DEPARTMENT OF ZOOLOGY

TEACHING-LEARNING PEDAGOGY

Pedagogy	**P_1**	General Lecture Using Blackboard and Chalk
	P_2	Demonstration
	P_3	Question and Answer
	P_4	Slide Share/PPT
	P_5	Group Discussion
	P_6	ICT (Virtual and online learning)
	P_7	Assignment (Written)
	P_8	Discovery - Story telling
	P_9	Seminar
	P_{10}	Guest Lecture
	P_X	Problem solving
	P_Q	Ouiz
	P_T	Written Test
External & Internal Evaluation	75:25	

Course: M.sc zoology	Year:I	Semester:I
Subject	**BIOSYSTEMATICS, BIODIVERSITY AND TAXONOMY**	
Units	**1. Definition & basic concepts of biosystematics & taxonomy, History, Problems, aims and tasks in taxonomy, Importance and applications of biosystematics in biology, Material basis of biosystematics.** **2. Theories of biological classification (Essentialism, Nominalism, Empirism, Cladism) Evolutionary classification, Trends in biosystematics- Concepts of different conventional and newer aspects, Chemotaxonomy; Cytotaxonomy; Molecular taxonomy; Eco - taxonomy and Behavioral taxonomy.** **3. Species Concept - Different species concepts, Sub-species and other infra specific categories, Polytypic species, Dimensions of speciation, Dimensions of speciation.** **4. Sustainable utilization of Biodiversity, Equitable sharing & conservation of Biodiversity, Genetic Variations & Non genetic Variations, Genetic Variations & Non genetic Variations.** **1. Taxonomic procedures, 2 Taxonomic Keys, Systematic publications, International code of Zoological Nomenclature (ICZN)**	
Duration	**60hours**	
LearningObjectives	***To obtain knowledge on basic concepts of biosystematics & taxonomy** ***To learn about trends in biosystematics** ***To know about species Concept** ***To have knowledge on conservation of biodiversity** ***To learn about taxonomic procedures, keys & ICZN**	

Units	U1	U2	U3	U4	U5
Hours Split:Total: 60	12	12	12	12	12
Internal valuation:40marks	4	4	4	4	4

Resource Material:	**Study Material(Handouts):** **Reference Books:** **1. M. Kato. The Biology of Biodiversity, Springer.** **2. J.C. Avise. Molecular Markers, Natural History and Evolution, Chapman &Hall, New York.** **G.G. Simpson, Principle of Animal taxonomy, Oxford IBM Publishing Company.**

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Academic-Pedagogical-Evaluation:Unit-wisePedagogy

UNIT	DESCRIPTION	PEDAGOGY	INTERNAL EVALUATION
I	**1.1 Definition & basic concepts of biosystematics & taxonomy.** **1.2 History, Problems, aims and tasks in taxonomy.** **1.3 Importance and applications of biosystematics in biology** **1.4 Material basis of biosystematics – Taxonomic attributes.**	P1, P2, P3, P4, P5, P6	PQ,P6,PT
II	**2.1 Theories of biological classification (Essentialism,Nominalism, Empirism, Cladism)** **2.2 Evolutionary classification.** **2.3Trends in biosystematics- Concepts of different conventional and newer aspects.** **2.4 Chemotaxonomy; Cytotaxonomy; Molecular taxonomy; Eco - taxonomy and Behavioral taxonomy**	P1, P3, P6, P4, P2, P5	PX,P6,PT
III	**3.1 Species Concept - Different species concepts - Typological, Nominalistic, Biological& evolutionary species concept.** **3.2 Sub-species and other infra specific categories, Polytypic species.** **3.3 Dimensions of speciation- types of lineage changes, production of additional lineage** **3.4 Speciation – Allopatric, Sympatric &Parapatric speciation, and factors affecting speciation.**	P1, P2, P3, P6, P4, P5	PQ,PT
IV	**4.1 Sustainable utilization of Biodiversity - Origin of biodiversity, Types of biodiversity & ecosystem, Threats of biodiversity.** **4.2 Equitable sharing & conservation of Biodiversity(in-situ & ex-situ & gene banks).** **4.3 Genetic Variations & Non genetic Variations - Molecular perspectives on conservation of Biodiversity, Hierarchy of categories.** **4.4 Origin of reproductive Isolation (Prezygotic&Post zygotic mechanisms).**	P1, P3, P2, P4, P5, P6	PQ,P6,PT
V	**5.1 Taxonomic procedures – taxonomic collections, preservation, curetting of animals and Process of identification. Preservation of specimens.** **5.2 Taxonomic Keys - Procedure keys in taxonomy,Types, merits & demerits.** **5.3 Systematic publications – different kinds of publications, Process of typication and different Zoological types.** **5.4 International code of Zoological Nomenclature (ICZN) - Operative principles, Interpretation and application of important rules, Zoological nomenclature, formation of scientific names of various taxa. Interpretation of rules of nomenclature.**	P1, P2, P3, P5, P6, P4	PQ,PT

Course: M.sc ZOOLOGY	Year:I	Semester:II
Subject	BIOSTATICS AND BIOINFORMATICS	
Units	**1. Introduction to Biostatistics, Data Collection and Presentation, Diagrammatic and Graphical Presentationof data.** **2. Measures of central tendency, Measures of dispersion, Probability and distributions, Probability distributions.** **3. Proportion data, Count data , Tests of Significance.** **4. Analysis of Variance, Correlation, Linear regression** **5. Bio informatics**	
Duration	**60hours**	
LearningObjectives	**LO 1:** Recognize importance and value of logical and statistical thinking, training, and approach to problem solving, in the discipline of biological sciences. LO 2: Can condense the given raw data and present diagrammatically & graphically. Calculate the central tendency value of mean, median, mode for the given data. Estimate the deviation amongthe raw data from the central tendency value. LO 3: Identify and choose correct statistical method toanalyze the data LO 4: Lay down the hypothesis and subject it to validationusing significance tests	

Units	U1	U2	U3	U4	U5
Hours Split:Total: 60	20	20	20	20	20
Internal valuation:40marks	4	4	4	4	4

Resource Material:	**Study Material(Handouts):** **Reference Books:** 1 1. Statistics - Gupta and Kumar 2. Biostatistics – A foundation for analysis in the Health Sciences: W.W. Daniel 3. Biostatistics - J. Zar 4. Bioinformatics for Dummies, Claverie J. M., Notredame C., (2nd Ed., 2007), Wiley Publishing, Inc., New York, USA. 5. Bioinformatics: Sequence and Genome Analysis, Mount, D. W. (2nd Ed., 2001), Cold Spring Harbor Laboratory Press, New York, USA.

Academic-Pedagogical- Evaluation :Unit-wise Pedagogy

UNIT	DESCRIPTION	PEDAGOGY	INTERNAL EVALUATION
I	1 **Introduction to Biostatistics** – Importance of Statistics in biology, Application and Role of biostatistics in modern research. Samples and populations, variables in biology, Accuracy and Precision. Sampling – Characteristics, advantages and methods of sampling and sampling errors. 2 **Data Collection and Presentation**: Types of biological data. **Presentation of the data** - Frequency distribution tables Preparation of ordered, discrete, continuous and Cumulative frequency distribution tables. **3 Diagrammatic and Graphical Presentation of data** - Data presentation by diagrams, graphs and curves, Skewness and Kurtosis.	P1, P2, P3, P4, P5, P6	PQ,P6,PT
II	**1 Measures of central tendency** - Mean, Median and Mode **2 Measures of dispersion**: Standard deviation variance and coefficient of variance. **3 Probability and distributions** - Elements of Probability, definition, terminology and laws, independent events. Addition and multiplication rules, conditional probability, example – Bernoulli. 4. **Probability distributions**: Binomial and Poisson distribution Normal Distribution: frequency distributions of continuous variables, properties of normal distribution, applications of normal distribution.	P1, P3, P6, P4, P2, P5	PX,P6,PT
	1 proportion data- Examples of Proportion data- MPM- sterility testing of medicines- animal toxicity- infection and immunization studies e.g., LD50, ED50, PD50 statistical treatment to proportion data- Chi-square test- goodness of fit to normal distribution. 2 **Count data**- Examples of count data (bacterial cell count, radioactivity count, colony and plaque count, etc.). Statistical treatment to count data- poission distribution- standard error- confidence limits of counts. 3 **Tests of Significance** - Concepts of Null hypothesis and alternative hypothesis, degrees of freedom Level of significance, errors of inference. Students t-test, Chi-square tes		
IV	1 **Analysis of Variance –** One Way and Two-Way ANOVA - Applications in biology 2. **Correlation** - Concepts and applications of correlation and regression, Bivariate data, Scatter plot, correlation coefficient (r), properties,	P1, P3, P2, P4, P5, P6	PQ,P6,PT

	interpretation of r. 3. **Linear regression -** Fitting of lines of regression, regression coefficient, coefficientof Determination standard curves and interpolations of unknown y-values thereon		
V	1. **Introduction to Bioinformatics**; Types of Biological data and its applications using computational tools; Omics studies Major resources of Bioinformatics: Nucleic acid sequence databases NCBI, Genbank, EMBL, EMBL – EBI, Protein sequence databases: Swiss- prot, PDB, BLAST, PSI- BLAST (Steps involved in use and interpretation of results). Literature databases: PubMed, PubMed Central and Public Library of Sciences. 2. **Databank search**- Data mining, data management and interpretation. Multiple sequence alignment of genes and primer designing. Phylogenetic analysis with the program PHYLIP, DISTANCES, and GROWTREE. Basics of designing a microarray, image analysis andnormalization, annotations. 3 **Genomics & Proteomics** Proteins,secondarystructureandfolding,RNAseconda rystructures, protein prediction tools- protein secondary structure, molecular modelling, identification and characterization of protein mass fingerprint, world- wide biological databases. Protein modelling, protein structure analysis,	P1, P2, P3, P5, P6, P4	PQ,PT

