# Department of Animal Biology
# School of Life Sciences
# University of Hyderabad

## Vision

Our vision is to achieve academic excellence in education and research by promoting systematic learning to understand the molecular basis of animal health and diseases in diverse areas of modern biology.

## Mission

**MS-1:** Providing high-quality education of international standards in animal biology and biotechnology at Master's and Doctoral level.

**MS-2:** Carrying-out research in frontier areas of animal biology and biotechnology through intra- and extra-mural research grants.

**MS-3:** Development of processes/technologies/methods through academia-industry interactions, thus promoting entrepreneurial skills

**MS-4:** Establishing national/international collaborations with premier research institutes/universities for advancing scientific knowledge in interdisciplinary areas of animal biology and biotechnology.

# Department of Animal Biology
# School of Life Sciences
# University of Hyderabad

M.Sc. in Animal Biology and Biotechnology

## Qualification Descriptors

After completion of M.Sc. program in Animal Biology and Biotechnology, the students will be able to

**QD-1:** Demonstrate comprehensive knowledge and skills in the area of **Animal Biology and Biotechnology.**

**QD-2:** Use knowledge and skills required for identifying problems and issues, collection of relevant quantitative and/or qualitative data pertaining to **animal health and welfare.**

**QD-3:** Apply disciplinary knowledge and transferable skills to **design novel strategies for improving animal and human health through biotechnological approaches.**

**QD-4:** Communicate the results of studies undertaken in **understanding the molecular basis of animal as well as human physiology and infectious diseases.**

**QD-5:** Demonstrate knowledge and transferable skills in the fields of **Molecular Biology and Genetic Engineering, Immunology, Genetics, Reproductive Biology and Endocrinology, Stem Cell Biology, Bioinformatics, and Transgenic Technology** that are relevant in job trades and employment opportunities like **Faculty/Scientists in academia and industry** and meet one's own learning needs, based on research and development work and professional materials.

## Mapping Qualification Descriptors with Mission Statements

| | MS-1 | MS-2 | MS-3 | MS-4 |
|---|---|---|---|---|
| **QD-1** | 3 | 3 | | |
| **QD-2** | | 3 | | |
| **QD-3** | 3 | 3 | 3 | 3 |
| **QD-4** | 3 | 3 | 3 | |
| **QD-5** | 3 | 3 | 3 | 3 |

'3' – *High-level*
'2' – *Medium-level*
'1' – *Low-level*

**Department of Animal Biology**
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M.Sc. in Animal Biology and Biotechnology

# Program Learning Outcome

**After completion of M Sc in Animal Biology and Biotechnology program offered by the Department of Animal Biology, the students will be able to**

**PLO 1: Disciplinary Knowledge:** Demonstrate comprehensive knowledge and skills in areas related to Molecular Biology and Genetic Engineering, Cell biology, Immunology, Genetics, Microbiology, Biochemistry, Developmental Biology, Reproductive Biology and Endocrinology, Evolutionary Biology, Stem Cell Biology, Bioinformatics, and Transgenic Technology.

**PLO 2: Communication Skills:** Various research themes of Animal Biology and Biotechnology conducted during the Master's thesis work helps to communicate and publish the results of studies undertaken in the field(s) of accurately in a range of different contexts using the main concepts, constructs and techniques of the subject(s).

**PLO 3: Critical Thinking and Problem solving:** Students are train in various specialized subjects from the first semester onwards for evidence-based evaluation of practices, policies and theories using well-defined scientific approach to knowledge development.

**PLO 4: Analytical Reasoning:** Students are trained to improve the ability to evaluate the reliability and relevance of evidence, identify logical flaws in the arguments of others, analyse and synthesize data from a variety of sources, and draw valid conclusions.

**PLO 5: Research related skills:** Students are trained to demonstrate a sense of inquiry and capability for asking relevant/appropriate questions; the ability to recognise cause-and-effect relationships, define problems, formulate hypotheses, test hypotheses, analyse, interpret and draw conclusions from data; plan, execute and report the results of an experiment or investigation. Training in frontier areas of biotechnology helps the students to use knowledge and skills required for identifying problems and issues, collection of relevant quantitative and/or qualitative data, analysis and evaluation using methodologies as appropriate to the subject(s) for formulating evidence-based solutions and arguments.

**PLO 6:** Collaboration/Cooperation/Team work: Practical and high-end techniques based M Sc courses train the students to demonstrate ability to work effectively with diverse teams, facilitate cooperative or coordinated effort on the part of a group, and act together as a group or a team in the interests of a common cause.

**PLO 7:** Information/Digital Literacy: Practical and certain taught courses of Animal Biology train the students to demonstrate capability to use ICT in a variety of learning situations, demonstrate ability to access, evaluate, and use a variety of relevant information sources and to use appropriate software for analysis.

**PLO 8:** Moral and Ethical Awareness/Reasoning: Students acquire the ability to identify ethical issues related to research work, avoid unethical behaviour such as fabrication, falsification or misrepresentation of data or committing plagiarism, not adhering to intellectual property rights, appreciate environmental and sustainability issues, and adopt objective, unbiased and truthful actions in all aspects of work.

**PLO 9:** Leadership Readiness/Qualities: Students of Animal Biology can demonstrate capability for mapping out where one needs to go to "win" as a team or an organization, formulate an inspiring vision, build a team who can help achieve the vision, motivate and inspire team members to engage with that vision, and use management skills to guide the team to the right destination. Manpower Skill Development: Apply disciplinary knowledge and transferable skills in areas related to stem cell biology and transgenic technology to new contexts in order to solve complex problems with well-defined solutions. Demonstrate knowledge and transferable skills in the fields of Enzymology, Immunology, Recombinant DNA technology, and Animal Biotechnology that are relevant in job trades and employment opportunities like teaching and research in organizations in educational institutions, research Institutes and Pharma/Biotech Industries.

**PLO 10:** Self Learning and Lifelong Learning: Students of Animal Biology can demonstrate to acquire knowledge and skills, including ‘learning how to learn’ that are necessary for participating in learning activities throughout life, through self-paced and self-directed learning aimed at personal development and to meet the changing trades and demands of work place.

**Department of Animal Biology**
**School of Life Sciences**
**University of Hyderabad**
M.Sc. in Animal Biology and Biotechnology

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|---|---|---|---|
| **Course Code** | **:** AB 401 | **Credits** | **:** 3 |
| **Title of the Course** | **:** Genetics | **L-T-P** | **:** 3-0-0 |
| **Prerequisite Course** | **:** B.Sc. Biology | | |

***After the completion of this course, the students will be able to***

CLO 1: Explain Mendelian analysis of inheritance, extensions and development of genetic maps using linkage studies.
CLO 2: Explain the chromosome structure and organization including large scale mutations.
CLO 3: Explain sex chromosome inheritance and sex determination in eukaryotes.
CLO 4: Explain the inheritance of the chloroplast and mitochondrial genes, their mapping and applications.
CLO 5: Describe the complexity of inheritance in higher organisms where more than one gene is involved in expression of a trait and also disease in a given population.
CLO 6: Discuss the utilization of identical and fraternal twins in understanding the relative influence of genes and environment on different human traits.
CLO 7: Discuss the genetic mechanisms underlying the early development in Drosophila.
CLO 8: Explain mechanisms of gene regulation including X-chromosome inactivation, genome imprinting and position effect variegation.

**Mapping with PLOs**

| | PLO 1 | PLO 2 | PLO 3 | PLO 4 | PLO 5 | PLO 6 | PLO 7 | PLO 8 | PLO 9 | PLO 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **CLO 1** | 3 | | | | | | | | | |
| **CLO 2** | 3 | | | | | | | | | |
| **CLO 3** | 3 | | | 3 | | | | | | |
| **CLO 4** | 3 | | | | | | | | | |
| **CLO 5** | 3 | | | 3 | | | | | | |
| **CLO 6** | 3 | | | | | | | | | |
| **CLO 7** | 3 | | | | 3 | | | | | |
| **CLO 8** | 3 | | | | | | | | | |

## Detailed Syllabus

**Unit 1:** Principles of heredity and extensions to basic principles: Mendelian Genetics and analysis: Extensions and modifications of basic principles of heredity, Chromosomal basis of inheritance.

**Unit 2:** Chromosome characteristics and transposable elements: Chromosome structure, Euchromatin and heterochromatin, Coding and Non-coding sequences, Characteristics of transposons, mechanism of transposition and mutagenic effects of transposition.

**Unit 3:** Genetic recombination in eukaryotes: Linkage and Crossing Over, Chromosome mapping, tetrad analysis and gene conversion, uses of genetic maps.

**Unit 4:** Mutations and mutagenesis: Detection, Molecular basis and Applications.

**Unit 5:** Chromosomal changes: Number variation – Euploidy (auto and allopolyploidy), aneuploidy; Structural variations – Deficiences, duplications, Inversions, translocations.

**Unit 6:** Interaction of genotype and environment, Twin studies, genetic environment, non-genetic environment, phenocopies, penetrance and expressivity.

**Unit 7:** Gene expression regulation during differentiation and growth: Heterochromatization in human beings, Drosophila and Yeast, position effect: Dosage compensation mechanism, sex chromatin and sex chromosomal inheritance.

**Unit 8:** Quantitative inheritance: Continuous traits – multigenic variability, dominance - additivity, norms of reaction, quantitative trait loci.

**Unit 9:** Non-Mendelian Inheritance; Plastid mutations – nature and mode of transmission Mitochondrial traits – nature and mode of transmission.

**Unit 10:** Population genetics: Genotype and allelic frequencies, the Hardy-Weinberg equilibrium, non-random mating, consequences of homozygosity, factors affecting gene frequencies, heterosis, mutation – effect on allele frequencies, migration and genetic drift.

**Unit 11:** Developmental genetics: Model system Drosophila, Genetic screen, pattern formation, maternal effect, homoetic transformations.

## References


1. Griffiths, A. J. F., Miller, J. H., Suzuki, D. T., Lewontin, R. C., Gelbart, W. M. An Introduction to Genetic Analysis, W. H. Freeman & Company, New York.
2. An Introduction to genetic analysis. Anthony A. J. F. Griffiths; Susan R. Wessler; Sean B. Carroll; John Deebly. 11th Edition
3. Genetics: A Conceptual approach. Benjamin A. Pierce. 7th Edition Genetics: analysis of genes and genomes. Daniel L Hartl; Maryellen Ruvolo. 8th Edition.

**Department of Animal Biology**
**School of Life Sciences**
**University of Hyderabad**
M.Sc. in Animal Biology and Biotechnology

| | | | |
|---|---|---|---|
| Course Code | : AB 402 | Credits | : 3 |
| Title of the Course | : Microbiology | L-T-P | : 3-0-0 |
| Prerequisite Course | : B.Sc. Biology | | |

***After the completion of this course, the students will be able to***

CLO 1: Explain the historical discoveries made in the field of microbiology and the evolution of microbiology including virology.
CLO 2: Discuss the applications of microorganisms in various fields like agriculture, medicine, industry and health.
CLO 3: Apply the knowledge of techniques for isolation and cultivation (including high-throughput cultivation) of microorganisms (algae, fungi, bacteria and virus).
CLO 4: Explain the diversity of bacteria, classification and identification with knowledge of general characters of various bacterial phyla.
CLO 5: Discuss the insights of cellular composition, function and physiology of bacteria and viruses.
CLO 6: Discuss the virus replication strategies, subgenomic RNAs, virusoids, Viroids and Prions.
CLO7: Explain the differences between cultured, uncultured, yet-to-be cultured and viable-but-not-cultivated microorganisms.
CLO8: Discuss the applications of metagenomics in microbiology and microbiomes.

