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NH-52, Namsai, Arunachal Pradesh -792103

MASTER OF SCIENCE (ZOOLOGY) – FIRST SEMESTER

First Semester			
S. No.	**Name of Subject**	**Credits**	**Total Marks**
1	Genetics and Cytogenetics	4	100
2	Principles of Gene Manipulation	4	100
3	Comparative Animal Physiology	4	100
4	Metabolism: Concepts and Regulation	4	100
5	Practical	6	100
Total		**22**	

Subject Name: GENETICS AND CYTOGENETICS

Mendel's laws and their chromosomal basis; extension of Mendel's principles: allelic variation and gene function- incomplete dominance and co-dominance, allelic series, testing gene mutations for allelism; gene action- from genotype to phenotype– penetrance and expressivity, gene interaction, epistasis, pleiotropy; nature of the gene and its functions: evolution of the concept of the gene, fine structure of gene (rII locus); methods of gene mapping: 3- point test cross in Drosophila, gene mapping in humans by linkage analysis in pedigrees.

Gene mutation and DNA repair: types of gene mutations, methods for detection of induced mutations, P- element insertional mutagenesis in Drosophila, DNA damage and repair; regulation of gene activity in lac and trp operons of E. coli, general introduction to gene regulation in eukaryotes at transcriptional and posttranscriptional levels, organization of a typical eukaryotic gene, transcription factors, enhancers and silencers, non coding genes.

Sex determination and dosage compensation: sex determination- in humans, Drosophila and other animals; dosage compensation of X-linked genes– hyperactivation of X-linked gene in male Drosophila, inactivation of X-linked genes in female mammals; human genetics- karyotype and nomenclature of metaphase chromosome bands; chromosome anomalies and diseases- chromosomal anomalies in malignancy (chronic myeloid leukemia, Burkitt's lymphoma, retinoblastoma and Wilms' tumor); genetic analysis of complex traits - complex pattern of inheritance, quantitative traits, threshold traits; human genome and mapping. Genetics and cancer: oncogenes- tumor inducing retroviruses and viral oncogenes; chromosome rearrangement and cancer; tumor suppressor genes- cellular roles of tumor suppressor genes, pRB, p53, pAPC, genetic pathways to cancer.

Suggested Literature:

1. Principles of Genetics, Snustad and Simmons, (4th Ed. 2005), John Wiley & Sons, USA

2. Modern Genetic Analysis: Integrating Genes and Genomes, Griffiths, J.F., Gelbart, M., Lewontin, C. and Miller, W. H. Freeman and Company , New York, USA

3. Genetics, J. Russell, Benjamin-Cummings Publishing Company, San Francisco, California, USA

Subject Name: PRINCIPLES OF GENE MANIPULATION

Basic recombinant DNA techniques, cutting and joining DNA molecules, restriction modification systems, various enzymes used in recombinant DNA technology, restriction maps and mapping techniques; nucleic acid probes, blotting techniques, DNA fingerprinting, foot printing, methyl interference assay. Polymerase chain reaction– methods and applications.

Basic biology of cloning vectors: plasmids, phages, single stranded DNA vectors, high capacity vectors, retroviral vectors, expression vectors and other advanced vectors in use. Gene cloning strategies: methods of transforming E. coli and other cells with rDNA; methods of selection and screening of transformed cells; construction of genomic and cDNA libraries; strategies of expressing cloned genes; phage display.

Principles of DNA sequencing, automated sequencing methods; synthesis of oligo-nucleotides, primer design; micro-arrays; confocal microscopy; changing genes- directed evolution, protein engineering in microbes.

Manipulating genes in animals: gene transfer to animal cells, genetic manipulation of animals, transgenic technology, application of recombinant DNA technology; genetically modified organisms: gene knockouts, mouse disease models, gene silencing, gene therapy, somatic and germ- line therapy.

Suggested Literature:

1. Recombinant DNA: Genes and Genomics – a short course, Watson et al., W. H. Freeman and Company, New York, USA

2. Principles of Gene Manipulation and Genomics, Primrose, S. B. And Twyman, R. M., (7th Ed. 2006), Blackwell Publishing, West Sussex, UK

3. Molecular Biotechnology: Principles and application of recombinant DNA, Bernard R. and Jack, ASM Press, Herndon, USA

Subject Name: COMPARATIVE ANIMAL PHYSIOLOGY

Internal Transport and Gas Exchange – Systems of circulation, Peripheral circulation, Regulation of heart beat and blood pressure, Transport and exchange of gases, Neural and chemical regulation of respiration, Gas transfer in air and water, Gas exchangers, Circulatory and respiratory responses to extreme conditions, Acid –base balance, Regulation of body pH.