Course: M.sc Zoology	Year:I	Semester:I
Subject	**TOOLS AND TECHNIQUES**	
Units	1.Assays,Electrophories,chromatography,spectrophotometer 2.Microscopy, Principle and applications of different types of microscopes, Electron microscopy, Imageprocessing methods in microscopy, 3.Microtomy,Tissue embedding (paraffin wax), Section cutting, Floatation (water bath), slide mounting, drying (oven or hot plate) and section adhesives, Applications of microtomy in biological studies,Cryotechniques. 4.Media preparation & Sterilization, Inoculation and growth monitoring,Biochemical Mutants and their use, Microbial assays,Cell Culture System,Cell culture techniques. 5.Detection and measurement of different types of radioisotopes,GM (Geiger-Muller) Counter,Scintillation Counter,Autoradiography,Electrophysiologicalmethods.	
Duration	**60hours**	
LearningObjectives	***To obtain knowledge on** chemical and biological assays ***To learn about** microscopy ***To know about** microtomy&cryotechniques ***To have knowledge on** microbiological and cell culturetechniques ***To learn about** radiation techniques and electrophysiological methods	

Units	U1	U2	U3	U4	U5
Hours Split:Total: 60	20	20	20	20	20
Internal valuation:40marks	4	4	4	4	4

Resource Material:	**Study Material(Handouts):** **Reference Books:** *Biophysical& Biochemical Techniques, Wilson K and Walker J.M., *Histological &Histochemical methods: Theory and Practice, Kiernan J.A.Scion Publ. *Histochemistry: Pearse A.G.E, Garfield.

Academic-Pedagogical- Evaluation :Unit-wise Pedagogy

UNIT	DESCRIPTION	PEDAGOGY	INTERNAL EVALUATION
I	1.1. Assays- Chemical and Biological assay Centrifugation, Working Principle and applications o Centrifugation; differential and density gradien centrifugation, Ultrafiltration. 1.2. Electrophoresis – Electrophoresis, Agarose Ge electrophoresis, 2- D Electrophoresis workingPrinciple structural components and applications o electrophoresis. Analysis of RNA, DNAand proteins by one and two-dimensional gel electrophoresis, Isoelectric focusing gels. 1.3. Chromatography-Working Principle and applications of chromatography, Chromatography Planar chromatography (paper & TLC), Gas Chromatography (GC-MS), High Performance Liquid Chromatography (HPLC), and LC-MS 1.4. Spectrophotometer - UV-visible, fluorescence circular dichroism, absorption spectrophotometry principles and applications, NMR and ESR spectroscopy Molecular structure determination using X-ray diffraction and NMR. Molecular analysis using light scattering different types of mass spectrometry and surface plasma resonance methods.	P1, P2, P3, P4, P5, P6	PQ,P6,PT
II	2.1. Microscopy - Visualization of cells and subcellular components by light microscopy, resolving powers of different microscopes, microscopy of living cells. 2.2. Principle and applications of different types o microscopes - Light, Phase Contrast, Fluorescence microscopy. 2.3. Electron microscopy: SEM, TEM and Atomic force microscopy (AFM). Image processing methods in microscopy: 2.4Image acquisition- 2D image techniques- 3D image techniques- Analysis.	P1, P3, P6, P4, P2, P5	PX,P6,PT
	3.1. Microtomy- Working principle and different types o Microtomes.Knives and Blades. 3.2. Tissue embedding (paraffin wax), Section cutting Floatation (water bath), slide mounting, drying (oven o hot plate) and section adhesives. 3.3. Applications of microtomy in biological studies Traditional Histology Technique-Frozen section procedure- Electron Microscopy Technique-Spectroscopy Technique. 3.4. Cryotechniques- History and applications o Cryotechniques for light and electron microscopy Different fixation and staining techniques for EM, freeze-etch and freeze fracture methods for EM.		

	4.1. Media preparation & Sterilization, Inoculation and growth monitoring. 4.2. Biochemical Mutants and their use, Microbial assays. 4.3. Cell Culture System - History and scope of animal cell and tissue culture, Advantages and disadvantages of tissue culture, Substrates andCulture media, Treatment of substrate surfaces, Feeder layers, gas phase for tissue culture, Culture media for cells and tissues, Culture procedures. Cell culture techniques - Primary culture and large scale cell cultures, Tissue and Organ 4.4. Culture: Primary explantation techniques, Tissue culture (slide, flask and test tube cultures), Organ culture, whole embryo culture, and tissue engineering (artificial skin and artificial cartilage).		
V	5.1. Detection and measurement of different types of radioisotopes normally used in biology, incorporation of radioisotopes in biological tissues and cells, molecular imaging of radioactive material, safety guidelines. 5.2. GM (Geiger-Muller) Counter, Scintillation Counter – Principle, Types, Description and Applications. 5.3. Autoradiography – Principle and applications. 5.4. Electrophysiological methods: Single neuron recording, patch-clamp recording, ECG, Brain activity recording, lesion and stimulation of brain pharmacological testing, PET, MRI, fMRI,CAT.	P1, P2, P3, P5, P6, P4	PQ,PT

Course: M.sc Zoology	Year:I	Semester:I
Subject	**MOLECULAR CELL BIOLOGY**	
Units	11. Exoskeleton in eukaryotic cell, structure andfunctions of microfilaments, microtubules. 12. Membrane structure and functions, transport across cell membranes, acidification of cell organellesand stomach.	
Duration	**60hours**	
LearningObjectives	• Acquire the knowledge about the complex organization in the eukaryotic cell and the molecular mechanisms of cellular processes thatexist in cell types. • Design and develop models and Sketch for various types ofcells and cell organelles. • Explain and illustrate the ultrastructure and functions ofvarious cell organelles.. □ Illustrate the chemistry and organization of cytoskeleton.	

Units	U1	U2	U3	U4	U5
Hours Split:Total: 60	20	20	20	20	20
Internal valuation:40marks	4	4	4	4	4

Resource Material:	**Study Material(Handouts):** **Reference Books:** 1. Molecular Cell Biology: J. Darnell. H. Lodish and D. Baltimore, Scientific American Book INC, USA. 2. Cell and Molecular Biology: Gerald Karp. (1996), John Wiley andSons. Inc. 3. Molecular Biology: W.H Freeman G: Lodish,H., Ber, A., 4. Zipuoskry, L.S., Matsudaira, P., Bahimore, D and Damell J. (2001).

Academic-Pedagogical- Evaluation :Unit-wise Pedagogy

UNIT	DESCRIPTION	PEDAGOGY	INTERNAL EVALUATION
I	1.1 Cytoskeleton in eukaryotic cell architecture and function - Recapitulation of the structure of the eukaryotic cell with emphasis on how it functionsas a unit of life. 1.2 Structure and dynamics of microfilaments; Cytoskeletal elements in cell shape and motility; their structure and dynamics (Microtubules, Cilia and Flagella). Cell movements –intracellular transport, role of kinesin and dynein. 1.3 Microtubules: structure, organization and dynamics Role of microtubules in cell shape and mitosis; Structure and function of intermediate filaments.	P1, P2, P3, P4, P5, P6	PQ,P6,PT
II	2.1 Membrane structure and function - Structure of model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels. 2.2 Transport across cell membranes - Active transport with suitable examples, membrane pumps, mechanism of sorting and regulationof intracellular transport. Cotransport by symporters and antiporters, Membrane potential. Acidification of cell organelles and stomach;transepithelial transport; Maintenance of cellular pH; Cell excitation; Bulk transport: Receptor mediated endocytosis. Intracellular 2.3 trafficking.	P1, P3, P6, P4, P2, P5	PX,P6,PT
III	3.1 Protein sorting and targeting to organelles;Targeting of proteins to lysosomes for degradation; Molecular mechanism of thesecretory pathway; Secretion of neurotransmitters. 3.2 Cell signaling – Types and stages of cellsignaling. Cell-Cell interactions: Cellular gap junctions and adhesions; structure and functionalsignificance of plasmodesmata; Mechanisms ofcellular recognition and communication. 3.3Cellular communication: Extracellular matrix,Signal transduction, Intracellular receptor andcell surface receptors; Signaling via G-proteinlinked receptors (PKA, PKC, CaM kinase);Overview of various cellular	P1, P2, P3, P6, P4, P5	PQ,PT