**Mapping with PLOs**

| | PLO 1 | PLO 2 | PLO 3 | PLO 4 | PLO 5 | PLO 6 | PLO 7 | PLO 8 | PLO 9 | PLO 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **CLO 1** | 3 | | | | | | | | | |
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| **CLO 4** | 3 | | | | | | | | | |
| **CLO 5** | 3 | | | | | | | | | |
| **CLO 6** | 3 | | | | | | | | | |
| **CLO 7** | 3 | | | | | | | | | |
| **CLO 8** | 3 | | | | | | | | | |

## Detailed Syllabus

**Unit 1:** Beginnings of microbiology: Discovery, Evolution of microbiology as a discipline. Importance of microorganisms in environment and industry.

**Unit 2:** Overview of bacterial systematics and taxonomy. Classification of bacteria and general characters of a few bacterial phyla.

**Unit 3:** Nutritional requirements of microorganisms: Nutritional types, Requirements, Design and types of nutrient media. Growth modes, Culture techniques, Microbial growth: Principles, Kinetics and Methods of measuring growth. Batch and continuous growth, Synchronous culture, Diauxic growth. Uptake of nutrients, Transport systems and protein secretion in prokaryotes.

**Unit 4:** Bacterial cell structure and morphology – Nucleoid, Cytoplasm, Cytoplasmic membrane, Cell wall, Capsules, Flagella, Pili, Inclusion bodies, Endospores – structure and the process of sporulation. Structure function relation in bacterial cell – Focus on cell wall and cell membrane (a comparative account with Archaea).

**Unit 5:** Introduction to metagenomics. VBNC and strategies to cultivate the yet-to-be-cultivated bacterial taxa.

**Unit 6:** Bacterial responses to chemical signaling. Microbial locomotion – Flagellar structure and different types of bacterial movement.

**Unit 7:** Overview of Plant-Microbe interactions: Symbiotic nitrogen fixation, Mycorrhizae, Plant pathogens.

**Unit 8:** Physical and chemical control of microorganisms.

**Unit 9:** History/Foundations of virology, Structure and functional Characteristics. Culturing, detection and Purification protocols of viruses. Nomenclature and recent classification. Viroids and prions. Over view of virus Life cycle.

**Unit 10:** Culture collection centers and preservation of microorganisms.

## References


1. Microbiology Edited by Prescott
2. Microbiology Edited by Torfora
3. Microbiology Edited by Peltzar
4. Microbiology Edited by Stanier
5. Biology of Microorganisms Edited by M.T. Medican, J.M. Martiniko and J. Parker

# Department of Animal Biology
# School of Life Sciences
# University of Hyderabad

M.Sc. in Animal Biology and Biotechnology

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|---|---|
| Course Code : AB 403 | Credits: 3 |
| Title of the course : Macromolecular Structure and Function | **L-T-P :** 3-0-0 |
| Prerequisite course : B.Sc. Biology and Chemistry | |

***After completion of this course, the students will be able to—***

CLO 1: Explain the chemical basis of life, properties of biomolecules in water, importance of pH and biomolecular hierarchy

CLO 2: Describe Structure-Function relationships of model proteins

CLO 3: Discuss on basic principles of protein purification and folding; tools to characterize expressed proteins

CLO 4: Explain principles of enzyme catalysis and catalytic strategies with specific examples

CLO 5: Discuss on quantification of enzyme activity and relevance of enzymes in metabolic regulation and discuss on principles of bioenergetics, logic and integration of central metabolism and signaling pathways

CLO 6: Describe about glycobiology and glycomics emphasizing the importance of glycoproteins and glycolipids associated inherited diseases in humans, and role of lectin-carbohydrate interactions in mediating biological processes

CLO 7: Explain about structure and properties of storage and membrane lipids and their inherited human diseases and, self assembly and transport phenomenon

CLO 8: Distinguish between structure and function of nucleic acids and discuss on DNA as the genetic material

**Mapping with PLOs**

| | PLO 1 | PLO 2 | PLO 3 | PLO 4 | PLO 5 | PLO 6 | PLO 7 | PLO 8 | PLO 9 | PLO 10 |
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| **CLO 1** | 3 | | | | | | | | | |
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| **CLO 4** | 3 | | | | | | | | | |
| **CLO 5** | 3 | | 3 | | 3 | | | | | |
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| **CLO 7** | 3 | | | | | | | | | |
| **CLO 8** | 3 | | | | | | | | | |

**Detailed Syllabus**

**Unit 1:**(8 lectures)

Chemical basis of life*:* Miller-Urey experiment, abiotic formation of amino acid oligomers, composition of living matter; Water – properties of water, essential role of water for life on earth pH, buffer, maintenance of blood pH and pH of gastric juice, pH optima of different enzymes (pepsin, trypsin and alkaline phosphatase), ionization and hydrophobicity, emergent properties of biomolecules in water, biomolecular hierarchy, macromolecules, molecular assemblies; Structure-function relationships: amino acids – structure and functional group properties, peptides and covalent structure of proteins, elucidation of primary and higher order structures, Ramachandran plot, evolution of protein structure, protein degradation and introduction to molecular pathways controlling protein degradation, structure-function relationships in model proteins like ribonuclease A, myoglobin, hemoglobin, chymotrypsin etc.; basic principles of protein purification; tools to characterize expressed proteins; Protein folding: Anfinsen's Dogma, Levinthal paradox, cooperativity in protein folding, free energy landscape of protein folding and pathways of protein folding, molten globule state, chaperons, diseases associated with protein folding, introduction to molecular dynamics simulation.

**Unit 2:**(7 lectures)

Enzyme catalysis – general principles of catalysis; quantitation of enzyme activity and efficiency; enzyme characterization and Michaelis-Menten kinetics; relevance of enzymes in metabolic regulation, activation, inhibition and covalent modification; single substrate enzymes; concept of catalytic antibodies; catalytic strategies with specific examples of proteases, carbonic

anhydrases, restriction enzymes and nucleoside monophosphate kinase; regulatory strategies with specific example of hemoglobin; isozymes; role of covalent modification in enzymatic activity; zymogens.

**Unit 3:**(8 lectures)

Carbohydrates and Glycobiology - mono, di, homopolysaccharides and ,heteropolysaccharides; suitability in the context of their different functions – cellular structure and extracellular matrix, energy storage, signaling; Glycoconjugates – proteoglycans, glycoproteins, glycolipids and lipopolysaccaharides; Glycomics - oligosaccharide linkages in glycoproteins, protein glycosylation associated inherited diseases in humans; Carbohydrates as informational molecules – sugar code, Lectins, Lectin-carbohydrate interactions in mediating biologoical processes and their specificity; Lipids - structure and properties of important members of storage and membrane lipids and their inherited human diseases; lipoproteins; lipids as signals, cofactors and pigments .

**Unit 4:**(7lectures)

Self-assembly of lipids, micelle, biomembrane organization - sidedness and function; membrane bound proteins - structure, properties and function; transport phenomena; nucleosides, nucleotides, nucleic acids - structure, a historical perspective leading up to the proposition of DNA double helical structure; difference in RNA and DNA structure and their importance in evolution of DNA as the genetic material.

**Unit 5: (**6 lectures)

Bioenergetics-basic principles; equilibria and concept of free energy; coupled interconnecting reactions in metabolism; oxidation of carbon fuels; recurring motifs in metabolism; elucidation of metabolic pathways; logic and integration of central metabolism; entry/ exit of various biomolecules from central pathways; principles of metabolic regulation; steps for regulation; Introduction to GPCR, Inositol/DAG//PKC and $Ca^{++}$ signaling pathways.

## References


1. LubertStryer, Jeremy Berg, John Tymoczko, Gregory Gatto (2019) Biochemistry, 9th Edition, New York, Freeman.
2. David L Nelson and Michael M. Cox (2017) Lehninger Principles of Biochemistry, 7th edition, NJ, W.H.Freeman
3. Donald Voet, Judith G. Voet (2011) Biochemistry, 4th Edition (International Student Version), John Wiley & Sons (Asia) Pte Ltd.
4. Dobson, C. M. (2003). Protein folding and misfolding. Nature, 426 (6968), 884-890. doi:10.1038/nature02261.
5. Richards, F. M. (1991). The Protein Folding Problem. Scientific American, 264(1), 54-63. doi:10.1038/scientificamerican0191-54.

**Department of Animal Biology**
**School of Life Sciences**
**University of Hyderabad**

M.Sc. in Animal Biology and Biotechnology

| | |
|---|---|
| Course Code : AB 404 | Credits: 3 |
| Title of the course : Molecular Biology-I | **L-T-P :** 3-0-0 |
| Prerequisite course : B.Sc. Biology | |

***After completion of this course, the students will be able to—***

CLO1: Understand the information storage in living systems
CLO2: Discuss the differences in information storage between Prokaryotic and Eukaryotic systems
CLO3: Understand how DNA, the carrier of genetic information replicates. This will be studied in bacteria and viruses followed by eukaryotic systems.
CLO4: Understand how DNA damage can be repaired by the living systems and the mechanisms of this process
CLO5: Understand the structural complexities of genetic storage from DNA to Chromatin and Chromosomes
CLO6: Understand the lateral gene transfer mechanisms in prokaryotes
CLO7: Discuss the molecular basis of lateral gene transfer and its impacts on generation of diversity among prokaryotes
CLO8: Understand the regulation of gene expression

**Mapping with PLOs**

| | PLO 1 | PLO 2 | PLO 3 | PLO 4 | PLO 5 | PLO 6 | PLO 7 | PLO 8 | PLO 9 | PLO 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **CLO 1** | 3 | | | | | | | | | |
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| **CLO 4** | 3 | | | | | | | | | |
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| **CLO 6** | 3 | | | | | | | | | |
| **CLO 7** | 3 | | | | 3 | | | | | |
| **CLO 8** | 3 | | | | 2 | | | | | |

## Detailed Syllabus

1. **Genetic material**: a) Classical experiments - Evidence of DNA as genetic material. RNA viruses – RNA as genetic material. Fine structure of gene – Benzer's classical studies on rII locus.

2. **Organization of genome in prokaryotic and eukaryotic cells.** a) Differences between prokaryotic and eukaryotic gene organization: concept of the operon; split genes in eukaryotes, b) Supercoiling of DNA - general concepts and role of topoisomerases c) Eukaryotic DNA: Chromatin and nucleoid structure-role of histones, denaturation-renaturation kinetics, repetitive DNA, satellite DNA.c) Horizontal gene transfer:Plasmids classification, incompatibility, T4SS, Mechanism of DNA transfer, Mobile Genetic Elements, transposons, insertion elements, Integrative Conjugative Elements, Genomic Islands-Structure and function.

3. **Replication of DNA.** a) Semi-conservative theory of Meselsonand Stahl, b) Semiconservative and discontinuous mechanism of DNA replication – leading, lagging strand, Okazaki fragments**,** c) Prokaryotic replication – origin of replication, enzymatic machinery including the role of topoisomerases, helicases, DNA polymerases, primases, ligases etc, d)Replication of b**a**cterial viruses – detailed s**t**udy of the replication of bacteriophage λ, Φx174, M13 – rolling mechanism of replication, e) Eukaryotic DNA replication – eukaryotic DNA polymerases, replication oflinear DNA – role of telomerases, replication timing, replication factories.

4. **Repair and Recombination.** Crossing over during cell division- breakage and rejoining of intact DNA molecules, Holliday model of homologous recombination – events at the molecular level; role of recA,recBC and chi sequences, Site- specific recombination – eg. bacteriophage λ; FLP/FRT and Cre/Lox recombination.DNA repair – Nucleotide excision repair; Mismatch correction; SOS repair; Photoreactivation.

