SEMESTER - I
COURSE – II: BIOSYSTEMATICS, BIODIVERSITY AND EVOLUTION

Teaching hours per week	Credits	Internal marks	External marks	Maximum marks
4	4	25	75	100

Course Outcome:

In this course the student is introduced to the fundamentals and principles of taxonomy, ICZN, theories of biological classification, basis of variation of life on earth, origin of life, hierarchial organization in the evolution of life based on various theories and understanding the role of different factors in the evolution of life. The mechanisms of origin of the species are explained to the students to get an understanding that many of the species that inhabit the earth today are different form that which inhabited it in the past.

UNIT - I

Biosystematics- Definition and basic concepts. Importance and applications of biosystematics. Material Basis of Biosystematics. Biological classification-Theories and objectives. Procedures in taxonomy - Taxonomic collections. taxonomic keys. Types of taxonomy-Conventional types, Cytotaxonmy. Chemotaxonomy and Molecular taxonomy. Concept of Zoological Nomenclature.

UNIT - II

Origin of basic biological molecules. Abiotic synthesis of organic monomers and polymers. Concept of Oparin and Haldane. Experiment of Miller. Evolutionary time scale – Eras, Periods and epochs. Origin and diversification of eukaryotes - Origin of cells and first organisms. Evolution of eukaryotic cell from prokaryotes. Evolution of eukaryotic genomes. duplication and divergence. Molecular divergences, molecular clocks and molecular drive. Phylogenetics- Molecular tools in phylogeny.

UNIT - III

Universal common ancestor and tree of life – three domain concepts of living kingdom. hierarchical components of bio-diversity. Evolutionary relationships among taxa. Concepts of species. Species category, subspecies and other infraspecific categories. Hierarchy of categories. Speciation- Genetics of speciation, modes of speciation, Patterns and mechanisms of reproductive isolation. Allopatry, sympatry, Convergent evolution, Sexual selection, Co-evolution.

UNIT - IV

Concepts of evolution – An overview of evolutionary biology, & theories of organic evolution. Concepts of Neutral Evolution, Population genetics- Populations, gene pool, Gene frequency; Hardy Weinberg law. Concepts and rate of change in gene frequency through Natural selection, mutation, migration and random genetic drift. Phylogenetic gradualism , punctuated equilibrium and origin of higher categories

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Suggested Reading:

1. Kato, M (Ed.), 2000, The Biology of Biodiversity, Springer, Japan.
2. Avice, J. C., Molecular Markers. Natural History and Evolution, Chapman & Hall, New York.
3. Wilson, E. O., Biodiversity, Academic Press, Washington.
4. Simpson, G. G., Principles of Animal Taxonomy, Oxford IBH Pub, Co.
5. Mayr, E., Elements of Taxonomy.
6. Wilson, E. O., The Diversity of Life (The College Edition), W.W. Northern & Co.
7. Dobzhansky, Th., Genetics and origin of species, Surjeet Publication, Delhi.
8. Dobzhansky, Th. Ayala, F. J. Stebbens G. L & Valentine J. M., Evolution, Surjeet Publication, Delhi.
9. Futuyama, D. J., Evolutionary Biology, Suinuer Associates, INC, Publishers, Dunderland.
10. Hartl, D. L. A., Primer of population Genetics, Sinauer Associates, INC Massachusetts.
11. Jha, A. P., Genes and Evolution, John Publication, New Delhi.
12. King, M., Species Evoluution - the role of chromosomal change. The Cambridge University Press, Cambridge.
13. Strikberger, M. W., Evolution, Jones and Bartett Publishers, Boston London.
14. Tandon, R. K., 1999, Biodiversity, Taxonomy & Ecology. Prithipal singh Scientific Publishers, Jodhpur.

SEMESTER - I
COURSE- III: BIOMOLECULES

Teaching hours per week	Credits	Internal marks	External marks	Maximum marks
4	4	25	75	100

Course Outcome:

The course provides knowledge to the students about basic aspects of carbohydrates, proteins and lipids including classification, structure and physicochemical properties etc. The course enables the student to understand key aspects of proteins such as protein purification, characterization and biological properties of proteins. Similarly, it provides an overview of important properties of carbohydrates and lipids, their derivatives and their biological role. It also provides the students knowledge about nucleic acids including DNA and RNA, their structure, function, denaturation and denaturation kinetics etc. The theoretical and practical knowledge gained in this course will provide students to work with various aspects of biomolecules in pharma and biotech industries at different levels.