	signaling cascadeswith examples such as Egfr, Notch, Wingless, JAKSTAT etc.; Enzyme linkedreceptor signaling pathways; Network and cross-talk between different signa mechanisms; regulation of signaling pathways Programmed cell death.		
IV	4.1 Cell division and Cell Cycle - Overview of mitosis and meiosis; chromosome labeling and cell cycle analysis; cell cycle and control mechanisms; types and regulation of cyclins, sister chromatid cohesion remodeling; differentia regulation of cohesion complex during mitosis and meiosis; mitotic spindle and arrangement of chromosomes on equator; regulation of exi from metaphase, chromosomemovement at anaphase. 4.2 Genetic control of meiosis with examplesfrom yeast. 4.3 Steps in cell cycle - Role of Cyclins' and Cyclin Dependent Kinases (CDKs) in the regulation and control o cell cycle. 4.4 Cell cycle checkpoints – Different types of checl points, Checkpoint genes and significance of checkpoints in cell cycle.	P1, P3, P2, P4, P5, P6	PQ,P6,PT
V	UNIT – V 5.1 Organization of Genes and Chromosomes -Hierarchy in organization 5.2 Chromosomal organization of genes andnon-coding DNA, Mobile DNA, unique and repetitive DNA, interrupted genes, gene families. 5.3 Morphological and functional elements ofeukaryotic chromosomes, structure of chromatin and chromosomes, heterochromatin, euchromatin, transposons. 5.4 Cancer - Genetic rearrangements in progenitor cells oncogenes, tumor suppressor genes, cancer and the cell cycle, virus-induced cancer, metastasis, interaction of cancer cells with normal cells, apoptosis, therapeutic interventions of uncontrolled cell growth.	P1, P2, P3, P5, P6, P4	PQ,PT

Course: M.sc Zoology	Year:I	Semester:II
Subject	Immunology	
Units	1. Overview of the immune system. 2. Cells, organs and microenvironment of the immunesystem. 3. Antigens.	
Duration	60hours	
LearningObjectives	Trace the history and development of immunology. Describe surface membrane barriers and theirprotective function. Explain the important of phagocytosis and naturalkiller cells innate body defense. Describe the role of different types of T-cells and BCells and APCs	

Units	U1	U2	U3	U4	U5
Hours Split:Total: 60	10	14	12	12	12
Internal valuation:40marks	8	8	8	8	8

Power point presentation: The structure, function and regulation of genetic material

https://www.slideshare.net/MarwanAlhalabi/genetic-material-66443541

Resource Material:	**Study Material(Handouts):** **Reference Books:** Kuby immunology. Basic and clinical immunology. Clinical immunology ;principles and practice.

Academic-Pedagogical- Evaluation :Unit-wise Pedagogy

UNIT	DESCRIPTION	PEDAGOGY	INTERNAL EVALUATION
I	1.Overview of the immune system. 2.Cells, organs and microenvironment of the immune system. 3.Antigens	P1, P2, P3, P4, P5, P6	PQ,P6,PT
II	1.Antibodies 2.Ag. - Ab. Interactions and Diagnostic techniques. 3. The major Histocompatibility complex and antigen presentation. 4.Antigen presentation.	P1, P3, P6, P4, P2, P5	PX,P6,PT
III	1.Innate Immunity. 2.Inflammatory response. 3. Receptors and signaling. 4. The complement system.	P1, P2, P3, P6, P4, P5	PQ,PT
IV	1.T- cell development. 2. B-cell development. 3. Effector responses.	P1, P3, P2, P4, P5, P6	PQ,P6,PT
V	1.Allergy. 2. Autoimmunity & immunodeficiencydisorders. 3. Transplantation immunology. 4. Cancer and the immune system.	P1, P2, P3, P5, P6, P4	PQ,PT

Course: MSC ZOOLOGY	Year:I	Semester:II
Subject	**GENERAL AND COMPARATIVE PHYSIOLOGY**	
Units	1.Digestive and respiratory system with neural andhormonal control of respiratory system. 2Blood circulation, cascade of biochemicalreactions, cardiovascular system, ECG. 3Excretory system, physiology of urine formation,waste elimination and micturition. 4Nervous system, types of synapses, grossneuroanatomy of the brain and spinal cord, typesof muscles. 5Homeostatic mechanisms of the body, 1. thermoregulation, stress physiology and sense organs.	
Duration	**60hours**	
LearningObjectives	• **To obtain knowledge on physiology & anatomy ofdigestive & respiratory systems** • **To learn about physiology & anatomy of circulatorysystem** • **To know about physiology & anatomy of excretorysystem** • **To have knowledge on physiology & anatomy ofnervous system & muscles** • **To gain knowledge on physiology of homeostasis &stress.**	

Units	U1	U2	U3	U4	U5
Hours Split:Total: 60	20	20	20	20	20
Internal valuation:40marks	4	4	4	4	4

Academic-Pedagogical- Evaluation :Unit-wise Pedagogy

UNIT	DESCRIPTION	PEDAGOGY	INTERNAL EVALUATION
I	1.1. Functional anatomy of digestive system. 1.2. **Digestion and absorption**. Neuroendocrine regulation of gastro – intestinal movements and secretions Energy balance, BMR 1.3 **Respiratory system** - Comparison of respiration in different species, anatomical considerations. Breathing movements, transport and exchange of gases, waste elimination. Respiratory quotient, Respiratory Pigments. 1.4 **Neural and hormonal control of breathing** Respiratory acidosis and alkalosis and regulation of blood	P1, P2, P3, P4, P5, P6	PQ,P6,PT

	pH.		
II	2.1. **Blood & Circulation** - Blood corpuscles hemopoiesis and formed elements, plasma function, blood volume, blood volume regulation, blood groups hemoglobin, hemostasis. 2.2. Cascade of biochemical reactions (factors) involving in blood coagulation. 2.3. **Cardiovascular System**: Comparative anatomy of heart structure, myogenic heart, specialized tissue. 2.4. **ECG** – its principle and significance, cardiac cycle heart as a pump, blood pressure, neural and chemical regulation.	P1, P3, P6, P4, P2, P5	PX,P6,PT
III	3.1**Excretory system** - Comparative physiology of excretion, kidney and its renal units. 3.2. **Physiology of urine formation**. The significance of Henley's loop.Role of hormones in renal physiology. 3.3. **Waste elimination**- Formation of nitrogenous excretory products NH3, Urea & Uric acid. 3.4. **Micturition**, regulation of water balance, blood volume, blood pressure, electrolyte balance, acid-base balance.	P1, P2, P3, P6, P4, P5	PQ,PT
IV	4.1 **Nervous system** - Structure of neuron, Fundamentals of nerve impulse- resting potential, Action potential, role of ion channels. 4.2 **Types of synapses**- electrical and chemical, gap junctions, ligand gated channels and the Mechanism of synaptic transmission, cholinergic and adrenergic Neuromuscular junction. 4.3 **Gross neuro anatomy of the brain and spinal cord** central and peripheral nervous system, neural control of muscle tone andposture. 4.4 **Types of muscles**: Striated, non-striated and cardiac muscles. Ultra-structure of striated muscle. Muscle contraction – Muscle proteins, sliding filament theory**.**	P1, P3, P2, P4, P5, P6	PQ,P6,PT
V	5.1 **Homeostatic mechanisms of the body** - Concepts of Homeostasis. 5.2 **Thermoregulation** - Comfort zone, body temperature – physical, chemical, neural regulation, acclimatization. 5.3 **Stress Physiology** - Basic concept of environmental stress and strain, concepts of elastic and plastic strain, stress resistance, stress avoidance and stress tolerance. Responses to bioticand abiotic factors.	P1, P2, P3, P5, P6, P4	PQ,PT

	5.4 **Sense organs** - Vision, hearing and tactile response**.**		

Course: MSC[ZOOLOGY]	Year:I	Semester:II
Subject	MOLECLAR BIOLOGY	
Units	18. **Chemical composition of DNA ,DNA content and -value paradox.** **2. DNA damage ; DNA repair mechanisms ; Enzymesinvolved.** **3 DNA replication.** **4 RNA Transcription.** **5 Protein Translation**	
Duration	**60hours**	
LearningObjectives	1 Utilize the knowledge for undertaking either research positions, or employability positions in scientific laboratories or academic institutions. 2 Imbibes deep understanding of molecular biology, and can explore different enzymes involved in DNA replication, the mechanism of DNA replication in prokaryotes and eukaryotes, the basic concept of DNA damage and repair. 3 Imparts knowledge to other stake holders and can bring social awareness on some misconceptions regarding molecular data and genetic code 4 To highlight the mechanism of prokaryotic and eukaryoticprotein synthesis. 5Details of eukaryotic post translationalmodifications. To study the inhibitors ●	

Units	U1	U2	U3	U4	U5
Hours Split:Total: 60	10	14	12	12	12
Internal valuation:40marks	8	8	8	8	8

Resource Material:	**Study Material(Handouts):** **Reference Books:** . Alberts, B., Bray, D. and Hopkin, K. (2004). Essential Cell Biology. 3rd edition. Garlan Science, U.S.A.