5. **Prokaryotic Transcription**: a) Transcription unit – start site, upstream promoter regions, terminator; b) Structure and function of RNA polymerases, sigma factors, anti-sigma factors; c) mechanism of transcription-initiation, elongation and termination – Rho-dependant and independent termination d) Promoter polymerase interactions –DNA foot printing techniques e) Promoters-Constitutive and Inducible promoters, other regulatory elements - upstream activating sequences (UAS); anti-termination, f) inhibitors of transcription.

6. **Regulation of gene expression:** Operon concept – inducible and repressible operons. Eg.*lac*, *trp*, *ara*, and *his* operons; global nutrient carbon, nitrogen, phosphate and iron status sensing mechanisms – link to gene expression. Bacterial small RNA (sRNA) and its role in regulation of gene expression. Riboswitch-structure and function.

## References


1. Lewin B. **Genes**. Jones & Bartlett Publishers.
2. Alberts B, Bray D, Lewis J, Raff M, Roberts K, and Watson J.D. **Molecular Biology of the Cell**. Garland Science
3. Watson J.D, Baker T.A, Bell S.P, Gann A, Levine M and Losick R. **Molecular Biology of the Gene**. Benjamin-Cummins Publishing Co., Freifelder D.**Molecular Biology**. Narosa Publishing House

# Department of Animal Biology
# School of Life Sciences
# University of Hyderabad

M.Sc. in Animal Biology and Biotechnology

| | |
|---|---|
| Course Code : AB 405 | Credits: 2 |
| Title of the course : Basics of Evolutionary Biology | **L-T-P** **:** 3-0-0 |
| Prerequisite course: B.Sc. Biology | |

***After completion of this course, the students will be able to—***

CLO1: Compare and contrast the theories that underlie the principles of evolution

CLO2: Understand the basis of variation, speciation and natural selection

CLO 3: Relate how selection pressure produces adaptation, variation, fitness for studying adaptive genetic change

CLO 4: Associate evolution of social behavior to human evolution

CLO5: Comprehend research literature on relevant topics of this course

CLO6: Appreciate the immense application of evolutionary biology to solve scientifically challenging problems

**Mapping with PLOs**

| | **PLO 1** | **PLO 2** | **PLO 3** | **PLO 4** | **PLO 5** | **PLO 6** | **PLO 7** | **PLO 8** | **PLO 9** | **PLO 10** |
|---|---|---|---|---|---|---|---|---|---|---|
| **CLO 1** | 3 | | | | | | | | | |
| **CLO 2** | 3 | | | | | | | | | |
| **CLO 3** | 3 | | | | | | | | | |
| **CLO 4** | 3 | | | | | | | | | |
| **CLO 5** | 3 | | | | 3 | | | | | |
| **CLO 6** | 3 | | | | | | | | | |

## Detailed Syllabus

1. From Darwin to the modern synthesis
2. Proximate and ultimate causation in Biology (Adaptation)
3. Speciation and Species, Tree of Life, Fossil record
4. Speciation and isolation mechanisms
5. Evolution of genomes genome size, genome organization, chromosomes
6. Origin of life
7. Introduction on Phylogenetics
8. Population genetics
9. Genetic Drift and Neutral Evolution and molecular clock
10. Natural selection: Theory and experimental evidence
11. Artificial selection and misconceptions about natural selection
12. Individual vs group selection
13. Micro & Macroevolution
14. Human evolution: Fossil evidence and Darwinial medicine
15. Kinship selection
16. Sexual selection
17. Archeology of genomes

## References


1. Evolution by Burton S. Guttman
2. The meaning of human existence by Edward O. Wilson

**Department of Animal Biology**
**School of Life Sciences**
**University of Hyderabad**
M.Sc. in Animal Biology and Biotechnology

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|---|---|
| Course Code : AB 407 | Credits: 2 |
| Title of the Course : Cell Biology | **L-T-P** **:** 3-0-0 |
| Prerequisite course : B.Sc. Biology | |

***After completion of this course, the students will be able to—***

CLO 1: Understand the evolution and origin of prokaryotes and eukaryotes
CLO 2: Discuss the organization at cellular level that accounts for their distinct functional physiology.
CLO 3: Understand the principle and applications of different research techniques used in cell biology like microscopy, molecular biology and biochemical approaches. Such knowledge will help in design of experimental protocols during their Master's dissertation or for addressing research problems.
CLO 4: Appreciate cell growth, division and how deregulation of cell cycle is detrimental in cancer. The induction will also help them to equate fundamental processes like homologous recombination occurring in meiosis for genome targeting strategies to generate mutants or transgenic organisms.
CLO 5: Appreciate the intrinsic or build in mechanism of programed cell death, the signals and mechanism that lead to their activation under certain physiological conditions.
CLO 6: Discuss the crosstalk between different organelles in exchanging the information and cargo

**Mapping with PLOs**

| | PLO 1 | PLO 2 | PLO 3 | PLO 4 | PLO 5 | PLO 6 | PLO 7 | PLO 8 | PLO 9 | PLO 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **CLO 1** | 3 | | | | | | | | | |
| **CLO 2** | 3 | | 3 | | | | | | | |
| **CLO 3** | 3 | | | | 3 | | | | | |
| **CLO 4** | 3 | | | | | | | | | |
| **CLO 5** | 3 | | | | | | | | | |
| **CLO 6** | 3 | | 3 | | | | | | | |

## Detailed Syllabus

1. Comparison of prokaryotic and eukaryotic cells
2. General methods in cell biology
3. Ultrastructure of plasma membrane
4. Cytoskeletal elements
5. Mitochondria- structure, biogenesis and evolution
6. Mitochondria and male sterility
7. Chloroplast –structure, organization, biogenesis, genome and genetic manipulation
8. Lysosomes- biogenesis, pathophysiology
9. Peroxisomes, glyoxysomes
10. Plant cell wall
11. Cell growth and division (mitosis, meiosis and cell differentiation)
12. Biosynthetic process in ER and Golgi apparatus
13. Vesicular Traffic from ER through Golgi apparatus
14. Trans-Golgi Network, endocytosis and exocytosis
15. Programmed Cell Death

## References


1. Alberts B, Bray D, Lewis J, Raff M, Roberts K, and Watson J.D. Molecular Biology of the Cell. Garland Science.

2. Pollard T.D., Earnshaw W.C, Schwartz J.L. Cell Biology. Elsevier Publishing Co.

**Department of Animal Biology**
**School of Life Sciences**
**University of Hyderabad**

M.Sc. in Animal Biology and Biotechnology

| | |
|---|---|
| Course Code : AB 406 | Credits: 6 |
| Title of the Course : Semester I Lab Practicals | **L-T-P : 0**-0-3 |
| Prerequisite course : B.Sc. Biology | |

***After completion of this course, the students will be able to—***

CLO1: Able to isolate and localize proteins in cells by biochemical and immunological labelling techniques.
CLO2: Perform immunization experiments with recombinant or model antigens and collect anti-sera
CLO3: Prepare solutions and buffers and able to estimate biomolecules
CLO4: Demonstrate chromosome segregation during mitosis and meiosis and perform karyotyping
CLO5: Isolate and identify inactive sex chromosome in females and metaphase chromosomes
CLO6: Isolate and demonstrate the polytene chromosomes from salivary glands of Drosophila
CLO7: Understand the use of various microbial media and sterilization techniques
CLO8: Isolate pure bacterial cultures and differentiate between Gram positive and Gram negative Bacteria. They should be able to perform antibiotic sensitive assays of bacteria and its growth curve Microbiology Techniques

**Mapping with PLOs**

| | **PLO 1** | **PLO 2** | **PLO 3** | **PLO 4** | **PLO 5** | **PLO 6** | **PLO 7** | **PLO 8** | **PLO 9** | **PLO 10** |
|---|---|---|---|---|---|---|---|---|---|---|
| **CLO 1** | 3 | | 3 | 3 | 3 | 3 | | | | |
| **CLO 2** | 3 | | 3 | 3 | 3 | 3 | | | | |
| **CLO 3** | 3 | | | | 3 | | | | | |
| **CLO 4** | 3 | | | | | 3 | | | | |
| **CLO 5** | 3 | | | | 3 | 3 | | | | |
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| **CLO 7** | 3 | | | | 3 | | | | | |
| **CLO 8** | 3 | | 3 | 3 | 3 | | | | | |

**Detailed Syllabus**

## Module 1: Biochemical techniques

1. Introduction to good laboratory practices
2. Solutions and buffers
3. Spectral characterization of macromolecules:
    i. Spectrophotometry: Determination of absorption spectra and extinction – coefficient
    ii. Quantitation of protein and DNA by UV-Visible and Calorimetry
    iii. Hyperchromic effect and Tm determination
    iv. Spectrofluorimetry (demonstration)
4. Separation and Chromatographic techniques:
    i. Dialysis
    ii. Size exclusion,
    iii. Ion exchange
    iv. Affinity
5. Statistical analysis

## Module 2: Genetic methods

1. Barr body localization
2. Mitosis from Onion root tips
3. Meiosis from grasshopper testis
4. Polytene chromosomes: Squash preparation from Drosophilamelanogaster salivary gland
5. Preparation of metaphase chromosomes from cell line
6. Immunofluorescence
7. Florescence In situ hybridization
8. Karyotyping

## Module 3: Microbiological techniques

1. Preparation of culture media and sterilization methods
2. Staining of microorganisms: Gram's staining, Acid fast staining
3. Ubiquitous nature of microorganisms
4. Isolation of pure cultures by streak, spread and pour plate methods
5. Determination of bacterial growth curve
6. Biphasic bacterial growth curve
7. Antibiotic sensitivity testing
8. Biochemical characterization by assaying enzymes like catalase and amylase
9. Phage titration

**Department of Animal Biology**
**School of Life Sciences**
**University of Hyderabad**

M.Sc. in Animal Biology and Biotechnology

| | |
|---|---|
| Course Code : AB 451 | Credits: 3 |
| Title of the Course : Mammalian Physiology | **L-T-P** **:** 3-0-0 |
| Prerequisite course : B.Sc. Biology | |

***After completion of this course, the students will be able to—***

CLO1: Appreciate various physiological organ systems and their importance to integrative functions in animal body
CLO2: Understand the concept of internal environment or homeostasis and body fluid dynamics
CLO3: Integrate the role of hemopoietic stem cells in body defense mechanism and immunogenesis
CLO4: Appreciate the mechanism of ventilation and its implications in cellular respiration
CLO5: Understand the physiology of digestion in mammals in general and how the process differs in ruminants.
CLO6: Link the hormonal and renal regulation of body fluids for maintenance of constant electrolyte balance and medical implications of renal failure
CLO7: Appreciate the organisation of central nervous system and the mechanism of nerve impulse transmission
CLO8: Understand the fundamentals of sensory perception involved in vision, olfaction, hearing, chemo and mechano reception.

