DEPARTMENT OF ZOOLOGY

SYLLABUS FOR M.Sc. IN ZOOLOGY
(CHOICE BASED CREDIT SYSTEM)

MADHABDEV UNIVERSITY

NARAYANPUR, LAKHIMPUR

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About the Department: Department of Zoology of Madhabdev University was established in 1967. The department was an important part of the Madhabdev College at that time. Madhabdev College was upgraded to the University in the year 2019. The department is providing now UG (NEP) course, PG course and PhD course. This PG and UG course includeteachingin diverse areas, such asChordates and Non chordates, Animal Physiology, Biochemistry, Fish Biology, Immunology, Developmental Biology, Genetics, Cell Biology, Taxonomy, Endocrinology, Bioinstrumentation, Biostatistics, Animal Behaviour and Evolutionary Biology. Apart from teaching, the faculty has been started research work in Biochemistry and Molecular Biology field.

The vision of the department is to develop an excellent centre in education & research in the field of It also aims to develop teaching and research programmes that have relevance to the society and employability.The M.Sc. programme is being revised under CBCS scheme of UGC to meet the expectations of students and to fulfil the vision and mission of the Department.

Programme Learning Outcomes (PLO):

The programmeoutcomes (specific skills, generic skills and attributes) that a post-graduate student of Zoology will have at the end of the completion of M.Sc. degree in Zoology are as follows :

PLO1.Disciplinary knowledge: Apply knowledge of Zoology, Life Sciences, and related subjects to comprehend complex life processes and phenomena.

PLO2.Reflective thinking andproblem solving: Identity, review, and analyse complex situations involving living forms.Design processes/strategies that meet the specified needs while taking into account public health and safety, as well as cultural, societal, and environmental factors.

PLO3.Investigating complex problems: To provide valid conclusions, apply research based knowledge and research methods such as experiment design, data analysis and interpretation, and information synthesis.

PLO4.Social responsibility: Apply reasoning informed by contextual knowledge to evaluate societal, health, safety, legal, and cultural issues, as well as the responsibilities that come with them, in the context of professional engineering practise.

PLO5. **Communication Skills**: To have the ability to present and express information, thoughts, experiments and results clearly and concisely for effective communication of any issues related to animals.

PLO6.**Understanding the environment:**Understanding the impact of natural and anthropogenic activities in societal and environmental contexts, as well as demonstrating knowledge of, and need for, sustainable development Identify and justify the conservation of a variety of invertebrates and vertebrates.

PLO7. Ethics: Apply ethical principles and commit to professional ethics, responsibilities, and work/research practise norms.

PLO8. Project management: Demonstrate knowledge and understanding of Zoology and management principles, and apply them to one's own work as a team member and leader.

ProgrammeSpecific Outcomes (PSOs):

It is expected that a student after successfully completing four semesters of M.Sc. in Zoologyprogrammewould be as follows:

PSO1. Students would be sufficientlyskilled and empowered to solve the problems in the realms of Zoology and its allied areas.

PSO2. They would have plethora of job opportunities in the education, environment,agriculture-based, sericulture, aquaculture, health related sectors etc.

PSO3.The bright and ignited mind may enter into research in the contemporary areas of Zoological/Biological Sciences. The broad skills and the deeper knowledge in the field would make them highly successful and excellent researcher in advanced areas of research in the Biological sciences.

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Semester wise distribution of credits

Semester	**Core course**	**Discipline specific Elective (DSE)**	**Ability Enhancement course (AEC)**	**Generic Elective (GE)**	**Total**
I	16	06	02	----	24
II	16	06	----	04	26
III	14	04	02	04	24
IV	10	08	----	----	18
Grand Total	**56**	**24**	**04**	**08**	**92**

Curriculum structure

Semester-I

Course	Course Code	Course Name	Type	Internal Assessment marks	End semester marks	Credit
Core Course-I	PZOC 101	Taxon, Phylogeny and Evolutionary Biology	Theory	40	60	4
Core Course-II	PZOC 102	Cell Biology & Histology	Theory	40	60	4
Core Course-III	PZOC 103	Genetics & Developmental Biology	Theory	40	60	4
Core Course-IV	PZOC PR 104	Taxon, Phylogeny and Evolutionary Biology	Practical	20	30	2
Core Course-V	PZOC PR 105	Cell Biology, Histology, Genetics & Developmental Biology	Practical	20	30	2
Discipline Specific Elective-I	PZOD 101	Biochemistry-I	Theory	40	60	4
	PZOD 102	Fish & Fisheries-I				
	PZOD PR103	Biochemistry-I	Practical	20	30	2
	PZOD PR 104	Fish & Fisheries-I				
Ability Enhancement Course -I	PZOA 101	Biodiversity Management-I	Theory	20	30	2
		Total		**240**	**360**	**24**

SEMESTER-I

PZOC 101: Taxon, Phylogeny and Evolutionary Biology
Total marks: 60+40 = 100
Credit=04 (60 lectures)

Course objective:

- The goal of taxonomy is to classify the species based on their shared trait and lineages. The primary goal of taxonomy is to recognise, characterise, classify, and name all living species based on their properties and the primary objective of Evolutionary Biology is to impart appreciation for different life forms on earth and drive home the relationship between different living forms both at the genetic and the ecological level.

Course content:

UNIT 1 Concept of Systematics and Taxonomy; Importance and application of Taxonomy; Modern trends in systematic; Taxonomic characters – morphological, ecological, ethological, geographical, biochemical and molecular characters; Characters with high and low taxonomic weight; Theories of classification. (15 lectures)

UNIT 2 Species concept- Typological, Biological and Evolutionary species concept; Merits and difficulties in applying biological species concept; Subspecies, Race, Cline, Incipient species; Principles of Zoological Nomenclature; International code for Zoological Nomenclature (15 lectures)

UNIT 3 Origin of life: Concept of prebiotic environment; Neo-Lamarckian and Neo-Darwinian theory of evolution; Forces of evolution – mutation, selection, random genetic drift and migration; Speciation: Mode of speciation and factors responsible for speciation; Hardy-Weinberg law. (15 lectures)

UNIT 4 Genetic polymorphism (DNA) and natural selection, selection coefficient; C-value paradox and Genomic evolution; Evolutionary history of proteins and nucleic acids; Concept of molecular clock; Molecular phylogenetics. (15 lectures)

Suggested Literature:

- Lawrence, G. H. (1955). An introduction to plant taxonomy. Central Book Depot
- Manktelow, M. (2010). History of taxonomy. Lecture from Dept. of Systematic Biology, Uppsala University, 29.
- Evolution, Barton, N. H., Briggs, D. E.G., Eisen, J. A., Goldstein, A. E., Patel, N. H., Cold Spring Harbor Laboratory Press, New York, USA
- Evolution, Hall, B. K. and Hallgrimsson, B., Jones and Bartlett Publisher, Sudbury, USA 30.
- Evolution, Futuyma, D. J., Sinauer Associates, Inc., Sunderland, USA Department of Zoology, University of Delhi
- What Evolution Is, Mayr, E., (2001), Basic Books, New York, USA

Learning outcomes:

- A student who has completed the course should have solid knowledge of importance and application of taxonomy in the realms of Zoology and also about the species concept. They should also have an idea of fitness, the measure for selection, and how it can be measured empirically, the causes of genetic variation; selection in its various forms; heritability; how these three processes together result in adaptation.

SEMESTER-I

PZOC 102: Cell Biology & Histology
Total marks: 60+40 = 100
Credit=04 (60 lectures)

Course objective:

- This course aims to provide a detailed understanding of cell biology covering all the basic structure and dynamicity of cell, cell communications, cell signalling, cell cycle and details about cancer cell and apoptosis. It also provides a good knowledge on microscopic structure and functions of different tissues.

