# Department of Animal Sciences

**Program: M.Sc. in Life Sciences (Specialization: Animal Sciences)**
**Academic Session: 2018 - 19**

**Semester – I**

| Course Code | Course Title | L (hr) | T (hr) | P (hr) | Cr |
|---|---|---|---|---|---|
| | **Foundation Course*** | | | | |
| **LAS.507** | Animal Classification and Diversity | **3** | **-** | **-** | **3** |
| | **Core Courses*** | | | | |
| **LAS.508** | Biochemistry | **2** | **1** | **-** | **3** |
| **LAS.510** | Ecology and Evolution | **2** | **1** | **-** | **3** |
| **LAS.511** | Cell Biology | **2** | **1** | **-** | **3** |
| **LAS.512** | Essentials of Genetics | **2** | **1** | **-** | **3** |
| **LAS.520** | Lab Course (Practical) – I | **-** | **-** | **12** | **6** |
| | **Elective Courses (Opt any one)** | | | | |
| **LAS.513** | Techniques in Life Sciences | **2** | **-** | **-** | **2** |
| **LAS.514** | Animal Cell Culture and Applications | **2** | **-** | **-** | |
| | **Inter-Disciplinary (ID) Course** | | | | |
| **LAS.515** | Fundamentals of Cell Biology (IDC) | **2** | **-** | **-** | **2** |
| | **Total Credits / Marks** | | | | **25** |

**L: Lectures; T: Tutorial; P: Practical; Cr: Credits; * Compulsory Courses**

## Examination Pattern

A: Continuous Assessment: [25 Marks]

i. Surprise Test (minimum three) - Based on Objective Type Tests (10 Marks)
ii. Term paper (10 Marks)
iii. Assignment(s) (5 Marks)

B: Pre-Scheduled Mid Semester Test-1: Based on Subjective Type Test [25 Marks]

C: Pre-Scheduled Mid Semester Test-2: Based on Subjective Type Test [25Marks]

D: End-Term Exam (Final): Based on Objective Type Tests [25 Marks]

E: Practical: (Annexure - A)

**Semester - I**

**Foundation Course**

**LAS.507: Animal Classification and Diversity** **3 Credits**

**Learning Objectives:** Students with varied graduation subjects take up our program. Hence, the course is designed to bring them on a common platform to provide a common understanding of diversity of life forms with an emphasis on animals. The three main objectives of the course are:

- To learn how organisms are classified according to their physical characteristics and evolutionary relationships
- To familiarize with animal diversity and classification
- To appreciate the vastness of biodiversity and understand its importance

| Unit | Syllabus | Lectures |
|---|---|---|
| 1. | **Systematics:** Binomial nomenclature; three domain classification; phylogenetic tree construction; applications of phylogeny; cladistics: monophyletic, paraphyletic and polyphyletic groups; shared and derived characters; homoplasy; parsimony analysis; molecular clocks | 10 |
| 2. | **Domain Eukarya:** Algae; Fungi; phylogeny of living animals; overview of non-chordates: phylums porifera, cnidarian, Platyhelminthes, Rotifera, Lopophorates, Mollusca, Annelida, nematode, Arthropoda, Echinodermata; overview of chordates:cephalochordate, urochordata, Myxini, Petromyzontida, Chondrichthyes, Actinopterygii, Actinistia, Dipnoi, Amphibia, Reptilia and Mammalia | 16 |
| 3. | **Animal models:** Animal models of disease & research: *Drosophila*, *C. elegans*, Zebrafish, Mice and Human; Common parasites and pathogens of humans, domestic animals, crops and fungi | 10 |
| 4. | **Biodiversity and Conservation:** Importance of biodiversity; types & patterns of biodiversity; measurement of biodiversity: Simpson' diversity index and Shannon-Weiner index; ecosystem services and value; loss of biodiversity; ex-situ and in -situ conservation strategies of biodiversity: national parks, wild life sanctuaries, biodiversity hotspots and world heritage sites; rare and endangered species; impact of climate change on biodiversity | 12 |

