Faculty of Life Sciences

JSS ACADEMY OF HIGHER EDUCATION & RESEARCH
(DEEMED TO BE UNIVERSITY) MYSURU

JSS Academy of Higher Education & Research

(Deemed to be University)

Re-Accredited "A+" Grade by NAAC

Sri Shivarathreeshwara Nagara Mysuru - 570015, Karnataka

Syllabus

M.Sc. MOLECULAR BIOLOGY

As per UGC's Learning Outcome Based Curriculum Framework (LOCF) under the CBCS pattern

Implementation Year 2021-22 onwards

MSc

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M.Sc. MOLECULAR BIOLOGY

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M.Sc. MOLECULAR BIOLOGY

Foreword

Molecular biology is the study of biology at a molecular level. It is the study of molecular underpinnings of the process of replication, transcription, and translation of the genetic material. The field overlaps with other areas of biology and chemistry, particularly genetics and biochemistry. The field is primarily concerned with understanding the interactions between various cell systems, such as the interrelationship of DNA, RNA, and protein synthesis, and learning how these interactions are regulated. Given the increasing demand for training manpower in Molecular Biology, Genetics, Medicine and Biotechnology, it was the consensus of the committee (Faculties & experts) that this course should be broad-based and should be able to give a good insight into modern biology and important component of hands-on training to the students. Thus, by nature, it will be an interdisciplinary course.

All the subjects included in the syllabus are at an advanced level. The course aims to provide students with in-depth knowledge of molecular biology as well as practical experience with current techniques in molecular research, molecular diagnostics, health care, and industry. Teaching is imparted in the form of lectures, seminars, demonstrations, web-based exercises, experimental and theoretical sessions as well as assignments, project work, site visits and symposia. The entire course deals with the basic core molecular biology knowledge sharing, instruments, and practical aspects, which might be very useful to carryout, various studies in molecular biology, immunology, molecular medicine, cancer biology, Stem cells, tissue engineering and regenerative medicine, radiobiology, genomics & proteomics. An emphasis is also laid on the Medical Genetics & Rare Diseases in the course which is highly relevant to understanding molecular disease mechanism, and its relation to drug designing. In the final year, a paper on molecular and cellular radiobiology is introduced to provide students with in-depth molecular details on how radiations can help combat-related human disorders and their hazardous reactions.

The students are required to submit a dissertation thesis in the last semester on any of the topics related to the molecular biology area. The aim is to provide students with experience in research design, data analysis and interpretation. The development of critical thinking processes and proficiency in scientific reading and writing will be emphasized throughout the course.

Course Overview

Programme Objectives

The study of molecular and cellular phenomena in biological systems, molecular aspects of human diseases, the human body's response to diseases, response heterogeneity and personalised medicine, stem cells, immune response, and genetic determinants are all examples of molecular medicine.

The course covers the application of molecular understanding in disease prevention, drug development, diagnosis, and therapy discovery research.

One of the course's distinguishing features is its emphasis on an interdisciplinary approach in which medical sciences, molecular and biochemical aspects of biology are addressed. All students will be required to complete a one-year thesis research project that will give them hands-on experience with molecular biology techniques, cell culture, biochemical techniques, and genetic analysis.

Molecular medicine is concerned with the molecular aspects of human diseases, as well as how the human body responds to drugs/personalized medicine, stem cells, immune therapy, and genetic determinants. The course thus aims to train students in molecular and cellular understanding of biochemical mechanisms involved in disease contexts to develop diagnostics or therapeutics and to prepare them to work in academia or industry and serve the community.

Programme Outcomes (PO)

Each graduate will be able to:-

- Acquire a strong molecular understanding of the various diseases we face and how, at the molecular level, one could deal with the issues to develop diagnostics and therapeutics for the betterment of healthcare.

- Students should be able to design strategies for addressing biotechnology development issues using the molecular techniques they have learned.

- Facilitate the student with skills that will enable them to take on transnationally oriented projects that will benefit society.

- Students have a wide option of choosing different medically oriented careers.

- Empower them to approach research with confidence as a result of hands-on training in various techniques and manuscript writing for publication.

- Students learn how to present their work in any forum to better project their work and biotechnology skills.

- As they become more familiar with the translational aspects of medicine, they are better prepared to launch innovative start-ups and become entrepreneurs.

PROGRAMME SPECIFIC OUTCOMES (PSO)

PSO1: Postgraduate students will be able to demonstrate and apply their knowledge of cell biology, biochemistry, microbiology, genetics, and molecular biology to solve Molecular Biology problems.

PSO2: Postgraduate students will be able to demonstrate and apply molecular biology principles in the design, analysis, optimization, and simulation of biological operations.

PSO3: Students will be able to gain fundamental knowledge in animal and plant biotechnology and its applications.

PSO4: Students will be equipped to understand three fundamental aspects of the biological phenomenon: a) what to seek; b) how to seek; c) why to seek?

PSO5: Students will be able to (a) Describe fundamental molecular principles of genetics; (b) Understand the relationship between phenotype and genotype in human genetic traits; (c) Describe the basics of genetic mapping; (d) Understand how gene expression is regulated.

PSO6: Students will be able to (a) elaborate concepts of molecular biology, genetics and biochemistry with easy to run experiments; (b) familiarize themselves with basic laboratory instruments and understand the principle of measurements using those instruments with experiments in biochemistry.

PSO7: Students will be able to comprehend various aspects of molecular procedures as well as the fundamentals of genomics, proteomics, and metabolomics that could be used in the early diagnosis and prognosis of human diseases.