**Mapping with PLOs**

| | PLO 1 | PLO 2 | PLO 3 | PLO 4 | PLO 5 | PLO 6 | PLO 7 | PLO 8 | PLO 9 | PLO 10 |
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| **CLO 1** | 3 | | | | | | | | | |
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| **CLO 8** | 3 | | | | | | | | | |

## Detailed Syllabus

### 1. Introduction to Animal Physiology

The various physiological organ-systems and their importance to the integrative functions of the animal body. The concept of homeostasis, including set point, negative and positive feedback loops, and compensatory responses.Body fluid and its dynamics. Transport of through biological membranes. (5 hr)

### 2. Blood and Circulation

Composition of blood, structure & functioning of its constitutes. Blood coagulation and anti-coagulants. Hemoglobin and its polymorphism. Anaemias. Sreticule-endothelial System. Body defense mechanism and immunogenesis. Structure and functions of the cardiovascular system, including the mechanical and electrical properties of cardiac muscle function. Excitation-contraction coupling in cardiac muscle. Reflex regulation of blood pressure. (5 hr)

### 3. Respiration

Structure and functions of the respiratory system, including lung volumes, gas exchange, and gas transport in blood. Regulation of ventilation. Structure and functions of smooth muscle, including excitation-contraction coupling in smooth muscle. Work and exercise physiology (5 hr)

### 4. Digestion

Structure, function and physiology of digestive system. Control of motility and secretion of alimentary canal and reflexes in the control of digestive functions. Control of rumen motility. Digestion in ruminant and monogastric animals. Absorption from rumen and the digestive tract. Manipulation of rumen microflora to enhance fibre digestion and microbial protein synthesis. Nitrogen recycling and rumen bypass mechanisms. Post-ruminal digestion. Physiology of rumen disorders. (6 hr)

### 5. Excretion

Structure and functions of the kidney nephrons, including glomerular filtration, tubular reabsorption, tubular secretion, and excretion. Transport of water, ions, and organic molecular across the tubular epithelia. Hormonal and renal regulation of body fluids and electrolyte balance. Physiology of micturition. Uremia and other renal disorders. (5 hr)

### 6. Muscle Physiology

Muscle types and their intra-cellular contractile mechanisms. Electrophysiology of muscles. Neuromuscular junction. Excitation contraction coupling, its biochemical and ionic mechanisms. Molecular basis of muscle contraction. Rigor mortis. (4 hr)

### 7. Nervous System

Neuron structure and function, Transmission of nerve impulse, Introduction to Central and Peripheral Nervous System. (3 hr)

**8. Sensory Physiology**

Basic principles of sensory physiology. Vision physiology (Photoreception). Hearing physiology. Auditory physiology. Chemoreception and mechanoreception. (3 hr)

## References


1. Schmidt-Nielsen, Animal Physiology, Cambridge University Press.
2. Christopher D. Moyes, Patricia M. Schulte, Principles of Animal Physiology, Pearson Press.
3. Arthur C. Guyton, John E. Hall, Textbook of Medical Physiology, W.B. Saunders Company.
4. General and Comparative Animal Physiology, William S. Hoar (Ed), Prentice Hall, India
5. Animal Physiology, Richard W. Hill, Gordon A. Wyse, Margaret Anderson (Eds), Sinauer Associates, USA

**Department of Animal Biology**
**School of Life Sciences**
**University of Hyderabad**

M.Sc. in Animal Biology and Biotechnology

| | |
|---|---|
| Course Code : AB 452 | Credits: 3 |
| Title of the Course : Developmental Biology | **L-T-P** : 3-0-0 |
| Prerequisite course : B.Sc. Biology | |

***After completion of this course, the students will be able to—***

CLO 1**.** Gives a detailed account of gametogenesis and fusion of their nuclei to achieve the appropriate complement of genetic material necessary for embryonic development.

CLO 2**.** Emphasizes molecular genetic mechanisms that govern the development and differentiation of a wide range of cell types.

CLO 3**.** Details the cellular-physical mechanisms as well as mechanistic approaches that promote spatiotemporal distribution and aggregation of distinct cell types.

CLO 4**.** Provides knowledge as how spatial patterns and axes of embryos are determined.

CLO 6**.** Understand the molecular basis of sex determination and differentiation

CLO 7: Emphasizes as how cells and tissues migrate and interact by distinct mechanisms to produce multiple organs.

CLO 8**.** Describes the mechanisms that are associated with major congenital malformations and developmental defects.

**Mapping with PLOs**

| | PLO 1 | PLO 2 | PLO 3 | PLO 4 | PLO 5 | PLO 6 | PLO 7 | PLO 8 | PLO 9 | PLO 10 |
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**Detailed Syllabus**

1. **Basic concepts of development:** Potency, commitment, specification (autonomous, regulative and syncytial), induction, competence, determination and differentiation, morphogenetic gradients, cell fate and cell lineages, genomic equivalence and the cytoplasmic determinants, imprinting.
2. **Gametogenesis and Fertilization:** Production and structure of gametes, cell surface molecules in sperm egg recognition in animals, acrosome reaction, fast and slow block to polyspermy, zygote formation.
3. **Cleavage and Early embryonic development:** Patterns and molecular mechanism of cleavage, blastula formation, gastrulation patterns, concept and functions of primary organizer, neural induction, differential gene expression during formation of germ layers.
4. **Neurulation:** Formation and differentiation of neural tube, differentiation of neurons, specification and regionalization of neural crest cells and their derivatives.
5. **Morphogenesis and organogenesis in animals:** Axes and pattern formation in Drosophila, amphibia and chick, derivatives of ectoderm, mesoderm and endoderm. Organogenesis- vulva formation in Caenorhabditiselegans; eye lens formation, formation of somite, limb development.
6. **Sex determination:** Chromosomal sex determination- mammals and Drosophila. Environmental sex determination.
7. **Postembryonic development & Aging and senescence:** Amphibian metamorphosis, metamorphosis in insects, regeneration in – flatworms, Hydra, Salamader limbs and mammalian liver. Biology of aging and senescence, Programmed cell death.
8. **Brief overview of:** Development in Health and Disease including birth defects, Development and the Environment (biotic, abiotic, and symbiotic regulation), Development and Evolution (developmental mechanisms of evolutionary change).

**References**


1. Gilbert S.F. Developmental Biology, 10th Edition, Sinauer Associates, Inc., Publishers Sunderland, Massachusetts, USA.
2. Slack J. M. W. Essential Developmental Biology, Wiley-Blackwell.
3. T. Subramonium (2013) Molecular Developmental Biology, ISBN.

**Department of Animal Biology**
**School of Life Sciences**
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M.Sc. in Animal Biology and Biotechnology

| | |
|---|---|
| Course Code : AB 453 | Credits: 3 |
| Title of the course : Enzymology and Metabolic pathways | **L-T-P** **:** 3-0-0 |
| Prerequisite course : B.Sc. Biology/AB403 | |

***After completion of this course, the students will be able to—***

CLO 1: Understand the complexity and regulation of metabolic pathways.

CLO 2: Discuss the cross-talk between different metabolic pathways to achieve cellular homeostasis.

CLO 3: Understand the effect of genetic variations on metabolic output

CLO 4: Understand how different factors affect enzyme Kinetics

CLO 5: Understand how energy is generated from carbohydrates and other functions of carbohydrates

CLO 6: Role of mitochondria in generating energy for biological activity

CLO 7: Explain the principles and catalytic strategies of Enzymes

CLO 8: Apply the basic understanding of enzymology towards assay development

**Mapping with PLOs**

| | PLO 1 | PLO 2 | PLO 3 | PLO 4 | PLO 5 | PLO 6 | PLO 7 | PLO 8 | PLO 9 | PLO 10 |
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## Detailed Syllabus

1. **Enzymes:** nomenclature, structure, isoenzymes, Structure-function relationship. Solubility, denaturation inactivation, stabilization
2. **Enzyme kinetics**: Michaelis-Menten equation, significance of Km, kinetic parameters, substrate co-operativity.
3. **Enzyme catalysis**. Measurement of enzyme activity; Enzyme Units; Specific activity; factors influencing enzyme activity.
4. **Enzyme inhibition** – competitive, non competitive, uncompetitive and irreversible. Regulation of enzyme activity – allosteric and irreversible.
5. **Carbohydrate metabolism:** Glycolysis, TCA cycle, glycogenesis, glycogenolysis, pentose phosphate shunt pathway.
6. **Metabolic pathways and bioenergetics**: electron transport and oxidative phosphorylation.
7. **Amino acid metabolism:** Transamination reaction, oxidative deamination, urea cycle, glucose-alanine cycle. Anabolic reactions involving incorporation of nitrogen into biological systems and amino acid synthesis from metabolic intermediates.
8. **Lipid metabolism:** Oxidation of fatty acids, biosynthesis of fatty acids and cholesterol, oxygenation of PUFAs- COX and LOX pathways.
9. **Nucleic acid metabolism:** De novo synthesis of purine and pyrimidines, salvage pathways.
10. **Anaplerotic reactions**, interaction of metabolic pathways, metabolic flux.
11. **Inherited disorders of metabolism.**
12. **Metabolism of drugs**: Phase I and Phase II detoxification systems.

## References


1. Voet V and Voet J.G. Biochemistry. John Wiley Publishers.
2. Lehninger A.L. Principles of Biochemistry. W.H Freeman and Company.
3. Stryer L. Biochemistry. W.H. Freeman and Company.
4. Biochemistry of Rawn David J., Neil Patterson Publishers
5. Medical Biochemistry by N.V. Bhagavan, Harcourt Academic Press

**Department of Animal Biology**
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M.Sc. in Animal Biology and Biotechnology

| | |
|---|---|
| Course Code : AB 454 | Credits: 4 |
| Title of the course : Molecular Biology-II & Genetic Engineering | **L-T-P :** 3-0-0 |
| Prerequisite course: B.Sc. Biology | |

***After completion of this course, the students will be able to—***

CLO1: Understand how RNA is synthesised in eukaryotic systems and how regulation is effected by various factors

CLO2: Understand how the introns that are seen between the coding sequences are removed to generate an RNA molecule that can be the template for protein synthesis

CLO3: Understand the link between metabolic pathways and gene regulation

CLO4: This will help to understand how we can clone and generate libraries of genes from different organisms and use them to express the gene of interest in different host systems. It also deals with different methods to identify these genes

CLO5: Discuss the transduction of chemical signals to gene expression

CLO6: Enhance the entrepreneurial activities among the students by discussing the impact of rDNA technology

CLO7: To expose the students to industry setting on recombinant protein production by conducting field visits to local biotech industries

CLO8: Learn strategies followed to codon optimise and synthesis of genes required for heterologous expression.

**Mapping with PLOs**

| | PLO 1 | PLO 2 | PLO 3 | PLO 4 | PLO 5 | PLO 6 | PLO 7 | PLO 8 | PLO 9 | PLO 10 |
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| **CLO 1** | 3 | | | | | | | | | |
| **CLO 2** | 3 | | | | | | | | | |
| **CLO 3** | 3 | | | | | | | | | |
| **CLO 4** | 3 | | | | 3 | | | | | |
| **CLO 5** | 3 | | | | | | | | | |
| **CLO 6** | 3 | | | | | | | | 3 | |
| **CLO 7** | 3 | | | | | | | | 3 | |
| **CLO 8** | 3 | | | | 3 | | | | | |

**Detailed Syllabus**

## Part A – MOLECULAR BIOLOGY II

1. **Eukaryotic transcription.** a) RNA polymerases I, II, III - structure and assembly; b) Basal transcription apparatus for the three polymerases with specific promoters and transcription factors, c) Other regulatory elements – enhancers, silencers, response elements, d) Transcriptional factors – general features, motifs - zinc fingers, leucine zippers, helix-turn helix, homeodomains etc; post-transcriptional modification – formation of 5' cap and addition of polyA tail at the 3' end of mRNA.
2. **RNA Splicing**: a) Splicing – mechanism, catalytic role of RNA, b) Group I, II and nuclear introns, nuclear splicing and role of snRNA, tRNA splicing,
3. **Translation:** a) Genetic code – universality and degeneracy, Wobble hypothesis, b) Translational machinery -ribosomes, charging of tRNA molecules and formation of aminoacyl tRNA; mechanism – initiation, elongation and termination, c) post-translational modifications of proteins – glycosylation, amidation, lipidation, processing of pre-proteins etc., d) Transport of proteins and molecular chaperones; protein stability; protein turnover and degradation, e) inhibitors of protein translation
4. **RNA editing, RNA interference** (**RNAi**) – roles of microRNA (miRNA) and small interfering RNA (siRNA) and their applications – functional genomics, medicine, transgenics etc.