UNIT - I

Chemical foundations of biology, Amino acids – classification, Peptide bond, Proteins – classification, structural organization of proteins, primary structure, secondary structure, tertiary structure, quaternary structure, Conformation of proteins (Ramachandran plot) - domains, motifs and folds. Denaturation & renaturation of proteins.

UNIT - II

Carbohydrates: Definition and classification of carbohydrates, nomenclature, Reaction of Mono-saccharides, Acid derivatives of Mono-saccharides, amino-sugars, Oligo-saccharides, structure and properties, Chemistry and biological roles of homo and hetero-polysaccharides, peptidoglycan, glycosaminoglycans, glycoproteins and other glycoconjugates.

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SEMESTER- I: PRACTICALS

A/Z 105 Tools and Techniques for Biology lab:

1. Spectrophotometer – Estimation of biomolecules
2. Centrifugation – Demonstration and working
3. Separation Techniques - Paper chromatography
4. Electrophoresis – Demonstration and usage
5. PH Meter – Preparation of Phosphate buffer Preparation
6. Microscope –
   a) Demonstration of oil immersion – WBC & RBC
   b) Preparation of tissue for SEM & TEM procedure

A/Z 106 Biosystematics, Biodiversity and Evolution Lab:

1. Invertebrate and Vertebrate Phyla
2. Types of Speciation-Models/Charts
3. Problems on Hardy-Weinberg law
4. Random genetic drift causing change in gene frequency-Practical demonstration.
5. Recent studies in Evolution- Examples

A/Z 107 Biomolecules lab:

1. Estimation of glycine by formal titration
2. Estimation of proteins by Lowry and Biurett methods
3. Analysis and identification of monosaccharides
4. Estimation of maltose by DNS method
5. Determination of Iodine value of oils
6. Estimation of Cholesterol
7. TLC of Amino acids

A/Z 108 Molecular cell Biology lab:

1. Light microscopic examination of tissues
2. Preparation of different cell – types Hepatic parenchymal cells, adipocytes, macrophages, neuronal cells, epithelial cells
3. Stages of Mitosis and Meiosis
4. Squash preparation
5. Sub-cellular fractionation – separation of macromolecules

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SEMESTER - II
COURSE – I: BIOSTATISTICS & BIOINFORMATICS

Teaching hours per week	Credits	Internal marks	External marks	Maximum marks
4	4	25	75	100

Course Outcome:

In this course the student is introduced to the subject of biostatistics. She/He will understand the scope and applications of biostatistics. The topics of sampling, different measures of statistics, the importance of the study by hypothesis testing, importance of computers in the handling of the data together with the fundamental aspects of the computer help the student to learn the design of the study either laboratory or field, realises the importance of data, the way it is treated depending upon the nature of the study. The student by use of technology can compute and create (visual form) the data to interpret the summary of the data whether qualitative or quantitative. Bioinformatics component introduces the student to the history, scope and importance and the role of internet in bioinformatics. The other topics are different types of biological databases, and introduction to the basics of sequence alignment and analysis.

After Completing this course the student can get an opportunity to work as Bio-Informaticians in Research Labs and Bio-Informatics companies

UNIT - I

Biostatistics- Introduction and Scope of biostatistics, Sampling. Primary and Secondary data, Frequency distribution, Graphic representation of data- bar diagram, histograms, pie diagram, frequency polygon and Ogive. Measures of central tendency- mean, median, mode. Measures of Dispersion- variance, standard deviation, coefficient of variation

UNIT - II

Probability and probability distributions-definition of probability - Bernoulli, binomial, Poisson and normal distributions; Correlation and regression Tests of Significance - hypothesis, critical region and error probabilities, t- test, chi-square test for independence, one way and two- way analysis of variance.

UNIT - III

Basic components of computers– hardware (CPU, input, output, storage devices), Software (operating systems), Application software; Introduction to MS-EXCEL. Use of in-built statistical functions for computations of mean, SD, correlation, regression coefficients, Use of bar diagram, histogram, scatter plots, 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.