PSO8: Graduates are capable of incorporating molecular biology-based ideas and strategies into their daily activities to benefit the environment and society.

PSO9: Graduates demonstrate entrepreneurial skills while integrating biomolecules management, intellectual property rights, and other domains.

PSO10: Basic principles of radiation, x-ray generators, particle accelerators and gained knowledge in various ionizing and non-ionizing radiations used in radiotherapy.

PSO-11:Students will be able to gain hands-on experience in gene cloning, protein expression and purification. This experience would enable them to begin a career in an industry that engages in genetic engineering as well as in research laboratories conducting fundamental research.

Eligibility:

Any undergraduate Science Degree recognized by UGC with Biology as one of the subjects.

M.Sc. MOLECULAR BIOLOGY

Semester I								
Sl. NO.	Study components and code	Title of the paper	Hours of Instruction / week	Examination				Credit
				Duration in Hours	CIA	Theory/ Practical Exam	Max. Marks	
1	DSC 01	Fundamentals of Biochemistry	4	3	30	70	100	4
2	DSC 02	Fundamentals of Molecular Biology	4	3	30	70	100	4
3	DSC 03	Fundamentals of Genetics and Evolution	4	3	30	70	100	4
4	AECC	Principles of Statistics	2	2	-	50	50	2
5	SEC 01	Biological Techniques	2	2	-	50	50	2
6	Practical 01	Basic Techniques in Genetics	4	3	15	35	50	2
7	Practical 02	Biochemical & Molecular Techniques	4	3	15	35	50	2
		Total Marks and Credits					**500**	**20**

Semester II								
Sl NO.	Study components and code	Title of the paper	Hours of Instruction / week	Examination				Credit
				Duration in Hours	CIA	Theory/ Practical Exam	Max. Marks	
1	DSC 04	Molecular Developmental Biology	4	3	30	70	100	4
2	DSC 05	Molecular Cell Signaling and Cellular receptors	4	3	30	70	100	4
3	DSC 06	Gene Manipulation	4	3	30	70	100	4
4	DSE 01a **Or** DSE 01b	Advances in Molecular Biology **(or)** Immunology & Vaccine development	4	3	30	70	100	4
5	DSE 02a **Or** DSE 02b	Tissue Engineering & Regenerative Medicine **(or)** IPR, Bioethics & Biosafety	4	3	30	70	100	4
6	SEC 02	Cell and Tissue culture Techniques	2	2	-	50	50	2
7	Practical 03	Immunology & Developmental Biology	4	3	15	35	50	2
8	Practical 04	Cell and tissue culture Techniques & IPR, Biosafety	4	3	15	35	50	2
		Total Marks and Credits					**650**	**26**

Semester III								
Sl NO.	Study components and code	Title of the paper	Hours of Instruction / week	Examination				Credit
				Duration in Hours	CIA	Theory/ Practical Exam	Max. Marks	
1	DSC 07	Cancer and Stem Cell Biology	4	3	30	70	100	4
2	DSC 08	Medical Genetics & Rare diseases	4	3	30	70	100	4
3	DSC 09	Concepts of Radiobiology	4	3	30	70	100	4
4	DSE 03a **Or** DSE 03b	Sequence Analysis & Pharmacogenomics **(Or)** Applications of Genomics & Proteomics	4	3	30	70	100	4
5	SEC 03	Research Design and Methodology	2	2	-	50	50	2
6	Practical 05	Applications of Genomics & Proteomics	4	3	15	35	50	2
7	Practical 06	Advanced Molecular Techniques	4	3	15	35	50	2
8		Internship	-	-	-	-	50	2
		Total Marks and Credits					**600**	**24**
	SEMESTER IV							
	Project						**300**	**12**
	Total (Semester I to IV)						**2050**	**82**

Abbreviations:

DSC – Discipline Specific Core.

DSE – Discipline Specific Elective.

AECC – Ability Enhancement Compulsory Course.

SEC – Skill Enhancement Course.

Students may choose any one elective course among the offered choices, specific to the discipline

Semester One

SEMESTER ONE

No. of Hours / Week	Credits
4	4

DSC 01- FUNDAMENTALS OF BIOCHEMISTRY

Course Objectives:

The course aims to highlight the role of biomolecules in the structure and function of life.It spans over the significance and methodology involved in characterizing major biomolecules.

Course Outcomes:

After successful completion of the course, students will be able to:

CO-1. Students will be exposed to the history of Biochemistry and the key contributions of scientists.

CO-2. They will study the properties of carbohydrates, proteins, lipids, cholesterol, DNA, RNA, glycoproteins and glycolipids and their importance in biological systems.

Co-3. They will understand the process of fermentation and manufacture of Biodiesel. They will understand the methods of determination of amino acid and nucleotide sequence of proteins and DNA respectively.

Unit 1:

Carbohydrates: Monosaccharides: Configuration and conformation of monosaccharides, Reducing and optical properties of sugars, Derived monosaccharides; Amino sugars. Disaccharides: Stability of glycosidic bond. Polysaccharides: Homopolysaccharides and heteropolysaccharides, Structural polysaccharide; Storage polysaccharides; Stearic factors in polysaccharides folding, sugar code and lectins, Glycosaminoglycans, mucopolysaccharides; Blood group polysaccharides, Bacterial cell wall polysaccharides– proteoglycans and peptidoglycans. Glycoproteins.