**Suggested Reading:**


1. Damron, W. S. (2012). Introduction to Animal Science. Prentice Hall. 5th Edition
2. Lisa AU. et al. (2016). Campbell Biology. Pearson publishers, 11th edition.
3. Primack, R. B. (2014). Essentials of Conservation Biology. Sinauer Associates Inc., 6 th edition
4. Modern textbook of zoology: vertebrates R.L. Kothpal
5. The Tree of Life by Pablo Vargas. Sinauer Associates, Oxford University Press
6. Kapoor, V.C., 1983. Theory and practice of animal taxonomy. (Oxford & IBH Publ. Co.)
7. Mayr, E. & Ashlock, P.D., 1991. Principles of Systematic Zoology. (McGraw Hill International Edition)

**Core Courses**

**LAS.508: Biochemistry** **3 Credits**

| **Learning Objective:** The course is designed to teach fundamentals and basics of biochemistry and to prepare the students for advanced aspects of biochemistry such as nutrition and metabolism associated with human physiology. | | |
|---|---|---|
| **Unit** | **Syllabus** | **Lectures** |
| 1. | **Principles of Biophysical Chemistry:** pH, buffers, reaction kinetics, thermodynamics, colligative properties, chemical bonds and stabilizing interactions: van der Waals, electrostatic, hydrogen bonding & hydrophobic interactions. | 8 |
| 2. | **Bioenergetics:** Concept of free energy, standard free energy, determination of ΔG for a reaction. Relationship between equilibrium constant and standard free energy change, biological standard state & standard free energy change in coupled reactions. Biological oxidation-reduction reactions, redox potentials, relation between standard reduction potentials & free energy change (derivations and numericals included). High energy phosphate compounds – introduction, phosphate group transfer, free energy of hydrolysis of ATP and sugar phosphates along with reasons for high ΔG, energy change. | 12 |
| 3. | **Composition, Structure and Function of Biomolecules:** Classification, structure, general properties and functions of **polysaccharides** and complex carbohydrates; amino sugars, proteoglycans and glycoproteins. **Lipids** – Classification, structure, properties and functions of fatty acids, essential fatty acids, fats, phospholipids, sphingolipids, cerebrocides, steroids, bile acids, prostaglandins, lipoamino acids, lipoproteins, proteolipids, phosphatidopeptides, lipopolysaccharides. **Proteins** – Peptide synthesis: chemical and Merrifield synthesis. Primary (peptide conformation, N- and C-terminal, peptide cleavage), Secondary (α-helix, β-sheet, random coil, Ramachandran plot), Tertiary and Quaternary structures of proteins. | 16 |
| 4. | **Enzymology:** Historical perspective, general characteristics, nomenclature, IUB enzyme classification (specific examples), measurement and expression of enzyme activity, enzyme assay, factors influencing enzyme activity, active site, Michaelis-Menten equation and its importance. Definitions of IU, Katal, enzyme turnover and specific activity. Methods for isolation, purification and characterization of enzymes, tests for homogeneity of enzyme preparation. Clinically important enzymes. | 12 |
| **Suggested Reading:** | | |

1. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2010). Biochemistry. W.H. Freeman & Company. USA.
2. Mathews, C. K., Van Holde, K. E. and Ahern, K. G. (2000). Biochemistry. Oxford University Press Inc. New York.
3. Nelson, D. and Cox, M. M. (2008). Lehninger Principles of Biochemistry. BI publications Pvt. Ltd. Chennai, India.
4. Shukla, A. N. (2009). Elements of Enzymology. Discovery Publishing. New Delhi, India.
5. Voet, D. and Voet, J. G. (2008). Principles of Biochemistry. CBS Publishers & Distributors. New Delhi, India.