UNIT - IV

Bio-informatics –Introduction, History, Internet, Knowledge. Review of relevant definitions in molecular biology. Biological Databases –introduction. Examples of databases together with steps

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involved in use and interpretation of results). Sequence alignment. Phylogenetic analysis with the program PHYLIP, Introduction to computational genomics and proteomics

Suggested Reading:

1. Batschelet, E., Introduction to Mathematics for Life Scientists, Springer- Verlag, Berling.
2. Principles of Biostatistics, Pagano, M. Gauvreau, K., (2000), Duxbury Press, USA.
3. Murray, J. D., Mathematical Biology, Springer – Verlag, Berlin.
4. Attwood, T. K. & Parry-Smith, D. J., 1999, Introduction to Bioinformatics, Pearson Education Asia.
5. Stephen Misener & Krawez, S. A., 2000, Bioinformatics, Methods and Protocol.
6. Bioinformatics: Sequence and Genome Analysis, Mount, D. W., (2nd Ed., 2001), Cold Spring Harbor Laboratory Press, New York, USA.
7. Bioinformatics for Dummies, Claverie, J. M. Notredame, C., (2nd Ed., 2007), Wiley Publishing, Inc., New York, USA.
8. Sokal, R. R & Rohlf, F.J., Biometry, Freeman, San Francisco.
9. Snedecor, G.W & Cochran, W.G., Statistical methods for environmental biologists, John Wiley Sons, New York.

SEMESTER - II
COURSE – II: ANIMAL PHYSIOLOGY

Teaching hours per week	Credits	Internal marks	External marks	Maximum marks
4	4	25	75	100

Course Outcome:

Animal Physiology will enable the students to gain knowledge of the human body structure and function of some organs like muscle, heart, lungs, kidney ec., The course also focuses on some physio-chemical parameters and processes like thermoregulation, osmoregulation and physiological adaptations in different environments like fresh water, brakish water and marine water. The components of the course on toriratory system, excretory system and circulatory system, the awareness about the receptor Physiology enables them to take care of their sense organs and their functions . Sensory physiology focuses on photoreceptor, auditory, chemical and Mechanoreceptors which provides knowledge about functions of receptor cells located on the sense organs. Yoga and Meditation helps to gain knowledge on how to gain good health physically and mentally.

After completing this course the student will have an opportunity to work as Research Fellow / Associate positions in DB funded project institutes like NDRI and NIAB, Pharma Companies & Teaching at UG/PG levels

UNIT - I

Muscle: Molecular Structure and properties of Muscle and muscle contraction , Sliding filament theory

Blood and Circulation – Blood corpuscles, haemopoiesis and formed elements, plasma function, blood volume, blood volume regulation, Blood groups, Haemoglobin, immunity, haemostasis , factors affecting blood coagulation

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5. Sambrook, J., Fritch E.F., & Maniatis, T., Molecular cloning : A Laboratory Manual. Cold Spring Harbor Laboratory Press, New York.
6. Daber, P.D. Introduction to practical Molecular Biology. John Wiley & Sons Ltd., New York.
7. Brown, T.a. (Eds.), Molecular Biology Lab Fax. Bios Scientific Publishers Ltd., Oxford.

SEMESTER- II: PRACTICALS

A/Z 205 Biostatistics & Bioinformatics lab:

1. Sampling and Frequency distribution
2. Graphical presentation of the data
3. Measures of Central Tendency – Mean, median and mode
4. Measures of Dispersion – Standard deviation and Coefficient of variation
5. Correlation and Regression
6. Nucleic acid and protein databases.
7. Retreval and analysis of DNA or protein sequence from NCBI
8. Sequence Alignment in excel sheet for data processing.

A/Z 206 Animal Physiology lab:

1. Digestive enzymes
2. Effect of body size vs oxygen consumption
3. oxygen consumption vs temperature
4. Osmotic regulation
5. Ion concentration measurements
6. Spotters
7. Dissection- Pituitary gland of fish
8. Dissection- Nervous system of prawn.

A/Z 207 Immunology lab:

1. Blood grouping
2. Widal test for detection of typhoid bacteria
3. VDRL Test
4. SRID
5. Ouchterlony DID
6. Immunoelectrophoresis
7. Blood clotting time and bleeding time.
8. RIA -Demonstration
9. ELISA - Demonstration

A/Z 208 Molecular Biology Lab:

1. Estimation of DNA (Colorimetric method)
2. Estimation of RNA in tissue (Colorimetric method)
3. Fulgen reaction method for DNA localization
4. Localization of RNA by methyl green pyronin – 'Y'

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2. Foster, R. L., Nature of Enzymology
3. Lodish et. al., Molecular Cell Biology
4. Annual Reviews of Biochemistry 5. Garett & Grisham., Biochemistry.