Unit 2:

Amino acids & Proteins: Nomenclature, classification, and buffering properties of amino acids, zwitterionic structure, reactions of amino acids, unusual amino acids, non-protein amino acids. Peptides: Features of the peptide bond, naturally occurring peptides; Hierarchy of protein structure. primary, secondary, tertiary, and quaternary structures: Protein folding: Anfinsen's experiment. Bonds in protein folding. Chaperones in protein folding and Levinthal paradox. Denaturation and renaturation of proteins. Protein-protein interactions. Structures of myoglobin haemoglobin, immunoglobulin, collagen, chymotrypsin and keratin.

Unit 3:

Lipids: Classification and biological role. Fatty acids – Nomenclature of saturated and unsaturated fatty acids. Physiological properties of fatty acids. Acylglycerols: Mono, di, and triglycerols. Saponification value, iodine value, peroxide value, acid value and their significance. Phosphoglycerides: Structure and roles of lecithin, cephalins, phosphatidylinositol, plasmalogens, and cardiolipin. Sphingolipids: Structure and importance of sphingomyelin. Glycosphingolipids: Structure and importance of gangliosides and cerebrosides. Lipid mediators, Eicosanoids: Structures and Biological roles.

Unit 4:

Nucleic Acids: Nitrogenous bases: Purines, Pyrimidines; Chargaff's rule. nucleosides, nucleotides, unusual bases. Physiochemical properties of nucleic acids. Difference between RNA and DNA. Chemical reactions of DNA and RNA. Secondary structure of DNA. Watson and Crick model; B and Z DNA, other models of DNA structure. Supercoiling of DNA. Denaturation and renaturation of Nucleic acids. Melting of DNA, Tm; factors affecting Tm, Cot curve, classification of DNA based on Cot curve. DNA protein interactions. Genetic Code, Types and roles of RNA, Secondary structure of tRNA: cloverleaf model. rRNA-types.

Recommended Textbooks and References:

1. Biochemistry by L. Stryer (1995) W.H. Freeman Press, San Francisco, USA.
2. Biochemistry, by Voet, D. and Voet, J.G. (2004). 3rd Edition, John Wiley & Sons,
3. Biochemistry by L. Stryer (1995) W.H. Freeman Press, San Francisco, USA.
4. Biochemistry, by Voet, D. and Voet, J.G. (2004). 3rd Edition, John Wiley & Sons, Inc.USA.
5. Biochemistry by U. Sathyanarayana Books and Allied (P) Ltd. Kolkata, (2014).
6. Textbook of Biochemistry by J.L Jain (2016)
7. Medical Biochemistry by Ramakrishnan (2012)
8. Textbook of Biochemistry by D.M. Vasudevan (2018)

SEMESTER ONE

No. of Hours / Week	Credits
4	4

DSC 02 -FUNDAMENTALS OF MOLECULAR BIOLOGY

Course Objectives:
The objectives of this course are to impart knowledge and understanding of various biological processes as we go down the scale of magnitude from basic principles of biochemistry, genetics, molecular biology, and cells to organelles to molecules. It is also to impart the concepts of genetic materials, central dogma, mutations, and DNA repair.

Course Outcomes:
After successful completion of the course students will be able to:
CO-1. Understand the structure and function of DNA, RNA and proteins
CO-2. Understand the concepts of the central dogma of life
CO-3. Understand the basics of DNA and RNA replication, transcription, translation and DNA- repair systems
CO-4. Understand how genetic switches work, the basics of gene regulation in prokaryotes and eukaryotes.
CO-5. Understand biochemical synthesis and molecular processes that occur during cell growth.

Unit 1:
The central dogma of molecular biology: Historical perspectives- Hammerling (Nuclear control), Griffith (DNA, the genetic material), Avery et al. (DNA as the genetic material), Hershey & Chase (DNA as the genetic material in bacteriophage), Frankel Conrad (RNA as the genetic material in TMV) and Meselson and Stahl's experiment (DNA replication by Semi conservative mechanism).

Unit 2:
DNA replication: Molecular mechanisms of DNA replication: Enzymes of replication – DNA polymerases, Helicases, Binding proteins, Nucleases, Topoisomerases, and DNA Ligases, DNA replication models – conservative, semi-conservative and dispersive, Prokaryotic and Eukaryotic replication mechanisms.

Unit 3:
Transcription: Transcription – initiation, elongation and termination, Prokaryotic and eukaryotic RNA polymerases; Transcriptional regulation–promoters, enhancers, Transcription factors; post-transcriptional modifications – mRNA, tRNA and rRNA processing; RNA interference – siRNA, miRNA and shRNA.
Translation: Universal genetic code, codon degeneracy, wobble hypothesis; Mechanism of translation – initiation, elongation, and termination; post-translational modifications.

Unit 4:
Concept of Gene: Fine structure of the gene, Beadle and Tatum's One gene-one enzyme concept, one gene-one polypeptide concept, Complementation test, Intragenic complementation, Cistron, Recon and Muton, Split gene, jumping gene, Overlapping gene & multiple genes. Operon concept- *lac* operon, Arabinos and tryptophan operon.