Academic-Pedagogical- Evaluation :Unit-wise Pedagogy

UNIT	DESCRIPTION	PEDAGOGY	INTERNAL EVALUATION		
	1 1.1 **Chemical composition of DNA** - Discovery of DNA, Evidence for DNA as the genetic material. Chemical structure of DNA and Base composition, biologically important nucleotides, Watson- Crick model, Supercoiled DNA, Structure of different types of nucleic acids, hydrolysis of nucleic acids. Conformation of nucleic acids: A-, B-, Z-, DNA, t-RNA, micro-RNA. Stability of nucleic acid structure. 1.2 **DNA content and C - value paradox**- Genome size and content over members of different orders and of the same family (Genomes of bacteria, viruses, plasmids, mitochondria and chloroplast). Methods to measure DNA content variation - Various types of DNA sequences (simple sequences, repetitive sequences, nonsense sequences, tandem gene clusters, satellites) 1.3 Resolving the paradox by DNA-DNA and DNA-RNA hybridization kinetics, Kinetics of DNA-DNA hybridization, DNA-RNA hybridization, Cotcurves, Rot curves.				
II	chemical and biological mutagens; types of damage caused by endogenous and exogenous agents, Molecular mechanisms of mutagenesis – Transition, Transversion, Frame Shift, mis-sense and non-sense mutations 2.2 **DNA repair mechanisms**: Direct reversal, photoreactivation, base excision repair, nucleotide excision repair, mismatch repair, double strand break repair, SOS repair; Recombination: Homologous, non-homologous and site-specific recombination. 2.3 **Enzymes involved**; Types of topoisomerases and their function in adding or removing super helical structures.	P1, P3, P6, P4, P2,P5	PX,P6,PT		

III	3.1 **Prokaryotic DNA replication** - Replication origin and site. Enzymes and accessory proteins and their mechanisms - DNA polymerases, composition and features, replication factors and mechanism of replication, leading strand and lagging strand synthesis, processivity and fidelity and regulation of replication. Extrachromosomal replicons, Replication of single stranded DNA, M13 viral DNA. Link with cell cycle.	P1, P2, P3,P6, P4,P5	PQ,PT		
	3.2 **Eukaryotic replication** - Replication origin, replication fork, replication initiation complexes and their assembly, licensing factors, DNA polymerases and their composition telomerase and mode of action, replication factors, disassembly of chromatin components and reassembly during replication.				
	3.3 Prokaryotic gene regulation: Lac and Trp operons. Lytic and lysogenic phases of Bacteriophage λ life cycle. Sporulation in Bacillus subtilis. Eukaryotic gene regulation: Role of chromatin in eukaryotic gene regulation. Cis-trans elements, DNA methylation, chromatin remodeling. Environmental gene regulation. RNAi in gene regulation. Epigenetic generegulation				
IV	4.1. Types of RNA, secondary and tertiary structure and function.				
	4.2. Prokaryotic and Eukaryotic transcription; Transcription factors and machinery, formation of initiation complex, transcription activator and repressor.	P1,P3,P2,P4 ,P5,P6	PQ,P6,PT		
	4.3. RNA polymerases, capping, elongation, and termination. RNA processing, RNA editing, splicing, and polyadenylation. Nuclear Export of m-RNA.				
	4.4. **Post transcriptional modifications** - RNA splicing and processing (5' capping, Poly Aadenylation), mRNA editing, transcription				
V	5.1 Ribosome structure, Genetic code (codon anticodon recognition, wobble hypothesis, mutations).	P1,P2,P3,P5 P6,P4	PQ,PT		
	5.2 **Prokaryotic and eukaryotic translation** – Polypeptide synthesis (initiation, elongation, termination), control of eukaryotic translation, Effect of antibiotics on protein synthesis				

	5.3	**post-translational modification** of proteins, protein folding, protein sorting; Mitochondrial translation, proteomics and proteomic analysis.			

Course: MSC ZOOLOGY	Year:I	Semester:II
Subject	**BIOMOLECULES**	
Units	1.**Biomolecules** **2.Carbohydrates** **3.Amino acids** **4. Biological importance of lipids** **5.Structural organization of DNA**	
Duration	**60hours**	
LearningObjectives	**1.To impart knowledge on various biomolecules** **2.To learn about chemistry and bioenergetics of carbohydrates** **3. To have knowledge on biological importance of proteins** **4. To know about the role of lipids in biological functions** **5. To gain knowledge on Nucleic acids & Enzymes**	

Units	U1	U2	U3	U4	U5
Hours Split:Total: 60	20	20	20	20	20
Internal valuation:40marks	4	4	4	4	4

Academic-Pedagogical- Evaluation :Unit-wise Pedagogy

UNIT	DESCRIPTION	PEDAGOGY	INTERNAL EVALUATION
I	**1.1 Biomolecules- chemical composition and bonding , chemical reactivity , ionization of water.** **1.2 Weak acids and weak bases (pH) , buffers: buffering in biological systems, Stabilizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc.).** **1.3 Principles of bioenergetics – Principles and Laws of thermodynamics, reaction kinetics, colligative properties and their applications in biological system : entropy and enthalpy.** **1.4 Standard free energy changes standard**	P1, P2, P3, P4, P5, P6	PQ,P6,PT

	reduction potentials, reaction.		
II	**2.1 Carbohydrates- Definition and classification of carbohydrates, nomenclature.** **2.2 Reaction of Mono-saccharides- Acid derivatives of Mono-saccharides, amino-sugars, Oligo - saccharides, structure and properties.** **2.3 homo and hetero - polysaccharides, peptidoglycan,glycosaminoglycans, glycoproteins,lycoproteins & other glycoconjugates.Biosynthesis and degradationof glucose and glycogen.** **2.4 Bioenergetics - Glycolysis, oxidative phosphorylation, coupled reaction, group transfer, biological energy transducers.**	P1, P3, P6, P4, P2, P5	PX,P6,PT
III	**3.1 Amino acids – classification, Peptide bond,** **3.2 Proteins – classification, structural organization of proteins, primary structure, secondary structure, tertiary structure, quaternary structure.** **3.3 Conformation of proteins (Ramachandran plot) domains, motifs and folds. Denaturation &renaturation of proteins.Biosynthesis of urea.** **3.4 Tissue proteinin health and diseases, collagen-structure and synthesis, abnormal collagens, elastin, keratins,muscle proteins, lens proteins and cataract.**	P1, P2, P3, P6, P4, P5	PQ,PT
IV	**4.1 Biological importance of lipids. Fatty acids: classification, nomenclature.** **4.2 Simple fats:Triacylglycerol (Triglycerides) – Physical properties. Reactions – Hydrolysis, Saponification,Rancidity. Acid number, Saponification number, Iodine number oxidation, Ketosis, Reichert-Meissl-Wollnyvalue.** **4.3 Compound lipids: Phospholipids- Lecithin, Phosphatidyl inositol, Cephalins,plasmologens,Glycolipids, Sphingolipids Steroids: Biologically important steroids-cholesterol,Vitamin D, Bile acids, Ergosterol, Terpenes.** **4.4 Prostaglandins- Structure, types, synthesis**	P1, P3, P2, P4, P5, P6	PQ,P6,PT

	andfunctions. Lipoproteins.		
V	**5.1 Structural organization of DNA (Watson-Crick model)-Characteristic features of A,B,C and Z DNA. Structural organization of tRNA and micro RNA- stability of proteins and nucleic acids.** **5.2 Protein-nucleic acid interactions-Electrostatic interaction,hydrogen bonding stacking interactions. DNA binding proteins-DNA regulatory proteins, foldingmotifs, finger motifs, Zipper motifs, conformation flexibilities- Biological roles of nucleotides andnucleic acids.** **5.3 Enzymes: Classification- (I.U.B.system) co-enzymes, iso-enzymes, ribozyme. Enzyme specificity.Mechanismof action of enzymes.Formation of enzyme substrate complex.Various theories.** **5.4 Enzyme kinetics:Michaelis-Menten equation. Km value and its significance.Enzyme velocity and factors influencingenzymevelocity.Enzyme inhibition-suicide inhibition and feedback inhibition. Enzyme regulation:Types of regulation, Allosteric regulations-Key enzymes, Covalent modification.**	P1, P2, P3, P5, P6, P4	PQ,PT

Course: M.sc Zoology	Year:II	Semester:III			
Subject	**POPILATION GENETICS AND EVOLUTION**				
Units	1.Theories of organic evolution 2. Gene Frequency and Genetic Equilibrium 3. Genetic structure of population 4. Genetics of quantitative traits in populations 5.Molecular Population Genetics				
Duration	**60hours**				
LearningObjectives	CO 1: In-depth knowledge into the area of Population genetics. CO 2: It also involves passing across to the students how the principles of Mendelian genetics play a role in Population genetics. CO 3: introduce the principles underlying the genetics of populations CO 4: let the students have an understanding of the implications and conditions under which gene and genotype frequencies change and/or remain the same CO 5: help the students realize the principles underlying the Hardy-Weinberg law and its application CO 6: understand the actual forces that drive evolution, sources of variation and the principle of natural selection. CO 7: through understanding of Quantitative genetics and its applications CO 8: the idea of construction of Phylogenetic trees using molecular data. CO 9: the scope and areas of application of Population genetics.				
Units	U1	U2	U3	U4	U5
Hours Split:Total: 60	10	14	12	12	12
Internal valuation:40marks	8	8	8	8	8