SEMESTER - III
COURSE– IV: PRINCIPLES OF ECOLOGY

Teaching hours per week	Credits	Internal marks	External marks	Maximum marks
4	4	25	75	100

Course Outcome:

The student is introduced to the core principles of ecology, focusing on the structure and functions of the aquatic, ecosystems, the significance of the abiotic and biotic component, the food chains, the food web, energy transfer in the ecosystems together with factors responsible for the stability of the ecosystems. .It also includes the basics of poluation ecology which includes the population dynamics and the factors affecting the populations abundance and nature of existence of the populations.Further the course focusses on the drivers of change in the ecosystems and also the management of the natural resources.. The student understands the ecological principles. He is equipped with field based skills, analysing the ecological data and also can be able to write scientific reports.

UNIT - I

Introduction to Ecology, Environmental concepts, Ecosystem structure and function-Biotic and Abiotic environments. Habitat and Ecological Niche. Dynamics of ecosystem- energy flow, food chain, food web, Ecological pyramids. Concepts of primary productivity. Mineral cycling.

UNIT – II

Population Ecology- Characteristics of population. Population growth. Growth models. Optimal yield. Life histories strategies (r and K Selection). Intraspecific and Interspecific interactions. Concept of metapopulation. Population Demography and life tables- mortality, natality, age structure, fecundity, net reproductive rate

UNIT – III

Evolutionary ecology. Community ecology- Nature of communities. community structure and attributes. Community composition. Concept of Ecological succession. Patterns of biodiversity, Latitudinal and altitudinal gradients: Theory of Island biogeography. Biogeographic realms of the world. Biogeographic zones of India and faunal diversity. Hotspots the world & in India.

UNIT – IV

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Environmental stress- environment pollution. Major drivers of bio-diversity change. Biodiversity status, Monitoring and documentation. Biodiversity conservation-Threats, major approaches to management. IUCN classification of wild life. Indian case studies on conservation/management strategy. Concepts of sustainable development.

Suggested Reading:

1. Begon, M., Harper, J. L & Townsend, C. R., Ecology, Individuals, Populations and Communities. Blackwell Science, Oxford, UK.
2. Koromondy, E. J., Concepts of Ecology. Prentice Hall, New Delhi.
3. Clarke, G. L., Elements of Ecology, John Wiley & Sons, New York.
4. Odum, E. P. Fundamentals of Ecology. Saunders, W.B., Philadelphia.
5. Krebs, C. J., Ecology. Harper & Row, New York.
6. Chapman, J. L & Reiss, M. J., 1995, Ecology Principles and Application. Cambridge University Press.
7. Trivedy, R. K. Goel & Trisa., 1997, Practical methods in Ecology & Environmental Science.
8. Agarwal, K. C., 1998, Biodiversity. India.
9. Peggy, I. Fieldler & Perer Kareiva, M., 1997, Conservation Biology.
10. Prabodh, K. Maiti & Paulami Maiti., 2011, Biodiversity: Perception, Peril & Preservation.
11. Saharia, V. V., 1982, Wildlife in India. Natraco Publishers, Dehradun.

SEMESTER – III: PRACTICALS

Z 305 Applied Zoology lab:

1. Production of protease/amylase by batch fermentation.
2. Selective isolation of *Actinomycetes* from soil samples
3. Microbial growth curve.
4. Production of alcohol by *S.cerevisiae* and its estimation.
5. Production of streptomycin by fermentation.
6. Production of citric acid by *A.niger*.
7. Production of red wine from grapes.
8. Determination of suspended solids in industrial effluents.
9. Removal of color of the industrial effluents by biological methods.
10. Reduction of pollution load in effluents by biological methods (laboratory models).

Z 306 Developmental Biology Lab

1. Estimation of shell calcium during the development of chick and its role
2. Estimation of phosphorous during the development of chick
3. Observation of spermatozoa in vertebrates
4. Effect of Iodine in the metamorphosis of frog.
5. Effects of Thyroxine in the metamorphosis of frog.

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6. Preparation of sperm smear from goat testis
7. Observation of slides: Cleavage, Morula, Blastula, Gastrula
8. Neurulation slides: Neural plate, Neural fold, Neural tube.