Recommended Textbooks and References:

1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2008). *Molecular Biology of the Cell* (5th Ed.). New York: Garland Science.
2. Lodish, H. F. (2016). *Molecular Cell Biology* (8th Ed.). New York: W.H. Freeman.
3. Krebs, J. E., Lewin, B., Kilpatrick, S. T., & Goldstein, E. S. (2014). *Lewin's Genes XI*. Burlington, MA: Jones & Bartlett Learning.
4. Cooper, G. M., & Hausman, R. E. (2013). *The Cell: A Molecular Approach* (6th Ed.). Washington: ASM; Sunderland.
5. Hardin, J., Bertoni, G., Kleinsmith, L. J., & Becker, W. M. (2012). *Becker's World of* the *Cell*. Boston (8th Ed.). Benjamin Cummings.
6. Watson, J. D. (2008). *Molecular Biology of the Gene* (5th Ed.) Menlo Park, CA: Benjamin/Cumming

SEMESTER ONE

No. of Hours / Week	Credits
4	4

DSC 03 - FUNDAMENTALS OF GENETICS & EVOLUTION

Course Objectives:

This course deals with genetics at cellular and organism levels, population genetics and microevolutionary processes with an emphasis on the understanding of basic molecular evolution at whole-genome level with a primary focus on eukaryotic organisms.

Course Outcomes:

After successful completion of the course students will be able to:

CO-1. Having a firm foundation of how molecular evolution has shaped the evolutionary and genetic mechanisms of life.

CO-2. The understanding of such core mechanisms assists them in future research as well as teaching professional endeavours.

CO-3. Mendelian inheritance and Chromosome transmission during cell division and sexual reproduction

CO-4. Extensions of Mendelian inheritance and Non-Mendelian inheritance

CO-5. Genetic linkage and mapping in eukaryotes

CO-6. Variation in chromosome structure and number and Chromosome organization and molecular structure.

CO-7. Understanding the concepts of Medical genetics and cancer

Unit 1:

Mendelism: History and Mendel's experiments, Laws of inheritance-dominance and recessive concept, the law of segregation, the law of independent assortment, back cross and test cross, sex-linked inheritance, sex-linked genes, sex-limited genes and sex influenced genes. Extension of Mendelism: incomplete dominance, codominance, multiple alleles, Pseudo alleles, Lethal alleles, Penetrance and expressivity, Interaction of genes-epistasis- dominance, recessive (atavism), complementary genes, supplementary genes, the interaction of genes in comb pattern of fowls, polygenic inheritance, pleiotropism.

Unit 2:

Chromosomal aberrations: Structural- Deletion, Duplication, Inversion, Translocation, Centric fusion, and fission; Numerical variations–Aneuploidy, Euploidy & Polyploidy; Chromosome syndromes- Causes & consequences of chromosomal aberrations; Karyotyping and chromosome banding. Chromosomes: Types of chromosomes, Chromosome theory of inheritance, Special chromosomes – B chromosome, Polytene & Lamp brush.

Extra Chromosomal inheritance - Maternal effect – Pigmentation in Ephistia, inheritance of shell coiling in Limnaea, Infectious heredity of Paramecium, Cytoplasmic inheritance – Male sterility in maize and plastid inheritance in Mirabilis jalapa. Mutations: Spontaneous, Induced mutation, Conditional lethal mutations – point mutation, Base substitution mutation, Mutation rates. Chemical mutagens, radiation-induced mutation, reverse mutations, and suppressor mutations - intergenic and intragenic suppression, Missense, Nonsense and Silent mutations; and Detection of mutations induced by chemicals (Ames test), radiations (ClB technique)

Unit 3:

History of evolution of life on earth: elements, molecules to species. Evolution of the genome - DNA, RNA and proteins, the origin of the genetic code: the chemical basis of evolution. Theoretical aspects: Neutral theory of molecular evolution (Kimura), Darwin Wallace theory of evolution by natural selection, Role of Mutation in evolution. Divergence rates as a function of heterozygosity and gene functionality. Computation of phylogenetic trees using distance matrix methods, Maximum Parsimony method, Maximum likelihood, and Bayesian inference.

Unit 4:

Evolutionary change by mutation: Gene flow, genetic drift, natural selection, and non-random mating. Role of gene duplication, transitions and transversions- chromosomal deletions and insertions, in evolution. Role of repetitive DNA, transposable elements, and junk DNA in evolution. Homology of proteins and DNA in evolution. The concept of the Molecular Clock. Calibration. Limitation of molecular clockmodels. Human molecular clock: deducing evolutionary histories through mitochondrial DNA and Y chromosome

Recommended Textbooks and References:

1. Gardner E J, Simmons M J, Snustad D P 1991. Principles of Genetics. John Wiley & Sons, Inc.
2. Griffith A J F, Miller J H, Suzuki D T, Lewontin R C, Gelbert W M.1996. An introduction to Genetic Analysis. W.H. Freeman and Co. New York
3. Strickberger, Monroe W. 1976. Genetics. Macmillan New York:
4. Watson, J. D., T. A. Baker, S. P. Bell, A. Gann, M. Levine, R. Losick. 2004. Molecular Biology of the Gene. 5th Edition. Pearson Education Pte. Ltd., New Delhi, India.
5. Robert H. Tamarin. 2002. Principles of Genetics Tata-McGraw Hill, Seventh Edition.
6. Lewin B., Gene IV, V, VI. Oxford University Press, Oxford.
7. Gardner, E.J. et al., 1996. Principles of Genetics, VII Edn. John Wiley and Sons, Inc., New York.

SEMESTER ONE

No. of Hours / Week	Credits
2	2

AECC – PRINCIPLES OF STATISTICS

Course Objectives:

To train the students intensively in both theoretical and practical aspects of statistics, to bring them in contact with basic concepts and methods and to create a problem-solving attitude with the aid of statistical methodology.