## LAS.510: Ecology and Evolution — 3 Credits

**Learning objective:** Through this course the students will gain insight into the living organism in relation to its environment. The two main objectives of the course are:

- To understand the interdependency of ecology and evolution and their importance in all the domains of life
- To realize that ecology and evolutionary biology play a crucial role in facing the grand challenges of our time

| Unit | Syllabus | Lectures |
|---|---|---|
| 1. | **Introduction to Ecology:** Habitat and niche, adaptation, ecosystem, biotic and abiotic factors, food chain, food webs, trophic level, Biogeography – classification and zones | 8 |
| 2. | **Ecosystem Dynamics:** Concept and components of ecosystem, ecological pyramids, energy flows in different ecosystems, energy models, ecosystem productivity. Types and characteristics of ecosystem-terrestrial (forest, desert, grassland) and aquatic (pond, marine), wetlands, estuaries, natural and manmade ecosystems, forest types in India. Biogeochemical cycles – cycling of water, nutrients. | 12 |
| 3. | **Population and Community Ecology:** Population characteristics, population interaction; prey-predator relationships; Theories of population growth, population dynamics, regulation. Concept of metapopulation, demes and dispersal, niche- concept and types, keystone species, flagship species and umbrella species; dominant species, ecotone, edge effect, ecotypes, plant indicators; ecological succession – types and mechanism, theory of island | 14 |
| 4. | **Evolution:** Darwin & the origin of species, Lamarckism, Micro-evolution: concept of natural selection, genetic drift (founder and bottle neck effect) and gene flow, Hardy-Weinberg law, directional, disruptive, stabilizing and sexual selection. Speciation: biological species concept, allopatric, sympatric and parapatric speciation, concept of hybrid zone. Macro-evolution: origin of life on earth, Oparin and Haldane hypothesis, Urey-Miller experiments, geological timescale and events, continental drift, mass extinctions, evolutionary trends | 14 |

**Suggested Reading:**


1. Urry, L. A. et al. (2016). Campbell Biology. Pearson publishers, 11th edition.
2. Smith, T. M. and Smith, R. L. (2012). Elements of Ecology. Benjamin Cummings Publishing Company, 8th edition.
3. Begon, M., Howarth, R. W. and Townsend, C. R. (2014). Essentials of Ecology. Wiley
4. Publishers, 4th edition.
5. Odum, E. and Barrett, G. W. (2004). Fundamentals of Ecology. Cengage Learning, 5th edition.
6. Prasanthrajan, M and Mahendran, P. P. (2008). A Text Book on Ecology and Environmental Science
7. Evolution: Making sense of life by Carl Zimmer


## LAS.511: Cell Biology — 3 Credits

**Learning Objective:** Students will understand the structure and basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and organelles and their related functions.

| Unit | Syllabus | Lectures |
|---|---|---|
| 1. | **Cell:** Evolution of the cell, molecules to cell, prokaryotes and eukaryotes. **Membrane Structure and Function:** Models of membrane structure, membrane proteins, membrane carbohydrates, membrane transport of small molecules, membrane transport of macromolecules and particles. | 10 |
| 2. | **Structural Organization and Function of Intracellular Organelles:** Lysosomes, ribosomes, peroxisomes, golgi apparatus, endoplasmic reticulum and its types, mitochondria and chloroplast, Structure of mitochondria and nucleus, oxidation of glucose and fatty acids, electron transport chain (ETC): oxidative phosphorylation, chloroplast and photosynthesis. | 14 |
| 3. | **The Cytoskeleton:** The nature of cytoskeleton, intermediate filaments, microtubules, actin filaments, cilia and centrioles, organization of the cytoskeleton. **Cell Communication:** Cell adhesions, cell junctions and the extra cellular matrix, cell-cell adhesion and communication, cell matrix adhesion, collagen the fibrous protein of the matrix, non-collagen component of the extra cellular matrix. | 14 |
| 4. | **Cell Division and Cell Cycle:** Mitosis and meiosis, their regulation, steps in cell cycle, regulation and control of cell cycle events. | 10 |

**Suggested Reading:**


1. Alberts, B., Bray, D., Lews, J., Raff, M., Roberts, K. and Watson, J. D. (2010). Molecular

Biology of the Cell. Garland publishers, Oxford.
2. Celis, J. E. (2006). Cell Biology: A Laboratory Handbook, Vol 1, 2, 3. Academic Press, UK.
3. Gupta, P. K. (2008). Cytology, Genetics and Evolution. Rastogi publications, Meerut, India.
4. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. John Wiley & Sons. Inc. New Delhi, India.