## Part B –GENETIC ENGINEERING

1. **Generation of DNA fragments:** a)mechanical shearing, b) digestion by restriction endonucleases - Type I, II and III; use of Type II enzymes in genetic engineering; other enzymes including DNA polymerase I, Klenow enzyme, T4 DNA ligase, Polynucleotide kinase, Alkaline phosphatase etc., c) Polymerase Chain reaction (PCR), d) chemical synthesis of a DNA fragment.
2. **Vectors**: a) Plasmid Vectors:Classical vectors – eg pBR322**;** Commonly used plasmid vectors - eg.pUC, pBlueScript, pGEM vectors; concepts of selectable marker, reporter genes, alpha complementation etc., expression vectors - pMal, GST-based, pET vectors, b) Bacteriophage λ vectors – λgt10, λgt11, λ ZAP and replacement vectors - EMBL c) Phagemids - M13-derived vectors, d) cosmids - Artificial chromosome vectors (YACs; BACs); d) Other viral vectors: SV-40, vaccinia, baculovirus& retroviral vectors**.**
3. **Cloning strategies and introduction of recombinant DNA into hosts:** a)basic concepts of cohesive and blunt end ligation; directional cloning, use of linkers and adaptors, b) T-vectors and cloning of PCR products, c) Introduction of recombinant DNA into suitable hosts -transformation, conjugation, transduction, transfection, particle bombardment techniques

4. **Construction and screening of genomic libraries:** a)Generation of genomic DNA fragments and construction of genomic libraries in λgt11, λ ZAP vectors; isolation of mRNA and generation of cDNA fragments; homopolymer tailing and construction of cDNA libraries, c) Screening: DNA probe-based screening - molecular hybridization techniques: Preparation of nucleic acid probes by nick translation, random primer labeling and end labeling, hybridization techniques for identification of clones with gene of interest, c) Screening by antibody-based methods: induction of protein expression, immunodetection using specific antibodies, radioactive and chemiluminescent methods of detection.
5. **Characterization of cloned genes:** a)Sequencing of DNA- Sanger's enzymatic method and Gilbert's chemical sequencing method; automated DNA sequencing; b) Identification of promoters and regulatory elements – promoter reporter fusions c) Site directed mutagenesis.
6. **Expression of recombinant proteins in E. coli:** Factors influencing the expression of recombinant proteins; purification of recombinant proteins - His-tag, GST-tag, MBP-tag etc.; commercially available E. coli hosts for expression of recombinant proteins,
7. **Alternate expression systems:** Advantages of other systems – post translational modifications in yeast, baculovirus and mammalian systems; examples of commercially available recombinant products, eg insulin, hepatitis B vaccine etc.
8. **Molecular Pharming in plants**: a) Ti plasmids and Agrobacterium-mediated transformation, Ri plasmids, b) Gene transfer methods in plants: direct and indirect DNA transfer. c) examples of recombinant proteins expressed in plant systems.
9. **Gene editing:** Gene editing by Cre-lox system; Zinc Finger Nucleases; TALENs, Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR) gene-editing technology, CRISPR/Cas9; applications of gene editing eg, sickle cell anemia etc.

## References


1. Lewin B. **Genes IX**. Jones & Bartlett Publishers.
2. Alberts B, Bray D, Lewis J, Raff M, Roberts K, and Watson J.D. **Molecular Biology of the Cell.** Garland Science.
3. Watson J. D, Baker T. A, Bell S. P, Gann A, Levine M and Losick R. **Molecular Biology of the Gene**. Benjamin-Cummins Publishing Co.,
4. Freifelder D. **Molecular Biology**. Narosa Publishing House.
5. R.W. Old and S. B.Primrose. **Principles of Gene Manipulation**. Blackwell Science.
6. Sambrook J and Russell D. W. **Molecular Cloning: A laboratory Manual**. Cold Spring Harbor Laboratory Press.

**Department of Animal Biology**
**School of Life Sciences**
**University of Hyderabad**
M.Sc. in Animal Biology and Biotechnology

| | |
|---|---|
| Course Code : AB 455 | Credits: 2 |
| Title of the Course : Human Genetics | **L-T-P** **:** 3-0-0 |
| Prerequisite course : B.Sc. Biology | |

***After completion of this course, the students will be able to—***

CLO1: Understand basic concepts of cytogenetics and human genetics
CLO2: Explain different types of gene mapping and sequencing techniques
CLO3: Understand and explain the mechanism of immune regulation by major histocompatibility complex and also diseases caused by immune dysregulation
CLO4: Understand the application of genetics in drug metabolism
CLO5: Describe the usefulness of genetic screening and genetic counselling to reduce disease burden in a given population
CLO6: Understand the concept of gene therapy and its types as solution for human genetic diseases.

**Mapping with PLOs**

| | PLO 1 | PLO 2 | PLO 3 | PLO 4 | PLO 5 | PLO 6 | PLO 7 | PLO 8 | PLO 9 | PLO 10 |
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| **CLO 1** | 3 | | | | | | | | | |
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| **CLO 8** | 3 | | | | | | | | | |

## Detailed Syllabus

### I. Introduction to Cytogenetics & Human Genetics

History and development of Human cytogenetics–;Morphological variability of the human chromosome and karyotyping; Banded chromosomes and individual characterization of the human chromosomes; Standardization in Human Cytogenetics History of Human Genetics; Pedigrees- gathering family history, pedigree symbols, construction of pedigrees; Monogenic traits - Autosomal inheritance-dominant and recessive; Sex-linked inheritance- dominant and recessive; Sex-limited and sex-influenced traits; Y-linked ; Mitochondrial inheritance

### II Genome sequencing & Mapping

The genome project- history, organization and goals of human genome project; landmarks on chromosomes generated by various mapping methods; BAC libraries and shotgun libraries preparation; Physical maps – cytogenetic map, contig map, restriction map, DNA sequence; DNA sequencing and sequence assembly; mapping strategies, current status of various maps; human genome diversity; Organization of human genome Mitochondrial genome, gross base composition of nuclear genome, gene density. Model organisms and other genome projects; Comparative genomics

### III The HLA complex

structure of classI and II HLA molecules, expression of HLA genes and HLA polymorphism, Immunodeficiency diseases- Agamma- globulinemia, Ataxia telangiectasia, Wiskott- Aldrich syndrome.

### IV Applied Human Genetics

Pharmacogenetics, Ecogenetics, Genetic screening and counseling

Pharmacogenetics and pharmacogenomics, Genes-environment interactions – ecogenetics, personalized medicine, Scope of genetic screening- Prenatal and Post natal screening. Population screening for genetic diseases, family screening. Prenatal screening methods- Amniocentesis- Chronic Villous sampling, Ultrasonography, fetoscopy, maternal blood sampling. Post-natal screening- chromosomal abnormalities, cytogenetic disorders and molecular methods. Scope of genetic counseling- methods of genetic counseling, educating the counselee, presenting the risks and options and guiding. Social, ethical and legal issues. Patterns of inheritance and risk assessment, chromosomal disorders, autosomal dominant and recessive disorders, X-linked disorders, multifactorial-polygenic disorders. Reproductive failures, consanguinity. Gene Therapy- classification of gene therapy- class I, II, and III. Types of gene therapy germline gene therapy and somatic gene therapy.

## References

Human Genetics – F. Vogel and A.G. Motulsky.
Principles of Human Biochemical Genetics by H. Harris
Human Molecular Genetics – Tom Strachan and Andrew Read

**Department of Animal Biology**
**School of Life Sciences**
**University of Hyderabad**
M.Sc. in Animal Biology and Biotechnology

| | |
|---|---|
| Course Code : AB 456 | Credits: 6 |
| Title of the Course: Semester II MSc Lab Practical | **L-T-P : 0**-0-3 |
| Prerequisite course: B.Sc. Biology | |

***After completion of this course, the students will be able to—***

*CLO1*: Understand various cell lysis and sub fractionation techniques of cells
CLO2: Able to perform and compare the differences between various cell lysis techniques
*CLO3*: Able to isolate different subcellular organelles
CLO4: To be able to isolate proteins and enzymes from crude lysates using classic biochemical and chromatography techniques
*CLO5*: To purify the enzymes and develop assays to monitor the effect of various factors on enzyme activities
CLO6:Able to perform diagnostics tests like ELISA and Western blotting
CLO7: Understand the basic principles of FACS and its applications in cell biology

**Mapping with PLOs**

| | **PLO 1** | **PLO 2** | **PLO 3** | **PLO 4** | **PLO 5** | **PLO 6** | **PLO 7** | **PLO 8** | **PLO 9** | **PLO 10** |
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| **CLO 6** | 3 | | | | 2 | | | | | |
| **CLO 7** | 3 | | | | | | | | | |

**Detailed Syllabus**

## Module 4: Isolation of organelles and macromolecules

1. Cell disruption techniques - Sonication, Homogenization and French press
2. Differential centrifugation for preparation of cellular fractions
3. Density gradient centrifugation for isolation of organelles
4. Isolation of macromolecules – DNA, proteins and lipids using liver tissue
5. Protein precipitation- Ammonium sulphate and TCA

## Module 5: Protein purification and analysis

1. Chromatographic separation techniques
    a. Gel permeation chromatography
    b. Ion exchange chromatography - DEAE and CM cellulose
    c. Affinity based-Ni and GST
    d. HPLC
2. Enzyme kinetics
3. Analytical techniques
    1) Electrophoretic separation of protein by SDS-PAGE
    2) Detection of glycoproteins
    3) Western blotting
    4) Analysis of total proteome by 2D electrophoresis (demonstration)
    5) MALDI-TOF, Q-TOF(demonstration)

## Module 6: Immunological methods

1. Raising of polyclonal antibodies (demonstration)
2. Purification of antibodies
3. Double immunodiffussion and radial immunoduffusion
4. ELISA.
5. Flow-cytometry (demonstration)
6. Phagocytic activity of macrophages

# Department of Animal Biology
# School of Life Sciences
# University of Hyderabad

M.Sc. in Animal Biology and Biotechnology

| | |
|---|---|
| Course Code : AB 501 | Credits: 3 |
| Title of the course : Endocrinology and Reproductive Biology | **L-T-P** **:** 3-0-0 |
| Prerequisite course: B.Sc. Biology | |

***After completion of this course, the students will be able to—***

CLO1: Explain basic concepts in endocrinology and reproductive biology

CLO2: Describe the function of endocrine glands

CLO3: Understand the molecular mechanism of hormone action including the non-genomic action

CLO4: Decipher the mechanism of sex determination and sexual development

CLO5: Explain the structure and function of male reproductive system

CLO6: Explain the structure and function of female reproductive system

CLO7: Understating contraceptive methods for male and females to control population

CLO8: Deliver application knowledge to understand assisted reproductive technology

**Mapping with PLOs**

| | **PLO 1** | **PLO 2** | **PLO 3** | **PLO 4** | **PLO 5** | **PLO 6** | **PLO 7** | **PLO 8** | **PLO 9** | **PLO 10** |
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| **CLO 7** | 3 | | | | | | | | | |
| **CLO 8** | 3 | | 3 | 3 | 3 | | | | | |