Osmoregulation Osmoregulation in aquatic and terrestrial environments, Kidney functions and diversity, Extra-renal osmoregulatory organs, Patterns of nitrogen excretion. Thermoregulation - Heat balance in animals, Adaptations to temperature extremes, torpor, Aestivation and hibernation, Counter current heat exchangers. Adaptations to Stress- basic concept of environmental stress, acclimation, acclimatization, avoidance and tolerance, stress and hormones.

Sensing the Environment- hotoreception, chemoreception, mechanoreception, echolocation, Endogenous and exogenous biological rhythms, Chromatophores and bioluminescence.

Feeding mechanisms and their control, effect of starvation. Muscle physiology – striated and smooth muscle, Adaptations of muscles for various activities, Neuronal control of muscle contraction, Electric organs.

Suggested Literature:

1. General and Comparative Animal Physiology, Hoar W. S. (ed), Prentice Hall, India.
2. Comparative Physiology (Handbook of Physiology): Vol. 1, 2, Dantzler, W.H. (ed.) Oxford University Press, New York, USA.
3. Animal Physiology: Adaptation and Environmental, Nelson K. S. (ed) Cambridge University Press, Cambridge, UK.

Subject Name: METABOLISM: CONCEPTS AND REGULATION

The living state, metabolism as the defining characteristic of living organisms, molecular approach to understanding life forms and living processes, biomolecule identification, separation and quantization, dynamic state of body constituents, experimental approaches to study metabolism.

A broad outline of metabolic pathways and their linkage, metabolism of primary metabolites – monosaccharides, lipids, amino acids and nucleotides.

Nature of enzymes – kinetics, reaction mechanism of chymotrypsin and lysozyme, purification and physico – chemical characterization, regulation of enzyme activity.

Metabolic basis of nutrition, metabolic basis of specialized tissue function, metabolic disorders, metabolic basis of diagnostics, metabolism and adaption with one example, regulation of metabolism at molecular, cellular and organismic levels, enzymes and receptors as drug targets.

Suggested Literature:

1. Biochemistry and Molecular Biology, Elliott and Elliott, Oxford University press, New York, USA (Indian edition)
2. Harper's Illustrated Biochemistry, Murray, Granner and Rodwell, (27th Ed.), McGraw Hill, New York, USA
3. Practical Biochemistry – Principles and Techniques, Wilson and Walker, Cambridge University Press, Cambridge, UK

Subject Name: PRACTICAL

1. Study of sex chromatin in buccal smear and hair bud cells (Human)
2. Study of mutant phenotypes of Drosophila. Demonstration of law of segregation using Drosophila mutants
3. Study of law of independent assortment
4. Identification of molecular tools and techniques.
5. Fundamentals of Agarose electrophoresis.
6. Principle and function of Polymerase chain reaction

7. Demonstration of tetany, action current and fatigue in muscle.
8. To study the effect of load on muscle contraction.
9. Concentration / dispersal of pigment in isolated scales of dark / light adapted fish.
10. Preparation of a „Good" buffer
11. Estimation of a sugar, an amino acid, a vitamin, a nucleotide/nucleic acid by appropriate chemical and biological methods
12. Biomolecules

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MASTER OF SCIENCE (ZOOLOGY) – SECOND SEMESTER

Second Semester			
S. No.	**Name of Subject**	**Credits**	**Total Marks**
1	Developmental Biology	4	100
2	Systematics, Biodiversity and Evolution	4	100
3	Immunology	4	100
4	Molecular Cell Biology	4	100
5	Practical	6	100
Total		**22**	

Subject Name: DEVELOPMENTAL BIOLOGY

History and basic concepts: the origin of developmental biology- cell theory, mosaic and regulative development, discovery of induction, genetics and development; basic concepts of developmental biology- cell division, cell differentiation, signaling, patterning; model systems: vertebrates model organism- Xenopus laevis, chicken, mammals, zebrafish; invertebrate model organism- Drosophila melanogaster, Caenorhabditis elegans; identification of developmental genes: spontaneous and induced mutation, mutant screening, developmental mutations in Drosophila.

Early embryonic development of vertebrates and invertebrates: structure of the gametes– the sperm, the egg; cleavage and gastrulation; axes and germ layers; morphogenesis– cell adhesion, cleavage and formation of blastula, gastrulation, neural tube formation, cell migration; Axis specification in Drosophila; origin of anterior- posterior and dorsal- ventral patterning- role of maternal genes, patterning of early embryo by zygotic genes; segmentation genes- the gap genes, the pair– rule genes, the segment polarity genes, the homeotic selector genes- bithorax and antennapedia complex.