Course content:

UNIT 1 Structure chemical composition and function of cell membrane; Membrane transport: diffusion osmosis, ion channels and active transport Nucleus, Organization of chromosome in nucleus and structure of nucleosome Structural organization of nuclear membrane; Structure and diversity of microtubules and microfilaments
(15 lectures)

UNIT 2 Mitochondria – Structure; Glycolysis and Kreb's cycle reactions and Electron transport chain. High energy phosphate compound, oxidative phosphorylation. Structure and Functions of ER and Golgi, protein translocation, processing and glycosylation in endomembrane system; lysosomes and exocytosis Structure and Functions of Peroxisome, Ribosome (15 lectures)

UNIT3 Cell Cycle- Mechanism and its regulation; Cell division: Mitosis, mitotic apparatus and Meiosis Characteristics and origin of cancer cells, oncogenes and chemical carcinogens, metastasis and angiogenesis Cell death pathway, apoptosis, apoptotic markers, benign and malignant tumors, characteristics of malignant tumors (15 lectures)

UNIT 4 Histological structures of epithelial tissue: characteristics, organization of epithelial cell and surface modifications, Muscle tissue: types, characteristics, & ultra structure and function; Connective tissue and bone – structure and function Neuronal anatomy: types, structure and function (15 lectures)

Suggested Literature:

- Lodish etal:MolecularCellBiology(Freeman, 2000)
- Pollard& Earnshaw: Cell Biology(Saunders, 2002).
- Albertsetal: MolecularBiologyof the Cell (4thEd.), Garland,2002
- A.Paul:CellandMolecularBiology,BooksandAllied(P) 2nd Edn.(2009)
- Lodish etal:MolecularCellBiology(5th Ed.), Freeman, 2004
- DeRobertis&DeRobertis:Cell&Molecular Biology,Lea &Febriger,1987
- J.D.Bancroft,&A.Stevens,TheoryandPractice ofHistologicaltechniques,Churchill-Livingstone,2002
- W.G.B Casselman:Histochemicaltechniques,JohnWiley,1959
- A.G.E Pearse: Histochemistry; Theoretical and Applied (Vol. I, II & III), (4th ed.), Churchill-Livingstones,1980-1993

Learning outcomes:

- Upon completion of this course students should be able to understand and interpret the structure and dynamicity of cell. They will also have a clear knowledge about the cell communication and signalling, protein sorting and transportand also have a profound knowledge on cancer and apoptosis. Upon completion the degree the students will enable to use different histological techniques to study histopathology and histochemistryand also will know how to use different bio-instruments along with their principles.

SEMESTER-I

PZOC 103: Genetics and Developmental Biology
Total marks: 60+40 = 100
Credit=04 (60 lectures)

Course objective:

- Genetics is offered as a core course that provides fundamental knowledge of how organisms, populations and species evolve. Apart from Mendel's laws and basic genetics, at Master's level, this course will provide some of the most incisive analytical approaches that are now being used across the spectrum of the biological disciplines.Overall, this course will highlight extension of Mendelian Genetics, dosage compensation, evolution of the concept of gene and its amalgamation with molecular biology and study of genetic diseases.
  The main objective of Developmental Biology course is to provide four-dimensional thinking of students to truly understand the patterns and process of embryonic development, body plan, fate map, induction, competence, regulative and mosaic development, molecular and genetic approach for the study of developing embryo which is not necessarily shared with any other disciplines in the biological sciences.

Course content:

UNIT1 Mandelian Laws: Gene interaction; Extension of Mendelism -Dominance relationship, epistasis, pleotropy. Expressivity and penetrance. Sex determination and Sexlinked inheritance; Studies on metaphase chromosomes; linkage, crossing over and recombination Multiple allelism, pseudoallelism, polygenic inheritance/ interaction Extranuclear inheritance; mutations in mitochordial DNA

(18 lectures)

UNIT2 Numerical & structural Changes in chromosomes (aneuploidy, euploidy, auto and allo polyploidy); chromosome anomalies & diseases; Human genome project: History, Organisation, Goal & characterization of chromosomes Drosophila embryogenesis & development; Zygotic genes and segment formation in drosophila Development of *Caenorabditis elegans*: genetic analysis of vulva formation (15 lectures)

UNIT 3 Ovulation, Oocyte maturation, formation of germinal vesicle and polar bodies Spermatogenesis, structure of sperm; Sperm acrosome reaction and fertilization; establishment of diploidy, zygote formation Nucleocytoplasmic interaction during zygote formation

(13 lectures)

UNIT4 Cleavage pattern and fate map; formation of morulla and blastula Gastrulation, formation of three germinal layers. Viviparity in mammals; development of extraembryonic membrane and formation of placenta in mammalian embryo; structure and types of placenta and its function, Organogenesis in mammal: development of eye and heart (15 lectures)

Suggested Literature:

- Principles of Genetics, Snustad and Simmons, John Wiley & Sons, USA [Latest edition].
- Modern Genetic Analysis: Integrating Genes and Genomes, Griffiths, J.F., Gilbert, M., Lewontin, C. and Miller, W. H. Freeman and Company, New York, USA[Latest edition].
- Genetics, J. Russell, Benjamin-Cummings Publishing Company, San Francisco, California, USA [Latest edition].
- Developmental Biology: Scott F Gilbert [Latest edition].
- Essentials of Developmental Biology: JMW Slack [Latest edition].
- Principles of Development: Louis Wolpert [Latest edition].

Learning outcomes:

- Geneticswill open several avenues for students in terms of research and employability.
- Genetics has made extensive use of model organisms, many of which will be used to teach this course. By observing genetic mutations in Drosophila, students can correlate phenotype with genotype, understand genetic interaction and their molecular basis.

- Students will be able to set hands on genetic crosses to understand recessive and dominant, segregation, pattern of inheritance and finally evaluating statistical significance by counting the progeny as statistical analysis provides crucial. insight into many biological processes.
- Students will learn how genetic information is passed on in eukaryotes and prokaryotes, how genes work together in a complex manner in biological system and any alteration can lead to major phenotypic change.
- Students will also learn about the functional interactions between maternal genes and zygotic genes during development of embryos.
- Developmental Biology enquires about the fundamental processes that understand the fertilization of an egg cell and its step-by-step transformation into the fascinating complexity of a whole organism.
- Students learn best by doing and by having the opportunity to put what they have learned into practice. Therefore, using various model organism as a learning tool in Developmental Biology, students will learn how a cell behaves in response to an autonomous determinant or an external signal depends on the combination of transcriptional and posttranscriptional regulators, signalling pathway components, cytoskeletal elements, and other proteins and RNAs that it has synthesized earlier: i.e., on its developmental history.

SEMESTER-I

PZOC 104 (PR): Taxon, Phylogeny and Evolutionary Biology
Credit=02 (30 classes)
(Practical)

Total marks: 30+20 = 50

1. Study of homologous and analogous organ
2. Identification of economically important Insects and Fish.
3. Study of Mouth Parts of Insects
4. Study of morpho taxonomy and closely related species
5. Study of stored grain and agricultural pest (Tea, Rice, Maize and Citrus)
6. Taxonomic identification and morphological characteristics of Nematode and Helminths.
7. Numerical taxonomic classification of fishes
8. Study of common animal species of the region

SEMESTER-I

PZOC 105 (PR): Cell Biology, Histology, Genetics & Developmental Biology
Credit=02 (30 classes)
(Practical)

Total marks: 30+20 = 50

1. Preparation of meiotic/ mitotic chromosomes from grasshopper /tadepole /rat /onion root tip
2. Chromosomal aberration in human buccal epithelium of smokers
3. Study of sex chromatin from buccal epithelium
4. Study of polytene chromosome in drosophila larva
5. Histological studies of important organ (Liver,G.I. Tract and Endocrine gland)
6. Study of histology through permanent slides
7. Drosophila culture
8. Preparation of permanent slides of developing chick embryo
9. Study of the different developing stages of chick embryo

Semester-II

Course	Course Code	Course Name	Type	Internal Assessment marks	End semester marks	Credit
Core Course-VI	PZOC 201	Ecology & Environmental Biology	Theory	40	60	4
Core Course-VII	PZOC202	Endocrinology and Behavioral Biology	Theory	40	60	4
Core Course-VIII	PZOC203	Physiology and Immunology	Theory	40	60	4
Core Course-IX	PZOC PR 204	Ecology & Environmental Biology	Practical	20	30	2
Core Course-X	PZOC PR 205	Endocrinology, Behavioral Biology, Ecology & Environmental Biology	Practical	20	30	2
Discipline Specific Elective-I	PZOD201	Biochemistry-II	Theory	40	60	4
	PZOD202	Fish & Fisheries-II				
	PZOD PR203	Biochemistry-II	Practical	20	30	2
	PZOD PR 204	Fish & Fisheries-II				
Generic Elective-I	PZOE201		Theory	40	60	4
		Total		**260**	**380**	**26**

SEMESTER-II

PZOC 201: Ecology & Environmental Biology
Total marks: 60+40 = 100
Credit=04 (60 lectures)

Course objective:

- The objective of this course to make awareness among the young students about the surrounding environment, the impact of climate change and its mitigation, and about pollution.