## Detailed Syllabus

1. Basic concepts: Important discoveries in endocrinology, Hypothalamo- Hypophyseal axis, Pituitary hormones and function.(4hr)
2. Endocrine glands - Adrenal, Thyroid, Parathyroid, Thymus.(3hr)
3. Mechanism of hormone action: Protein, steroid and thyroid hormones.(3hr)
4. Gonadal development: Sex determination and differentiation. Hormonal regulation of reproduction and puberty.(4hr)
5. Structure and function of male reproductive system: Testis: Leydig and Sertoli cells, Epididymis and accessory reproductive glands, hormonal regulation of spermatogenesis and spermiogenesis, biochemistry of semen,Y specific probes, Assessment of sperm functions, inhibin and androgen binding proteins, capacitation of spermatozoa.(8hr)
6. Structure and function of female reproductive system: Ovary, influence of hormones on development of ovarian follicles and oogenesis; reproductive cycles: estrous and menstrual cycle; ovulation, atresia and corpus luteum formation; pregnancy and lactation; implantation and placentation.(8hr)
7. Contraception in males and females: Hormonal and chemical; recent advances in contraception research,immunological methods in contraception.(4hr)
8. Artificial insemination techniques and their development: Assisted reproductive Technology, Superovulation and Intra-cytoplasmic Sperm Injection ICSI.(2hr)

## References


1. Wilson J.D. Text Book of Endocrinology. Saunders Publishers.
2. Schatten H and ConstanitinescuG.M.Comparative Reproductive Biology. Blackwell Publishers, UK
3. Bolander F F, Molecular Endocrinology, Elsevier.
4. Stephen Nussey and Saffron Whitehead. Endocinology- An Integrated Approach, Oxford: BIOS Scientific Publishers.
5. Kenneth S. Polonsky, P. Reed Larsen, Henry M. Kronenberg. Williams Textbook of Endocrinology, Elsevier.
6. R.G. Edwards, Human Reproduction, Oxford Univ. PressG. Litwack, Biochemical actions of Hormones, Academic press

**Department of Animal Biology**
**School of Life Sciences**
**University of Hyderabad**

M.Sc. in Animal Biology and Biotechnology

| | |
|---|---|
| Course Code : AB 502 | Credits: 3 |
| Title of the course : Stem Cell Biology | **L-T-P : 3-0-0** |
| Prerequisite course: B.Sc. Biology | |

***After completion of this course, the students will be able to—***

CLO1: Explain basic concepts in stem cell biology and cell differentiation

CLO2: To understand the differences among various somatic and germ cells

CLO3: Understand the molecular mechanism of stem cell maintenance and differentiation

CLO4: Decipher the methods of generation of stem cells from adult cells and their uses in regenerative medicine

CLO5: Explain how one can manipulate the genome in stem cells for understanding the gene function

CLO6: Explain methods to characterize and purify stem cell from an organism

CLO7: Understating of tissues and their engineering towards creation of organs outside the organismal body

CLO8: Descries the various epigenomic methods that were used to understand the mechanism of stem cell maintenance and differentiation

**Mapping with PLOs**

| | PLO 1 | PLO 2 | PLO 3 | PLO 4 | PLO 5 | PLO 6 | PLO 7 | PLO 8 | PLO 9 | PLO 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **CLO 1** | 3 | | | | | | | | | |
| **CLO 2** | 3 | | | | | | | | | |
| **CLO 3** | 3 | | | | | | | | | |
| **CLO 4** | 3 | | | | 3 | | | | | |
| **CLO 5** | 3 | | | | 3 | | | | | |
| **CLO 6** | 3 | | | | 3 | | | | | |
| **CLO 7** | 3 | | | | | | | | | |
| **CLO 8** | 3 | | | | 3 | | | | | |

## Detailed Syllabus

1. **Introduction:** Cellular potency, lineage commitment, cellular development, differentiation, dedifferentiation & trans differentiation, Cell cycle control, Immortal DNA strand hypothesis, Asymmetric cell division, telomerases in relevance to stem cell development and differentiation. (5 hrs)
2. **Somatic and Germ cell derived stem cells:** Germline stem cells and germ line-derived pluripotent cells, Stem cell niche, epithelial stem cells, mesenchymal stem cells, neural stem cells, haematopoitic stem cells, cardiac stem cells, Cancer stem cells, Markers, molecular and evolutionary mechanisms addressing origin and maintenance of cancer stem cells. (5hrs)
3. **Regulatory mechanisms in Embryonic and adult stem cells**: Core regulatory circuitry, DNA methylation, histone modifications, histone modifiers, chromatin remodelers, RNA PolII code, post transcriptional control of gene expression in ESC: role of miRNAs, LincRNAs and RNA binding proteins. Spatial organization of genome during ESC development and differentiation. (6hrs)
4. **Stem cell therapies:** Generation of induced pluripotent cells, and molecular mechanism of iPSCs reprogramming. Direct differentiation. (4 hrs)
5. **Stem cell technologies:** Generation of chimeric animals and animal cloning; Pro-nuclear injection of blastocysts, transplantation of blastocystes into pseudo-pregnant mice and generation of chimeric and knockout animals. Potential application of transgenic animals: Reprogramming of the nuclei and generation cloned animals. Gene editing technologies - TALEN, CRISPR Cas9. (6hrs)
6. **Stem cell and progenitor cell assays:** Purification of tissue specific stem cells and transplantations. Hematopoietic progenitor cell analyses such as flow cytometry, dynabeads, colony forming assays and *in vitro* differentiation assays of lymphoid (B and T), myeloid lineages and other tissue lineages. (6hrs)
7. **Tissue engineering:** Soft tissue engineering (Breast and Urinary bladder), Hard tissue engineering (Bone and cartilage), Complex tissue engineering (Cardio vascular system and muscular joints). 6hrs)
8. **Methods & Bioinformatics resources related to Stem cells:** Next generation sequencing; DNA-seq, RNA-seq, ChIP-seq etc. Utility of genome browsers (UCSC), ENCODE &stemformatics. (4hrs)

### Suggested reading:


1. Lanza R, Gaerhart J, Hogan B, Melton R, Thomas D, Thomas J, and Wilmut S. Essentials of Stem Cell Biology. Elsevier Inc.
2. Stillman B, Stewart D and Grodzicker T, Control and Regulation of Stem Cells.
3. TursenKursad, Stem Cell Biology and Regenerative Medicine, Humana Press.

**Department of Animal Biology**
**School of Life Sciences**
**University of Hyderabad**

M.Sc. in Animal Biology and Biotechnology

| | |
|---|---|
| Course Code: AB 503 | Credits: 3 |
| Title of the Course: Immunobiology | **L-T-P** **:** 3-0-0 |
| Prerequisite course: B.Sc. Biology | |

***After completion of this course, the students will be able to—***

CLO 1: Understand the molecular mechanisms of immune recognition and effector responses against pathogens

CLO 2: Appreciate the effector mechanism that execute the innate immune response

CLO 3: Understand the activation of lymphocytes, mechanisms of humoral and cell mediated immunity and immunological memory

CLO 4: Comprehend the knowledge pertaining to autoimmunity, allergy, hyper sensitivity

CLO 5: Appreciate different aspects of cancer immunology like tumor cell recognition,.

CLO 6: Discuss the evolution of immune mechanisms and strategies

CLO 7: Discuss anti-tumor immunity and novel approaches of delivering immune therapeutics into tumor cells

CLO 8: Understand the basics of transplantation

**Mapping with PLOs**

| | **PLO 1** | **PLO 2** | **PLO 3** | **PLO 4** | **PLO 5** | **PLO 6** | **PLO 7** | **PLO 8** | **PLO 9** | **PLO 10** |
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| **CLO 1** | 3 | | | | | | | | | |
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| **CLO 7** | 3 | | | | | | | | | |
| **CLO 8** | 3 | | | | | | | | | |

## Detailed Syllabus

1. **Cell, molecular and developmental biology of immune system:** Evolution of the immune system, development and survival of immune cells. molecular mechanisms of immune recognitions, and effector responses against pathogens

2. **Molecular components of Immune system:** Structure, function and generation of antigen receptors, regulation of immune responses, signal transduction, autoimmunity, tolerance.

3. **Innate immune system:** The effector mechanisms of innate immune system, pattern recognition, complement system, antimicrobial peptides, cytokine products in response to viral, bacterial and parasitic pathogens and antigen processing, and presentation.

4. **Adaptive immune system:** Antigen recognition, lymphocyte activation, humoral and cell mediated immunity, immunological memory, physiological and pathological aspects of inflammation.

5. **Immune Dysfunction:** Autoimmunity, immunodeficiency, allergy, hypersensitivity, alloantigens and transplantation rejections.

6. **Cancer immunology:** Tumor cell recognition, Mechanic insights of anti-tumor immunity, immunosuppressive mechanisms, inhibitory receptors, cancer vaccines, and new approaches for delivery of immunotherapies into tumors.

## References:

Goldsby RA, Kindt TK, Osborne BA and Kuby J. Immunology, 7th Edition, W.H. Freeman and Company.

Janeway CA, Travers P, Walport M, and Shlomchik M. Immunobiology, 8th Edition, Garland Publishing.

**Department of Animal Biology**
**School of Life Sciences**
**University of Hyderabad**
M.Sc. in Animal Biology and Biotechnology

| | |
|---|---|
| Course Code : AB 504 | Credits: 2 |
| Title of the Course : Transgenic Technology | **L-T-P** **:** 3-0-0 |
| Prerequisite course : B.Sc. Biology | |

***After completion of this course, the students will be able to—***

CLO1: Explain basic concepts in animal transgenesis
CLO2: Describe the generation of vectors for transgenesis
CLO3: Understand the molecular methodology to confirm altered gene expression
CLO4: Grasp on latest developments in gene editing in animals
CLO5: Explain the pros and cons of transgenesis
CLO6: Virtually plan protocol for embryonic stem cell mediated transgenesis

**Mapping with PLOs**

| | PLO 1 | PLO 2 | PLO 3 | PLO 4 | PLO 5 | PLO 6 | PLO 7 | PLO 8 | PLO 9 | PLO 10 |
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| **CLO 3** | 3 | | | | | | | | | |
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| **CLO 6** | 3 | | | | 3 | | | | | |

## Detailed Syllabus

1. An overview of animal transgenic technology.
2. Development of transgenic mice and other animal models: by injection of foreign DNA/gene into zygote; optimization of construct for in vivo expression by GFP and other methods.
3. Promotors, vectors, general and cell specific construct design and validation in transgenesis.
4. Variations in transgenesis: Generation of chimeric, transgenic and knockout mice and other animals and their characterization.
5. Generation of transgenic animals using testicular electroporation, manipulation of spermatogoinial stem cells and CRISPR-Cas9 technology.
6. Potential application of transgenic animals: models for various diseases/disorders, production of peptides and proteins of biopharmaceutical interest (molecular farming), transgenic fishes, transgenic poultry and transgenic insects as bioreactors.