## LAS.512: Essentials of Genetics — 3 Credits

**Learning Objective:** Students will learn the basic and essential principles of inheritance.

| Unit | Syllabus | Lectures |
|---|---|---|
| 1. | **Mendelian Principles and Concept of Gene:** Dominance, segregation, independent assortment, allele, multiple alleles, pseudoallele, complementation tests. **Extension 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. | 12 |
| 2. | **Gene Mapping Methods:** Linkage maps, tetrad analysis, mapping with molecular markers, mapping by somatic cell hybrids, development of mapping population. **Human Genetics:** Pedigree analysis, LOD score for linkage testing, karyotypes, genetic disorders. **Quantitative Genetics:** Polygenic inheritance, heritability and its measurements, QTL mapping. | 14 |
| 3. | **Gene Concept:** Fine structure of gene, Benzer's experiments, complementation analysis and recombination. **Recombination:** Site-specific, homologous, transposition and non-homologous end joining (NHEJ). **Mutation:** Types, causes and detection, mutant types – lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants, insertional mutagenesis, applications in reverse and forward genetics, mutations and Hardy Weinberg equilibrium, molecular basis of spontaneous and induced mutations. | 14 |
| 4. | **Extra-Chromosomal Inheritance:** Chloroplast and mitochondrial inheritance, structural and numerical alterations of chromosomes: deletion, duplication, inversion, translocation, ploidy and their genetic implications. | 14 |

**Suggested Reading:**

1. Anthony, J. F., Miller, J. A., Suzuki, D. T., Richard, R. C., Gilbert, W. M. (1998). An

Introduction to Genetic Analysis. W.H. Freeman publication, USA.
2. Atherly, A. G., Girton, J. R., Mcdonald, J. F. (1999). The Science of Genetics. Saundern College publication.
3. Snusted, D. P., Simmons, M. J. (2010). Principles of Genetics. John Wiley & Sons, New York.
4. Gupta, P. K. (2009). Genetics. Rastogi publications, Meerut, India.
5. Gupta, P. K (2008). Cytology, Genetics and Evolution. Rastogi publications, Meerut, India.

**Additional reading:**

6. Jocelyn, E. K., Elliott, S. G., Stephen, T. K. (2009). Lewin's Genes X. Jones & Bartlett Publishers, USA.
7. Schaum, W. D. (2000). Theory & problems in Genetics by Stansfield, outline series McGrahill, USA.
8. Tamarin, R. H. (1996). Principles of Genetics, McGrawhill, USA.

**Elective Courses:**

**LAS.513: Techniques in Life Sciences** **2 Credits**

**Learning Objective:** The goal of this course for students is to acquire the necessary theoretical knowledge of various laboratory and analytical instruments.

| Unit | Syllabus | Lectures |
|---|---|---|
| 1. | **Spectroscopy and Chromatography Techniques:** Colorimetry, UV-Vis, fluorimeter, FTIR, mass, IR, NMR, and X-ray. Principle, procedure and applications of thin layer chromatography (TLC), gel filtration, FPLC and ion exchange, affinity chromatography, GC, GLC and HPLC. | 8 |
| 2. | **Microscopy:** Light microscopy, phase contrast microscopy, fluorescent microscopy, confocal microscope, scanning electron microscopy (SEM/FESEM), transmission electron microscopy (TEM), atomic force microscopy. | 12 |
| 3. | **Basic Molecular Biology Techniques:** Isolation, purification and analysis of protein and nucleic acids. Electrophoresis: Principle of gel electrophoresis, polyacrylamide gel electrophoresis (PAGE and SDS-PAGE), agarose gel electrophoresis and 2-Dimensional gel electrophoresis. Polymerase chain reaction (PCR): Principle, types and applications. Blotting techniques: Southern, Northern, Western analysis, *In situ* hybridization etc. | 8 |
| 4. | **Advanced Immunological and Cell Culture Techniques:** Perfusion, Fixation, different techniques of sectioning, MTT assay, Electrophysiological techniques like Patch clamp immunochemical | 8 |

