics of bacterium and bacteriophage: Transformation, transduction and conjugation in bacteria; F- mediated sexduction, mechanism of recombination in bacteria, Life cycles of bacteriophage, plasmids and episomes.	(6) Hours
Unit III: Gene Regulation in prokaryotes and Eukaryotes	
Gene regulation: Prokaryotes- operon model- positive and negative regulation; Eukaryotes - model of gene regulation, transcription factors, Cis and trans acting elements in eukaryotes. Dosage compensation in human, *Drosophila* and *Caenorhabditis elegans*. Genome imprinting.	8 Hours
Unit IV: Chromosome abnormalities	
Variation in chromosome structure: cytogenetic implications of duplication, deletion, inversion, translocation and position effect. Transposons- transposable elements in bacteria and in eukaryotes. Mutations- spontaneous and induced mutations; Molecular basis of mutation, effect of mutations	(6) Hours
Unit V: Genetic Diseases	

Genetic diseases: Single gene inheritance; cystic fibrosis, sickle cell anemia, Marfan syndrome, Huntington's disease, and, hemochromatosis. Multifactorial inheritance: heart disease, high blood pressure, Alzheimer disease, arthritis, diabetes, cancer, and obesity. Chromosome abnormalities: Turner syndrome, Klinefelter syndrome, Down syndrome and Cri-du-chat syndrome. Mitochondrial inheritance: Leber's hereditary optic atrophy, epilepsy, myoclonic epilepsy and dementia.	(12) Hours
Unit VI: Genomics and Proteomics	
Salient features of yeast, *Drosophila* and Human genomes; Evolutionary genomics; Proteomics.	(4) Hours

Paper Code and Name	**PG87T202: Molecular Cell Biology**
COURSE OUTCOMES (COs)	
After completing this paper, the students will be able to:	
• Acquainted with scope of modern cell biology, principles and applications of different microscopes. • Study the molecular organization of biomembranes, structural and functional aspects of cell organelles, composition of prokaryotic and eukaryotic cells. • Understand the molecular structure and functions of chromosome biomolecule and their significance. • Understand immunology, cell cycle, apoptosis, cancer cell biology, properties and treatment of cancer cells.	

PG87T202: Molecular Cell Biology	**Teaching Hours (Max. 48)**
Unit I: Introduction and Microscopy	
Scope of modern cell biology, Microscopy: Magnification, Limit of resolution, Resolution power. Types of microscopes: Phase contrast, Fluorescence, Transmission Electron, Laser Confocal microscopes- principle, structure and applications.	(04) Hours
Unit II: Molecular organization of biomembranes	
Organization and composition of plasma membrane, Fluid mosaic model. Membrane fluidity-role of cholesterol. Membrane asymmetry. Transport across membranes (solutes, gases, ions and water); Passive and active transport, Cell junctions: types, structure and functions	(08) Hours
Unit III: Molecular organization and functions of cell organelles	
Endoplasmic reticulum; Ribosomes – Structure, translation and translocation, nascent polypeptide chain, protein folding and processing. Golgi apparatus- signal hypothesis, protein glycosylation, protein sorting and transport, endocytosis and lysosome formation. Mitochondria – bioenergetics, oxidative phosphorylation, protein import and transport metabolites; Peroxisomes. Cytoskeleton- Molecular organization of microfilaments, Intermediate filaments and microtubules and their role in cell architecture and functioning	8 Hours
Unit IV: Biomolecules	
Amino acids- structure and classification, Peptide bond formation. Proteins - primary, secondary and tertiary structures. Polypeptide folding: Random coiling, Alpha helix and Beta sheet. Protein modifications - Glycoproteins, Proteoglycans and Lipoproteins. Carbohydrates -	8Hours

Complex polysaccharides. Lipids – Triglycerides and compound lipids	
Unit V: Nucleus and Chromatin Biology	
Ultra structure of nucleus and functions. Molecular structure of chromosomes: Euchromatin and Heterochromatin; Role of histones in Packaging DNA; Nonhistone proteins; C- Value Paradox. Nucleolus – organization and functions. Unit VI: Cell Cycle, Apoptosis, Cancer biology and Immunology 13) Cell Cycle- Molecular events; Role of Cyclins and Cyclin Dependent Kinases (CDK) in cell cycle. Apoptosis - Mechanism and significance Cancer Biology - Benign and Malignant tumors; Characteristics and properties of cancer; Development and causes of cancer; Carcinogens; Oncogenes; Oncoviruses; Tumor suppressor genes; Diagnosis and treatment of cancer. Immunology: Cells and tissues of immune system, types of immunity, T and B lymphocytes; Cytokines, MHC molecules. Immunoglobulins: types, structure and functions of immunoglobulins.	7 Hours

Paper Code and Name	**PG87T203: Animal Physiology**
COURSE OUTCOMES (COs)	
After completion of Animal Physiology paper students will be able to: • Understand the entire animal's functions of the body, including nutrition, • Respiration, blood circulation, excretion, • Nerve and muscle physiology etc., • Attain knowledge on the mechanism of osmoregulation and • Thermoregulation in animals.	