Course content:

UNIT1 Concept of Ecology. Autecology and synecology; Ecosystem: structure & types Trophic structure and function, Food chain, food web, ecological pyramids, ecological Energy flow and productivity in the ecosystem (12 lectures)

UNIT2 Population ecology: Population structure, growth and fluctuation. Species interaction – interspecific and intra-specific competition, predation, parasitism, mutualism and commensalisms. Community structures and stability and community succession Ecological succession, Mechanism and causes of succession (15 lectures)

UNIT3 Pollutants (Mercury, Arsenic, PAN, Lead, Organochlorine, CO2, Methane) and their effects on organism Environmental impact assessment Greenhouse effect and global warming Concept of habitat loss and ecological balance. (15 lectures)

UNIT4 Major terrestrial Biomes: freshwater, forest- Vegetation types in Arunachal Pradesh, grassland and tundra Environmental Biotechnology: Definition, Scope and role in environmental protection Bioremediation and Eco-restoration: Definition and Scope Concept of habitat and ecological niches; Niche overlap and species coexistence. (18 lectures)

Suggested Literature:

- Field Sampling: Principles and Practices in Environmental Analysis. 2004. Conklin, A.R. Jr. CRC Press.
- Principles and Standards for Measuring Primary Production. 2007. Fahey, T.J. and Knapp, A.K. Oxford University Press, UK.
- Ecological Modeling. 2008. Grant, W.E. and Swannack, T.M., Blackwell.
- Fundamental Processes in Ecology: An Earth system Approach. 2007. Wilkinson, D.M. Oxford University Press, UK.
- Principles of Terrestrial Ecosystem Ecology. 2011. Chaplin, F.S., Matson, P.A. and Vitousek, P.M. Springer.

- Environmental Chemistry. 2010. Stanley and Manahan, E. CRC, Taylor & Francis. London.
- Freshwater Ecology: A Scientific Introduction. 2004.Closs, G., Downes, B. and Boulton, A. Wiley-Blackwell publisher, Oxford.

Learning outcomes:

- Students will be exposed to the fundamental aspects of ecology. They will get idea about the impact of anthropogenic activities on the environment. They will also have an idea about pollution and the major terrestrial biomes.

SEMESTER-II

PZOC 202: Endocrinology and Behavioural Biology

Total marks: 60+40 = 100
Credit=04 (60 lectures)

Course objective:

- The endocrinology section is designed to provide a thorough understanding of non-mammalian and mammalian endocrinology, as well as the physiological roles of the endocrine system. The section on animal behaviour focuses on the fundamental concepts of animal behavioural patterns.

Course content:

UNIT1 Endocrine system in vertebrates; Hormones: Definition and types Paracrine and autocrine action of hormone Structure of hypothalamus & Pituitary in mammal; Hypothalamic and hypophyseal hormones; Neurohypophyseal octapeptides: structure and function in vertebrates (15 lectures)

UNIT2 Structure and physiological functions of steroid hormones; Mechanism of hormone action (steroid, peptide); hormone receptors and cell signalling; Hormones of metabolism: Thyroid and parathyroid hormones & Calcium metabolism Endocrine pancreas & carbohydrate metabolism Structural Organization of Adrenal gland; Physiological role of glucocorticoid, Mineralocorticoid, catecholamine (18 lectures)

UNIT3 Pineal gland and circadian rhythm, Biological clock Courtship and mating behaviour among birds and mammals: sexual selection, sexual behaviour in higher vertebrates; Pheromones in vertebrates and behavioural implications (12 lectures)

UNIT4 Pattern of behaviour -Innate behaviour, Taxes, Kinesis, Reflexes Territoriality, aggression and conflicts behaviour Threat display and physiological changes in conflict situation Imprinting; Learning & motivation,Biological communication; Social behaviour

(15 lectures)

Suggested Literature:

- ComparativeEndocrinologyof InvertebratesbyHighman and Hill.
- Comparative VertebrateEndocrinologybyP.J.Bentley,Cambridge Univ.Press.
- Generaland Comparative EndocrinologybyE.J.W.Barrington, Oxford ClarendanPress
- EndocrinologyVol.1-3byDeGroot L.J.et.al.
- Text BookofEndocrinePhysiologybyC.R.Martin, Oxford Univ.Press, NewYork.
- TextBookofEndocrinologybyTurnerandBangnara(W.B.Sanders).
- VertebrateEndocrinologybyMc.Hadley.
- Text Book of Comparative Endocrinology by Gorbman A, and Bern H.A., John Harley and Sous, NewYork.
- Alcock: Animal Behaviour-An EvolutionaryApproach.(7th ed.) SinaurAssociates, Inc. 2001.
- Drickamer&Vessey:AnimalBehaviour Concepts,ProcessesandMethods(2nd ed.),Wadsworth,1986.
- Gadagkar:SurvivalStrategiesCooperationandConflictinAnimalSocieties.UniversitiesPress,1998.

Learning outcomes:

At the end of this course students should enable to understand the role of different hormones in human physiology along with their biosynthesis in the bodyand also will understand animal behaviour. They will develop a critical viewpoint and to interpret observations from experiments on biological rhythms regulating daily and seasonal biology.

SEMESTER-II

PZOC 203: Physiology and Immunology
Total marks: 60+40 = 100
Credit=4 (60 lectures)

Course objective:

- The main objective of this study is to knowabout the different biological processes and how they perform their functions and their regulations. It will also provide a better understanding on cellular immunology i.e. how the body fight against different pathogens.

Course content:

UNIT1 Physiology of digestion and absorption of Macronutrients, balance diet structure of GI tract:Gastro intestinal hormones and functions, Pattern of nitrogen excretion, Urea synthesis and formation of urine, Countercurrent mechanism and hormonal regulation of excretion. Thermoregulation, hibernation in vertebrates, Physiology of Bioluminescence in invertebrates (Firefly) & vertebrates. (15 lectures)

UNIT2 Physiology of Reproduction in insects, sexual dimorphism, parthenogenesis, Physiology of Reproduction in vertebrates: seasonal and nonseasonal breeders, Reproductive cycles, spermatogenesis & Oogenesis Physiology of respiration: Transportation of Oxygen and CO2, acid base balance, Nerve impulse conduction through neurons and synapse, neuromuscular junctions. (15 lectures)

UNIT3 Antigen: chemical nature, and antigenic determinants Antigen-antibody binding sites and reaction Immunoglobulin heterogeneity-Allotype, idiotype Antigen and Immunogen, Hapten, Adjuvant- properties and mechanism of action Complement system activation: classical and alternate pathways. (12 lectures)

UNIT 4 Cellular immunity: origin and maturation of T & B lymphocytes & their functions T-cell activation- molecular mechanism Allograft reaction, prevention of graft rejection Hybridoma and monoclonal antibodies-applications and therapeutic uses Hypersensitivity and autoimmunity-factors responsible for autoimmunity Histocompatibility antigen (MHC)-structure, Biological significance of HLA antigens. (17 lectures)

Suggested Literature:

- Guyton A, C & Hall, J. E. Textbook of Medical Physiology, XI Ed. W. B. Saunders Co.
- Tortora G. J. & Grabowski S. Principles of Anatomy & Physiology, XI Ed. John Wiley & Sons
- Christopher D. Moyes, Patricia M. Schulte. Principles of Animal Physiology, 3rd Ed. Pearson Education.
- Hill Richard W., et al., Animal Physiology, Vol. 2 Sunderland, M A: Sinauer Associates
- Chatterjee C C, Human Physiology Vol. 1 &2 CBS publication
- Kuby,W.F.Freeman,Immunology,U.S.A
- W.Paul,FundamentalsofImmunology

Learning outcomes:

- The students at the completion of the course will learn to develop a better understanding of various physiological processes of human body and how these processes are corelated with each other.

- They will also gain a better knowledge on Immunology. How the body react with the pathogens and what are the mechanisms through which the body can mitigate the pathogenicity.