Resource Material:	**Study Material(Handouts):** **Reference Books:** **1. Dobzhansky, Th. Genetics and origin of Species. Colombia University Press** **2. Dobzhansky, Th., F.J. Ayala. G.L. Stebbens and J.M. Valentine. Evolution, Surjeet Publication,** **Delhi.** **3. Futuyama, D.J. Evolutionary Biology. Suinuaer Associates, INS Publishers, Dunderland** **4. Hartl, D.L. A Primer of population genetics. Sinauer Associates, INC, Massachusetts.**

Academic-Pedagogical- Evaluation :Unit-wise Pedagogy

UNIT	DESCRIPTION	PEDAGOGY	INTERNAL EVALUATION
I	1.1 Theories of organic evolution- Lamarckism, Neo Lamarckism, Darwinism, Neo Darwinism. Concepts of Variation - Genetic drift, Migration, Selection, Adaptation, Struggle, Fitness and Mutations. 1.2 Natural Selection, the Modern Synthesis, Evolution of populations. 1.3 Origin of unicellular and multicellular organisms, plants and animal - Origin of basic biological molecules, Abiotic synthesis of organic monomers and polymers, Concept of Oparin and Haldane; Experiment of Miller (1953). 1.4 The first cell - Evolution of Prokaryotes; Evolution of unicellular eukaryotes; Anaerobic metabolism, photosynthesis and aerobic metabolism.	P1, P2, P3, P4, P5, P6	PQ,P6,PT
II	2.1 Gene Frequency and Genetic Equilibrium – Gene pool, gene frequencies and genotype frequencies, Hardy Weinberg Law, conservation of gene frequency. Assumptions and Testing Hardy-Weinberg principle with population models. 2.2 Gene evolution - Multigene families, gene duplication and Divergence, Molecular drive. 2.3 Speciation and Evolution – Race formation, the species, modes of speciation (allopatric, parapatric, sympatric). Evolutionary processes causing speciation - natural selection, sexual selection, random genetic drift, Muller incompatibility. 2.4 Evolutionary genetics of speciation - Evolution of Proteins and nucleotide sequences. Mechanism of reproductive isolation.	P1, P3, P6, P4, P2, P5	PX,P6,PT
III	**3.1 Genetic structure of populations - Optimum phenotypes and Selection pressure, kinds of selection, Fisher's theorem, genetic variability, Canalization, Genetic homeostasis, genetic load, genetic death. Mutational and Segregational load.** **3.2 Phenotypic Variation** **3.3 Models explaining the genetic structure of populations** **3.4 Factors effecting Human disease frequency**	P1, P2, P3, P6, P4, P5	PQ,PT
IV	4.1 Analysis of quantitative traits, Quantitative traits and natural selection, 4.2 Heritability or Estimation of – Broad sense and narrow sense heritability, 4.3 Genotype: Environment interactions 4.4 Inbreeding and Heterosis.	P1, P3, P2, P4, P5, P6	PQ,P6,PT

V	5.1 Molecular phylogeny- Immunological techniques, amino acid sequences, DNA – DNA hybridizations nucleic acid phylogeny. 5.2 Patterns and modes of substitution - Nucleotide substitutions, Evolutionary rate, Molecular clock. 5.3 Phylogenetic trees, construction method, phylogenetic gradualism, punctuated equilibrium, phylogenetic classification, phenetics, cladistics. 5.4 Induced Changes in genetic material - Ionizing and UV radiation, Chemical mutagens, Oxygen and environmental effects, DNA repair, induced mutations in humans.	P1, P2, P3, P5, P6, P4	PQ,PT

Course: M.sc Zoology	Year:II	Semester:III
Subject	DEVELOPMENTAL BIOLOGY	
Units	1.**Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; mutants and transgenics in analysis of development.** **,Heterogamy in eukaryotes,Comparative account of differentiation of gonads in a mammal and an invertebrate (Snail).** **2. Production of gametes, Fertilization, Cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals, embryogenesis.** **3. Cell aggregation and differentiation in Dictyostelium, Axes and pattern formation in Drosophila, amphibia and chick, Organogenesis, Post embryonic development.** **4. Collection and cryopreservation of gametes and embryos, Multiple ovulation and embryotransfer technology (MOETT), Transgenic animals and knockouts, Embryonic stem cells.**	
Duration	60hours	
LearningObjectives	***To impart knowledge on basic concepts of development** ***To learn about gametogenesis, fertilization & early development** *** To have knowledge on morphogenesis and organogenesis** ***To know about the advanced technologies** ***To gain knowledge on assisted reproduction technologies & contraceptive measure**	

Units	U1	U2	U3	U4	U5
Hours Split:Total: 60	10	14	12	12	12
Internal valuation:40marks	8	8	8	8	8

Resource Material:	**Study Material(Handouts):** **Reference Books:** **1. Gilbert, S.F. Developmental Biology. 10th Edition, Sinauer Associated Inc., Massachusetts** **2. Balinsky, B.I. Introduction to Embryology. Saunders, Philadelphia** **3. Berril, N.J. and Karp, G.Development Biology. McGraw Hill, New York**

Academic-Pedagogical- Evaluation :Unit-wise Pedagogy

UNIT	DESCRIPTION	PEDAGOGY	INTERNAL EVALUATION
I	**1.1 Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; mutants and transgenics in analysis of development.** **1.2 Heterogamy in eukaryotes.** **1.3 Comparative account of differentiation of gonads in a mammal and an invertebrate (Snail).**	P1, P2, P3, P4, P5, P6	PQ,P6,PT
II	**2.1 Production of gametes – Spermatogenesis, Spermiogenesis (Sperm structure, Semen composition and formation; assessment of sperm functions), Oogenesis and Vitellogenesis (Ovarian follicular growth and differentiation) cell surface molecules in sperm - egg recognition in mammals (Rodents), Acrosomal reaction, zygote formation.** **2.2 Fertilization - Pre-fertilization, Biochemistry of fertilization, Post-fertilization** **2.3 Cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals, embryogenesis**.	P1, P3, P6, P4, P2, P5	PX,P6,PT
III	**3.1 Cell aggregation and differentiation in Dictyostelium, Axes and pattern formation in Drosophila, amphibia and chick.** **3.2 Organogenesis – vulva formation in Caenorhabditiselegans, eye lens induction, limb development and regeneration in vertebrates; differentiation of neurons,** **3.3 Post embryonic development - larval formation, metamorphosis; environmental regulation of normal development; sex determination.**	P1, P2, P3, P6, P4, P5	PQ,PT
IV	**4.1 Collection and cryopreservation of gametes and embryos.** **4.2Multiple ovulation and embryotransfer technology (MOETT) (Superovulation,In vitro oocyte maturation, In vitrofertilization, embryo transfer).** **4.3 Transgenic animals and knockouts:**	P1, P3, P2, P4, P5, P6	PQ,P6,PT

	Production & Applications. **4.4 Embryonic stem cells.**		
V	**5.1 Assisted reproduction technologies – Ovulation induction- In vitro fertilization- Pre-implantation genetic diagnosis- Mitochondrial replacement therapy- gamete intrafallopian transfer- Reproductive surgery, treating- cryopreservation.** **5.2 Embryo sexing and cloning, Screening for geneticdisorders, ICSI, Cloning of animals by nuclear transfer** **5.3 Teratological effects of Xenobiotics.** **5.4 contraception: Barrier methods- hormonal birth control- intrauterine devices (IUDs) - Surgical sterilization - behavioral methods - Immunocontraception.**	P1, P2, P3, P5, P6, P4	PQ,PT

Course: M.sc Zoology	Year:II	Semester:III
Subject	**AQUACULTURE**	
Units	1. 1.General Principles, Scope, Cultural &Socio-economic basis. 2. Types of culture system 3. Biological characteristics of aquaculture systems 4.Reproduction and genetic selection.	
Duration	**60hours**	
LearningObjectives	**1.** 1.To Impart knowledge on basis of aquaculture. **2.** To learn about construction & management of aquaculture ponds. **3.** To have knowledge on aquaculture of different shell fish & fin fish. **4.** To know about the water quality & feed management. **5.** To gain Knowledge on post-harvest technology.	

