











**H. Quantitative genetics:** Polygenic inheritance, heritability and its measurements, QTL mapping.

**I. Mutation:** Types, causes and detection, mutant types – lethal, conditional, biochemical, loss of function, gain of function, germinal versus somatic mutants, insertional mutagenesis.

**J. Structural and numerical alterations of chromosomes:** Deletion, duplication, inversion, translocation, ploidy and their genetic implications.

**K. Recombination:** Homologous and non-homologous recombination, including transposition, site-specific recombination.

## 9. DIVERSITY OF LIFE FORMS

**A. Principles and methods of taxonomy:** Concepts of species and hierarchical taxa, biological nomenclature, classical and quantitative methods of taxonomy of plants, animals and microorganisms.

**B. Levels of structural organization:** Unicellular, colonial and multicellular forms; levels of organization of tissues, organs and systems; comparative anatomy.

**C. Outline classification of plants, animals and microorganisms:** Important criteria used for classification in each taxon; classification of plants, animals and microorganisms; evolutionary relationships among taxa.

**D. Natural history of Indian subcontinent:** Major habitat types of the subcontinent, geographic origins and migrations of species; common Indian mammals, birds; seasonality and phenology of the subcontinent.

**E. Organisms of health and agricultural importance:** Common parasites and pathogens of humans, domestic animals and crops.

## 10. ECOLOGICAL PRINCIPLES

**A. The Environment:** Physical environment; biotic environment; biotic and abiotic interactions.

**B. Habitat and niche:** Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement.

- C. Population ecology:** Characteristics of a population; population growth curves; population regulation; life history strategies (*r* and *K* selection); concept of metapopulation – demes and dispersal, interdemec extinctions, age structured populations.
- D. Species interactions:** Types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis.
- E. Community ecology:** Nature of communities; community structure and attributes; levels of species diversity and its measurement; edges and ecotones.
- F. Ecological succession:** Types; mechanisms; changes involved in succession; concept of climax.
- G. Ecosystem:** Structure and function; energy flow and mineral cycling (CNP); primary production and decomposition; structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, eustarine).
- H. Biogeography:** Major terrestrial biomes; theory of island biogeography; biogeographical zones of India.
- I. Applied ecology:** Environmental pollution; global environmental change; biodiversity-status, monitoring and documentation; major drivers of biodiversity change; biodiversity management approaches.
- J. Conservation biology:** Principles of conservation, major approaches to management, Indian case studies on conservation/management strategy (Project Tiger, Biosphere reserves).

## 11. EVOLUTION AND BEHAVIOUR

- A. Emergence of evolutionary thoughts:** Lamarck; Darwin–concepts of variation, adaptation, struggle, fitness and natural selection; Mendelism; spontaneity of mutations; the evolutionary synthesis.
- B. Origin of cells and unicellular evolution:** Origin of basic biological molecules; abiotic synthesis of organic monomers and polymers; concept of Oparin and Haldane; experiment of Miller (1953); the first cell; evolution of prokaryotes; origin of eukaryotic cells; evolution of unicellular eukaryotes; anaerobic metabolism, photosynthesis and aerobic metabolism.
- C. Paleontology and evolutionary history:** The evolutionary time scale; eras, periods and epoch; major events in the evolutionary time scale; origins of unicellular and multicellular organisms; major groups of plants and animals; stages in primate evolution including Homo.

- D. Molecular Evolution:** Concepts of neutral evolution, molecular divergence and molecular clocks; molecular tools in phylogeny, classification and identification; protein and nucleotide sequence analysis; origin of new genes and proteins; gene duplication and divergence.
- E. The Mechanisms:** Population genetics – populations, gene pool, gene frequency; Hardy-Weinberg law; concepts and rate of change in gene frequency through natural selection, migration and random genetic drift; adaptive radiation and modifications; isolating mechanisms; speciation; allopatricity and sympatricity; convergent evolution; sexual selection; co-evolution.
- F. Brain, Behavior and Evolution:** Approaches and methods in study of behavior; proximate and ultimate causation; altruism and evolution-group selection, kin selection, reciprocal altruism; neural basis of learning, memory, cognition, sleep and arousal; biological clocks; development of behavior; social communication; social dominance; use of space and territoriality; mating systems, parental investment and reproductive success; parental care; aggressive behavior; habitat selection and optimality in foraging; migration, orientation and navigation; domestication and behavioral changes.