SEMESTER-II

PZOC 204 (PR): Ecology & Environmental Biology
Credit=02
(Practical)

Total marks: 30+20 = 50

1. To study the physical and chemical characteristics of soil -C, N contentand pH of soil by rapid soil test method.

2. Determination of dissolve oxygen, carbon-di-oxide, alkalinity of the soil.

3. Estimation of the size of the population by capture-recapture method (any vertebrate/invertebrate)

4. To determine the frequency, density and abundance of the primary producers of a grassland community by quadrat method.

5. To determine the abundance and density of soil fauna.

6. Study of trophic relation (food chain/ food web) in a grassland ecosystem.

7. Decomposition of various organic matters and nutrient release mechanisms/role of arthropods and other micro-, and macrofauna in decomposition.

8. Understanding ecosystem succession by studying various stages of vegetation/community assemblages' development.

SEMESTER-II

PZOC 205 (PR): Endocrinology and Behavioural Biology, Physiology and Immunology
Credit=02
(Practical)

Total marks: 30+20 = 50

1. Neuroendocrine system of cockroach – Dissection and display
2. Prothoracic gland of cockroach – Dissection, display and mounting
3. Thyroid and parathyroid gland of mouse/chicken – dissection and display and slide preparation
4. Pituitary gland of mouse /fish – Dissection, display and permanent slide preparation using metachromatic stains.
5. Histological study of endocrine glands of vertebrates
6. Study of geotactic, phototactic, chemotactic and sociotactic behaviour of earthworm, cockroach and fish
7. Detection of uric acid in malpighian tubules
8. Haemocyte count and estimation of protein in hemolymph.
9. Haemoglobin estimation of human blood.
10. Total RBC and WBC count in human blood.
11. Determination of ABO blood group and Rh factor
12. Histological study of spleen, thymus, and lymph nodes
13. Demonstration of RIA and ELISA

Semester-III

Course	Course Code	Course Name	Type	Internal Assessment marks	End semester marks	Credit
Core Course-XI	PZOC 301	Biological Techniques & Aquatic Biology	Theory	40	60	4
Core Course-XII	PZOC302	Biostatistics, Biotechnology & Bioinformatics	Theory	40	60	4
Core Course-XIII	PZOC 303	Research Methodology	Theory	40	60	4
Core Course-XIV	PZOC PR 304	Biological Techniques, Mol. Biology, Aquatic Biology	Practical	20	30	2
Discipline Specific Elective-I	PZOD301	Biochemistry-III TH+PR	Theory & Practical	40	60	3+1=4
Discipline Specific Elective-II	PZOD302	Fish & Fisheries-III	Theory & Practical	40	60	3+1=4
Generic Elective-II	PZOE301	Applied Zoology	Theory	40	60	4
Ability Enhancement Course-II	PZOA 301	Biodiversity Management-II	Theory	20	30	2
			Total	**280**	**400**	**24**

SEMESTER-III

PZOC 301: Biological techniques & Aquatic Biology
Total marks: 60+40 = 100
Credit=4 (60 lectures)

Course objective:

- Biological techniques are the various techniques for the measurement and manipulation of different parameters within the biological system. It will also focus on the application of the techniques in various fields and focus on the diagnosis of different diseases.
- The main objective of studying aquatic biology is the protection and restoration of water quality, the management of aquatic environment

Course content:

UNIT 1 Microscopy (Principle, Application and instrumentation): Fluorescence and phase contrast, TEM and SEM, Confocal microscopy,Spectroscopy and its application,Electrophoretic technique for protein and nucleic acid separation: SDS-PAGE, agarose gel electrophoresis, ChromatographyPrinciples and applications:Ion exchange and affinity chromatography; HPLC & GC. (15 lectures)

UNIT2 Principles and application of Radio tracer techniques: RIA, ELISA, Basic histological techniques for paraffin embedded sections and cryosection; staining methods,Principles and methods of nucleic acid extraction, amplification; Construction of cDNA libraries; RT-PCR and Q-PCR Principles; techniques of In-situ hybridization of nucleic acids. (15 lectures)

UNIT3: Brief introduction of the aquatic biomes: freshwater ecosystem (Lakes, wetlands, streams and rivers), estuaries, intertidal zone, oceanic pelagic zone, marine benthic zone; Salinity and density of sea water, continental shelf, adaptation of deep-sea organisms, coral reefs, sea weeds (12 lectures)

UNIT4: Origin and classification of lake, lake as an ecosystem, lake morphometry, physico-chemical characteristics: light, temperature, thermal stratification, dissolved solids, carbonate, bicarbonates phosphate and nitrates, turbidity, dissolved gases (oxygen, carbon dioxide); nutrient cycles in lakes-nitrogen, sulphur and phosphorous.Management of aquatic resources: Causes of pollution: agricultural, industrial, sewage, thermal and oil spills, eutrophication, management, and conservation (Legislations), sewage treatment water quality assessment BOD and COD (18 lectures)

Suggested Literature:

- Webster, J. G. (Ed.). (2003). Bioinstrumentation. John Wiley & Sons.
- Bisen, P. S., & Sharma, A. (2012). Introduction to instrumentation in life sciences. Crc Press.

- Maitland, P. S. (2013). Biology of fresh waters. Springer Science & Business Media.
- Stanford, L. L., & Spacie, A. (1994). Biological monitoring of aquatic systems. Crc Press.
- Fay, R. R., & Tavolga, W. N. (Eds.). (2012). Sensory biology of aquatic animals. Springer Science & Business Media.

Learning outcomes:

- Upon completion of the course the students will know the use of bioinstruments along with their principles and they will also know about the different aquatic environments along with their different parameters.

SEMESTER-III

PZOC 302: Biostatistics, Biotechnology & Bioinformatics

Total marks: 60+40 = 100
Credit=4 (60 lectures)

Course objective:

- This course is designed so that students can practice the various important skills related to biological data that are important in the research and development sector. This course will teach computer-based programming for biological data, as well as a detailed overview of data types and statistical procedures for experiment design, data collection, and analysis of results. The students will introduce to basics of bioinformatics and biotechnology.

Course content:

UNIT1 Concept of statistics: types of data, methods of data collection. Sampling technique; classification and tabulation of data- diagrammatic and graphical representation of data. Measures of central tendency - mean, median and mode Measures of dispersion, Standard deviation, Coefficient of variation (CV), Standard error of mean(SEM)

(15 lectures)

UNIT2 Probability distribution and its application in biological studies; Test of significance- t- test, Chi square and Goodness of fit, F-test; Analysis of Variance (ANOVA); Correlation analysis (Karl Pearson's and Spearman's Rank) and Regression analysis.

(15 lectures)

UNIT3 Introduction to animal tissue culture: Principle of animal cell culture: Primary culture, cell line, and cell clones; Basic techniques in mammalian cell culture Types of growth media, component Transgenic animal-its application; Stem cell culture, applications in medicine and Biotechnology Cloning vectors (Plasmid, Cosmid, Phasmid) Lytic and Lysogenic cycle, RAPD, RFLP, DNA fingerprinting and barcoding

(15 lectures)

UNIT4 Introduction & scope of bioinformatics, Knowledge discovery and data mining, Biological databases & bioinformatics, important servers in bio-informatics, Protein &nucleotide sequence databases, Access to molecular biology databases, Sequence alignment and phylogenetic trees, Application of available software (GENEIOUS pro.5.5, PHYLIP, SWISS prot, CLUSTAL W) (15 lectures)

Suggested Literature:

- Antonisamy, B., Premkumar, P. S., & Christopher, S. (2017). Principles and Practice of Biostatistics-E-book: Principles and Practice of Biostatistics-E-book. Elsevier Health Sciences.
- Rao, P. S., & Richard, J. (2012). Introduction to biostatistics and research methods. PHI Learning Pvt. Ltd.
- BruningJ.L.andB.L.KintzComputationalHandbookofStatistics,Scott,Foresmaln andCompany(1977).
- DanielW.W.Biostatistics:AFoundationforAnalysisinHealthSciences,JohnWiley(2000).
- MiltonJ.S.andJ.O.TsokosStatistical MethodsintheBiologicalandHealthSciences,McGrawHillBookCo. (1983)
- Quinn G.P. and Keough M.J. (2002) Experimental Design and Data Analysis for Biologists,CambridgeUniv.Press.
- Barnes&Gray(ed):Bioinformaticsforgeneticists,Wiley(2003)Lesk:Bioinformatics,Oxf ord(2003,Indianed)
- Westheadetal:BioinformaticsInstantNotes,VivaBooks(2003,Indianed)

Learning outcomes:

By studying this course, students will be able to perform the data analysis and data presentation using several statisticaltools available on various computer programs. Handlethroughproteomicandgeneticdata. Understand the principle and application of biotechnology for the benefit of human being. Acquire the necessary knowledge to pursue jobs in biological data science, particularly in scientific academics, funding agencies, and educational institutions.