PG87T203: Animal Physiology	**Teaching Hours (Max. 48)**
Unit I: Introduction to Physiology and Physiology of Respiration and Blood	
History and central themes of Animal Physiology and its sub-disciplines Respiration: The atmosphere, solubility of gases, respiratory organs in the vertebrates; Respiratory mechanisms in aquatic and air breathing fishes, birds and mammals; respiration in eggs; Exchange of O_2 and CO_2 and transport. Oxygen dissociation curve. Blood - components and functions; acid-base balance regulation. Circulation: General principle, vertebrate circulation, the physics of flow in tubes, Hemostasis.	12 Hours
Unit II: Water and Osmoregulation	
Properties of water molecules; Osmoregulation, osmoregulators and conformers; Obligatory exchanges of ion and water; Osmoregulatory organs; Osmoregulation in aqueous and terrestrial animals	6 Hours
Unit III: Temperature	
Classification of animals based on thermal biology, Temperature relations of ectotherms, heterotherms and endotherms, specialized metabolic states – torpor, hibernation, and aestivation.	6 Hours
Unit IV: Feeding, Digestion and Energy metabolism	

Feeding methods and mobility of the alimentary canal; Physiology of digestion and absorption, gastrointestinal secretions; nutritional requirements (micro and macro). Enzymes and metabolism: General properties, Regulation of metabolic reactions, Metabolic production of ATP; Efficiency of energy metabolism.	12 Hours
Unit V: Movement	
Structural organization of contractile proteins of muscle-actin and myosin; Mechanism of muscle contraction; Adaptations of muscle for various activities – jumping, swimming, sound and flight.	6 Hours
Unit VI: Nervous system	
Structural organization and functions of nervous system; Electrochemical, resting and action potential; Transmission of information within neuron, synaptic transmission (electrical and chemical); Neurotransmitters.	6 Hours

	Practicals	
Paper Code and Name	**PG87P201- MOLECULAR GENETICS PRACTICALS**	**Teaching Hours (Max. 48)**
PG87P201- MOLECULAR GENETICS PRACTICALS • Study of polytene chromosomes in: a. *Chironomous* larva *Drosophila* larva • Study of genetics of blood group in Man • Study of X-chromatin or Barr body in buccal cell of Human • Human Karyotype analysis: a. Normal male b. Normal female 6. Human Karyotype analysis: a. Down syndrome b. Cri-du-chat syndrome c. Klinefelter syndrome d. Turner syndrome e. Translocation • 7. Study of *Drosophila* mutants a.Normal male b.Normal female c.Yellow body d.Bar eye e.White eye f.Vestigial wing g.Ebony body h.Sepia eye • Study of sex comb and genital plate of different *Drosophila* species • Study of karyotype of different *Drosophila* species • Study of Sternopleural and Acrostical bristles and statistical analysis of *Drosophila* • Study of eye pigments of *Drosophila* by paper chromatography. • Study of inversions of *Drosophila.* • Any other practical depending on feasibility.	

PARTICULARS	Teaching Hours (Max. 48)
PG87P202- - MOLECULAR CELL BIOLOGY PRACTICALS 1.Study of epithelial tissues: ciliated, columnar and squamous, etc. 2.Study of nervous tissue: Myelinated and unmyelinated nerve cells 3.Study of Muscular tissue : Smooth muscles, striated muscles and cardiac muscle 4.Study of connective tissues ; Bone and cartilage; Blood cells – Neutrophils, Basophils, Eosinophils, Lymphocytes and Monocytes 5.Estimation of DNA by Diphenylamine (DPA) method 6.Estimation of RNA by Orcinol method 7Study of mitosis - observation of permanent slides 8.Study of stages of Mitosis in onion root tips 9.Study of meiosis – observation of permanent slides 10Study of stages of meiosis in grasshopper testis 11.Histopathological examination (HPE) of normal and malignant cells. 12.Preparation of stains and fixatives 13.Observation of Lactobacillus from the curd sample 14.Study of eukaryotes from rectal parasite of frog. 15.Any other practical depending on feasibility.	
PG87P203- - ANIMAL PHYSIOLOGY PRACTICALS 1.Qualitative analysis of carbohydrates 2.Qualitative analysis of polysaccharides 3.Qualitative analysis of proteins 4.Qualitative analysis of lipids 5.Total count of blood corpuscles 6.Differential count of WBCs 7.Estimation of blood clotting time 8.Estimation of protein and hemoglobin 9.Estimation of cholesterol and triglycerides 10.Analysis of pathological contents of urine 11.Estimation of glucose 12.Identification of adulterants 13. Any other practical depending on feasibility.	48 Hours