Z 307 Metabolic cell functions and regulation lab:

1. Enzyme kinetics
2. Dehydrogenase assay
3. Lactic acid estimation
4. Proteins, glucose and Lipid estimations
5. DNA, RNA estimation
6. Transaminases

Z 308 Principles of Ecology Lab

1. Ecosystem-structure and function-demonstration.
2. Populations interactions.
3. Local fauna- Identification. Conservation activities for any
4. Enumeration of Plankton.
5. Estimation of Population-Plant/Animal sps by quadrant method
6. Diversity indices- Abundance, dominance and Diversity
7. Creation of Life tables

SEMESTER - IV
COURSE – I: NEUROBIOLOGY & ANIMAL BEHAVIOR

Teaching hours per week	Credits	Internal marks	External marks	Maximum marks
4	4	25	75	100

Course Outcome:

While studying Developmental biology, the students would understand that the first formed organ system during development is the nervous system. Nervous system is one of the communicating systems in our body which is faster. The course enables the students to understand that this is the only system which responds to external environmental cues and accordingly co-ordinates the internal physiological activities. This course deals with structural organization and functional anatomy of the brain, the cell types that make up the nervous system, properties of neuron, information flow within a neuron and neural communication, the messengers involved in communication. In addition to this, students would also learn about the abstract functioning of brain, the cognition which discusses on the way we perceive, think and memorize. This course makes the learners more inquisitive such as, though neural connections and communication is stereotyped, yet actions are sensory & motor of various kinds and different perceptions, how communication between neurons modified by experience etc. Finally, this course tells the learner to 'Know Thyself'.

UNIT - I

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Introduction to Neurobiology: Organization of the Brain: Functional Anatomy of the brain. Systems neurobiology – Visual systems, Hearing systems. Neurons, astrocytes, oligodendroglia, Schwaan cells, microglia, ependymal cells, neuroglial cell interaction.

UNIT - II

Neuron: Passive and membrane properties, information flow in neurons, compartments, spike initiation zone. Neuron – Excitability, conductivity, Membrane potentials (Resting & Action), Single neuron recording, Patch-clamp recording, Nerve Impulse, Refractory period, The Nernst equation and Goldman equation.

UNIT - III

Signaling and Channels: Ion and Voltage-gated Channels. Sodium, Potassium & Calcium channels structure and function.

Neural Communication: Synapses- Electrical and Chemical synapses, Nerve-muscle synapse and signaling, Neurotransmitters (synthesis, storage and function), post-synaptic action of neurotransmitters, neuro-transmitter gated ionic channels; Dale's principle drugs affecting their activities, ionotropic and metabotropic receptors. Synaptic Integration, Synaptic Plasticity.

UNIT - IV

Cognitive Neuroscience: Nerve cells and their network, Role of limbic System in cognition, Cognitive skills, Learning and memory- Conditioning, habituation, insight learning, association learning. Imprinting – case studies of animal models.

Suggested Reading:

1. Fundamental Neuroscience by Haines. Duane, E., Churchill Livingston, New York.
2. Principles of Neural Science by Kandel, Eric. James, H. Schwartz & Thomas Jessel., 4th ed, Mc Graw-Hill.
3. Basic Neurochemistry: Molecular, Cellular and Medical Aspects, by George, M.D. Siegel, R. Wayne Albers. Scott Brdy. Donald M. D., Price Seventh Edition; Elsevier Academic Press.
4. Foundations of Neurobiology by Fred Delcomyn, Freeman. N.Y.,
5. The Neuron: Cell and Molecular Biology 3ed by Irwin, B. Levitan. Leonard, K. Kaczmarek (2002), Oxford University Press.
6. Neuroscience (Book with CD-ROM) 3ed by Purves, Dale. George, J. Augustine, David Fitzpatrick. William, C. Hall. Lawrence, C. Katz, Anthony-Samuel LaMantia, Jomes, O. McNamara, S. Mark Williams., (2004), Sinauer Assoc.,
7. Fundamental Neuroscience, 2ed by Larry, R. Squire. Floyd, E. Bloom. Susan, K. McConnell, James, L. Roberts (Editor), Nicholas, C. Spitzer, Michael, J., Zigmond (2002), Academic Press.
8. An Introduction to Animal Behaviour, 5th Edition by Aubrey Manning and Marian Stamp Dawkins.

SEMESTER - IV

COURSE – II: ANIMAL CELL CULTURE & STEM CELL TECHNOLOGY

Teaching hours per week	Credits	Internal marks	External marks	Maximum marks
4	4	25	75	100

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