SEMESTER-III

PZOC 303: Research Methodology
Total marks: 60+40 = 100
Credit=4 (60 lectures)

Course objective:

- A research methodology provides a framework and guidelines for the students to clearly define research questions, hypotheses, and objectives. It helps researchers to identify the most appropriate research design, sampling technique, and data collection and analysis methods

Course content:

UNIT 1: Concept and nature of research, Types of research, Significance of research, Formulation of research problem, Novelty of research in support of existing literature, Setting the hypothesis or objective, criteria of good research, problems encountered by researchers in India (13 lectures)

UNIT 2: Definition of sampling,Sampling designs and types, Types of data collection, introduction of data presentation, statistical analysis of data and interpretation of data.

(13 lectures)

UNIT 3: Different forms of scientific writing- article, reports, notes, review article; Dissertation writing format: content, writing style, drafting titles/ subtitles, chapterization, Proper description of methods and methodology, presentation of data with statistical analysis, writing results, discussion and conclusion. Bibliography and referring style, Appendices.

(18 lectures)

UNIT 4: Utility of computer/software- MS office, excel, power point, graphics, SPSS; Use of internet for research purpose- Email, WWW., web browsing, Use of E-journals, use of E-library. (16 lectures)

Suggested Literature:

- Business Research Methods- Donald Cooper & Pamela Schindler, TMGH, 9th editions.
- Business Research Methods- Alan Bryman & Emma Bell, Oxford University Press.
- Research Methodology- C. R. Kothari 4. Select references from the Internet

Learning outcomes:

By studying the course, the students will have a clear idea about research, how to looking forward the research gap, setting the objective of the study and also will have the knowledge

on how to write a dissertation or any other research article. They will also gain a basic knowledge of computer and different computer applications.

SEMESTER-III

PZOC 304 PR: Biological Techniques, Biostatistics, Biotechnology, Bioinformatics & Aquatic Biology
Credit=2

1. Separation of substrates or amino acids by paper chromatography/TLC
2. Spectrophotometric estimation of ammonia/ urea/Amino acids
3. Extraction and estimation of protein from biological sample
4. Subcellular fractionation of tissues by differential Centrifugation
5. Graphical representation of given set/sets of data (bar & pie diagram, histogram, frequency polygon, frequency ogive & curve)
6. Submission of assignment on central tendency, deviation, and correlation of any set of data collected by students on field
7. Preparation of liquid culture medium and raise culture of *E. coli*
8. Case study on ethical issues of application of GMOs
9. Primer designing for gene amplification
10. Construction of phylogenetic trees for DNA and proteins
11. Identification of important macrophytes, phytoplankton and zooplanktons present in a lake /pond ecosystem
12. Study of feeding habits of fishes by gut content analysis
13. Determined the amount of turbidity/ transparency, dissolved oxygen, free carbon dioxide, alkalinity (carbonates & bicarbonates) in water collected from a nearby lake/pond/ stream

Semester-IV

Course	Course Code	Course Name	Type	Internal Assessment marks	End semester marks	Credit
Core Course-XI	PZOC 401	Molecular Biology/ Biochemistry	Theory	40	60	4
Core Course-XII	PZOC402	Applied Zoology	Theory	40	60	4
Core Course-XIV	PZOC403 PR	Molecular Biology, Applied Zoology&Biochemistry	Practical	20	30	2
Discipline Specific Elective-I	PZOD401	Biochemistry-IV	Project	40	60	8
Discipline Specific Elective-II	PZOD402	Fish & Fisheries-IV				
			Total	**140**	**210**	**18**

SEMESTER-IV

PZOC 401: Molecular Biology and Biochemistry
Total marks: 60+40 = 100
Credit=04 (60 lectures)

Course objective:

- The discipline particularly seeks to understand the gnome organisation of the organisms and other molecular processes through which it could be understand how the different traits are carried to the next generations and how they are regulated.
- The main motive of this discipline is to understand about the different properties of the biomolecules and anabolic processes. Moreover, to have a deep idea about the natural catalyst.

Course content:

UNIT1 Genome Organization in prokaryotes and eukaryotes. Structure and forms of eukaryotic DNA, DNA supercoiling, DNA replication: mechanism of replication in prokaryotes & eukaryotes, Molecular basis of recombination and genetic exchange, homologous and site -specific recombination (15 lectures)

UNIT2 Transcription in eukaryotes, RNA processing and splicing, Translation in eukaryotes, Genetic code, Type of mutation, molecular basis of mutation, DNA damage and repair site directed mutagenesis. Regulation of gene expression in prokaryotes: Operon concept, Attenuation and antitermination (15 lectures)

UNIT3 Classification and properties of **lipids**; Biosynthesis and oxidation of fatty acids; ketogenesis: formation and utilization of ketone bodies,**Protein**: Structure and properties of amino acid, formation of peptide bond. Catabolic routs of amino acids: Transamination, deamination and decarboxylation. Conformation of protein and polypeptide; Primary, secondary, tertiary and quaternary structures, Ramachandran plot (15 lectures)

UNIT4 Enzyme classification and Nomenclature. Mechanism of enzyme catalysed reaction and enzyme specificity. Enzyme-substrate complex, Active sites, and allosteric site Enzyme Kinetics: Michaelis- Menten Equation and its derivation Various plots for determination of km and Vmax, Enzyme inhibitions (15 lectures)

Suggested Literature:

- Albertsetal: MolecularBiologyof the Cell (4thEd.),

- Garland,2002 8. A.Paul:CellandMolecularBiology,BooksandAllied(P) 2nd Edn.(2009)
- Lodish etal:MolecularCellBiology(5th Ed.), Freeman, 2004
- DeRobertis&DeRobertis:Cell&Molecular Biology,Lea &Febriger,1987
- Friefielder:MolecularBiology
- Darnell,LodishandBaltimore:Molecular cellbiology(Scientific AmericanBooks)
- H.D. Kumar:Moleculerbiology
- W.H. Elliotand D. C.Elliot: Biochemistryand molecular biologyby(OUPress)
- Lehninger's Principles of Biochemistry, Nelson and Cox, Sixth Edition or recent edition, Macmillan Press.
- Principles of Biochemistry, Voet, Voet and Pratt, 5th edition (2012) or recent edition, Wiley.
- Harper's Illustrated Biochemistry, Murray, Granner and Rodwell, (27th Ed.), McGraw Hill, New York, USA.
- Practical Biochemistry – Principles and Techniques, Wilson and Walker, Cambridge University Press, Cambridge[Latest edition].

Learning outcomes:

- By studying the course, the students will have a clear idea about different metabolic events along with their regulation and also will have the knowledge on the genetic material and the role of different molecular processes inside the body.

SEMESTER-IV

PZOC 402: Applied Zoology
Total marks: 60+40 = 100
Credit=04 (60 lectures)

Course objective:

The purpose of the student to provide this course to learn the basic principles involved in the culture and breeding of common edible and ornamental fishes; applications of insects in Medical&forensic field; Solid waste management,Organic farming and medicalapplication.