	SEMESTER-III
Paper Code and Name	**PG87T301: Developmental Biology**
COURSE OUTCOMES (COs)	
After completion of Developmental Biology paper students will be able to: • Understand the process of development of animals, process of organogenesis of selected organs, development of extra, embryonic membrane and the nature and physiology of placenta. • Learn the inducer and inductor role in embryogenesis and gaining knowledge about the metamorphosis and the process of regeneration. Familiar with various stages involved in the developing embryo. Understand the initial developmental procedures involved in Amphioxus, frog and chick. Ability to explain various Prenatal Diagnosis. • Familiarise with the principle of developmental biology, various Techniques and tools of Embryology.	

PG87T301: DEVELOPMENTAL BIOLOGY	**Teaching Hours (Max. 48)**
Unit I: Introduction	
Overview of development, Anatomical and experimental approach to developmental Biology: embryological origin of gene theory, Evidence for genomic equivalence. Nuclear transplantation experiments in frog and mammal- the concept of totipotency. Nucleo-cytoplasmic interactions during early development in Ameoba and Frog.	(6)
Unit II: Fertilization and early development	
Fertilization- Cellular and biochemical processes during early fertilization; Strategies for monospermy and prevention of polyspermy in conservation of species; Signal transduction and egg activation.	5Hours
Unit III: Development in Drosophila	
Genetic and molecular analysis of axis formation in *Drosophila*: Development of larva; Establishment of anterior, posterior, dorsal and ventral polarity; Role of maternal effect genes, segmentation genes and homeotic selector genes.	8 Hours
Unit IV: Development in Amphibians	
Genetic and molecular analysis of axes formation in amphibia: Mechanism of progressive determination of amphibian axes – the origin and molecular biology of Nieuwkoop centre, primary embryonic and regional specificity of induction: Organizer functions and its diffusible proteins.	9 Hours
Unit V: Cell differentiation and organogenesis	
Development of somites and differential cell proliferation in shaping organ primordia – Myogenesis – Determination of myotome, specification and differentiation by myogenic bHLH proteins, muscle cell fusion. Differentiation of neural tube - Primary and secondary neurulation, Differentiation of neural tube- Anterior-posterior axis, dorsoventral axis; Differentiation of erythrocytes - Hematopoiesis.	10 Hours
Unit VI: Post-embryonic development and Teratology	
Metamorphosis in Amphibia- Morphological, biochemical changes and molecular mechanism of hormonal regulation; Regeneration in Hydra, Planaria and Salamander. Growth- concept, isometric and allometric. Teratology: Causation of abnormal development, experimental studies; Teratogens.	10 Hours

Paper Code and Name	PG87T302: Evolutionary Biology

COURSE OUTCOMES (COs)

After completion of Evolutionary Biology paper students will be able to:

1.Understand the contributions of evolutionary biologists and interpret various theories on evolution.
2.Identify the significance of evolution in understanding biology.
3.Explain the Hardy-Weinberg principle of genetic equilibrium and various forms of evolutionary forces.
4.Grasp the concepts of Neo-Darwinism and Non-Darwinism.
5.Get an insight into different mechanisms of speciation and origin of higher categories.
6.Understand the evolution of life histories, trade-offs and the evolutionary basis of aging.
7.Understand the theories of evolution and highlighted the role of evidences in support of evolution.
8.Learn the evolutionary knowledge through the concepts of coloration and mimicry.
9.Obtain the knowledge about direct observation of fossils and their evolutionary relationship of animal groups.
10.Understand the inheritance of mendelian traits by direct observation among students.
11.Acquire knowledge skill development and observation of blood group identification and pedigree chart preparations.