Course Outcomes:

After successful completion of the course students will be able to:

CO-1. Specific topics include tools for describing graphical methods,
CO-2. Central tendency, and variability; probability and sampling techniques,
CO-3. Statistical hypothesis testing and its application to group comparisons.
CO-4. By the end of the course, the students can appreciate the importance of statistical methods in biology.
CO-5. Tests of Significance used in Statistical analysis.
CO-6. The different types of multivariate analysis are used in research.

Unit 1:

Descriptive statistics: Importance and Scope of Statistics, Data Types, Variables, Frequency Distribution, Graphical Representation Methods (Histogram, Bar Charts, Pie Charts), Measures of Center Tendency (Mean, Median, Mode,) and Dispersion (Standard Deviation, Variance) Advantages and Disadvantages.

Unit 2:

Probability: Basic Terminology: Trial, Events, Sample Space and Sample Points, Basic Laws of Probability, Types of Probability, Normal probability curve, Standard Normal Distribution, Bayes theorem - simple problems.

Unit 3:

Sampling Methods: Concept of Population, Sample, Sampling, Sample Size, Sampling Error, Advantages and Disadvantages of Sampling Method, Types of Random Sampling Methods – SRS, Stratified Random Sampling, Systematic Random Sampling and Cluster Sampling

Unit 4:

Testing of Hypotheses: Statistical Hypotheses-Null and Alternative, Level of Significance, Type I and Type II Error, P-Value, Degrees of Freedom, Chi-Square Test, Student's t-Test: One-Sample t-Test and Paired and unpaired t-Test, Analysis of Variance. Correlation-Karl Pearson's and Spearman's rank correlation. Regression Analysis.

Recommended Textbooks and References

1. Fundamentals of Biostatistics. Veer Bala Rastogi. Publisher: ANE Books. 2nd Edition, 2009.
2. Fundamentals of Mathematical Statistics, S.C. Gupta and V. K. Kapoor, Publisher: Sultan Chand & Sons (2014).

3. Fundamentals of Statistics. S.C. Gupta. Publisher: Himalaya Publishing House Pvt. Ltd.Edition.7th Edition, 2012.

4. Introductory Statistics for Biology. R. E. Parker. Publisher: Cambridge University Press 2nd Edition, 1991.

5. Statistics for behavioural science. Chintamani Kar. Publisher**:** Dominant Publishers & Distributors (P) Ltd. (2015).

SEMESTER ONE

No. of Hours / Week	Credits
2	2

SEC 01 - BIOLOGICAL TECHNIQUES

Course Objectives:

The course provides an in-depth understanding of various scientific instruments used for analysis. The objective of this course is to understand the scope of application, advantages, and limitations of the various modern analytical and separation techniques.

Course Outcomes:

After successful completion of the course students will be able to:

CO-1. Understand the principals involved in the functioning of various instruments and the causes of uncertainties in instrumental measurements

CO-2. Understand the advantages and limitations of various modern, analytical techniques.

CO-3. Have in-depth knowledge about separation techniques

CO-4. Make use of instrumental methods for solving complex biological problems.

CO-5. Estimate the concentration of enzyme in serum quantitatively.

CO-6. To separate protein in the given sample using SDS-PAGE (Sodium Dodecyl sulfate poly Acrylamide Gel Electrophoresis).

Unit 1:

Centrifugation and Cell Disintegration: Basics: Basic principles of centrifugation, RCF and other factors affecting sedimentation, sedimentation velocity, sedimentation equilibrium, sedimentation coefficient, factors affecting Standard Sedimentation Coefficient. Instrumentation: Types of centrifuge machines, Rotors, Preparative and analytical centrifuges, Applications of Boundary Sedimentation, Band sedimentation, Determination of Molecular weights. Cell Disintegration: Physical, chemical and enzymatic methods of microbial, plant and animal cell disintegration.

Unit 2:

Chromatography: Chromatographic techniques: History Basic principles, Partition coefficient, the nature of partition forces, counter current distribution, Introduction to planar and column chromatography. Theory, principle and applications of Paper, Thin Layer, Gel Filtration, Ion Exchange, Affinity, Reverse phase chromatographic techniques, GLC and HPLC, Some specialized techniques of chromatography.

Unit 3:

Electrophoresis and Blotting: Electrophoretic Techniques: Basic Principles of Electrophoresis, Types of electrophoresis: free, zone and capillary electrophoresis. Theory, principles and applications of Paper, Cellulose acetate and Gel Electrophoresis, Isoelectric focusing, Specialized Electrophoretic techniques viz., Discontinuous gel electrophoresis, Immunoelectrophoretic, Gradient, 2-D gel and Pulse-field gel electrophoresis, High voltage electrophoresis. Blotting techniques: southern, northern, and western blotting.

Spectroscopy Basics: Basic principles, Laws of absorption, Absorption spectrum, Chromophore concept. Theory, Principles, Instrumentations and Applications of UV-

Visible and IR spectrophotometry, Fluorescence, NMR, Atomic absorption, Mass, Raman, CD, ORD and Flame spectrophotometry, Luminometry, Flowcytometry.

Unit 4:

Radio-Isotopic Techniques: History, Introduction to Isotopes and Radioactivity, Radioactive Decay, Production of Isotopes, Synthesis of radioactive compounds, Radioactive labelling procedures, Interaction of radioactivity with the matter, Use of radioisotopes in Life Sciences, Commonly used isotopes, Safety aspects. Detection and Measurement of radioactivity: Methods based upon Gas Ionization (ionization chambers, Proportional Counters and Geiger-Muller counters), Photographic methods, Methods based upon Excitation (Scintillation counters and their types). Principles and applications of Tracer Techniques, Autoradiography and its applications.