Units	U1	U2	U3	U4	U5
Hours Split:Total: 60	10	14	12	12	12
Internal valuation:40marks	8	8	8	8	8

Resource Material:	**Study Material(Handouts):** **Reference Books:** 1. Pillay, T.V.R. 1993.Aquaculture: Principles and practices. Fishing news books. Blackwell 2. Scientific Publications. 3. Jhingran, V.G 1993. Fish and fisheries of India. Hindustan Publishing Corporation, New Delhi

Academic-Pedagogical- Evaluation :Unit-wise Pedagogy

UNIT	DESCRIPTION	PEDAGOGY	INTERNAL EVALUATION
I	1. .General Principles, Scope, Cultural & Socio-economic basis. 2. Types of culture system 3. Biological characteristics of aquaculture systems Reproduction and genetic selection.	P1, P2, P3, P4, P5, P6	PQ,P6,PT
II	1.selection of site for aquaculture 2. pond preparation and management 3. pre stockingmanagement 4. post stocking management	P1, P3, P6, P4, P2, P5	PX,P6,PT
III	1.Freshwater culture 2.Brakish water culture 3.Mariculture 4.Integrated farming	P1, P2, P3, P6, P4, P5	PQ,PT
IV	1.Hydrology of ponds 2.water quality management 3.feed management 4.feed formulation and processing	P1, P3, P2, P4, P5, P6	PQ,P6,PT
V	1. Post harvest technology 2. Methods to supress bacterial growth 3. Different kinds of aquaculture and productivity 4.Environmental impact of aquaculture	P1, P2, P3, P5, P6, P4	PQ,PT

Course: M.sc Zoology	Year:II	Semester:III
Subject	**PRINCIPLES OF ECOLOGY & CONSERVATION**	
Units	4. **Ecology, Factors affecting ecosystem,Habitat and Ecological Niche.** 5. **Ecosystem, Productivity, Energy flow and trophic dynamics, Climate change .** 6. **Attributes of population, Population energetics and interactions, Population growth, Population Regulation.** 7. **Population Regulation, Life history strategies,Succession and climax.** **Terrestrial and aquatic communities, Biodiversity & Conservation Biology,Conservation Biology, Biogeography**	
Duration	**60hours**	
LearningObjectives	*Provide students with the scope to develop knowledge base covering all attributes of the environment. * Help students to understand the structure and function of an ecosystem, habitat ecology and Ecological niche. * Enable them to understand population growth attributes. *Develop awareness among the young students about the surroundingenvironment,theimpactofclimatechangeanditsmitigation,and biodiversity. *Enable them to attain scientific/technological capabilities to find answers to the fundamental questions before the society with regards to human action and environmental effects with due diligence. *Enhance the ability to apply this knowledge and proficiency to find solutions relating to environmental concerns of varied dimensions of present times.	

Units	U1	U2	U3	U4	U5
Hours Split:Total: 60	10	14	12	12	12
Internal valuation:40marks	8	8	8	8	8

Resource Material:	**Study Material(Handouts):** **Reference Books:** 1. Koromondy, E.J. Concepts of ecology. Prentice Hall, New Delhi. 2. Clarke, G.L. Elements of Ecology, John Wiley & Sons, New York. 3. Odum, E.P. Fundamentals of Ecology. W.B. Saunders, Philadelphia. 4. Krebs, C.J. Ecology. Harper & Row, New York.

Academic-Pedagogical- Evaluation :Unit-wise Pedagogy

UNIT	DESCRIPTION	PEDAGOGY	INTERNAL EVALUATION
I	1.1 **Ecology:** Basic concepts, scope, multidisciplinary nature and relevance; Ecosystem concept, organization and significance; Biosphere concept, organization and significance; Cybernetic nature of ecosystems. Ecosystem structure; ecosystem function. 1.2 **Factors affecting ecosystem**: Major environmental factors (biotic and abiotic) influencing organisms in various ecosystems; Concept of limiting factors; Liebig's law of the minimum; Shelford law of tolerance. 1.3 **Habitat and Ecological Niche** – Concept of habitat and niche; niche width and overlap niche width and overlap; fundamental and realized niche; resource partitioning; character displacement	P1, P2, P3, P4, P5, P6	PQ,P6,PT
II	2.1 **Ecosystem -** Nature of ecosystem, bio-geochemicalcycles,resilienceofecosystem,ecosystem management.Thebiosphere,biomesandimpactofclimate on biomes. 2.2 **Productivity**: Primary productivity; concept, methods of estimation, world patterns of primary productivity and Man's exploitation of primary productivity; Secondary productivity; concept, methods of estimation, world patterns of secondary productivity, and man's exploitation of secondary productivity. 2.3 **Energy flow and trophic dynamics**: Energy flow in ecosystems; Concept of trophic dynamics and trophic cascade; Food chains, food webs and trophic levels; Ecological pyramids; Energy transfer; Ecological efficiencies; Biogeochemical cycles (water, oxygen, carbon, nitrogen, phosphorus and Sulphur) and man's impact. 2.4 **Climate change** - Environmental Stresses and their management, global climatic pattern, global warming, atmospheric ozone, acid and nitrogen deposition, coping with climatic variations.	P1, P3, P6, P4, P2, P5	PX,P6,PT
III	3.1 **Attributes of population**: Population growth, density; Density dependent and density independent factors; Natality, mortality, biotic potential, carrying capacity; Survivorship and age structure; Seasonal population fluctuation. 3.2 **Population energetics and interactions**: Population energetics; Patterns of population distribution, aggregation and Allee's principle; Isolation; Population interactions: competition (allelopathy), parasitism, predation, herbivory, protocooperation, commensalisms, mutualism.	P1, P2, P3, P6, P4, P5	PQ,PT

	3.3 **Population growth –** Growth of organisms with non-overlapping generations, exponential growth, Verhulst – Pearl logistic growth model, Stochastic and time lag models of population growth, stable age distribution, population growth projection using Leslie Matrix. Lotka- Volterra equations. 3.4 **Population Regulation-** Extrinsic and Intrinsic Mechanisms: Case studies in population dynamics (examples from fisheries). Ecological Modelling: Fundamentals of constructing models and testing them		
IV	**4.1 Community ecology**: Community concept; Nature of communities; community structure and attributes; levels of species diversity and its measurement. Individualistic and organismic nature of communities; Qualitative and quantitative characters of community; Methods of studying vegetation; Species diversity and its measurement. 4.2 **Life history strategies-** Evolution of life history traits, longevity and theories of ageing, energy apportionment between somatic growth and reproduction, reproductive strategies, optimal body size, r and K selection. Demography construction of Life Tables and their demographic application. 4.3 **Succession and climax**: Types of succession, trends of succession; Models of succession; Mechanisms; Concept of climax community; theories on climax, ecotone and edge effect; Ecotypic differentiation; r and k strategies.	P1, P3, P2, P4, P5, P6	PQ,P6,PT
V	**5.1 Terrestrial and aquatic communities**: Plant and animal communities in forest, grassland, desert and mangrove ecosystems; High altitude communities; Zonation and stratification of plant and animal communities. 5.2 **Biodiversity & Conservation Biology –** Overview of global environmental change, Biodiversity status monitoring and documentation, Major drivers of biodiversity change. 5.3 **Conservation Biology**: Principles of conservation, major approaches to management, Indian case studies on conservation, management strategy (Project Tiger, Biosphere reserves). 5.4 **Biogeography-** Major terrestrial biomes; theory of island biogeography; biogeographical zones of India. Faunal diversity and biodiversity Hotspots in India.	P1, P2, P3, P5, P6, P4	PQ,PT

Course: M.sc Zoology	Year:II	Semester:IV			
Subject	ENDOCRINOLOGY AND ANIMAL BEHAVIOUR				
Units	1.Scope and significance of endocrinology, Mechanism of hormone action, Hypothalamo-hypophysial System, Ad,nohypophysial hormones. 2.Thyroid Gland, Testis- Organization, Ovary-Organization, Adrenal Cortex, Role of parathormone. 3.Neuro-endocrine system in invertebrate groups, Neuroendocrine regulation of reproductive processes & gametogenesis, Physiological actions of hormones of Parathyroid and Thymus glands. , Role of endocrinology in health and diseases. 4.Physiological actions of adrenal medullary hormones, Evolution of discrete adrenal gland, Comparative aspects of endocrine physiology in vertebrates, Hormones in IVF, pregnancy testing, and Amniocentesis. 5. Neural basis of learning, Approaches and methods in study of behavior, Development of behavior, Aggressive behavior.				
Duration	60hours				
LearningObjectives	*To impart knowledge on chemical and neural integration *To learn about physiology of endocrine glands in vertebrates *To have knowledge on neuro-endocrine mechanisms in invertebrates *To know about the comparative physiology of vertebrate hormones *To gain knowledge on animal behavior				
Units	U1	U2	U3	U4	U5
Hours Split:Total: 60	10	14	12	12	12
Internal valuation:40marks	8	8	8	8	8

Resource Material:	**Study Material(Handouts):** **Reference Books:** ***Endocrinology: Mac E. Hadely. 5th ed. Pearson Education, 2000.** ***General and comparative Endocrinology: E.J.W. Barington.** ***Comparative Vertebrate Endocrinology: P. J. Bentley.** ***Comparative Endocrinology: A. Gorbman et.al.**