PG87T302: Evolutionary Biology	Teaching Hours (Max. 48)
Unit I: Introduction to evolution and Theories of evolution	
Evolution of evolutionary thoughts. Lamarckism; Natural Selection (Darwinism), Contributions of Charles Darwin, Alfred Russel Wallace, Thomas Malthus and Hugo de Vries; Postulates of Natural Selection and evidences; Natural Selection in action- Industrial melanism; Darwin's finches, Experimental evidences of Natural selection- Endler's guppies ; Concepts of inclusive fitness – altruism and kin selection.	14 Hours
Unit II: Neo-Darwinism	
Hardy-Weinberg Law of genetic equilibrium; Genes and genotype frequencies, Concept of Mendelian Population and gene pool; Factors operating against Hardy-Weinberg Law; Selection - types of selection- balancing selection, frequency dependent selection, directional selection, disruptive selection, artificial selection; Random Genetic drift (Bottle neck effect, Founder's effect); Migration.	10Hours
Unit III: Non-Darwinism	
Molecular polymorphism: Nucleic acids and proteins; Molecular clock; Neutral theory of evolution and evolution random walk; Forces in evolution- stochastic vs deterministic.	4 Hours
Unit IV: Speciation and origin of higher categories	
Reproductive isolation mechanisms – pre- and post-zygotic. An overview of speciation - allopatric, sympatric, peripatric and parapatric modes of speciation; Phyletic gradualism and punctuated equilibrium; micro and macroevolution	6 Hours
Unit V: The Evolution of Life histories	
Basic questions in life history evolution; Life history trade-offs: Optimality arguments, age and size at maturation; clutch size and reproductive investment, empirical evidences of life-history trade-offs; Life span and aging; evolutionary theories for aging.	10 Hours
Unit VI: Impact of Darwin's thoughts in understanding human health and diseases	
Darwinian medicine; Proximate versus ultimate causes of diseases; Design defects; Defense Mechanisms; Allergy; Evolution of antibiotic / Pesticide resistance; Evolution of behaviors such as anxiety, fear and depression.	4 Hours

Paper Code and Name	PG87T303: Animal Biotechnology

COURSE OUTCOMES (COs)

After completion of Animal Biotechnology paper students will be able to:

1.Get knowledge about animal cell culture, growth of cell lines and its applications

2.Understand gene and animal cloning through r DNA technology.

3.Describe recombinant DNA technology, genetic manipulations and their use in a variety of industrial processes.

4.Highlight the importance of transgenic animals and application of gene therapy.

5.Understand the applications of animal biotechnology in production of various products , nanotechnology and its applications.

6.Attain knowledge about the history, branches, scope of biotechnology and gene transfer technique.

7.Understand the recombinant technology, gene integration into the vector and with host genome and creation of transgenic animals.

8.Attain knowledge about in-vitro fertilization and embryo transfer.

9.Understand the DNA finger printing, blotting technique and micro array.

10.Describe the applications of stem cells and gene therapy and biotechnology devices**,** sterilization technique, and DNA isolation from cells and its use in animal identification.

PG87T303: Animal Biotechnology	Teaching Hours (Max. 48)
Unit I: Introduction Concept, scope, development, current status and future of animal biotechnology	02 Hours
Unit II: Animal cell culture and Stem cell technology: Animal cell culture: Cell culture techniques; Cell lines and storage. Equipments, Culture media, Applications of animal cell culture. Stem cell technology: Types and properties of stem cells, Differentiation of stem cells, Advantages and disadvantages of stem cell technology.	10 Hours
Unit III: Gene and Animal cloning Gene cloning: Method of gene cloning; Molecular tools; Restriction enzymes, ligases and other enzymes, cloning vectors; Selection and screening of transformed cells. Cloning strategies: Construction of genomic and cDNA library. Application of gene cloning. Gene transfer techniques- Transformation; Microinjection; Electroporation; Polycations; Lipofection and Retroviral infection. Animal cloning: Cloning in different animals with special reference to Dolly; Somatic cell nuclear transfer (SCNT).	12 Hours
Unit IV: Transgenic Animals and Gene therapy Transgenic animals: Importance of rDNA technology; Genetically Modified Organisms (GMOs), gene targeting, gene knock-out and knock-in technology, gene-silencing; Advantages and disadvantages of transgenic animals – ethical concerns. Gene therapy: Methods; somatic and germ line therapy, gene therapy in animals and embryos.	8 Hours
Unit V: Application of Animal Biotechnology Production of regulatory proteins (insulin, somatostatin); Whole blood; RBC; Platelet concentration, Albumin; Clotting factors, Hemoglobin. Anticoagulants (heparin, vitamins, plasminogen activator). Hybridoma technology - Production and applications of monoclonal antibody. Recombinant vaccines; DNA vaccines, DNA probes, Biochips.	8 Hours

Paper Code and Name	PG87P301 - DEVELOPMENTAL BIOLOGY (PRACTICAL)	Teaching Hours (Max. 48)
PG87P301 - DEVELOPMENTAL BIOLOGY PRACTICALS Study of different developmental stages of chick embryo in whole mounts.Study of transverse sections (T. S.) of chick embryos Temporary mounting of chick blastoderms, embryos of different developmental stages and study of morpho-anatomical features of these embryos. Observation of development of *In vivo* cultured chick embryo by 'window method'. Study of transverse sections (T. S.) of frog embryos and tadpoles. Study of morpho-anatomical changes during metamorphosis in frog. Study of development and life cycle of *Drosophila*: a) Egg b) I Instar c) II Instar d) III Instar e) Pupal stage Temporary mounting of cellular blastoderm, sex comb and halters in *Drosophila melanogaster*. Study of development and life cycle of mosquito. Study of rat spermatozoa and ova. Study of pre-implantation stages in mouse, *Mus musculus* a) Zygote b) 2 cell embryo c) 4 cell embryo d) 8 cell embryo e) Morula f) Blastocyst with intact zona pellucida g) Hatched blastocyst 13. Any other practical depending on feasibility.		