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| | techniques, immunocytochemistry, immunofluorescence, radioimmunoassay (RIA), Different enzyme linked immunosorbent assay (ELISA), immunoprecipitation, flow cytometry. Cell and tissue culture techniques: Primary and secondary cultures. | |

**Suggested Reading:**


1. Brown, T. A. (2010). Gene Cloning and DNA Analysis: An Introduction. 6th Edition, Wiley-Blackwell Publisher, New York.
2. Goldsby, R. A., Kindt, T. J. and Osborne, B. A. (2008). Kuby Immunology. 6th Edition, W. H. Freeman & Company, San Francisco.
3. Gupta, P. K. (2005). Elements of Biotechnology. Rastogi Publications, Meerut.
4. Kothari, C. R. (2008.) Research Methodology. New Age International (P) Ltd., New Delhi
5. Lewin, B. (2010). Genes X, CBS Publishers & Distributors. New Delhi.
6. Nelson, D. and Cox, M. M. (2009). Lehninger Principles of Biochemistry. W.H. Freeman and Company, New York.
7. Primrose. S. B. and Twyman, R. (2006). Principles of Gene Manipulation and Genomics. Blackwell Publishing Professional, U.K.
8. Sambrook, J. (2006). The Condensed Protocols from Molecular Cloning: A Laboratory Manual. Cshl Press. New York.
9. Sambrook, J. and Russell, D. W. (2000). Molecular Cloning: A Laboratory Manual (3 Vol-set). 3rd Edition, CSHL Press, New York.
10. Sawhney, S. K. and Singh, R. (2005). Introductory Practical Biochemistry. Narosa Publishing House, New Delhi.
11. Wilson, K. and Walker, J. (2006). Principles and Techniques of Biochemistry and Molecular biology. 6th Edition, Cambridge University Press India Pvt. Ltd., New Delhi.


## LAS.514: Animal Cell Culture and Applications — 2 Credits

**Learning Objective:** The goal of this course is to provide the necessary theoretical knowledge on animals cells for *in vitro* studies, maintenance of animal cells *in vitro*, manipulation of animal cells *in vitro*, and application of molecular techniques to *in vitro* situations.

| Unit | Syllabus | Lectures |
|---|---|---|
| 1. | **Introduction to Animal Cell Culture:** Historical background. Good Laboratory Practices (GLP), sterilization methods and techniques. Biology of animal cell and cell-cell interactions, growth environment and culture requirement. Primary culture, subculture, cell line, cell strain, cell clone. Importance of serum and serum-free media, culturing and sub-culturing of animal cells, *in vitro* transfection of animal cells, cell-based assays, cell differentiation and movement, animal cell culture | 10 |

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|---|---|---|
| | facility. | |
| 2. | **Cell Culture Types and Characterization:** Primary cell culture, tissue culture, organ culture, cell line immortalization, cell line preservation & characterization, karyotype analysis, cellular markers, commercial cell lines, and insect cell culture. | 8 |
| 3. | **Applications of Animal Cell Culture:** Cancer Research, vaccine manufacture, gene and stem cell therapy, production of recombinant proteins, IVF Technology, toxicology studies. | 8 |
| 4. | **Translational Research Applications:** Animal cells as the applicable products (recombinants, hybridomas, stem cells and transplants). Focus on Rodent and murine models in scientific research associated with cancer and neurodegenerative diseases. | 6 |