Recommended Textbooks and References

1. Hobert H Willard D. L. Merritt & J. R. J. A. Dean, "Instrumental Methods of Analysis", CBS Publishers & Distributors, 1992
2. Chatwal and Anand, "Instrumental Methods of Chemical Analysis", 5th edition, Himalaya Publications, 2006.
3. Keith Wilson, Kenneth H. Goulding, "A Biologist Guide to Principles and Techniques of Practical Biochemistry", 3rd edition, ELBS Series.2006.
4. Douglas A., Skoog & West, "Fundamentals of Analytical Chemistry", 8th edition, Harcourt Publications, 2006.
5. F. Settle, "Handbook of Instrumental Techniques for Analytical Chemistry", Prentice-Hall Publications, 1997.

SEMESTER ONE

No. of Hours / Week	Credits
4	2

PRACTICALS 01 - BASIC TECHNIQUES IN GENETICS

List of Experiments

1. Microscope Basics; Identification of parts. Cleaning and Maintaining the Microscope
2. To study the parts of a phase-contrast microscope and its maintenance.
3. To study living matter under a phase-contrast microscope.
4. Separation of RBCs and platelets.
5. Study of morphology and handling of Drosophila melanogaster.
6. Study of mutants of Drosophila melanogaster.
7. Study of inversion in Drosophila.
8. Preparation of Salivary gland chromosomes of Drosophila melanogaster.
9. Demonstration of Mendel Monohybrid ratio.
10. Demonstration of Mendel Dihybrid ratio.
11. Demonstration of Sex-linked inheritance.
12. Study of Karyotyping (normal and syndrome)
13. Catalase assay in peroxisomes.
14. Photographs related to Genetics.

No. of Hours / Week	Credits
4	2

PRACTICALS 02 - BIOCHEMICAL & MOLECULAR TECHNIQUE

List of Experiments

1. Estimation of Protein by Lowry's Method.
2. Qualitative and quantitative analyses of carbohydrates
3. Qualitative and quantitative analyses of amino acids.
4. Blood cell counting: Total and differential count.
5. Estimation of Cholesterol- HDL, LDL in serum by Zak's Method.
6. Estimation of blood sugar by glucose oxidase test
7. Estimation of calcium in serum by a titrimetric method.
8. Salivary amylase assay – Specific activity, pH, Temperature, Time Kinetics.
9. TLC separation of Amino acids /sugars
10. Isolation of DNA from the Chicken liver.
11. Isolation of RNA from yeast.
12. Estimation of RNA by Orcinol method
13. Estimation of DNA by Diphenylamine method
14. Agarose gel electrophoresis of DNA.

Semester Two

SEMESTER TWO

No. of Hours / Week	Credits
4	4

DSC 04 - MOLECULAR DEVELOPMENTAL BIOLOGY

Course Objectives:

Developmental biology seeks to address how complex multicellular organisms with diverse forms and cell types arise from single cells. The paper comes to introduce studentsto the molecular and cellular mechanisms that underlie the early development of organisms.

Course Outcomes:

After successful completion of the course students will be able to:

CO-1. Having a profound molecular understanding of an organism at whole-body level serves them to conceptualize developmental disorder manifestations.

CO-2. the knowledge about blast action, gastrulation and neural induction

CO-3. Understanding the basic concepts of organogenesis, morphogenesis, and regeneration.

CO-4. Have fundamental knowledge of animal embryonic development, how an egg develops into an adult.

CO-5. Detailed knowledge on developmental aspects of Drosophila and mammals will be gained by students.

Unit 1:

Introduction to developmental biology: origin, and history. Concepts and stages of development in animals. Gametogenesis - Structure of the Gametes; Isogamy and Anisogamy, Spermatogenesis vs. Oogenesis, Fertilization, Sperm and Egg Recognition. Fertilization - sperm and Egg Binding; Membrane and Pronuclear Fusion, Gamete Fusion andthe Mechanisms of Prevention of Polyspermy; Molecular Activation of fertilized Egg Metabolism. Genes and Development - The Embryological Origins of the Gene Theory, Homologous Pathways of Development

Unit 2:

Molecular basis of early development and differentiation: Caenorhabditis elegans: Anterior-posterior axis formation, formation of the dorsal-ventral and right-left axes, control of blastomere identity. Differentiation of pharynx. Drosophila: Primary axis formation during oogenesis. Generating dorsal – ventraldorsal-ventral pattern in embryo. Segmentation and the anterior-posterior body plan, segmentation genes, homeotic selector genes. Mammals: Anterior-posterior axis formation, the dorsal-ventral and right- left axes in mice.

Unit 3:

Molecular basis of later development: The Central Nervous System (CNS) and Epidermis - Formation and Differentiation of the Neural Tube, The Neural Crest, The Epidermis, Mesoderm -Paraxial Mesoderm, Intermediate Mesoderm, Lateral-Plate Mesoderm. Endoderm and Limb Formation - Formation and molecular differentiation of the Limb Bud,Cell Death and the Formation of Digits and Joints, Front Limb vs. Hind Limb The formation, Very Late - And Post Embryonic Development.