General concepts of organogenesis: development of chick limb- development and patterning of vertebrate limb, proximal- distal and dorso- ventral axis formation, homeobox genes in patterning, signaling in patterning of the limb; insect imaginal disc– determination of wing and leg imaginal discs, organizing center in patterning of the wing, butterfly wing development, the homeotic selector genes for segmental identity; insect compound eye– morphogenetic furrow, ommatidia, signaling, eyeless gene; kidney development– development of ureteric bud and mesenchymal tubules.

Postembryonic development: growth- cell proliferation, growth hormones; aging- genes involved in alteration in timing of senescence; regeneration– epimorphic regeneration of reptile (salamander) limb, requirement of nerves for the proliferation of blastema cells; embryonic stem cells and their applications; medical implications of developmental biology: genetic errors of human development- the nature of human syndromes– pleiotropy, genetic heterogeneity, phenotypic variability, mechanism of dominance; gene expression and human disease– inborn errors of nuclear RNA processing, inborn errors of translation; teratogenesis- environmental assaults on human development- teratogenic agents like alcohol, retinoic acid etc.

Suggested Literature:

1. Developmental Biology, Gilbert, (8th Ed., 2006) Sinauer Associates Inc., Massachusetts, USA.
2. Principles of Development, Wolpert, Beddington, Brockes, Jessell, Lawrence, Meyerowitz, (3rd Ed., 2006), Oxford University Press, New Delhi, INDIA.
3. Analysis of Biological Development, Kalthoff, (2nd Ed., 2000), McGraw-Hill Science, New Delhi, INDIA.

Subject Name: SYSTEMATICS, BIODIVERSITY AND EVOLUTION

An overview of evolutionary biology, concept of organic evolution during pre- and post- Darwin era; evolution and molecular biology- a new synthesis; from molecules to life, life originated from RNA, introns as ancient component of genes.

The universal common ancestor and tree of life, three domain concept of living kingdom; molecular phylogeny– history, terms, definition and limitations, construction of phylogenetic trees using molecular data, construction of phylogenetic trees by using 16S rRNA gene sequences and concept of speciation in bacteria; molecular divergence and molecular clocks and molecular drive; complication in inferring phylogenetic trees; origin and diversification of bacteria and archea; diversification of genomes; the nature of bacterial and archeal genomes; origin of genomes by horizontal gene transfer; role of plasmid, transposons, integrons and genomic islands in DNA transfer.

Origin and diversification of eukaryotes- origin of cells and first organisms; early fossilized cells; evolution of eukaryotic cell from prokaryotes- a case of symbiosis; evolution of eukaryotic genomes; gene duplication and divergence.

Mode of speciation- factors responsible for speciation; tempo of evolution; systematics- definition and role in biology, biological classification- theories and objectives, types of taxonomy, taxonomic diversity- definition and types, origination and extinction, rates of change in origination and extinction, causes of extinction, causes of differential rates of diversification, current status and future of biodiversity; human evolution- human evolutionary history; placing humans on tree of life; genomics and humanness; current issues in human evolution.

Suggested Literature:

1. 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
2. Evolution, Hall, B. K. and Hallgrimsson, B., Jones and Bartlett Publisher, Sudbury, USA
3. Evolution, Futuyma, D. J., Sinauer Associates, Inc., Sunderland, USA
4. What Evolution Is, Mayr, E., (2001), Basic Books, New York, USA

Subject Name: IMMUNOLOGY

Overview of the immune system: components of the immune system, principles of innate and adaptive immunity, the recognition and effector mechanisms of the adaptive immunity- antigen and immunogenicity, clonal selection theory.

Antigen recognition by immune cells: Adaptive immunity- antibody structure, antigen recognition by B lymphocytes, TCR, antigen recognition by T- cells, co- receptors, structure and function of MHC complex; generation of lymphocyte antigen receptors- generation of diversity in immunoglobulins, T- cell receptor gene rearrangement, structural variations in immunoglobulin constant regions; antigen processing and presentation to T lymphocytes- antigen presenting cells, generation of T- cell receptor ligand, and MHC restriction, role of CD1 in antigen presentation; Innate Immunity- pattern recognition in the innate immune system, role of TLRs in innate immune response, complement and innate immunity, induced innate response to infection.

Effector mechanisms and regulation of immune responses: Signaling through immune system receptors- antigen receptor structure and signaling pathways, other signaling pathways that contribute to lymphocyte behavior; development and survival of lymphocytes- B lymphocyte development and survival, humoral immune response, T lymphocyte development and survival, production of effector T- cells, cytotoxic T- cell effector mechanisms; NK and NKT cell functions; mucosal immunity; immunological memory; regulation of immune response: cytokines and chemokines, complement system, leukocyte activation and migration, APC regulation of the immune response, T- cell mediated regulation of immune response, Immunological tolerance and anergy.