**Suggested Reading:**


1. Freshney, R. I. (2010). Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications. Wiley-Blackwell, 2010. 6th Edition.
2. Davis, J. M. (2008). Basic Cell Culture. Oxford University Press. New Delhi.
3. Davis, J. M. (2011). Animal Cell Culture. John Willy and Sons Ltd. USA.
4. Freshney R. I. (2005). Culture of Animal Cells. John Willy and Sons Ltd. USA.
5. Butler, M. (2004). Animal Cell Culture and Technology. Taylor and Francis. New York, USA.
6. Verma, A. S. and Singh, A. (2014). Animal Biotechnology. Academic Press, Elsevier, USA.
7. Cartwright, E. J. (2009). Transgenesis Techniques. Humana Press. London, UK.
8. McArthur, R. A. and Borsini, F. (2008). Animal and Translational Models for CNS Drug Discovery. Elsevier. London, UK.
9. Research Journals and Review Articles as suitable and applicable.


## Inter Disciplinary Course

### LAS.515: Fundamentals of Cell Biology — 2 Credits

**Learning Objective:** This is an interdisciplinary course to acquaint the students of different streams with a very basic knowledge and understanding of the basic unit of life: the cell, its structure, composition and function.

| Unit | Syllabus | Lectures |
|---|---|---|
| 1. | **Basic unit of Life:** Life at the cellular and molecular level. Introduction to the topics include cellular energetics, membrane phenomena, genetics, and molecular biology. | 8 |

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|---|---|---|
| 2. | **Introduction to the Cell:** The evolution of the cell, from molecules to first cell, from prokaryotes to eukaryotes, prokaryotic and eukaryotic genomes, from single cell to multicellular organism. | 8 |
| 3. | **Membrane Structure and Function:** Biomembrane at a glance**,** membrane models: structure and composition, and membrane transport. | 8 |
| 4. | **Structural Organization of Intracellular Organelles:** Introduction of subcellular organelles: lysosomes, ribosomes, peroxisomes, golgi apparatus, endoplasmic reticulum, nucleus, mitochondria, and chloroplast. | 8 |

**Suggested Reading:**


1. Gupta, P. K. (2005). Cell and Molecular Biology. Rastogi publications, Meerut, India.
2. James, D. W., Baker, T.A., Bell, S.P., Gann, A. (2009). Molecular Biology of the Gene. Benjamin Cummings, USA.
3. Johnson, A., Lewis, J., Raff, M. (2007). Molecular Biology of the Cell. Garland Science, USA.
4. Lodish, H., Berk, A., Chris, A. K. and Krieger, M. (2008). Molecular Cell Biology. W.H. Freeman, USA. Alberts, B., Bray, D., Lews, J., Raff, M., Roberts, K. and Watson, J.D. (2010).
5. Molecular Biology of the Cell. Garland publishers, Oxford.
6. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. John Wiley & Sons. Inc. New Delhi, India.

**LAS.520: Lab Course (Practical) – I**

1. Laboratory instrumentation
2. Preparation of Buffers and Solutions
3. Biochemical estimation and analysis of Proteins, Lipids and Carbohydrates
4. SDS-and native polyacrylamide gel electrophoresis
5. Gel filtration and Ion-exchange chromatography
6. Cell structure: Compound, Fluorescence, and Electron microscopy
7. Histochemistry: Fixation, Sectioning, Embedding, Processing and Staining
8. Immunocytochemistry
9. Identification of cell mitosis and meiosis stages
10. Specimen identification, DNA barcoding & Construction of phylogenetic trees

**Note: *Practicals may be added / modified depending on the available faculties / facilities / latest advancements**

**Annexure – A**

## Examination Pattern

**Practical: Lab course – I, II & III [100 Marks each]**

**i. Day to day performance – 60 Marks**

- *a. Attendance – 10 Marks*
- *b. Continuous assessment - 30 Marks*
- *c. Lab Record - 10 Marks*
- *d. Overall performance - 10 Marks*

**ii. End-semester exam – 40 Marks**

- *a. Major Question - 20 Marks*
- *b. Minor Question - 10 Marks*
- *c. Viva-voce - 10 Marks*

***Updated on: 18-1-2018***