ARUNACHAL UNIVERSITY OF STUDIES

Established by Govt. of Arunachal Pradesh vide Act 9 of 2012, the Arunachal University of Studies Act, 2012 Recognized as per u/s 2(f) of University Grants Commission Act, 1956
NH-52, Namsai, Arunachal Pradesh -792103

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