Immunity in health and disease: introduction to infectious disease, innate immunity to infection, adaptive immunity to infection, evasion of the immune response by pathogens; immunodeficiency diseases- inherited immunodeficiency diseases, acquired immune deficiency syndrome; allergy and hypersensitivity- IgE and allergic reactions, hypersensitivity diseases; autoimmunity- responses to self-antigens, transplant rejection- responses to alloantigens; manipulation of immune responses, vaccines; evolution of immune system- evolution of innate immune system, evolution of adaptive immune system.

Suggested Literature:

1. Kuby Immunology, Richard, Thomas, Barbara, Janis, (5th Ed., 2003), W. H. Freeman and company, New York, USA.
2. Immuno Biology- The immune system in health and disease, Janeway, Travers, Walport and Shlomchik, (6th Ed., 2005), Garland Science Publishing, New York, USA.
3. Immunology, David, Brostoff and Roitt, (7th Ed., 2006), Mosby & Elsevier Publishing, Canada, USA.

Subject Name: MOLECULAR CELL BIOLOGY

Transport - recapitulation of the plasma membrane; mechanism of diffusion, facilitated diffusion, active transport with suitable examples; movement of water; Donnan equilibrium; ion movements and cell function: acidification of cell organelles and stomach; transepithelial transport; maintenance of cellular pH; cell excitation; bulk transport: receptor mediated endocytosis; protein sorting and targeting to organelles; molecular mechanism of the secretory pathway; secretion of neurotransmitters.

Cellular shape, motility and energetics- cytoskeletal elements in cell shape and motility: structure and dynamics; role in cell locomotion and mitosis; Intercellular communication: extracellular matrix; cell- cell and cell-matrix adhesion; gap junctions; cellular energetics: oxidation of glucose and fatty acids; the proton motive force; F_0F_1 ATP synthase; mechanism and regulation of ATP synthesis.

Life cycle of a cell - cell cycle and its regulation; checkpoints in the mammalian cell cycle; tumor suppressors and role of helicases; regulation of cell proliferation and differentiation by hormones, neuropeptides and growth factors; cell differentiation; apoptosis; turnover of cellular components: targeting of proteins to lysosomes for degradation; degradation of cytosolic proteins; cells in culture: requirements for cell culture; aseptic technique; primary culture; cell lines; organotypic cultures; cytotoxicity assays.

Cell regulatory mechanisms- regulatory and control mechanisms in a mammalian cell at the biochemical level; key concepts about cellular signaling mechanisms: proliferative, survival and death pathways; G- protein coupled receptors; receptor tyrosine kinases; MAP kinase cascade; second messenger systems; desensitization of receptors; signaling and toxins; Signaling pathways in malignant transformation of cells; cell transformation: role of oncogenes. siRNA and miRNA basics, regulation of transcription and translation of proteins by miRNA.

Suggested Literature:

1. Molecular Cell Biology, Lodish ET. al., (2007), W.H. Freeman and Company, New York, USA
2. Molecular Biology of the Cell, Alberts ET. al., (2008), Garland Science, Taylor & Francis Group, New York, USA.
3. Cell Physiology Source Book: A Molecular approach, Sperelakis, (2001), Academic Press, New York, USA.

Subject Name: PRACTICAL

1. CIB method of drosophila
2. Study of life cycle of Drosophila melanogaster
3. Study of regeneration in Hydra
4. Protocol of DNA extraction
5. Study of Bioinformatics tools and database
6. Procedure of Dot blot hybridization
7. Procedure of ELISA technique
8. Demonstration and principle of western blot
9. Principle of cell colony counter
10. Principle and protocol of centrigution
11. Theory of cytoskeleton and its function
12. Study of cell culture

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MASTER OF SCIENCE (ZOOLOGY) – THIRD SEMESTER

Third Semester			
S. No.	**Name of Subject**	**Credits**	**Total Marks**
1	Principles of Ecology	4	100
2	Computational Biology, Biostatistics and Bioinformatics	4	100
3	Biology of parasitism	4	100
4	Animal Behavior	4	100
5	Practical	6	100
	Total	**22**	

Subject Name: PRINCIPLES OF ECOLOGY

Introduction to ecology, evolutionary ecology, environmental concepts – laws and limiting factors, ecological models. Characteristics of population, population size and exponential growth, limits of population growth, population dynamics, life history pattern, fertility rate and age structure. Competition and coexistence, intra-specific and inter-specific interactions, scramble and contest competition model, mutualism and commensalism, prey-predator interactions.

