Center for Animal Sciences

Program: M.Sc. in Life Sciences (Specialization: Animal Sciences)
Academic Session: 2017-18

Semester – I

Course Code	Course Title	L (hr)	T (hr)	P (hr)	Cr
	Foundation Course*				
LAS.501	Introduction to Animal Sciences	**2**	**-**	**-**	**2**
	Core Courses*				
LAS.503	Biochemistry	**2**	**1**	**-**	**3**
LAS.504	Ecology, Evolution and Diversity	**2**	**1**	**-**	**3**
LAS.505	Cell Biology	**2**	**1**	**-**	**3**
LAS.506	Essentials of Genetics	**2**	**1**	**-**	**3**
LAS.525	Lab Course (Practicals) - I	**-**	**-**	**12**	**6**
	Elective Courses (Opt any one)				
LAS.551	Techniques in Life Sciences	**2**	**-**	**-**	**2**
LAS.552	Animal Cell Culture and Applications	**2**	**-**	**-**	
	Inter-Disciplinary (ID) Course				
LAS.401	Fundamentals of Cell Biology	**2**	**-**	**-**	**2**
	Seminar				
LAS.595	Seminar - I	**1**			**1**
	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: Seminar-I (Annexure - A)
F: Practicals: (Annexure - B)

Semester - I

Foundation Course

LAS.501: Introduction to Animal Sciences **2 Credits**

Learning Objective: This course will help the students to familiarize with the Animal Sciences. Students will be oriented towards understanding its role in the environment, human life, and its applications in industry and the betterment of human health.

Unit	Syllabus	Lectures
1.	**Animal Sciences:** Scope, importance & career opportunities; classical zoology to modern animal biotechnology; timeline of animal research and industry; overview of the courses offered under this program.	8
2.	**From Benchtop to the Bedside:** Animal cell; *in vitro* and *in vivo* animal model systems; animal research; animal welfare and ethics; global, biological, social, and industrial Perspectives and latest trends in Animal Sciences.	10
3	**Animal classification and taxonomy:** Introduction & historical aspects; need for the classification; Three domains of life; Taxonomy & Systematics; Concept of species and taxonomical hierarchy; Binomial nomenclature; Tools for study of taxonomy. Salient features, classification and economic importance of animals-nonchordates and chordates.	14

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. Verma, A. and Singh, A. (2013). Animal Biotechnology: Models in Discovery and Translation. 1st Edition. Academic Press.
3. Damron, W. S. (2012). Introduction to Animal Science. Prentice Hall. 5th Edition.
4. Ranga, M.M. (2007). Animal Biotechnology. 3rd edition.

Core Courses

LAS.503: 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	8

	interactions.	
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.504: Ecology, Evolution and Diversity **3 Credits**

Learning Objective: An intensive introduction to the field of biology, stressing concepts and theories that underlie our understanding of evolution, ecology, and diversity. Topics include the origin of diversity, evolutionary change, phylogeny and classification, diversity in form and function, and the adaptations and interactions of organisms within communities and populations.

Unit	Syllabus	Lectures
1.	**Ecology:** Biosphere, ecosystem and biogeochemical cycles; **Landscape ecology:** terrestrial and aquatic biomes; **Community ecology:** species interactions: competition, predation, symbiosis, parasitism, mutualism, commensalism, trophic structure: food chains and food webs, bottom-up and top-down models, ecological succession **Population ecology**: demography, exponential and logistic models, life history patterns: k- and r-selections.	16
2.	**Biodiversity and Conservation:** Importance of biodiversity, types & patterns of biodiversity, measurement of biodiversity, Ecosystem services, loss of biodiversity and conservation strategies of biodiversity.	8
3.	**Evolution:** Darwin & the origin of species, Lamarck's hypothesis of evolution, **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.	16
4.	**Systematics:** Classification, phylogenetic tree construction, cladistics, molecular clocks. The three domains of life; protists, fungal and animal classification.	8

Suggested Reading:

1. Urry, L. A. et al. (2016). Campbell Biology. Pearson publishers, 11th edition.
2. Primack, R. B. (2014). Essentials of Conservation Biology. Sinauer Associates Inc., 6th edition
3. Smith, T. M. and Smith, R. L. (2012). Elements of Ecology. Benjamin Cummings Publishing Company, 8th edition.
4. Begon, M., Howarth, R. W. and Townsend, C. R. (2014). Essentials of Ecology. Wiley 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.

LAS.505: 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.506: 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	12

	and expressivity, phenocopy, linkage and crossing over, sex linkage, sex limited and sex influenced characters.	
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.551: 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.	8
4.	**Advanced Immunological and Cell Culture Techniques:** Histochemical and immunochemical techniques, immunocytochemistry, immunofluorescence, radioimmunoassay (RIA), enzyme linked immunosorbent assay (ELISA), immunoprecipitation, flow cytometry. Cell and tissue culture techniques: Primary and secondary cultures.	8

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.552: 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 facility.	10
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:** Rodent and murine models in scientific research associated with cancer and neurodegenerative diseases. Animal cells as the applicable products (recombinants, hybridomas, stem cells and transplants).	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.401: 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
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.525: Lab Course (Practicals) – I **6 Credits**

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

LAS.595: Seminar – I **1 Credit**

Learning Objective: To improve student's scientific aptitude and presentation skills. The student should select a specific topic based on a review / research article and prepare a presentation of approximately 15 - 20 minutes, and the student is also required to prepare a short report of 6-10 pages.

Annexure – A

Examination Pattern

Credit Seminars: I & II

Seminar: **[50 Marks]**

a. *Report submission -* *10 Marks*
b. *Contents -* *10 Marks*
c. *Presentation skills -* *10 Marks*
d. *Innovation -* *10 Marks*
e. *Question & Answers -* *10 Marks*
(Interaction session)

Annexure – B

Examination Pattern

Practicals: Lab course – I, II & III [100 Marks]

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

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