Unit 4:

Sex Determination: Drosophila and mammals; Transcriptional Regulation of an Entire Chromosome: Dosage Compensation. Hox Genes: Descent with Modification. Molecular Techniques- RNA Localization Techniques; Chimeras; Reproductive biotechnology: Collection and cryopreservation of gametes – human and animals, superovulation, and collection of eggs, in-vitro- fertilisation (test tube baby), surrogate mothers.

Recommended Textbooks and References

1. Gilbert S. F. 2006. Developmental biology 8th end. Sinauer Associates, Massachusett
2. Bhojwani S.S. and Soh W.Y. (2001). Current Trends in Embryology of Angiosperms, Kluwer Academic Publishers.
3. Srivastava, L. M. 2003. Plant growth and development. Oxford University Press.
4. Lyndon R.F. (1990) Plant Development the Cellular Basis. Unwin Hyman
5. Raghavan V. (2000) Developmental Biology of Flowering Plants. Springer Verlag.
6. Buchanan B. B., Gruissem W. and Jones R. L. (2000) Biochemistry and Molecular Biology of Plants. America Society of Plant Physiology, Maryland.
7. Weiss P., Willier B. H., Hamburger V. 1955. Analysis of Development. Saunders, Philadelphia.

SEMESTER TWO

No. of Hours / Week	Credits
4	4

DSC 05 - MOLECULAR CELL SIGNALING AND CELLULAR RECEPTORS

Course Objectives:

The paper aims to describe how cells exploit signaling components to assemble the specific signaling pathways, which they require to communicate which each other or to adapt to changes nonexternal environment. Attention will be focused on the role of signaling pathways in the control of gene expression, cellular metabolism, and cell death.

Course Outcomes:

After successful completion of the course students will be able to:

CO-1. Students will be having a better understanding of cell signaling in various molecular biology and genetics courses.

CO-2. Demonstrate the types of transport mechanisms on membranes

CO-3. Encompass the fundamentals of ligand and receptor interactions

CO-4. Understand the basics and different types of signaling pathways

CO-5. Gain knowledge on signal transduction and role of second messengers

Unit 1:

Introduction to molecular cell signaling: Introduction, significance of cell signaling. Concept of cell signaling: Endocrine, paracrine, merocrine, juxtacrine and autocrine signaling. Hormone receptors - structure of Insulin receptor, cytokine receptor, EGF receptor,receptor up regulation, down regulation, desensitization.

Unit 2:

Signaling in Bacteria: Quorum sensing in Bacteria, mechanism of chemokine signaling. Molecules and mechanisms. Signaling in yeast, signaling in plant - Signaling by stress and light. Phytochrome system.

Unit 3:

Signaling in animal systems: Signaling by hydrophilic molecules - Receptors, & 7 TM helicalsegments, Tyrosine kinase receptors, cytokine receptors, e.g. TNF alpha G proteins, G protein cycle, SH and PH motifs, PI3K, PLC, SMase, Second messengers-c AMP, discovery, function and regulation by Cholera toxin and Pertusis toxin. Lipid second messengers - DAG and ceramide.

Unit 4:

Signaling Pathway: MAPK pathway, stress pathway, cytokine pathway, Growth factor pathway, Transcription factors - NF KB-regulation. Other transcription factors.

Signaling by hydrophobic molecules - Steroid hormone signaling, cytoplasmic receptors, signaling cross talk, Glucocorticoid and estrogen receptors and their mechanism of action, antihormones (Eg. RU 486) Hormone replacement therapy.

Recommended Textbooks and References

1. Cooper G. M. 1996. The Cell a Molecular Approach, Sinauer Associates, Inc.,
2. Waterman. Introduction to Computational Biology: Maps, Sequences and Genomes, CRC Press.
3. Molecular Biology of the Cell. B. Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts and J.D. Watson. Garland Publishing, New York, and London.
4. Watson, J. D., Hopkins N. H., Roberts J. W., Steitz J. A., Weiner A. M. 1987. Molecular Biology of the Gene. Benjamin/Cummings.

SEMESTER TWO

No. of Hours / Week	Credits
4	4

DSC 06 – GENE MANIPULATION

Course Objectives:

The course is oriented towards understanding the processes of gene expression and regulations. The objective of the course is to provide awareness about different vectors used for gene transfer, enzymes, cloning methods, expression, and detection of clones. It is also aimed to provide insights into molecular methods, markers, and applications of r-DNA technology.

Course Outcomes:

After successful completion of the course students will be able to:

CO-1. Gain knowledge on gene expression and regulations.

CO-2. Analyse structure and organization of different vectors used in gene transfer.

CO-3. Understand and handle enzymes used in gene manipulation.

CO-4. Perform cloning methods, expression and detection of clones.

CO-5. Knowledge of applications of genetic engineering in various fields like forensics, biomedical technology etc.

CO-6. Knowledge about latest technologies in the field of genome editing and synthetic biology.

Unit 1:

Introduction to genetic engineering: Recombinant DNA technology. Tools for Genetic Engineering: restriction endonucleases and methylases; DNA ligase, Taq polymerase, polynucleotide kinase, alkaline phosphatase; Reverse transcriptase, DNase, Rnase, S1 nuclease, terminal Transferase. Polymerase Chain Reaction (PCR).

Unit 2:

Vectors and their types: Features of an ideal vector; MCS, selectable marker. Plasmids, Phage based vector, Cosmids, Phagemids. Cloning vector, Expression vector, Shuttle vector. Plant based Plant-based vectors, Yeast vectors. Animal vectors. Restriction based cloning and Gateway based cloning. Insertion of foreign DNA into host cells; transformation, electroporation, transfection.