Nature of ecosystem, production, food webs, energy flow through ecosystem, biogeochemical cycles, resilience of ecosystem, ecosystem management. The biosphere, biomes and impact of climate on biomes.

Environmental Stresses and their management, global climatic pattern, global warming, atmospheric ozone, acid and nitrogen deposition, coping with climatic variations. Major classes of contaminants. Uptake, biotransformation, detoxification, elimination and accumulation of toxicants. Factors influencing bioaccumulation from food and trophic transfer. Pesticides and other chemical in agriculture, industry and hygiene and their disposal. Impact of chemicals on biodiversity of microbes, animals and plants. Bioindicator and biomarkers of environmental health. Biodegradation and bioremediation of chemicals.

Biodiversity – assessment, conservation and management, biodiversity act and related international conventions. Sustainable development, natural resource management in changing environment. Molecular ecology, genetic analysis of single and multiple population, phylogeography, molecular approach to behavioural ecology, conservation genetics.

Suggested Literature:

1. Field Sampling: Principles and Practices in Environmental Analysis, Conklin, A.R. Jr., (2004), CRC Press.
2. Principles and Standards for Measuring Primary Production, Fahey, T.J. and Knapp, A.K., (2007), Oxford University Press, UK
3. Ecological Modeling, Grant, W.E. and Swannack, T.M., (2008), Blackwell.
4. Fundamental Processes in Ecology: An Earth system Approach, Wilkinson, D.M., (2007), Oxford University Press, UK.

Subject Name: COMPUTATIONAL BIOLOGY, BIOSTATISTICS AND BIOINFORMATICS

Basic components of computers– hardware (CPU, input, output, storage devices), Software (operating systems), Application software; Introduction to MSEXCEL- use of worksheet to enter data, edit data, copy data, move data; Use of in- built statistical functions for computations of mean, S. D., correlation, regression coefficients etc., Use of bar diagram, histogram, scatter plots, etc., Graphical tools in EXCEL for presentation of data; Introduction to MS- WORD word processor- editing, copying, moving, formatting, table insertion, drawing flow charts etc; Introduction to Power Point, image and data handling.

Biostatistics- population, sample, variable, parameter, primary and secondary data, screening and representation of data, frequency distribution, tabulation, bar diagram, histograms, pie diagram, mean, median, mode, quartiles and percentiles, variance, standard deviation, coefficient of variation; Probability and distributions- definition of probability (frequency approach), independent events. Addition and multiplication rules, conditional probability, examples- bernoulli, binomial, poisson and normal distributions; bivariate data- scatter plot, correlation coefficient (r), properties (without proof), interpretation of r, linear regression: Fitting of lines of regression, regression coefficient, coefficient of determination; hypothesis, critical region, and error probabilities, tests for proportion, equality of proportions, equality of means of normal populations when variances known and when variances are unknown: chi-square test for independence, P- value of the statistic, confidence limits, introduction to one way and two- way analysis of variance.

The era of computerized biology information, review of relevant definitions in molecular biology, overview of challenges of molecular biology computing, proteins, secondary structure and folding, RNA secondary structures, introduction to phylogenetic analysis; introduction to bioinformatics; introduction to genomics and proteomics databases- nucleic acid sequence database: Genbank, UCSC, ENSEMBL, EMBL, DDBJ, protein sequence databases: Swiss- prot, PDB, BLAST, PSI- BLAST (steps involved in use and interpretation of results) and HMMER, BLAST vs FASTA, file formats- FASTA, GCG and ClustalW.

Databank search- data mining, data management and interpretation, multiple sequence alignment, genes, primer designing; Protein modeling, protein structure analysis, docking, ligplot interactions, phylogenetic analysis with the program PHYLIP, DISTANCES, GROWTREE etc.; introduction to computational genomics and proteomics- basics of designing a microarray, image analysis and normalization, annotations, protein prediction tools- protein secondary structure, molecular modeling, identification and characterization of protein mass fingerprint, world- wide biological databases, Introduction to programming languages such as "C".

Suggested Literature:

1. Principles of Biostatistics, Pagano M., Gauvreau, K, (2000), Duxbury Press, USA
2. Bioinformatics for Dummies, Claverie J. M., Notredame C., (2nd Ed., 2007), Wiley Publishing, Inc., New York, USA
3. Bioinformatics: Sequence and Genome Analysis, Mount, D. W. (2nd Ed., 2001), Cold Spring Harbor Laboratory Press, New York, USA

Subject Name: BIOLOGY OF PARASITISM

UNIT 1

Introduction to parasitology; animal associations and host – parasite relationship; distribution

of diseases and Zoolnosis caused by animal parasites; morphology, life-cycle, mode of infection of Plasmodium, molecular biology of Plasmodium – drug targets, mechanism of drug resistance, vaccine strategies and proteomic approaches.