PG87P302- Evolutionary Biology PRACTICALS	Teaching Hours (Max. 48)
PG87P302- Evolutionary Biology PRACTICALS 1-2. Evidence for Principle of Evolution: a. Homologous structures. b. Serial homology. 3-4. Evidence for Principle of Evolution: a. Analogous organs. b. Vestigial organs. 5. Embryological evidence for evolution: Descent with modification. 6. Fossils and Living fossils. 7-8. Application of Hardy-Weinberg principle to determine allelic frequency of: a. PTC trait in man b. blood group trait in man 9. Experiment to elucidate the principle of overproduction that leads to struggle for existence. 10. Study to elucidate that every individual is unique and variations are universal. 11-12. Experiment to demonstrate how natural selection works: a) alphabet analogy. b) beetle survival. 13. Modification of structures for new function that have lost their original role. 14. Any other practical depending on feasibility.	
PG87P303- ANIMAL BIOTECHNOLOGY PRACTICALS	
PG87P303- ANIMAL BIOTECHNOLOGY PRACTICALS 1.General requirements of animal biotechnology laboratory 2.Sterilization Techniques – Physical, Chemical & Radiation 3.Separation of Amino acids by paper chromatography	48 Hours

4.Identification of bacteria's through Graham's staining method 5.Cell viability test by using trypan blue 6.Extraction of DNA and RNA from animal tissues 7.Isolation of Casein, Lactose, and Albumin from Milk 8.Preparation of buffers used in animal biotechnology 9.Preparation of different types of media. 10.Protozoan's culture in laboratory as a model for cell culture 11.Demonstration of Agarose Gel Electrophoresis 12.Demonstration of PolyAcrylamide Gel Electrophoresis (PAGE) 13.Demonstration of Instruments used in animal Biotechnology 14.Cell Death during development (Apoptosis). 15.Any other practical depending on feasibility.	

	SEMESTER-IV
Paper Code and Name	**PG87T401: General and Comparative Endocrinology**

COURSE OUTCOMES (COs)

After completion of General and Comparative Endocrinology paper students will be able to:
1.Explain the feedback mechanisms of hormonal action and their significance in homeostasis.
2.Discuss the hormonal regulation of calcium, glucose and intermediary metabolism.
3.Understand the biological actions of different hormones.
4.Describe the comparative anatomy of different endocrine glands.
5.Establish a link between immune system and endocrine system and elucidate the hormonal regulation of immune response.
6.Have an idea about the glands which works inside the body and secretes a chemical called hormone, their classification and regulation and antibody antigen reaction.

PG87T401: General and Comparative Endocrinology	**Teaching Hours (Max. 48)**
Unit I: Aim and scope of Endocrinology	
Pioneers in Endocrinology - Discovery of hormones; Techniques in endocrinology; Hormones as chemical messengers - Classification of hormones.	5 Hours
Unit II: Comparative anatomy of Endocrine glands	
Endocrine hypothalamus, pituitary, pineal, thyroid, parathyroid, adrenal and pancreas; Neurovascular hypothesis.	5 Hours
Unit III: Hormones – Homeostasis and Biological actions	
Positive and negative feedback of hormone action. Calcium and glucose homeostasis; ormonal regulation of intermediary metabolism: carbohydrate, protein and lipid. Hormones and behaviour. Biological actions of hormones of hypothalamus, pituitary, pineal, thyroid, parathyroid, adrenal and pancreas.	14 Hours
Unit IV: Mechanism of hormone action, Biosynthesis and secretion of hormone	
Hormone receptors- types and structure, regulation; Mechanism of hormone action- peptide hormone, receptor signal transduction, G proteins, Cyclic AMP, other membrane messengers - Protein kinase C; Phospholipase C. Mechanism of action of steroid hormones; Termination of hormone action. Biosynthesis and secretion of steroid hormones - corticosteroids and sex-steroids, Catecholamines, thyroid hormones, Peptide hormones- insulin; Hormonal inactivation.	13 Hours
Unit V: Growth factors	
Insulin, Prolactin, placental lactogen and IGFs; Neurotrophic growth factors; Hematopoietic growth factors; Epidermal growth factors; Transforming growth factors; Fibroblast growth factors; Cytokines, chalone.	5 Hours
Unit VI: Immunoendocrinology	