## 12. APPLIED BIOLOGY:

- A.** Microbial fermentation and production of small and macro molecules.
- B.** Application of immunological principles (vaccines, diagnostics). tissue and cell culture methods for plants and animals.
- C.** Transgenic animals and plants, molecular approaches to diagnosis and strain identification.
- D.** Genomics and its application to health and agriculture, including gene therapy.
- E.** Bioresource and uses of biodiversity.
- F.** Breeding in plants and animals, including marker – assisted selection.
- G.** Bioremediation and phytoremediation.
- H.** Biosensors.

### 13. METHODS IN BIOLOGY

- A. Molecular biology and recombinant DNA methods:** Isolation and purification of RNA, DNA (genomic and plasmid) and proteins, different separation methods; analysis of RNA, DNA and proteins by one and two dimensional gel electrophoresis, isoelectric focusing gels; molecular cloning of DNA or RNA fragments in bacterial and eukaryotic systems; expression of recombinant proteins using bacterial, animal and plant vectors; isolation of specific nucleic acid sequences; generation of genomic and cDNA libraries in plasmid, phage, cosmid, BAC and YAC vectors; in vitro mutagenesis and deletion techniques, gene knock out in bacterial and eukaryotic organisms; protein sequencing methods, detection of post-translation modification of proteins; DNA sequencing methods, strategies for genome sequencing; methods for analysis of gene expression at RNA and protein level, large scale expression analysis, such as micro array based techniques; isolation, separation and analysis of carbohydrate and lipid molecules; RFLP, RAPD and AFLP techniques
- B. Histochemical and immunotechniques:** Antibody generation, detection of molecules using ELISA, RIA, western blot, immunoprecipitation, flow cytometry and immunofluorescence microscopy, detection of molecules in living cells, *in situ* localization by techniques such as FISH and GISH.
- C. Biophysical methods:** Analysis of biomolecules using UV/visible, fluorescence, circular dichroism, NMR and ESR spectroscopy, structure determination using X-ray diffraction and NMR; analysis using light scattering, different types of mass spectrometry and surface plasma resonance methods.
- D. Statistical Methods:** Measures of central tendency and dispersal; probability distributions (Binomial, Poisson and normal); sampling distribution; difference between parametric and non-parametric statistics; confidence interval; errors; levels of significance; regression and correlation; t-test; analysis of variance;  $\chi^2$  test; basic introduction to Multivariate statistics, etc.
- E. Radiolabeling techniques:** Properties of different types of radioisotopes normally used in biology, their detection and measurement; incorporation of radioisotopes in biological tissues and cells, molecular imaging of radioactive material, safety guidelines.
- F. Microscopic techniques:** Visualization of cells and subcellular components by light microscopy, resolving powers of different microscopes, microscopy of living cells, scanning and transmission microscopes, different fixation and staining techniques for EM, freeze-etch and freeze-fracture methods for EM, image processing methods in microscopy.
- G. Electrophysiological methods:** Single neuron recording, patch-clamp recording, ECG, Brain activity recording, lesion and stimulation of brain, pharmacological testing, PET, MRI, fMRI, CAT .

- H. Methods in field biology:** Methods of estimating population density of animals and plants, ranging patterns through direct, indirect and remote observations, sampling methods in the study of behavior, habitat characterization-ground and remote sensing methods.
  
- I. Computational methods:** Nucleic acid and protein sequence databases; data mining methods for sequence analysis, web-based tools for sequence searches, motif analysis and presentation.