UNIT 2

Morphology, life-cycle, mode of infection of Leishmania, molecular biology of Leishmania – drug targets, drug resistance and vaccine strategies. Morphology, biology, life-cycle, mode of infection of Entamoeba, morphology, biology, life-cycles, mode of infection of Giardia.

UNIT 3

Gastro-intestinal nematodes, morphology, biology, life-cycles, modes of entry of Schistosoma, Wuchereria, Brugia, Ancylostoma, Trichinella and Dracanculus; molecular biology of nematodes, vaccine strategies.

UNIT 4

Immune response and self-defense mechanisms, immune evasion and biochemical adaptations of parasites; parasites of veterinary importance. Parasites of insects and their significance.

UNIT 5

Nematode parasites of plants, morphology, biology, lifecycle and infection of crop plants by plant parasitic nematodes, plant parasitic nematodes, host parasite interactions.

Suggested Literature:

1. Foundations of Parasitology, Roberts L.S. and Janovy J., McGraw-Hill Publishers, New York, USA.
2. Modern Parasitology: A Textbook of Parasitology, FEG Cox., Wiley-Blackwell, U. K.

Subject Name: ANIMAL BEHAVIOR

UNIT 1

Introduction - definition, historical out line, patterns of behaviour, objectives of behaviour, mechanism of behaviour, asking questions. Reflexes- reflex action, types of reflexes, reflex arch, characteristics of reflexes and complex behaviour.

UNIT 2

Orientation primary and secondary orientation; kinesis – orthokinesis, klinokinesis; taxis – different kinds of taxis; sun-compass orientation, dorsal- light reaction.

UNIT 3

Eusociality, social organization in honey bee, polyphenism and its neural control, flower recognition, displacement and translocation experiment, various type of communications, production of new queen and hive, swarming, honey bee as super organism.

UNIT 4

Fixed action pattern: mechanism, deprivation experiment, controversies. FAP- characteristics and evolutionary features. Learning and instincts: conditioning, habituation, sensitization, reasoning. Innate releasing mechanisms: key stimuli, stimulus filtering, and supernormal stimuli, open and closed IRM, mimetic releaser, code breakers.

UNIT 5

Homeostasis and behaviour: motivational system, physiological basis of motivation, control of hunger drive in blow fly and thirst drive in goat, role of hormone, motivational conflict and decision making, displacement activity, models of motivation, measuring motivation. Hormones and pheromones influencing behaviour of animals.

UNIT 6

Altruism – reciprocal altruism, group selection, kin selection and inclusive fitness, cooperation, alarm call. Parental care, parental manipulation, evolutionarily stable strategy, cost benefit analysis of parental care with suitable case studies. Sexual selection: intra sexual selection (male rivalry), inter-sexual selection (female choice), infanticide, sperm competition, mate guarding, sexual selection in human, consequences of mate choice for female fitness, monogamous verses polygamous sexual conflict.

Suggested Literature:

1. Mechanism of Animal Behaviour, Peter Marler and J. Hamilton; John Wiley & Sons, USA.
2 Animal Behaviour, David McFarland, Pitman Publishing Limited, London, UK.
3 Animal Behaviour, John Alcock, Sinauer Associate Inc., USA.
4 Perspective on Animal Behaviour, Goodenough, McGuire and Wallace, John Wiley & Sons, USA
5 Exploring Animal Behaviour, Paul W. Sherman & John Alcock, Sinauer Associate Inc., Massachusetts, USA.
6 An Introduction to Animal Behaviour, A. Manning and M.S Dawkins, Cambridge University Press, UK .

Practical Syllabus:

1. Physical and chemical characteristics of soil.
2. Assessment of density, frequency and abundance of plants and animals in a community using various techniques i.e. transect, quadrate.
3. Study of various environmental stress caused by population explosion.

4. Effects of pesticides and other chemicals in soil.
5. To study the geotaxis behaviour of earthworm.
6. To study the orientational responses of 1st instar noctuid larvae to photo stimuli.
7. To study the orientational responses of larvae to volatile and visual stimuli.
8. Use of excel sheet for data processing.
9. Use of search engines like Scopus, Science direct for reference material collection and management
10. Phylogenetic tree construction using MEGA software
11. Collection of data, designing questionnaire, preparing frequency table, graphic presentation, averaging and correlation analysis.
12. Study of prepared slides and museum specimens of selected parasites of representative groups of protozoans, helminths and arthropods.
13. Demonstration of in vitro culture of Plasmodium
14. Studying the infection of tomato plant by root knot nematode.