An overview of organization and function of immune system, effect of endocrine ablation and replacement on immune response; Sexual dimorphic immune response and its mechanism; Effect of pregnancy on immune response; Hormonal regulation of immune responses; Immuno-endocrine interactions involved in the immune response.	6 Hours

Paper Code and Name	**PG87T402Biology of Reproduction**
COURSE OUTCOMES (COs)	
After completion of Biology of Reproduction paper students will be able to: 1.Understand the overview of reproduction, differentiation of sex and gonads and their hormonal regulation, implantation gestation, parturition and lactation. 2.Describe the structure of the organs of the male and female reproductive system and their function like, spermatogenesis, oogenesis and folliculogenesis. 3.Describe the biological principles underlying contraceptive technology, compare and contrast the various options for control of fertility. 4.Explain how sexually transmitted disease will spread, its control and may contribute to altered neonatal or reproductive function.	

PG87T402Biology of Reproduction	**Teaching Hours (Max. 48)**
Unit I: An overview of Reproduction	
Sex determination and differentiation of gonads, gonadal ducts and their hormonal regulation	4 Hours
Unit II: Male Reproductive system	
Anatomy of male reproductive system, Histo-architecture of testis, Spermatogenesis, Functions of Sertoli and Leydig cells; Seminiferous epithelial cycle and wave, Stem cell renewal. Hormonal control of spermatogenesis. Patterns of spermatogenesis and testicular cycles in non-mammalian vertebrates.	10 Hours
Unit III: Male accessory reproductive organs	
Functional morphology and hormonal regulation of epididymis, Vas deferens, Prostate gland, Seminal vesicle, Coagulating and Cowper's glands; Biology of spermatozoa, and Biochemistry of semen; Biological actions of androgens.	10 Hours
Unit IV: Female Reproductive system	
Anatomy of female reproductive system; Histo-architecture of ovary, Folliculogenesis, Follicular atresia, ovulation, Corpus luteum; Hormonal regulation of estrous and menstrual cycle; Biological actions of estrogens. Structure of ovary and ovarian cycles in non-mammalian vertebrates.	10Hours
Unit V: Implantation, Gestation, Parturition and Lactation	
Types of implantation, sequential events and hormonal regulation, delayed implantation; Placenta – histophysiology and endocrine function, Endocrine regulation of pregnancy and parturition; Lactation– Development of mammary glands, Hormonal control of lactation.	8Hours
Unit VI: Fertility and Infertility	
Fertility control in male and females – Natural methods, barrier methods, intrauterine devices, hormonal contraceptives, surgical and immunological approaches; Amniocentesis; ARTs – Induction of ovulation, Artificial insemination, IVF, GIFT, ZIFT, Surrogate pregnancy, Gestational carrier.	(06)

Paper Code and Name	PG87T403 Applied Zoology

COURSE OUTCOMES (COs)

After completion of Applied Zoology paper students will be able to:

1.Get a holistic idea about the aquaculture, fisheries, apiculture, lac, poultry, diary, vermiculture, sericulture, and their industries.

2.Understand the various types and methods of aquaculture practicesand the physiology and reproductive mechanisms of important fishes.

3.Learn the modern techniques and methods of fishery industries.

4.Attain knowledge about important cultivable fin fishes, shell fishes and importance of value added fishery products.

5.Understand the culture of mulberry plants, methods of rearing *B. mori*.

6.Gain knowledge about quality determination of mulberry silk and marketing strategies.

7.Describe the diseases and pests of *B. mori*.

PG87T403 Applied Zoology	Teaching Hours (Max. 48)
Unit I: Vermiculture	
Life cycle of earthworm; Establishment of vermiculture unit; Earthworm as a tool for conversion of waste material into vermicompost; Types of earthworm; Earthworm as Fish and Poultry feed; Vermiwash.	6 Hours
Unit II: Apiculture and Sericulture	
Apiculture: Life cycle, foraging and colony organization in different species; Bee keeping practices in India. Composition and uses of honey; Bee products; Lac insect- life cycle, cultivation and uses of Lac. Sericulture: Classification of silkworms based on moultinism, voltinism and geographical distribution; Popular silkworm breeds and hybrids. Life cycle of *Bombyx mori;* Diseases and pests of silkworm: protozoan, bacterial, viral and fungal diseases (mode of infection, transmission, prevention and control measures).	12 Hours
Unit III: Insect Pest Management	
Crop pests: Life cycle and damaged caused by pests of cotton, sorghum, pulses and fruits. Household pests; Integrated Pest Management. Mass multiplication of bio-control agents.	6Hours
Unit IV: Parasitology	
Kinds of vectors and blood sucking dipterans; Important humans and veterinary parasites (Protozoan and Helminthes), Host- parasite interactions.	6 Hours
Unit V: Fisheries	
Freshwater, brackish water and marine fisheries resources of India and its importance. Culture of Exotic fishes; Composite fish culture; Induced breeding. Cold water fisheries, Shell fisheries. Preservation and processing of fish and fish by-products	8 Hours
Unit VI: Poultry and Dairy science	
Poultry: Indigenous and Exotic Poultry Breeds. Techniques and methods of breeding; Poultry products; Nutritive value of egg and meat. Poultry diseases: Viral, bacterial, fungal, protozoan and Helminth diseases and their control, vaccines for infections. Dairy science: Indigenous and Exotic breeds. Principles and methods of breeding. Modern trends in breeding dairy animals. Dairy products: Processing, preservation and marketing of milk and milk products. Nutritive value of milk. Dairy pathology: Viral, bacterial and parasitic (Endo-Ecto) infections. Vaccination and control of diseases.	10 Hours