Course content:

UNIT1 Generalapplicationof insects: Insect as pollinators in agriculture, Role of insects in tropical forest ecosystem, Lac & silk products&industrialeconomy, Insect as bioreactors &insectincellculture, Medical&forensicentomology: Pests of public health importance and their control (Mosquitoes, house flies, bad bugs, fleas), Insectbornediseases (15 lectures)

UNIT2 General economic zoology: Solid waste management with vermicompost, Organic farming, Biology and importance of finfish (Indian major carps, freshwater catfish) and shellfish (Prawns and shrimps), Composition and nutritive value of raw fish, processed fish & preserved fish, Ornamental fishes, Exotic & indigenous ornamental fish & economic importance (15 lectures)

UNIT3 Sericulture in N.E. India: Mulberry and non-mulberry silk worms, their host plants, life history and commercial culture; Diseases of silkworm-Prophylaxis, symptoms and control; Different species of honey bees, social organization, Life history, Commercial culture, Commercial products and Economic importance. (15 lectures)

UNIT4: Aquaculture: Integrated fish farming(Fish cum livestock farming& paddy cum fish culture), Polyculture of fish for high yield, Edible oyster & pearl oyster. (15 lectures)

Suggested Literature:

- Fundamentals of Applied Zoology by Dr. Shaheen Khurshid
- Applied Zoology by G. Suhasini
- Applied Zoology by N. Arumugam, T. Murugan, J. Johnson Rajeswar, R. Ram Prabhu

Learning outcomes:

- After completion the course the student will have a deep knowledge on different farming systems, their diseases and prophylaxis. The student can be independent by growing different farms in recent time.

SEMESTER-IV

PZOC 403 PR: Mol. Biology, Applied Zoology and Biochemistry
Credit=2

1. Detection of DNA and RNA from histochemical slides
2. Demonstration of PCR / ELISA
3. Blotting techniques: Southern blot, Western Blot
4. Identification of silkworm (eri, muga and mulberry), immature and adult stages
5. Identification of economically important indigenous fishes
6. Composting of waste materials by vermiculture
7. Study of action of salivary amylase on carbohydrate
8. Preparation of standard curve and estimation of carbohydrate/ protein

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SEMESTER-I
DISCIPLINE SPECIFIC ELECTIVE
PZOD101: BIOCHEMISTRY-I (Intermediary Metabolism)
Total marks: 60+40 = 100
Credit=4 (60 lectures)

Course objective:

- To understand the significance of enzyme reactions. metabolism. To enable the students to visualize energy production and utilisation in biological processes. The course gives metabolism of different biomolecules that can help students in understanding chemical pathway living system.

Course content:

UNIT1 Types and features of biochemical reactions. Bioenergetics: redox reaction, redox potential and free energy, oxidative and photophosphorylation and their mechanism. Structure of ATPase and Chemiosmotic theory of ATP synthesis. (15 lectures)

UNIT2 Metabolism of Carbohydrates: Regulation of Glycolysis, Kreb's Cycle, HMP pathway, glycogenesis, glycogenolysis; Glyoxylate cycle. (15 lectures)

UNIT3 Lipids: β oxidation of saturated and unsaturated fatty acids, ω-oxidation; metabolism of ketone bodies, biosynthesis of saturated fatty acids, its regulation; metabolism of eicosanoids andcholesterol. (15 lectures)

UNIT4 Metabolism of amino acids phenylalanine, histidine, tryptophan and Arginine. Metabolism of Purines and Pyrimidines, its regulation,Interrelationship of carbohydrate, lipid and protein metabolism, Inborn errors of metabolism. (15 lectures)

Suggested Literature:

- Lehninger's Principles of Biochemistry, Nelson and Cox, Sixth Edition or recent edition, Macmillan Press.
- Principles of Biochemistry, Voet, Voet and Pratt, 5th edition (2012) or recent edition, Wiley.
- Harper's Illustrated Biochemistry, Murray, Granner and Rodwell, (27th Ed.), McGraw Hill, New York, USA.
- Practical Biochemistry – Principles and Techniques, Wilson and Walker, Cambridge University Press, Cambridge[Latest edition].

Learning outcomes:

- After completion of the course student will know about intermediary metabolism of human body. They will also have a knowledge on different deficiency diseases along with certain inborn diseases.

SEMESTER-I

PZOC 101 PR: BIOCHEMISTRY-I (Intermediary Metabolism)
Credit=2

1. Fractionation of tissue by differential centrifugation.
2. Estimation of protein, carbohydrate, free phosphate in biological samples
3. Estimation of ascorbic acid (Colorimetric).
4. Estimation of cholesterol.
5. Estimation of urea in biological samples.

SEMESTER-II
DISCIPLINE SPECIFIC ELECTIVE
PZOD201:BIOCHEMISTRY-II
(Protein chemistry and Enzymology)
Total marks: 60+40 = 100
Credit=04 (60 lectures)

Course objective:

- The major learning objective of the course is to understand the theories of enzyme kinetics, the mechanisms of enzyme catalysis, and the mechanisms of enzyme regulation in the cell.Proteins are biopolymeric structures composed of amino acids, of which there are 20 commons found in biological chemistry. Proteins serve as structural support, biochemical catalysts, hormones, enzymes, building blocks, and initiators of cellular death.

Course content:

UNIT1 Structure of protein in relation to their biological functions, primary, secondary, tertiary, and quaternary structure, maintenance of secondary structure, Ramachandran Plot, protein folding, determination of amino acidsequence. (15 lectures)

UNIT 2 Biosynthesis of protein, direction of chain growth, Inhibitors of protein biosynthesis, Co-translational and Post translational modification of protein. Protein purification,Mechanism of protein and steroid hormone action, role of cAMP and G-protein in metabolism, prostaglandins (15 lectures)

UNIT3 Enzymes: Enzyme catalyzed reaction. Single and bi-substrate reactions, mechanism of action, Allosteric enzymes, Enzyme induction and inhibition (competitive, non-

competitive, and uncompetitive), purification of enzymes. (15 lectures)

UNIT4 Enzyme kinetics; Michalis-Menten Equation., Line weaver Burk plot, Hill plot, Restriction enzymes, RNA as an enzyme, Isoenzyme and their significance. Regulation of metabolism of enzyme (Carbohydrate metabolism) (15 lectures)

Suggested Literature:

- Lehninger's Principles of Biochemistry, Nelson and Cox, Sixth Edition or recent edition, Macmillan Press.
- Principles of Biochemistry, Voet, Voet and Pratt, 5th edition (2012) or recent edition, Wiley.
- Harper's Illustrated Biochemistry, Murray, Granner and Rodwell, (27th Ed.), McGraw Hill, New York, USA.
- Practical Biochemistry – Principles and Techniques, Wilson and Walker, Cambridge University Press, Cambridge[Latest edition].

Learning outcomes:

- After completion of the course the students will have a deep knowledge on the protein structures, their synthesis, functions and about the enzyme actions and their inhibitors.

SEMESTER-II

PZOD201:BIOCHEMISTRY-II
(Protein chemistry and Enzymology)
Credit=2

1. Estimation of protein by Bradford method.
2. Estimation of amino-acids
3. Determination of pK and IPH
4. Separation of amino acids by Paper/Thin Layer Chromatography
5. Assay of activity of an enzyme in biological samples
6. Electrophoretic separation of protein using PAGE
7. Purification of proteins using column chromatography.

SEMESTER-III

DISCIPLINE SPECIFIC ELECTIVE
PZOD301:BIOCHEMISTRY-III
(Molecular Biochemistry)
Total marks: 45
Credit=3(45 lectures)

Course objective:

- The discipline particularly seeks to understand the molecular basis of genetic processes; molecular biologists map the location of genes on specific chromosomes, associate these genes with particular characters of an organism.

Course content:

UNIT1 Organisation of DNA in chromosomes, Molecular structure, physico-chemical properties of DNA, DNA-replication, DNA polymerase in Prokaryotes and Eukaryotes, DNA sequencing, satellite DNA, Palindrome sequences, repetitive DNA. (12 lectures)

UNIT2 Types of genes: Split genes, Overlapping genes, pseudogenes, transposable genes and transposons, plasmids, Regulation of prokaryotic gene expression - inducible and repressible operon systems; Regulation of gene expression at transcription and translation level in eukaryotes, gene silencing and gene imprinting (12 lectures)

UNIT3 Transcription of RNA, sense and antisense strand, RNA polymerase in Prokaryotes and Eukaryotes, types and functions of RNA, RNA processing, spliceosome, catalyzed RNA splicing, Ribozyme, RNA editing, RNA sequencing. Reverse transcriptase and its significance.