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MASTER OF SCIENCE (ZOOLOGY) – FOURTH SEMESTER

Fourth Semester			
S. No.	**Name of Subject**	**Credits**	**Total Marks**
1	Insect Physiology, Toxicology and Vector Biology	4	100
2	Aquatic Resources and Their Conservation	4	100
3	Genomics	4	100
4	Molecular endocrinology	4	100
5	Practical+ Dissertation	6	100
Total		**22**	

Subject Name: INSECT PHYSIOLOGY, TOXICOLOGY AND VECTOR BIOLOGY

Structure and physiology of integumentary, digestive, excretory, circulatory, respiratory, endocrine, reproductive, and nervous system. Sensory receptors. Growth, metamorphosis and diapause in insect.

Definition of pesticides, brief history, pesticides registration, pesticide industries and markets. Dose-response relationship; mode of action of insecticide, carcinogenic, mutagenic and teratogenic effects, and evaluation of toxicity. Group characteristics of insecticide, structure and function of organochlorine, organophosphorus, carbamate, pyrethrod, other plant origin as well as bio-insecticides, neonicotinoids and nitrogenous insecticides, fumigants, IGRs. Metabolism or degradation of pesticides - phase I and phase II reactions. Insecticide resistance and health hazards.

Introduction to vector biology, economic importance and control of fleas, lice, bugs, mosquitoes, flies and parasitoids. Vector-parasite interaction; host-pathogen interaction, Insect transmitting bacteria and viruses of medical, veterinary and agricultural importance; control of insect vector.

Suggested Literature:

1. The Insects: Structure and function, Chapman, R. F., Cambridge University Press, UK
2. Physiological system in Insects, Klowden, M. J., Academic Press, USA
3. The Insects, An outline of Entomology, Gullan, P. J. , and Cranston, P. S., Wiley Blackwell, UK
4. Insect Physiology and Biochemistry, Nation, J. L., CRC Press, USA

5. Toxicology and Risk Assesssment: A Comprehensive Introduction, Greim H., and Snyder, R. (ed), John Wiley and Sons, UK
6. The Complete Book of pesticide management, Whitford, F., Wiley Interscience, John Wiley and Sons, UK
7. Safer Insecticides, Hodgson, E., and Kuhr, R. J., (ed), Marcel Dekker Inc., New York, USA
8. Pesticide Application Methods, Matthews, G, A., Blackwell Science, London, UK
9. Pesticide Biochemistry and Physiology, Wilkinson, C. F., Plenum Press, New York, UK
10. Metabolic pathways of agrochemicals Part II, Roberts, T. R., and Hutson, D. H. The Royal Society of Chemistry, UK
11. Medical and Veterinary Entomology Mullen, G., Durden, L., Academic Press, USA
12. Medical and Veterinary Entomology, Kettle, D. S., Cabi Press, USA
13. Medical Entomology for students, Service, M. Cambridge University Press, UK

Subject Name: Aquatic Resources and Their Conservation

UNIT 1

Riverine fisheries- important river systems and their hydrological conditions, flora and fauna with special reference to fisheries, dams and their impact on riverine fisheries, fish ladders, interlinking of rivers and likely impact on fisheries. Cold water fisheries - ecology of hill streams, biology of important cold water fishes of India, recreational fishing. Lacustrine fisheries - origin of lakes and lake morphology, light, temperature and density relationship in the lacustrine ecosystems, heat energy and water movements, oxygen and other dissolved gases in lakes, pH and redox potential, fisheries profile and potential of major Indian lakes.

UNIT 2

Estuarine fisheries- major estuarine systems of India, hydrography, flora and fauna with special reference to fisheries. Marine fisheries – coastal and deep sea fisheries, permanent and seasonal stratification, upwelling, the photic zone, control of primary production by light and nutrients availability, chemical properties of sea water, biology of important fishes (sardine, mackerel, tuna), marine protected areas. Integrated resources- coastal wet lands, mangroves, coral reefs, sea grasses and their conservation.

UNIT 3

Fishing techniques-- technologies for localizing catches- remote sensing, sonar, radar; crafts and gears. Stock assessment and management-- Natural markers- morphological analyses, environmental signals, genetic analyses; Applied markers- marking and tagging, Stock identification data analysis - stock composition analysis, age and growth, fecundity estimation, application of statistical methods in fisheries.

UNIT 4

Fish conservation- fishing laws and regulation, permitting. Post-harvest technology—Fish spoilage, rigor mortis, rancidity, enzymatic spoilage, microbial spoilage; Fish preservation and processing- handling of fish at harvest/onboard, principles of fish preservations, methods of preservation, problems associated with fish preservations, quality control, fishery byproducts.