Paper Code and Name	PG87P401GENERAL AND COMPARATIVE ENDOCRINOLOGY (PRACTICALS)	Teaching Hours (Max. 48)
PG87P401GENERAL AND COMPARATIVE ENDOCRINOLOGY PRACTICALS Display of endocrine glands in rat. Study of pituitary and pineal glands in rat. Study of pituitary and pineal glands in fish. Preparation of fixatives and stains, fixation of all endocrine glands as per the protocol. 5-6. Processing of following endocrine glands for histology: a) Ovary b) Testis c) Adrenal d) Thyroid with Parathyroid e) Pancreas – Islets of Langerhans 7-8. Comparative histoarchitecture of following endocrine glands (fish to mammals): Pituitary gland. Thyroid and parathyroid Pancreas Adrenal and inter-renal glands 9-10. Enzyme histochemistry - localization of steroid dehydrogenase enzyme activity (Δ^5-3β-HSDH and 17-3β-HSDH) in the adrenal, ovary and testis of rat. 11. Estimation of Acetylcholinesterase enzyme (AChE) activity. 12. ELISA- Quantitative measurement of sex steroid hormones in serum of rat. 13. Any other practical depending on feasibility.		

PG87P402BIOLOGY OF REPRODUCTION PRACTICALS	Teaching Hours (Max. 48)
PG87P402BIOLOGY OF REPRODUCTION PRACTICALS Study of estrous cycle in rat Study of mammalian ovary- Primordial follicle, primary follicle, antral follicle, Graafian follicle, corpus luteum, corpus albicans and atretic follicles. Study of female accessory reproductive organs in rat - T. S. of Fallopian tube - T.S. of Uterus 4. Induction of pseudopregnancy in rat. 5. Histology of testis and male accessory reproductive organs in rat - Epididymis - Seminal vesicles - Coagulating glands -Ventral prostrate and - Cowper's glands / Bulbourethral gland. 6. Androgen bioassay in rat. 7. Study of abnormal spermatozoa in rat. 8. Quantification of number of sperms in rat epididymal fluid. 9. Comparative anatomy of the ovary in non- mammalian vertebrates - T. S. of Fish ovary - T. S. of Amphibian ovary - T. S. of Reptilian ovary - T. S. of Bird ovary 10. Comparative anatomy of the testis in non- mammalian vertebrates - T. S. of Fish ovary - T. S. of Amphibian ovary	

- T. S. of Reptilian ovary
- T. S. of Bird ovary

11. Pathology of Reproductive system
- Cryptorchid testis, Prostate cancer
- Polycystic ovary, Endometriosis

12. Contraceptive methods - Intra-uterine device - Hormonal contraception

13. Any other practical depending on feasibility.

PG87P403- APPLIED ZOOLOGY	48 hours

PG87P403- APPLIED ZOOLOGY

1.Vermitechnology: Study of Digestive system in Earthworm.

2.Vermitechnology: Mounting of setae, blood glands, nephridia and ovary of Earthworm.

3.Apiculture: Bee keeping appliances: Study of digestive system in Honey bee.

4.Apiculture: Mounting of poison apparatus, pollen basket, pollen brush, wax glands and mouth parts of Honey bee.

5.Insect pest management: Study of agricultural and horticultural pests and bio control agents.

6.Parasitology: Study of pathogenic parasites.

7.Fisheries: Economically important freshwater fishes: (*Catla catla, Labio rohita, Cirrhinus mrigala, Cyprinus carpio, Wallago attu, Clarius batrachus, Mystus seengala and Channa punctatus).*

8.Fisheries: Marine fishes: Sardine, Mackerel, Trygon, Scoliodon, 9.Bombay duck and Pomfret). Shell fishes: Prawn, Pearl oyster and Sepia.

10.Silkworm Biology: Life cycle of *Bombyx mori*. Study of digestive system of larva. Mounting of silk gland and spiracles.

11.Study of Silkworm pathogens.