(14 lectures)

UNIT4 DNA damage and repair; Alterations in DNA molecule, repair of incorrect bases, repair of thymine dimmers, recombination repair, SOS repair. (12 lectures)

Suggested Literature:

- G.M.CooperandR.E. Hausman:TheCell,AMolecularApproach. 5th Ed.ASM Press(2009)
- Bostock&Sumner:EukaryoticChromosome (North-Holland,1987)
- Karp:CellandMolecularBiology(JohnWiley&Sons, 2002)
- Lewin, GenesVIII(Wiley,2004)
- Lodish etal:MolecularCellBiology(Freeman, 2000)
- Pollard& Earnshaw: Cell Biology(Saunders, 2002).
- Albertsetal: MolecularBiologyof the Cell (4thEd.), Garland,2002
- A.Paul:CellandMolecularBiology,BooksandAllied(P) 2nd Edn.(2009)
- Lodish etal:MolecularCellBiology(5th Ed.), Freeman, 2004
- DeRobertis&DeRobertis:Cell&Molecular Biology,Lea &Febriger,1987

- Friefielder:MolecularBiology
- Darnell,LodishandBaltimore:Molecular cellbiology(Scientific AmericanBooks)
- H.D. Kumar:Molecularbiology
- W.H. Elliotand D. C.Elliot: Biochemistryand molecular biologyby(OUPress)

Learning outcomes:

- Students will Recognize and interpret the structural and functional aspects of molecules and their interactions that give rise to the supramolecular complexes such as organelles and cells and how those complexes function within organisms.

SEMESTER-III

PZOD301 PR:BIOCHEMISTRY-III
(Molecular Biochemistry)
Credit=1

1. Estimation of RNA
2. Estimation of DNA
3. Estimation of protein
4. Separation of proteins using SDS-PAGE.
5. Isolation of DNA from biological samples.
6. Restriction digestion analysis of DNA using agarose gel electrophoresis

SEMESTER-IV

DISCIPLINE SPECIFIC ELECTIVE
PZOD 401: BIOCHEMISTRY-IV
Credit=8 (Project)

SEMESTER-I

DISCIPLINE SPECIFIC ELECTIVE
PZOD 102: FISH & FISHERIES-I
Total marks: 60+40 = 100
Credit=04 (60 lectures)

Course objective:

- To understand the classification of fishes, their basic needs along with their different body systems.

Course content:

UNIT1 Classification of fishes: Various trends in the classification of fishes; Classification of major groups of living fishes; General anatomy of fish. Organization of skin and function; Origin and types of scales; Types of muscles, their structure and functions; Role of musculature, fins and tails in locomotion. (15 lectures)

UNIT2 Food and feeding habits of cultivable fishes; Modifications of alimentary canal and other organs associated with food and feeding habits; Physiology of digestion, absorption and assimilation; Structure and function of gills; Accessory respiratory organs in fishes; Structure and function of gas bladder. (15 lectures)

UNIT3 Heart and circulatory vessels; Components of fish blood; Structure of different parts of brain; Cranial nerves and theirfunctions,Endocrine organs; Osmoregulatory and excretory organs; Physiology of excretion and osmoregulation in fresh water, brackish water and marine fishes. (15 lectures)

UNIT4 Determination of age in fishes; Absolute and relative growth, growth curve, length-weight relationship, condition factor and their significance; Sexual dimorphism; Maturity cycle and gonadal development; Reproductive strategies and parental care; Types, causes and mode of migration in anadromous and catadromous fishes. (15 lectures)

Suggested Literature:

- Fish and fisheries in North East India Editors R. N. Bhuyan, D. Ghose and D. Sharma
- The Biology of Fishes H. M. Kyle
- The illustrated encyclopaedia of Fish. Biodiversity of Assam Edited by A. K. Bhagabati, M. C. Kalita and S. Baruah

Learning outcomes:

After completion of the course Students can identify different types of fishes and will have a deep knowledge on the basic body processes along with their food habit.

SEMESTER-I
PZOD 102 PR: FISH & FISHERIES-I
Credit=2

1. Identification of locally available fishes.
2. Study of museum specimens.
3. Dissection: (a) Cranial nerves (5th, 7th, 9th& 10th) of cat fishes or carps. (b) Urino-genital system of male and female fishes. (c) Weberian ossicles (d) Afferent and efferent vessels of carps and catfishes.
4. Study of Accessory respiratory organ of the following fishes: (i) *Clarias*, (ii) *Heteropneustes*, (iii*) Anabas*, (vi) *Channa*.
5. Studies of gastrosomatic index, gonadosomatic index, K-factor, length-weight relationship of fecundity and other body parameters.

SEMESTER-II

DISCIPLINE SPECIFIC ELECTIVE
PZOD 202: FISH & FISHERIES-II
Total marks: 60+40 = 100
Credit=4 (60 lectures)

Course objective:

- To understand the ecology of the pond and have a better knowledge on fish culture and management of the fish culture.

Course content:

UNIT1 Construction and layout of fish ponds: Classification of ponds, choice of ground – topographical conditions, quality of water requirement, installation planning; Layout of the pond bottom, the dyke, draining installation bypass channel, water inlet. Reclamation of swamps. (12 lectures)

UNIT2 Ecology of fish pond: Abiotic and biotic components; Food chain; Concept of productivity, methods of measuring productivity, classification of water bodies on the basis of their productivity; Layout and design of nursery, rearing and stocking ponds; Predatory and weed fishes and their control; Fertilization, aquatic insects and their control; Supplementary feeding. (15 lectures)

UNIT3 Culture of air-breathing and other predatory fish (*Clarias Heteropneustes, Anabas, Monopterus*, *Pangasius* and *Ompok*), Integrated aquaculture (paddy cum fish culture; duck-cum and pig-cum fish culture); Culture of pearl and frog; sewage fed fisheries; Composition of sewage and sludge; Treatment of sewage: physical, chemical and biological processes; Rearing techniques and production in sewage ponds. (17 lectures)

UNIT4 Fish preservation and by-product: Causes of fish spoilage: biochemical changes during fish spoilage; Principle and practice of fish preservation; By-products of fishes; Symptoms of different fish diseases and their aetiology; prophylactic measures, control and therapeutics; Fish quarantine. (15 lectures)

Suggested Literature:

- Fish and fisheries in North East India Editors R. N. Bhuyan, D. Ghose and D. Sharma
- The Biology of Fishes H. M. Kyle
- The illustrated encyclopaedia of Fish. Biodiversity of Assam Edited by A. K. Bhagabati, M. C. Kalita and S. Baruah
- Freshwater fish pond culture and managementMarilyn Chakroff

Learning outcomes:

- Students will have a deep knowledge on the culture and management of fish culture.

SEMESTER-II
PZOD 202 PR: FISH & FISHERIES-II
Credit=2

1. Biological survey of pond (2 no.s)
2. Analysis of soil sample: pH, texture and porosity.
3. Analysis of physico-chemical parameters of pond water. (a) turbidity, (b) dissolved oxygen, (c) alkalinity, (d) hardness, (e) TDS, (f) TSS, (g) Nitrate-nitrite (h)Phosphate.
4. Study of bucco-pharyngeal region of followingfishes: (i) *Labeo*, (ii) *Punitus*, (iii) *Channa*, (iv) *Heteropneustes*
5. Gut content analysis of *Labeo*, *Punitus*, Channa and *Heteropneustes.*
6. Gonadosectomy in fishes
7. Identification and reports on locally available aquatic weeds.

SEMESTER-III

DISCIPLINE SPECIFIC ELECTIVE
PZOD 302: FISH & FISHERIES-III
Total marks: 45
Credit=3 (45 lectures)

Course objective:

- The prime objective of fisheries extension is to persuade and empower aquafarmers and fishing communities to improve their socioeconomic condition and quality of life by making improvement in their farming practices resulting in increased fish production and income.