UNIT 5

Aquatic pollution- types and sources, impact of pollution on aquatic organisms, ecosystem analysis- bio-indicators, biomonitoring, environmental factors and fish health, xenobiotics. Waste management- national and international standards. Extension services – basic principles and emerging issues of extension, role of information and communication technology in fisheries extension.

Suggested Literature:

1. Computers in Fisheries Research, Megrey, B. A. and Moksness, E. (2009), Springer, USA
2. Biological Invasions in Marine Ecosystems Ecological, Management and Geographic Perspectives. Rilov, G. and Jeffrey, A. C. (2009), Springer-Verlag, GERMANY
3. Handbook of Fisheries and Aquaculture, Indian Council of Agricultural Research, ICAR, (2006), DIPA, New Delhi, INDIA

Subject Name: GENOMICS

UNIT 1

Organization and structure of genomes - size, complexity, gene-complexity, virus and bacterial genomes, organelle genome, architecture of mitochondrial genome, conserved chloroplast DNA; organization and nature of nuclear DNA in eukaryotes; transposable elements, retro-teaspoons, SINE, LINE, Alu and other repeat elements, pseudogenes, segmental duplications.

UNIT 2

Mapping genomes - physical maps, EST, SNPs as physical markers, radiation hybrids, FISH, optical mapping, gene maps, integration of physical and genetic maps; sequencing genomes: high-throughput sequencing, strategies of sequencing, recognition of coding and non-coding regions and annotation of genes, quality of genome-sequence data, base calling and sequence accuracy.

UNIT 3

Bioinformatics - datasets, sequence analysis based on alignment, de novo identification of genes, in silico methods. Comparative genomics - orthologs and paralogs, protein evolution by exon shuffling; human genome project, comparative genomics of bacteria, organelles, and eukaryotes

UNIT 4

Large scale mutagenesis and interference - genome wide gene targeting; systematic approach, random mutagenesis, insertional mutagenesis, libraries of knock-down phenocopies created by RNA interference; transcriptome analysis, DNA micro-array profiling, data processing and presentation, expression profiling, proteomics – expression analysis, protein structure analysis, protein-protein interaction.

Suggested Literature:

1. Principle of Genome Analysis and Genomics, Primrose, S. B. and Twyman R. M., (7^{th} Ed., 2006), Blackwell Publishing Company, Malden, USA

2. Genomes 3, Brown, T. A., Garland Science Publishing, London, UK
3. Bioinformatics: Sequence and Genome Analysis, Mount, D. W., Cold Spring Harbor Laboratory Press, New York, USA

Subject Name: MOLECULAR ENDOCRINOLOGY

UNIT 1

Discovery of hormones as chemical signals for control and regulation of physiological processes. Nature of hormonal actions. Major questions in biology of hormones. Techniques for quantitation of hormones. Design and development of hormonal assays.

UNIT 2

Structure of peptide and protein hormones. Purification and characterization of hormones. Structure-Function relationships in different hormones. Phylogenic analysis of hormonal structures and functions. Biosynthesis of protein hormones. Storage and secretion of hormones: molecular mechanisms of regulation. Transcriptional and post-transcriptional mechanisms of hormone biosynthesis and secretion. Regulation of biosynthesis and secretion. Inhibitors of hormone biosynthesis and their use.

UNIT 3

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

UNIT 4

Hormones as therapeutic agents. Current developments in design and production of hormonal contraceptives. Recombinant protein hormones-production and application in regulation of fertility in farm animals and humans. Evolution of chemical communication in animal systems. Unsolved problems in hormonal biology.

Suggested Literature:

1. Peer reviewed journal articles, monographs and reviews as and when recommended.
2. Molecular Biology of Steroid and Nuclear Hormone receptors, ed. Freedman L. P., (1998), Birkhauser, Boston, USA
3. Biochemical actions of hormones, ed. Litwack, G. (1985), Academic press, New York, USA

Subject Name: PRACTICAL+ DISSERTATION

1. Model study of respiratory system in butterfly.
2. Estimation of LD50 and LC50 using insects.
3. Identification and morphological studies of major vector species of Anopheles,culex and Ades.
4. PCR amplification and analysis by agarose gel electrophoresis.

5. Transformation in E.coli.
6. Southern hybridization of genomic DNA with suitable gene as probe.
7. Study of benthic macro invertebrates in natural water bodies.
8. Study of fishing gears and nets with the help of models.
9. Determination of age and growth; gonadosomatic index.
10. Principle and function of light or electron microscope.
11. Study and function of molecular cloning.
12. Theory and function of expression vector.

Note: The Normal Rule and Regulation pertaining to the Examination and other issues will be applicable in Faculty of Science as per Arunachal University of Studies Act 2012, Subsequent Statute and Rules & Regulations.