Academic-Pedagogical- Evaluation :Unit-wise Pedagogy

UNIT	DESCRIPTION	PEDAGOGY	INTERNAL EVALUATION
I	**1.1 Scope and significance of endocrinology- Concept of neurohormones and neurotransmitters.** **1.2Mechanism of hormone action: Protein Hormones- Membrane receptors- G-proteins and control of adenylatecyclase- Cyclic AMP cascade- Other signal Transduction systems (PLC and PLA pathways)- Steroid hormones** **1.3Hypothalamo-hypophysial System: General organization- Neurohypophysialoctapeptides (Oxytocin and Vasopressin)-Hypophysiotropic hormones: Chemistry- localization and actions.** **1.4 Adenohypophysial hormones- Chemistry and physiological roles ofSomatotropin and Prolacin- Glycoprotein hormones (FSH, LH and TSH)- Pro-opiomelanocortin (ACTH, MSH, β-LPH & β-endorphin)- Neural control of adenohypophysis**	P1, P2, P3, P4, P5, P6	PQ,P6,PT
II	**2.1 Thyroid Gland- biosynthesis of thyroid hormones- Control of secretion- Physiological roles- Steroid hormone biosynthesis and pathways.** **2.2Testis- Organization- Physiological roles of androgens- Inhibin- Ovary- Organization- Physiological roles of Estrogen, Progesterone and Relaxin- Inhibin.** **2.3Adrenal Cortex- Organization- Control of mineralocorticoid and glucocorticoid secretions- Physiological roles of glucocorticoid and mineralocorticoid- Adrenal Medulla: Catecholamine biosynthesis, release and its physiological roles.** **2.4Role of parathormone: Calcitonin and vitamin D in calcium homeostasis- Endocrine Pancreas: Biosynthesis and physiological actions of Insulin and Glucagon**	P1, P3, P6, P4, P2, P5	PX,P6,PT
III	**3.1 Neuro-endocrine system in invertebrate groups - neuro-endocrine mechanisms of moulting, growth and reproduction in crustaceans & insects-hormonal control of**	P1, P2, P3, P6, P4, P5	PQ,PT

	reproduction in Mollusca and Echinodermata. **3.2 Neuroendocrine regulation of reproductive processes & gametogenesis** **3.3 Physiological actions of hormones of Parathyroid and Thymus glands.** **3.4 Role of endocrinology in health and diseases.**		
IV	**4.1 Physiological actions of adrenal medullary hormones - Importance of adrenocortical and adrenomedullary interaction. renin-angiotensin system, hormonal control of water and electrolyte balance, Catecholamine biosynthesis, its storage and release mechanism.** **4.2 Evolution of discrete adrenal gland; Synthesis of corticosteroid, structural diversity of glucocorticoids among vertebrates, role of glucocorticoid in gluconeogenesis.** **4.3 Comparative aspects of endocrine physiology in vertebrates – Structure and Function of Gastrointestinal hormones or gut hormones; Gastrin family hormones, Secretin glucagon family, GI regulatory peptides - Physiological actions of these hormones.** **4.4 Hormones in IVF, pregnancy testing, and Amniocentesis.**	P1, P3, P2, P4, P5, P6	PQ,P6,PT

V	**5.1 Neural basis of learning, memory, cognition, sleep and arousal; Biological clocks.** **5.2 Approaches and methods in study of behaviour; Proximate and ultimate causation; Altruism and evolution-Group selection, Kin selection, Reciprocal altruism.** **5.3 Development of behavior; Social communication; Social dominance; Use of space and territoriality; Mating systems, Parental investment and Reproductive success; Parental care;** **5.4 Aggressive behaviour; Habitat selection and optimality in foraging; Migration, orientation and navigation; Domestication and behavioral changes.**	P1, P2, P3, P5, P6, P4	PQ,PT

Course: M.sc Zoology	Year:II	Semester:IV
Subject	**PARASITOLOGY**	
Units	.Introduction to Parasites. 8. Protozoa and Cestoda 9. Trematoda and Nematoda 10. Beyond humans: Parasites of veterinary importance. Immune reactions to Parasitic infections & Pathology	
Duration	**60hours**	
LearningObjectives	• **An overview of biological basis of parasitic lifestyles.** • It includes host responsesandparasiteevasionofhostdefensemechanisms. • Thestudentsareexposedtoknowledgeon parasites that not only infect humans, but also animals. • It emphasizes on the evolutionary aspect of host-pathogen interactions leading to host specificity. • The students learn about transmission, epidemiology, diagnosis, clinical manifestations, pathology,treatmentandcontrol ofmajorparasites. • It includes through knowledge on the major parasitic groups like Helminthes and protozoans. • The course has been structured in a way that the students assimilate the classroom knowledge for applied aspects of parasitology and publichealth. • The student gets an insight into immune mechanisms exhibited by parasites present in various habitats and representing different groups.	

Units	U1	U2	U3	U4	U5
Hours Split:Total: 60	10	14	12	12	12
Internal valuation:40marks	8	8	8	8	8

Resource Material:	**Study Material(Handouts):** **Reference Books:** 1. Parasitology: An Integrated Approach by Alan Gunn, Sarah Jane Pitt. Wiley – Blackwell 2. Modern Parasitology: A Textbook of Parasitology by F. E. G. Cox 3. General Parasitology by Thomas C. Cheng, Academic Press, College Division.

Academic-Pedagogical- Evaluation :Unit-wise Pedagogy

UNIT	DESCRIPTION	PEDAGOGY	INTERNAL EVALUATION
I	1.1 **Introduction to Parasitology -** Scope of the subject, definition and concept of parasitism and parasites. Types of animal associations, parasite and types of parasitism (Commensalism, Symbiosis, Predaterism, Phoresis and Mutualism). Hyper-parasitism. 1.2 **Types of Hosts**: Final, intermediate, paratenic and reservoir hosts with examples, Vectors, natural and unnatural, host parasite relationship and types of parasites 1.3 **Host-parasite relationship-** Effects of parasitism to their host - Mechanical action. Hosts response to parasitic infection. Specificity of parasites in relation to species, breed, sex of host and location in the host (organ specificity). 1.4 **Factors influencing Pathogenesis –** Host factors and Parasite factors. Mechanisms by which parasites induce pathology. Modes of transmission of parasites and methods of dissemination of infective stages of parasites	P1, P2, P3, P4, P5, P6	PQ,P6,PT
II	2.1 Salient morphological features of diagnostic importance, life cycle, transmission, pathogenesis, symptoms, epidemiology, diagnosis and general control measures including treatment of: *Entamoebahistolytica, Giardia intestinalis, Trichomonastenax. Trypanosomagambiense, T. cruzi. Leishmaniadonovani, L. tropica, P. vivax, Plasmodium* sps. - their Differential diagnosis and *Toxoplasma gondai* 2.2 Free living amoebae: Hartmanella, Acanthamoeba and Naegleria 2.3 Cestodes: *Diphyllobothriumlatum, Taeniasolium, T. saginata, Hymenolepis nana, Echinococcusgranulosus* 2.4 Classification of Parasitic Protozoans and Cestodes up to families	P1, P3, P6, P4, P2, P5	PX,P6,PT
III	**3.1 Animal Breeding -** Principles, Structure of livestock breeding – poultry, sheep and cattle.Marker -assisted selection. Artificial insemination (AI) techniques, in vitro fertilization. Preservation of endangered species. Germplasm bank. **3.2 Production of transgenic animals** and their applications: Mice, sheep and fish. Molecular farming and animal cloning.	P1, P2, P3, P6, P4, P5	PQ,PT

IV	**3..3 Somatic cell nuclear transfer in humans –** Legal and ethical aspects. Potential applications of transgenic animals – Animal models for diseases and disorders**.** 4.1 **Types of fermentation and fermenters** – Solid state and liquid-state (stationary and submerged) fermentations, Microbial growth kinetics in batch, continuous and fed-batch (eg. baker's yeast) fermentation process. 4.2 **Microbial production of industrial products** - Microbial preparation of Tempeh, Miso, Yogurt, Probiotics, Single cell protein. Microbiology and production of alcoholic beverages (wine & beer), organic acids (acetic and gluconic acids), amino acids (glutamic acid, lysine and tryptophan), vitamins (riboflavin and vitamin A) & enzymes (protease & lipase).	P1, P3, P2, P4, P5, P6	PQ,P6,PT
V	5.1 **Bioremediation** - Bioremediation using naturally occurring microorganism - removal of spilled oil and grease deposits. Bioremediation using Genetically Engineered Microbes (GEM) – detection of PAHs in the soil, treating oil spills, and for sequestering heavy metals. **Bioleaching** – Microbial recovery of metals and acid mine drainage. 5.2 **Biosensors** - Biosensor to detect environmental pollutants (In situ bioremediation of both soil and ground water contamination).Bioremediation of contaminated soil and contaminated surface waters (pits, ponds and lagoons). Treatment of toxic wastes before they reach environment, Conservation of soil city wastes, SPCI's strategy on biotreatment. 5.3 **Biofertilizers**– Blue green algal fertilizers – Azolla, Anabaena, symbiotic association. Sea weed fertilizers. Mycorrhizalbiofertilizers, bacterial fertilizers. Biopesticides in agricultural production.	P1, P2, P3, P5, P6, P4	PQ,PT

Course: M.sc Zoology	Year:II	Semester:IV
Subject	**GENETICS AND MOLECULAR CYTOGENETICS**	
Units	**UNIT – I Genetics & Concept of gene** **UNIT – II DNA Structure and Chromosome Organisation** **UNIT – III Chromosome segregation and Genome mapping** **UNIT – Iv genome mapping stratigies** **UNIT –V Human Cytogenetics**	
Duration	**60hours**	
LearningObjectives	Genetics and Cytogenetics course will open up several avenues for students in terms of research and employability. LO 2: summarize the principles of inheritance as discovered by Mendel, and show how subsequent genetic research led to the development of linkage analysis. LO 3: 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.	