12.Dairy Science: Study of Different breeds: Study of Ecto and endo parasites (Mode of infection, prevention and control measures).

13.Poultry: Study of Different breeds: Study of Ecto and endo parasites. (Mode of infection, prevention and control measures).

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	OPEN ELECTIVE COURSES (OEC)
Paper Code and Name	**PG87T204A-Animal Behaviour**
COURSE OUTCOMES (COs)	
After completion of Animal behavior paper students will be able to: 1.Learn a wide range of theoretical and practical techniques used to study animal behavior 2.Develop skills, concepts and experience all aspects of animal behavior. 3.Objectively understand and evaluate information about animal behaviour and ecology encountered in our daily lives. 4.Evaluate the role of behaviour in the protection and conservation of animals in the wild. 5.Consider and evaluate behavior of all animals, including human in the complex ecological world including the urban environment.	

PG87T204A-Animal Behaviour	Teaching Hours (Max. 48)
Unit I: Introduction to Animal Behavior	
Animal Behavior: Introduction, definition and history (Lorenz, Tinbergen, von Frisch); Questions about animal behavior	4 Hours
Unit II: Development of Behavior	
Behavior and genes; Innate behavior; Parent-offspring interaction; Imprinting- Filial Imprinting and Sexual imprinting; Instinct- Interaction between instinct and learning	8 Hours
Unit III: Learning	
Definition and forms learning: Habituation; Associative learning/ conditioning (Classical conditioning- Pavlov; Operant conditioning, instrumental learning, Skinner), Spatial learning; Insight learning; Social learning; Cognitive maps; Observational learning/imitation; Insight learning; Social learning	8 Hours
Unit IV: Communication	
Sign and normal stimuli; Channels of communication; Pheromones and acoustic signals; Evolution of display and mimicry, aposematic coloration, deception and honesty; communication in social groups, alarm calls, alarm pheromones, trail pheromones; Dance language in honey bee; Primate language	10 Hours
Unit V: Evolution of Social system	
Society, benefits and costs of sociality; Social interactions of groups- Altruism – concept of inclusive fitness, (Kin selection, parental care); Reciprocal Altruism, selfish, spite, conflict and infanticide; Insect eusociality: a case of altruism and cooperation (honey bee); Vertebrate societies; Human sociobiology; Biological and cultural evolution	10 Hours
Unit VI: Cooperation and conflict	
Fine balance between Cooperation and conflict : Queen-worker conflict in ants; Worker-worker conflict in honey bees; disease as an enhanced social conflict; Chimpanzee politics, Parental harassment of sons in bee eaters; communal nursing: Mutiny in ant colony; mother – offspring conflict	8 Hours

Paper Code and Name	PG87T304A-Economic Zoology

COURSE OUTCOMES (COs)

After completion of Economic Zoology paper students will be able to:
1.Understand the culture technique of fish and vermiculture..
2.Understand the silk worm rearing and their products
3.Understand the bee keeping equipments and apiary management.
4.Understand dairy animals management, the breeds of economically important animals and learn the testing of egg and milk quality.
5.Learn various concepts of lac cultivation.
6.Aware of a broad array of career options and activities in human medicine, biomedical research and allied health professions.
7.Understand the pests, parasites and their management and also about the disease of they spread.

PG87T304A-Economic Zoology	Teaching Hours (Max. 48)
Unit I Introduction	
Importance of Economic Zoology	1 Hours
Unit II: Vermiculture	
Establishment of vermiculture unit; Earthworm as a tool for the conversion of biodegradable waste into vermicompost; Earthworms as poultry and fish feed; Vermiwash.	6 Hours
Unit III: Beekeeping and Sericulture	
Beekeeping practices in India; Foraging and colony organization in honeybees; Composition and uses of honey and bee products. Lac culture: Cultivation and uses of lac. Importance of sericulture as a rural industry; Life cycle of *Bombyx mori*; Modern rearing methods, reeling, grading and marketing.	11 Hours
Unit IV: Pest management and Parasitology	
Pests of economically important crops; Household pests; Damages caused by pests; Integrated Pest Management (IPM)- Different components and general idea about the biocontrol agents; Vertebrate (birds and rodents) pest management. Definition and types of parasites and vectors; Blood sucking dipterans; Important human and veterinary parasites (protozoans and helminthes); Host-parasite interactions.	16 Hours
Unit V: Fisheries	
Culture of major carps and exotic carps; Off-shore fisheries- Sardin; Composite fish culture; Ornamental fishes; Pearl culture; Fish by-products.	10 Hours
Unit VI: Poultry keeping	
Different breeds of chicken and different breeding systems; Egg production and economics.	4Hours

REFERENCES

Note: The figure in the parantheses indicates approximate number of lecture hours to reflect the weightage to be given to respective topics.

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