Course content:

UNIT 1 Induced breeding: Purpose, technique of induced breeding, influence of abiotic factors, Recent advances in induced breeding; Concept of hatchery, designing of Chinese and cemented hatchery, management of hatcheries. (12 lectures)

UNIT2 Requirement of micro and macro nutrient of cultivable species; Effect of malnutrition, basic principle of fish feed formulation, preparation and mode of fish feed storage, use of unconventional feed as source ofnutrients. (13 lectures)

UNIT3 Fish stock improvement through selective hybridization; Androgenesis and gynogenesis; polyploidy; Sex reversal and sterility; Transgenesis; Cryopreservation of gametes and embryos, Principles of economics as applied to aqua products; Law of demand and supply, consumer surplus; Law of returns, market demand and prices; International trade and export promotion; Existing system of fish marketing; Use of modern marketing and transportation for aqua products.
(17 lectures)

UNIT4 Present status and scope of development of fishing technology in India; Types of fishing crafts and gears in marine and inland waters, their maintenance and operation; Economics of fishing operations; Modern transportation system; Management and conservation of inland fisheries resources; Fisheries legislation. (18 lectures)

Suggested Literature:

- Fish and fisheries in North East India Editors R. N. Bhuyan, D. Ghose and D. Sharma
- The Biology of Fishes H. M. Kyle
- The illustrated encyclopaedia of Fish. Biodiversity of Assam Edited by A. K. Bhagabati, M. C. Kalita and S. Baruah
- Freshwater fish pond culture and managementMarilyn Chakroff
- An introduction to fish Biology and fisheries by Dr. S. S. Khanna & Dr. Neeraj Kapoor
- Extension Strategies for Managing Agricultural Enterprises and Enterpreneurships D.Basu, by S.K Acharya, M.M Adhikary

Learning outcomes:

- Students will have a deep knowledge on the technology, economics, and extension of the fish.

SEMESTER-II
PZOD 302 PR: FISH & FISHERIES-II
Credit=1

- Induced breeding experiment in fish.
- Histological study of guts/gonads
- Preparation of fish weed using locally available feeding redients
- Mounting of the following materials: Cypris, Daphnia, Diatoms, Ctenoid, Cycloid, Placoid and Rhomboid scales, Spirogyra, Nostoc, Navicularia.
- Collection of fish parasites, their mounting, and identification.
- Study of commonly used fishing gears.
- Determination of age in fishes.
- Identification of permanent slides.

SEMESTER-IV

PZOD 401: FISH & FISHERIES-IV
Credit=8 (Project)

SEMESTER I
ABILITY ENHANCEMENT COURSES
PZOA101: Biodiversity Management: I
Marks: 30 + 20= 50
Credit: 2

Objective of the Course:

Biodiversity management involves restoring, protecting, conserving and enhancing the verities of biological resource.

Course content:

UNIT1: Understanding Biodiversity: The biodiversity concept, megadiversity countries of the world, reduction in biological diversity, present scenario (lectures 8)

UNIT2: Monitoring and documentation of biodiversity: Measuring biodiversity, biodiversity indices (Shannon-Weiner, Margaleff and Simpson) (lectures 8)

UNIT3:Biodiversity Utility: Value of biodiversity as natural resources, as genetic resources, instrumental resources, means of abiotic resource optimization (lectures 8)

UNIT4: Conventions on biological diversity. (lectures 6)

Suggested Literature:

- Sandlund, O. T., Schei, P. J., & Viken, Å. (Eds.). (2001). Invasive species and biodiversity management (Vol. 24). Springer Science & Business Media.
- Altieri, M., & Nicholls, C. (2018). Biodiversity and pest management in agroecosystems. CRC press.
- Krishnamurthy, K. V. (2018). An advanced textbook on biodiversity: Principles and practice. Oxford and IBH Publishing.

Learning outcomes:

- Students will realize that people are dependent on intact habitats that sustain the different organisms we need to produce food, medicines, clothing and other materials. They will also learn about the roles of certain species in ecosystem.

SEMESTER I
ABILITY ENHANCEMENT COURSES
PZOA 301: Biodiversity Management: II
Marks: 30 + 20= 50
Credit: 2

Objective of course:

- The main objective of this field trip is to bring the concept of what students have learnt in the normal classroom and to reveal the facts of what they have learned or for the purpose of first-hand observation.

Course content:

UNIT 1: Field trip: National Park, Wild life sanctuary, Wetland etc.

Lerner outcome:

- After completion of the course the student will have a knowledge on to protect the life and the environment. They will also have a knowledge on the diversity of animals and plants for the ecological balance of nature and its conservation.

SEMESTER II
GENERIC ELECTIVE
PZOE: Animal Biotechnology
Marks- 60+40=100
Credit-4 (60 classes)

Objective of course:

- To create awareness on advance steam like stem cell Biology, Animal cell culture, Genomes and proteomics, drug design, genetic engineering and bioinformatics.

Course content:

UNIT1:Overview on the scope and importance of biotechnology; types, methods and applications of animal cell and tissue culture; culture media and tools in animal biotechnology; concept of somatic hybridization, hybridoma technology, colony and plaque hybridization; Principles and applications of blotting techniques (southern, northern, western and eastern), DNA fingerprinting, DNA microarray. (15 lectures)

UNIT2:Principles in recombinant DNA technology, restriction endonucleases and cleavage patterns, gene cloning and cloning vectors, polymerase chain reaction, DNA libraries (construction of genomic and cDNA library), molecular probes and molecular markers, application of r DNA technology in agriculture, environment, medicine, and gene therapy.

(15 lectures)

UNIT3:Principles and methods of transfection (nuclear transplantation, retroviral method, DNA microinjection), production of transgenic animals (embryonic stem cell transfer, targeted gene transfer), knockout gene, knockout mice and their utility, production of transgenic plants (*Agrobacterium* mediated gene transfer), importance of GMOs. (15 lectures)

UNIT4: Bio-risk and bio-risk assessment, biosafety and biosafety guidelines in general and in India, risk groups and biosafety levels; concept of intellectual property rights (IPR), forms of IPR, benefits and problems of IPR, patent law and protection of IP. (15 lectures)

Suggested Literature:

- Gahlawat, S. K., Duhan, J. S., Salar, R. K., Siwach, P., Kumar, S., & Kaur, P. (Eds.). (2018). Advances in animal biotechnology and its applications. Springer.
- Verma, A. S., & Singh, A. (Eds.). (2013). Animal biotechnology: models in discovery and translation. Academic Press.
- Singh, B., Mal, G., Gautam, S. K., & Mukesh, M. (2019). Advances in animal biotechnology (pp. 145-153). Springer International Publishing.

Lerner outcome:

- Students will understand about the applicationson different fields, ethical values of biotechnology. They will also have a knowledge on limitations and challenges that are facing by the animal industries and disciplines.

SEMESTER III
GENERIC ELECTIVE
PZOE: applied Zoology
Marks- 60+40=100
Credit-4 (60 classes)

Objective of course:

- Applied zoology is a specialization within Zoology that uses the knowledge and methods to solve the real-world problems

Course content:

UNIT1 Basic concept: Inland fisheries, Marine fisheries & Aquaculture Sports and ornamental fishes. Problems of aquaculture: Fish parasites, identification, classification and control measure Natural breeding and induced breeding of Carps. Composite fish culture & Integrated farming; Types of fish food: Natural food organisms and artificial fish feed.

(15 Lecture)

UNIT2 Sericulture in N.E. India, Mulberry and non-mulberry silk worms, their host plants, life history and commercial culture; Diseases of silkworm-Prophylaxis, symptoms and control; Apiculture - Different species of honey bees, Social organization, Life history, Commercial culture, Commercial products and Economic importance, Diseases of honey bee: prophylaxis, symptoms and control (15 Lectures)

UNIT3 Biology of composting earthworm, methods and processing of vermicomposting, advantages of vermicompost, Life history of lac insect, cultivation of lac, composition and properties of lac, enemies of lac cultivation, economic importance of lac culture

(15 Lecture)

UNIT4 Major insect pests of rice, tea and maize: Biology, damage and their control; Defoliators and borers of forest trees and their control. Pests of crops and vegetables and its control. Different groups of pesticides and their mode of action; Pest Control: Mechanical, Biological, Genetical, Pheromonal, Insect growth regulators; Integrated Pest Management: Principle and strategies. (15 Lecture)

Suggested Literature:

- Griffiths, M. (2015). Echidnas: International Series of Monographs in Pure and Applied Biology: Zoology (Vol. 38). Elsevier.
- Schmidt, D. (2003). Guide to reference and information sources in the zoological sciences. Bloomsbury Publishing USA.

Learning outcomes:

- Students will be able to integrate and analyse the information across levels of organization ranging from cells to ecosystems within the zoological sciences to formulate arguments and critically evaluate scientific claims.Students will also gain knowledge and skill in the fundamentals of aquaculture, sericulture understand the complex interactions among various living organisms