## References

1. Houdebine L.M. Animal Transgenesis and Cloning. Wiley Publishers.

**Department of Animal Biology**
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M.Sc. in Animal Biology and Biotechnology

| | |
|---|---|
| Course Code : AB 521 | Credits: 2 |
| Title of the Course : Oxidative Stress and antioxidants in health and Disease | **L-T-P :** 3-0-0 |
| Prerequisite course : B.Sc. Biology | |

***After completion of this course, the students will be able to—***

CLO1: Explain basic concepts and diversity of Oxygen radicals
CLO2: Understand the mechanism of Lipofuscin formation and lipid peroxidation
CLO3: Explain the mechanism of leukotriene formation and their role in allergy and asthma
CLO4: Explain the mechanism of prostaglandin formation and their role in inflammation and cancer
CLO5: Understand the role of Inflammation in pathogen defense and Oxidative stress in Reproduction and Brain development
CLO6: Describe the role of Oxidative stress in Chronic respiratory disorders like Asthma, Atherosclerosis, Neurodegenerative disorders – stroke, Parkinson's, Alzheimer's, Diabetes, Cancer, Aging

**Mapping with PLOs**

| | PLO 1 | PLO 2 | PLO 3 | PLO 4 | PLO 5 | PLO 6 | PLO 7 | PLO 8 | PLO 9 | PLO 10 |
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| **CLO 6** | 3 | | | | | | | | | |

**Detailed Syllabus**

1. **Chemistry of oxygen**
2. **Free radicals**-Definition, Oxy radicals – types, mechanism of formation, environmental factors in generation of free radicals
3. **Free radicals, oxidative stress and lipid peroxidation**
   - non-enzymatic-lipofusion (age pigments)
   - enzymatic
   - leukotrienes -mediators of allergy, asthma
   - prostaglandins – mediators of inflammation and cancer
4. **Oxidative stress: Role in physiological and pathological processes**
   - Inflammation & pathogen defenses
   - Reproduction, ovulation, fertilization, implantation, parturition
   - Brain development: Differentiation into type I & II neurons
   - Chronic respiratory disorders – asthma
   - Cardiovascular disease- atherosclerosis
   - Neurodegenerative disorders – stroke, Parkinson's, Alzheimer's
   - Diabetes
   - Cancer
   - Aging

**References:**


1. Packer L and Helumt S. Oxidative Stress and Inflammatory Mechanisms in Obesity, Diabetes, and the Metabolic Syndrome. CRC Press.

2. Qureshi A.G and Parvez SH. Oxidative stress and neurodegenerative disorders Elsevier Publishers.

3. Singh. Oxidative Stress Disease and Cancer. World Scientific Publishing.

4. Surh Y.J and Packer L. Oxidative Stress, Inflammation, and Health. CRC Press.

5. Ozbenm T. Free Radicals, Oxidative Stress, and Antioxidants: Pathological and Physiological Significance. Springer Publishers.

**Department of Animal Biology**
**School of Life Sciences**
**University of Hyderabad**

M.Sc. in Animal Biology and Biotechnology

| | |
|---|---|
| Course Code : AB 524 | Credits: 2 |
| Title of the course : Epigenetics and Nuclear Dynamics | **L-T-P : 3-0-0** |
| Prerequisite course : B.Sc. Biology | |

***After completion of this course, the students will be able to—***

CLO1: Explain basic concepts epigenetics, origin and importance in the context of animal development

CLO2: To understand the significance of histone post translational modifications in establishing gene expression status of cells

CLO3: Understand the molecular mechanism of miRNAs and long non coding RNAs in controlling gene expression during animal development

CLO4: Explain the importance and significance of spatial organization of genome

CLO5: Explain how spatial organization of genome has influence in orchestrating cell type specific functions executed by various nuclear proteins in establishing cell type specific gene expression patterns

CLO6: Explain methods to study nuclear structure and function

**Mapping with PLOs**

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| **CLO 6** | 3 | | | | 3 | | | | | |

## Detailed Syllabus

1. **Epigenetic reprogramming, Genomic imprinting**: Nuclear Cloning, Epigenetic Reprogramming, and Cellular Differentiation in Early Mammalian Development, Genomic Imprinting: Germ Line and Early Embryo. (4hrs)
2. **DNA & Histone modifications:** Reading the DNA Methylation Signal, Role of De Novo DNA Methyltransferase, The Rigidity and Plasticity of the Marks, Histone code hypothesis, Histone modifiers. Links between the DNA Replication Machinery and Epigenetic Gene regulation, Non-covalent Modification of Chromatin: chromatin remodelling and accessibility complexes, (4hrs)
3. **Regulatory roles of Noncoding RNA**: miRNAs, LincRNAs, Chromatin RNA interactions. Role of XIST and AIR non-coding RNAs in Mammalian X–Chromosome Inactivation and An Imprinted cis–silencing at Kcnq1 locus respectively. nRNA Interference and Related Mechanisms, eRNAs. (4hrs)
4. **Structural organization cell nucleus:** Electron microscopic studies on nuclear organization. Spatial organization of euchromatin, heterochromatin. Concept of nuclear matrix. Chromosome territories, gene positioning. Fractal geometry of chromatin, Primary, secondary and tertiary structural organization of chromatin, Spatial organization of genes and regulatory elements. (6hrs)
5. **Functional organization of the cell nucleus:** Chromatin movements, Nuclear bodies and its significance: RNA PolII transcription factories, Polycomb silencing bodies, PML bodies, splicing speckles, Cajal bodies and other nuclear domains. Gene clustering and long-range chromatin interactions for transcriptional activation or silencing, Nucleolus, Telomere Clustering. Epigenetic regulation of higher order chromatin structure, chromatin insulators and its role in genome architecture. Gene regulation in 3-dimensions. Thermodynamics of nucleus. Phenomenon of molecular crowding effect (6hrs)
6. **Epigenomic methods and epigenetic perspective of diseases. (4hrs)**

## References


1. Nuclear organization and function: Cold spring harbour symposia on quantitative biology Volume LXXV (2010).Cold Spring Harbor Laboratory Press
2. Allis D et al., Epigenetics: Cold Spring Harbor Laboratory Press,
3. Armstrong L. Epigenetics: Garland Science publishers

# Department of Animal Biology
# School of Life Sciences
# University of Hyderabad

M.Sc. in Animal Biology and Biotechnology

| | |
|---|---|
| Course Code : AB 505 | Credits: 3 |
| Title of the course : Bioinformatics | L-T-P : 3-0-0 |
| Prerequisite course : B.Sc. Biology | |

***After completion of this course, the students will be able to—***

CLO 1: Describe the importance of DNA and protein sequence alignments, methods of alignment and application.
CLO 2: Explain dynamic programing algorithms, methods of scoring.
CLO 3: Describe how to find a best match for a given DNA or protein sequence from the target databases, learn various BLAST variants.
CLO 4: Discuss the methods for alignment of multiple sequences, scoring schemes and become familiar with various MSA tools.
CLO 5: Demonstrate the knowledge of various Biological databases and tools
CLO 6: Describe evolutionary relationships based on sequence comparisons and molecular phylogenetics.
CLO 7: Describe Bioinformatics methods and tools to understand Protein structure.
CLO8: Discuss the application of Bioinformatics tools in Animal Biology research

**Mapping with PLOs**

| | PLO 1 | PLO 2 | PLO 3 | PLO 4 | PLO 5 | PLO 6 | PLO 7 | PLO 8 | PLO 9 | PLO 10 |
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| **CLO 1** | 3 | | | | | | | | | |
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| **CLO 5** | 3 | | | | | | | | | |
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| **CLO 8** | 3 | | | | 3 | | | | | |

**Detailed Syllabus**

1. **Unit I** (8 lectures)
   Bioinformatics basics: Computers in biology and medicine; Importance of Unix and Linux systems and its basic commands; Database concepts; Protein and nucleic acid databases; Structural databases; Biological XML DTD‟s; pattern matching algorithm basics; databases and search tools: biological background for sequence analysis; Identification of protein sequence from DNA sequence; searching of databases similar sequence; NCBI; publicly available tools; resources at EBI; resources on the web; database mining tools.

2. **Unit II** (5 lectures)
   DNA sequence analysis: gene bank sequence database; submitting DNA sequences to databases and database searching; sequence alignment; pairwise alignment techniques; motif discovery and gene prediction; local structural variants of DNA, their relevance in molecular level processes, and their identification; assembly of data from genome sequencing.

3. **Unit III** (7lectures)
   Multiple sequence analysis; multiple sequence alignment; flexible sequence similarity searching with the FASTA3 program package; use of CLUSTAL W and CLUSTAL X for multiple sequence alignment; submitting DNA protein sequence to databases: where and how to submit, SEQUIN, genome centres; submitting aligned set of sequences, updates and internet resources; methods of phylogenetic analysis.

4. **Unit IV** (6 lectures)
   Protein modelling: introduction; side chains and neighbours; fixed regions; hydrogen bonds; mapping properties onto surfaces; fitting monomers; RMS fit of conformers; assigning secondary structures; sequence alignment-methods, evaluation, scoring; protein completion: backbone construction and side chain addition; small peptide methodology; software accessibility; building peptides; protein displays; substructure manipulations, annealing.

5. **Unit V** (10 lectures)
   Protein structure prediction: protein folding and model generation; secondary structure prediction; analyzing secondary structures; protein loop searching; loop generating methods; loop analysis; homology modelling: potential applications, description, methodology, homologous sequence identification; align structures, align model sequence; construction of variable and conserved regions; threading techniques; topology fingerprint approach for prediction; evaluation of alternate models; structure prediction on a mystery sequence; structure aided sequence techniques of structure prediction; structural profiles, alignment algorithms, mutation tables, prediction, validation, sequence based methods of structure prediction, prediction using inverse folding, fold prediction; significance analysis, scoring techniques, sequence-sequence scoring; protein function prediction; Virtual library: Searching Medline, PubMed, current content, science citation index and current awareness services, electronic journals, grants and funding information.

**References:**


1. Lesk, A. M. (2002). Introduction to bioinformatics. Oxford: Oxford University Press.
2. Mount, D. W. (2001). Bioinformatics: Sequence and genome analysis. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
3. Baxevanis, A. D., & Ouellette, B. F. (2001). Bioinformatics: A practical guide to theanalysis of genes and proteins. New York: Wiley-Interscience.
4. Pevsner, J. (2015). Bioinformatics and functional genomics. Hoboken, NJ.: Wiley-Blackwell.
5. Bourne, P. E., & Gu, J. (2009). Structural bioinformatics. Hoboken, NJ: Wiley-Liss.
6. Lesk, A. M. (2004). Introduction to protein science: Architecture, function, and genomics. Oxford: Oxford University Press.

# Department of Animal Biology
# School of Life Sciences
# University of Hyderabad
## Cancer and Cancer Stem Cell Biology (AB 573)

M.Sc. in Animal Biology and Biotechnology

| | |
|---|---|
| Course Code : AB 522 | Credits: 2 |
| Title of the course :Infection Biology | **L-T-P** **:** 3-0-0 |
| Prerequisite course : B.Sc. Biology | |

***After the completion of this course, the students will be able to--***

CLO 1: Comprehend the events associated with establishment of infection and classification of infectious disease

CLO 2: Appreciate the challenges associated with antibiotic resistance

CLO3: Understand the mechanism of host immune responses to viral infections

CLO4: Appreciate the mechanisms of immune evasion exhibited different infectious agents

CLO5: Know the principles involved in different diagnostics test for detection of infectious diseases

CLO6: Discuss the importance and application of diagnostic techniques in immunology.

**Mapping with PLOs**

| | PLO 1 | PLO 2 | PLO 3 | PLO 4 | PLO 5 | PLO 6 | PLO 7 | PLO 8 | PLO 9 | PLO 10 |
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| **CLO 6** | 3 | | | | 3 | | | | 2 | |

## Detailed Syllabus

1. **Overview and introduction to infection biology:** historic perspectives, Kochs hypothesis, General events in establishment of infection, infectious dose, lethal dose, infectious disease epidemiology, nosocomial infections, antisepsis, modes of disinfection/sterilization, modes of disease transmission, specific and non-specific defense responses
2. **Bacteriology**
   a) The fundamental structure of bacteria, especially structures important for pathogenicity and virulence
   b) Basic biology and host-pathogen interactions with reference to important infections due to Gram negative bacteria (pathogenic E. coli, Vibrio cholera, Salmonella, Yersinia pestis), Gram positive bacteria (Staphylococci, Streptococci), tuberculosis, zoonotic diseases: leptospirosis, Helicobacteri pylori and peptic ulcer
   c) Importance of different virulence factors, e g. exotoxins, the endotoxin, secretion systems, the invasiveness, intracellular survival, antigenic variation and other mechanisms to avoid the immune system.
   d) Antibiotics and drug resistance: Principles for mechanisms of antibiotic action, bacteriostatic and bacteriocidal effect. Mechanisms of antibiotics resistance and its importance within the healthcare: MRSA, MDR and XDR in tuberculosis
3. **Virology**
   a) Components and structures of virus particles; classification of viruses; DNA and RNA viruses.
   b) Host immune response to viral infections: Flu, HIV, polio, hepatitis etc
   c) Control measures: diagnosis, anti-viral therapy, vaccines
4. **Parasitic infections**
   a) Malaria, toxoplasmosis, leishmaniasis, trypanosomiasis etc
   b) Immune evasion: adaptation of parasites for survival within the mammalian host.
   c) Mechanism of antigen export and antigen presentation in Plasmodium and Toxoplasma.
   d) Host immune responses to protozoan diseases and model systems to study immune activation during protozoan infections
5. **Diagnostics**: Identification of the infecting bacteria by staining and culture technqiues, immuno assays including ELISA, Western blotting, agglutination etc and molecular techniques using PCR, RT-PCR.