Units	U1	U2	U3	U4	U5
Hours Split:Total: 60	10	14	12	12	12
Internal valuation:40marks	8	8	8	8	8

Resource Material:	**Study Material(Handouts):** **Reference Books:** **1.**. Concepts of Genetics, Klug WS and Cummings MR – Prentice Hall 2. Genetics: Analysis of Genes and Genomes, Hartle DL and Jones EW – Jones and Bartlett

Academic-Pedagogical- Evaluation :Unit-wise Pedagogy

UNIT	DESCRIPTION	PEDAGOGY	INTERNAL EVALUATION
I	**1.1** **Concept of gene -** Evolution of gene concept: Mendel to Beadle and Tatum; Complementation test as an operational definition of gene, cistron concept. Fine structure of gene: exons, introns, UTRs; Split genes; pseudogenes; overlapping genes and multi-gene families 1.2 **Mendelian Principles and Extension studies -** Dominance, Segregation, Independent assortment. Allele, multiple alleles, pseudo-alleles. Extensions of Mendelian principles - Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy, linkage and crossing over, sex linkage, sex limited, and sex influenced characters. 1.3 **Extra chromosomal inheritance -** Inheritance of Mitochondrial and chloroplast genes, maternal inheritance.	P1, P2, P3, P4, P5, P6	PQ,P6,PT
II	1 **Molecular Structure of DNA -** A, B, Z and triplex DNA structure, Central dogma, DNA as genetic material; Histones, DNA, nucleosome morphology and higher-level organization. DNA compaction, nucleosome, 10 nm "beads-on-a-string" fibre, nuclear matrix in chromosome organization and function. Repetitive and unique sequence, Satellite DNA, DNase hypersensitive regions, DNA methylation patterns & epigenetic effects. 2.2 **Chromosome organization -** Structure of eukaryotic chromosomes, Metaphase chromosome, centromere, kinetochore, telomere and its maintenance. Heterochromatin and euchromatin; position effect, variegation, functional states of chromatin and alterations in chromatin organization, chromatin remodelling. 2.3 Holocentric chromosomes and supernumerary chromosomes, Giant chromosomes polytene and lamp brush chromosomes, Chromosomal domains (matrix, loop domains) and their functional significance.	P1, P3, P6, P4, P2, P5	PX,P6,PT
III	3.1 **Linkage, recombination and crossing over -** Crossing over as a measure of genetic distance, Recombination mapping with two-point and three-point test cross, recombination frequency and genetic map distance, Detection of linkage in experimental organisms: Tetrad analysis in fungi, balancer chromosome technique in Drosophila, centromere mapping in ordered tetrads in Neurospora, cytogenetic mapping in Drosophila, detection of linked loci by pedigree analysis in humans.	P1, P2, P3, P6, P4, P5	PQ,PT

IV	**3.2RegulationofGeneExpression:**General introduction to gene regulation in eukaryotes at transcriptional and posttranscriptional levels; Regulationofgeneactivityin*lac*and*trp*operons of *E. coli*.; Chromatin organization and gene expression, transcription factors, enhancers and silencers, non-coding genes. 3.3MechanismsofsexdeterminationandDosageCompensation: Human, *Drosophila* and *C. elegans*. 4.1 **Genome mapping strategies:** Overview of genome mapping - **Genetic analysis** with biochemical markers (*Saccharomyces cerevisiae*), DNA markers for genetic mapping - Restriction fragment length polymorphisms (RFLPs), Simple sequence length polymorphisms (SSLPs), Single nucleotide polymorphisms (SNPs), Linkage analysis is the basis of genetic mapping, Gene mapping by human pedigree analysis, Genetic mapping in bacteria. 4.2 Physical Mapping- Restriction mapping, Fluorescentinsitu hybridization. 4.3 Human Genome Project (HGP): Strategies involved, outcome and applications. Ethical, legal and social issues involved (ELSI	P1, P3, P2, P4, P5, P6	PQ,P6,PT
V	5.1 **Human genetics -** Human karyotype - Karyotyping, Chromosomal banding and staining Techniques, Chromosomal nomenclature. 5.2 **Chromosomal abnormalities –** Cytogenetic implications (chromosomal non-disjunction), **structural abnormalities**: Deletions, Duplications, Inversion and Translocations. **Numerical abnormalities**: Autosomal and Sex chromosomal syndromes, Sex determination in *Caenorhabditiselegans*, *Drosophila melanogaster* and mammals. Dosage compensation in *Drosophila melanogaster* and mammals. 5.3 Molecular cytogenetic techniques in human chromosome analysis - Spectral karyotyping (SKY); Chromosome Painting; Comparative genomic hybridization (CGH), GISH, FISH, DNA Finger Printing and Flow Cytometry.	P1, P2, P3, P5, P6, P4	PQ,PT

Course: M.sc Zoology	Year:II	Semester:IV
Subject	**BIOTECHNOLOGY AND APPLIED BILOGY**	
Units	**11.** .Recombinant DNA technology & Genetic engineering. **12.** Gene Amplification & Sequencing **13.** Animal breeding, production of transgenic animals and somatic cell nuclear transfer in humans. **14.** Microbial fermentations. Bioremediation	
Duration	**60hours**	
LearningObjectives	• To understand concept of rDNA technology and genetic engineering • To acquaint the student with the application of recombinant technology • To impart knowledge on gene amplification and sequencing techniques • Connect the knowledge acquired with its application in the field of health and agriculture • Utilize the acquired knowledge for the improvement of animals and crops • To understand the role of microbe in fermentation and their industrial usage. • To show the student how Bioremediation can be an effective tool for monitoring pollutants present in different habitats. • To understand the importance of biosensors and biofertilizers for the management of crops and toxicants.	

Units	U1	U2	U3	U4	U5
Hours Split:Total: 60	10	14	12	12	12
Internal valuation:40marks	8	8	8	8	8

Resource Material:	**Study Material(Handouts):** **Reference Books:** 1) Principles of Gene manipulation: An Introduction to genetic Engineering. R.V. Old and B.Primrose (Blackwell Scientific Publications). 2) Biotechnology by U. Satyanarayana (Books & Allied (P) Ltd). 3) Biotechnology by B. D. Singh (Kalyani).

Academic-Pedagogical- Evaluation :Unit-wise Pedagogy

UNIT	DESCRIPTION	PEDAGOGY	INTERNAL EVALUATION
I	1.1**Outlines of recombinant DNA technology**Restriction endonucleases, Isolation of gene fragments using restriction endonucleases, c-DNA, PCR, RACE PCR. 1.2 **Cloning vectors** – plasmids, bacteriophages, cosmids, Ti - plasmid. Expression vectors, CRISPR- Cas 9 technology. **Construction of gene libraries** –cDNA library, genomic library, YAC, BAC library. Cloning strategies – shot gun experiments, cDNA cloning in bacteria. Screening of libraries 1.3 **Chemical synthesis of genes** : Ligation of fragments. RFLP, restriction maps Mapping genes –chromosomal walking, chromosomal jumping.	P1, P2, P3, P4, P5, P6	PQ,P6,PT
II	2.1. **Gene Amplification** - Basic PCR and its modifications (inverse PCR, anchored PCR, PCR for mutagenesis, asymmetric PCR); Application of PCR in biotechnology and genetic engineering. 2.**2** **DNA sequencing methods** - Major landmarks in DNA sequencing : Maxam-Gilbert sequencing, Chain-termination methods, Advanced methods and de novo sequencing, Shotgun sequencing, Next-generation sequencing, Massively Parallel Signature Sequencing (MPSS), Polony sequencing, pyrosequencing, Illumina (Solexa) sequencing, SOLID sequencing, Ion semiconductor sequencing, DNA nanoball sequencing,Heliscope single molecule sequencing, Single molecule real time (SMRT) sequencing. 2.3 **Genomics and its application to health and agriculture, including gene therapy**.	P1, P3, P6, P4, P2, P5	PX,P6,PT
III	**3.1 Animal Breeding -** Principles, Structure of livestock breeding – poultry, sheep and cattle.Marker -assisted selection. Artificial insemination (AI) techniques, in vitro fertilization. Preservation of endangered species. Germplasm bank. **3.2 Production of transgenic animals** and their applications: Mice, sheep and fish. Molecular farming and animal cloning. **3..3 Somatic cell nuclear transfer in humans –** Legal and ethical aspects. Potential applications of transgenic animals – Animal models for diseases	P1, P2, P3, P6, P4, P5	PQ,PT

IV	and disorders. 4.1 **Types of fermentation and fermenters** – Solid state and liquid-state (stationary and submerged) fermentations, Microbial growth kinetics in batch, continuous and fed-batch (eg. baker's yeast) fermentation process. 4.2 **Microbial production of industrial products** - Microbial preparation of Tempeh, Miso, Yogurt, Probiotics, Single cell protein. Microbiology and production of alcoholic beverages (wine & beer), organic acids (acetic and gluconic acids), amino acids (glutamic acid, lysine and tryptophan), vitamins (riboflavin and vitamin A) & enzymes (protease & lipase).	P1, P3, P2, P4, P5, P6	PQ,P6,PT
V	4.1 **BIOREMEDIATION -** Bioremediation using naturally occuring microorganism (removal of spilled oil and grease depostis),Bioremediation using GEM (treating oil spills,dection of PHAs,sequestring heavy metals) 4.2 **BIOLEACHING -** Microbial recovery of metals & acid mine drainage. 4.3 **BIOSENSORS** -Biosensor to detect environmental pollutants(In situ bioremediation of both soil,ground water contamination) 4.4 **BIOFERTILIZERS -** Bluegreen algal fertilizers-Azolla &Anabaena symbiotic association.Sea weed,Mycorrhizal,Bacterial fertilizers.Biopesticide in agricultural production.	P1, P2, P3, P5, P6, P4	PQ,PT