## References


1. Cole ST, Eisenach K.D, McMurray D.N and Jacobs W.R.Tuberculosis and the tubercle bacillus. ASM Press.
2. Hacker J.H and Heesemann J, Molecular infection biology: Interactions between microorganisms and cells. Wiley Blackwell Publishers.
3. Schaible U.E and Haas A, Intracellular Niches of Microbes: A Pathogens Guide Through the Host Cell by Modern Parasitology. Wiley Blackwell Publishers.
4. A textbook of Parasitology by F.E.G. Cox. Wiley Blackwell Publishers.
5. Frank SA, Immunology and Evolution of Infectious Disease.Princeton University Press.
6. J.D Smyth, Introduction to Animal Parasitology.Cambridge University Press.
7. Ahmed N, Dawson N, Smith C and Wood Ed. Biology of Disease. Taylor and Francis Group.
8. Sherman I.W. Malaria Parasite Biology, Pathogenesis and Protection. ASM Press.
9. Ajioka J.W and Soldati D. Toxoplasma Molecular and Cellular Biology. Horizon Bioscience.
10. Pommerville J.C. Alcamo's Fundamentals of Microbiology. Jones and Bartlett Publishers.
11. Salyers A. A and Whitt D.D. Microbiology-Diversity, Disease and Environment. Fitzgerald Sciences Publishers.

# Department of Animal Biology
# School of Life Sciences
# University of Hyderabad
## Cancer and Cancer Stem Cell Biology (AB 573)

M.Sc. in Animal Biology and Biotechnology

| | | | |
|---|---|---|---|
| Course Code | : AB 573 | Credits: 2 | |
| Title of the course | : Cancer and Cancer Stem Cell Biology | **L-T-P** | **:** 3-0-0 |
| Prerequisite course | : B.Sc. Biology | | |

***After the completion of this course, the students will be able to--***

CLO 1: Able to understand the characteristics of cancer cells, various cancer agents and causes and significance and difference of cancer initiation, promotion and progression.

CLO2: Importance of Cell cycle regulation, various events and checkpoints at G1/R phase and mechanisms of important genes (pRB, Cyclin D, E2F) in regulation and their association in different types of cancers.

CLO3: Able to learn significance of Tumor suppressor function, cell death mechanisms and their deregulation (p53, Caspases) in some of the cancers.

CLO4: Significant events in angiogenesis and its role in invasion, metastasis of cancer cells.

CLO5: Role of Tumor antigens, cytokines, vaccine development, immunotherapy and its limitations, Tumor cell evasion of immune defenses.

CLO6: Biology of cancer Stem cells and its role in drug resistance, cancer recurrence.

**Mapping with PLOs**

| | PLO 1 | PLO 2 | PLO 3 | PLO 4 | PLO 5 | PLO 6 | PLO 7 | PLO 8 | PLO 9 | PLO 10 |
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| **CLO 5** | 3 | | | | | | | | | |
| **CLO 6** | 3 | | | | | | | | | |

## Detailed Syllabus

1. **Introduction:** Epidemiology of cancer**,** Cancer types, Characteristics of cancer cells; Carcinogenesis: cancer initiation, promotion and progression, termination. Factors responsible for carcinogenesis: Physical, chemical and biological.
2. **Tumor Development:** Models, Tumor angiogenesis, Overview of invasion and metastasis, Cell-cell interactions in cancer, Invasion and the extracellular matrix, Specific cases of Prostate, Breast, Intestinal cancers
3. **Oncogenes and their role in Cancer:** Introduction to oncogenes, Mechanisms of oncogene activation (gene amplification), Mechanisms of oncogene activation (chromosomal translocations), Chromosomal translocations with dominant negative effects, Introduction to tumor suppressor genes.
4. **Cell-Cycle Regulation and Cancer:** Mutations affecting mitogenic signal transduction pathways, Cell Cycle Regulation - Mutations affecting the cell cycle, Loss of checkpoint control and genetic instability, Replicative senescence
5. **DNA Damage, Repair failure and Carcinogen Mechanisms:** Carcinogens, DNA damage and repair, Carcinogenesis: Chemical and physical agents, Carcinogenesis: Repair mechanisms, Aberrant repair and genetic instability, Genetic predisposition to cancer
6. **Tumor Immunology.** Tumor immunology [tumor antigens, cytokines, vaccine development, immunotherapy and its limitations, Tumor cell evasion of immune defenses.
7. **Biology of Cancer Stem cells:** self-renewing properties, disease prognosis and resistance to therapies
8. **Epigenetics, miRNAs in human cancer**
9. **Principles of chemotherapy and chemoprevention.**

## References


1. Keinsmith L.J. Principles of Cancer Biology. Amazon Publishers.
2. Weinberg R.A. Biology of Cancer. Taylor and Francis Inc.
3. Alberts B, Bray D, Lewis J, Raff M, Roberts K, and Watson J.D. Molecular Biology of the Cell. Garland Science
4. Ruddon R.W. Cancer Biology: 4th Edition. Oxford University Press

**Department of Animal Biology**
**School of Life Sciences**
**University of Hyderabad**

M.Sc. in Animal Biology and Biotechnology

| | |
|---|---|
| Course Code : AB 506 | Credits: 6 |
| Title of the Course: Semester III MSc Lab Practical | **L-T-P** **:** 0-0-3 |
| Prerequisite course: B.Sc. Biology | |

***After completion of this course, the students will be able to—***

CLO1: Down load genomic sequences, design primers and clone a gene
CLO2: Produce recombinant protein using E. coli expression system
CLO3: Able to perform tissue fixation, paraffin embedding and sectioning
CLO4: Able to perform Hematoxylin-eosin staining
CLO5: Should be able to perform Light microscopy
CLO6: Can perform Antibody staining and Immunoflourescence
CLO7: Should be able to culture the mammalian cell lines
CLO8: Perform cell viability and proliferation assays
CLO9: Able to use gene manipulation methods in mammalian cell culture systems

**Mapping with PLOs**

| | **PLO 1** | **PLO 2** | **PLO 3** | **PLO 4** | **PLO 5** | **PLO 6** | **PLO 7** | **PLO 8** | **PLO 9** | **PLO 10** |
|---|---|---|---|---|---|---|---|---|---|---|
| **CLO 1** | 3 | | | | 3 | | | | | |
| **CLO 2** | 3 | | | | 3 | | | | | |
| **CLO 3** | 3 | | | | 3 | | | | | |
| **CLO 4** | 3 | | | | | | | | | |
| **CLO 5** | 3 | | | | | | | | | |
| **CLO 6** | 3 | | 2 | | 3 | | | | | |
| **CLO 7** | 3 | | | | 3 | | | | | |
| **CLO 8** | 3 | | | | 3 | | | | | |
| **CLO 9** | 3 | | | | 2 | | | | | |

**Detailed Syllabus**

## Module 7: Histological techniques

1. Histology
    i. Tissue fixation, paraffin embedding and sectioning.
    ii. Hematoxylin-eosin staining
    iii. Light microscopy and microphotography (demonstration)
2. Immunocytochemistry
    i. Antibody staining and chromogen detection.
    ii. Immunoflourescence
3. In situ hybridization (demonstration)

## Module 8: Genetic Engineering and Bioinformatics

1. Isolation of Genomic DNA from bacteria.
2. Plasmid DNA isolation and Cloning
3. Bacterial transformation and screening of recombinants
4. Genomic PCR and Restriction mapping
5. Southern / Northern hybridization (non-radioactive)
6. Isolation of total RNA, RT-PCR, Realtime PCR and microarray (demonstration)
7. Expression and purification of recombinant proteins in E. coli
8. Public domain databases: overview and retrieving of gene sequences
9. BLAST analysis of DNA and protein sequences
10. Analysis of genes: restriction sites, translation of DNA sequence etc
11. Primer designing
12. In silico prediction: signal peptide, transmembrane domains, nuclear export and import signals, mitochondria targeting signals, DNA binding domains, post translational modifications on proteins like phosphorylation and glycosylation

## Module 9: Mammalian Cell Culture

1. Preparation of culture media
2. Establishment of primary cell culture: mouse splenocyte culture
3. Handling mammalian cell lines: thawing, culture maintenance and cryopreservation
4. Cell counting using hemocytometer
5. Cell viability and proliferation assays:
    i. Trypan blue exclusion test
    ii. MTT assay
    iii. Propidium Iodide staining
    iv. CFSC labeling
6. Mammalian cell transfection (transient)
7. Immunofluorescence detection to check transfection efficiency (using fluorescence and confocal microscopes)

**References**


1. Holme D.J and Peck H. Analytical Biochemistry. Longman Scientific and technical Publishers.
2. Plummer D.T. An Introduction to Practical Biochemistry. Tata McGraw-Hill Publishing Company Limited.
3. Sambrook J and Russell D.W. Molecular Cloning, volumes 1,2 and 3 . Cold Spring Harbor Lab Press.
4. Wilson K and Walker J. Principles and techniques of Biochemistry and Molecular Biology. Cambridge University Press.
5. Harlow E and Lane D. Antibodies: A Laboratory Manual. Cold Spring Harbor Lab Press.

# Department of Animal Biology
# School of Life Sciences
# University of Hyderabad
## Cancer and Cancer Stem Cell Biology (AB 573)

M.Sc. in Animal Biology and Biotechnology

| | |
|---|---|
| Course Code : AB 551 | Credits: 12 |
| Title of the course : Project work + Seminar | **L-T-P** **:** 0-0-3 |
| Prerequisite course : B.Sc. Biology | |

***After the completion of this course, the students will be able to--***

CLO 1: Able to conduct the experiments in the designated laboratory

CLO2: Understand the research theme and finding their own topic

CLO3: Performing research systematically with established/new methodologies

CLO4: Able to analyze research data to draw valid conclusions

CLO5: Able to develop communication skills

CLO6: Develop scientific writing skills

**Mapping with PLOs**

| | PLO 1 | PLO 2 | PLO 3 | PLO 4 | PLO 5 | PLO 6 | PLO 7 | PLO 8 | PLO 9 | PLO 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **CLO 1** | 3 | | 3 | 3 | 3 | | | 3 | | |
| **CLO 2** | 3 | | 3 | 3 | 3 | | | 3 | | |
| **CLO 3** | 3 | | 3 | 3 | 3 | | | 3 | | |
| **CLO 4** | 3 | | 3 | 3 | 3 | | | 3 | | 2 |
| **CLO 5** | 3 | | 3 | 3 | 3 | | | 3 | 3 | 3 |
| **CLO 6** | 3 | | 3 | 3 | 3 | | | 3 | 3 | 3 |