Unit 3:

Isolation of mRNA: Reverse transcription PCR and cDNA synthesis; cDNA and genomic libraries. Promoters are used in an expression vector and their types. Transcriptional and Translational fusion. Reporter genes. pET-based vectors, Protein purification; His-tag. Protein-DNA interactions – Protein-Protein interactions. Probes – probe construction and labelling. DNA sequencing, Gene expression analysis; quantitative Real-time PCR (qRTPCR), Southern hybridization, Northern blotting, Western blotting, DNA Microarray, RNA-seq.

Unit 4:

Functional Characterization of genes: Knock-out and overexpression. Creation of transgenic plants; debate over GM crops. Creation of transgenic and knock-out mice. Principle and application of gene silencing using RNAi. Genome editing by CRISPR/Cas9.

Recommended Textbooks and References

1. Hartl, D. L. and E. W. Jones, 2002 Essential Genetics. 3rd ed. Jones & Bartlett, Sudbury, Massachusetts. 613 pp.

2. Hartl, D. L. and E. W. Jones, 2004 Genetics: Analysis of Genes and Genomes. 6th Ed. Jones& Bartlett, Sudbury, MA. 854 pp.

3. Conner, J. K., and D. L. Hartl, 2000 A Primer of Ecological Genetics. Sinauer Associates, Sunderland, Massachusetts. 304 pp.

4. Epstein RJ (2002) Human molecular biology. Cambridge University Press, Cambridge.

5. Gardner A, Howell RT, Davies T (2000) Biomedical sciences explained. Human genetics. Arnold, London.

6. Lewin B (2000) Genes VII. Oxford University Press, New York.

7. Strachan T, Read AP (2004) Human molecular genetics 3. Garland Science, New York.

8. Mobile genetic elements-Shapilo/NY Academic press, Microbial genetics. Maloy SR. Friefelder /Jones and Bartlett pub., 1994.

SEMESTER TWO

No. of Hours / Week	Credits
4	4

DSE 01a - ADVANCES IN MOLECULAR BIOLOGY

Course Objectives:
Cell biology is the study of the structure and function of prokaryotic and eukaryotic cells. In this course, we will examine many aspects of the basic cellular biology of prokaryotes and eukaryotes at the molecular scale.

Course Outcomes:
At the successful completion of the course, the students will be able to:

CO-1. Understand the basic structural and cell biology-related molecular mechanisms in both prokaryotic and eukaryotic cells.

CO-2. Understand the molecular mechanisms regulating and controlling cell division and the cell cycle and exemplify how extracellular signals affect cell division.

CO-3. Describe the molecular mechanisms behind DNA damage and repair.

CO-4. Explain different molecular mechanisms to bring about cell death and linked to DNA damage.

CO-5. Explain the principles of how extracellular signals can reach the cell interior, be amplified transmitted and terminated.

Unit 1:
Plasma membrane: Membrane biogenesis-lipids and proteins, membrane flow hypothesis, regulation of plasma membrane composition, membrane lipid and protein turnover, polarized cells Mechanism of protein sorting and targeting (ER, golgi, plasma membrane, mitochondria), signal peptide. Special features of other organelles: Golgi & ER – processing of glycoproteins, peroxisomes – lipid degradation and oxidative stress, vacuoles, and their functions.

Unit 2:
Membrane dynamics: Lateral diffusion, FRAP, FRET, single particle tracking, trans bilayer movement of lipids (flip-flop) (flippase, floppase, scramblase), microdomains caveolae, rafts. Membrane fusion eg: neurotransmitters release. Membrane Transport: Law of diffusion overview, glucose transporter, Na+ K+ ATPase, receptor mediated endocytosis, Ion channels (ligand gated and voltage gated), aquaporin channel, ionophores, and patch clamp technique.

Unit 3:
Structural framework of eukaryotic cell: cytoskeleton, microfilaments, microtubules, and intermediate filaments. Composition, assembly, and function. Cell dynamics – Flagella and cilia, structure and assembly, cell movement, diapedesis, and moment of vesicles (vesicular trafficking).

Unit 4:

Cell cycle regulation: cell cycle overview, cell cycle checkpoints, cell cycle regulatory genes, cyclins (D, E, A, and B), cdk's role, phase transition regulation (G1-S, S-G2, G2-M), S phase replication initiation regulation by S-cdk's & MCM proteins, the role of microtubule & kinesin, dynein in anaphase, anaphase-promoting complex, and cytokinesis.

Cell death: Apoptosis & necrosis role and mechanism, caspases and cathepsins. Cell death signals, survival factors, cell death genes. Cell death pathways, pro & anti-apoptotic molecules. Molecular markers for apoptosis: Membrane markers and DNA ladders.

Recommended Textbooks and References

1. Cooper Geoffrey M. 2000. The Cell - a molecular approach. 2nd Edn. ASM Press.Washington.
2. Sharma A K & Sharma A. 1980. Chromosome Techniques: Theory & Practice.Butterworth.
3. Bray A. D., Lewis J., Raff M., Roberts K., and Watson J.D. Molecular Biology of the Cell. B. Garland Publishing, New York, and London.
4. De Robertis E.D.P., De Robertis E.M.F. 2001. Cell and Molecular biology. LippincottWilliams & Wilkins. Bombay.
5. Freifelder D. 1990. Molecular biology. Narosa Publishing House, New Delhi
6. Gardner E J & D P Snustad 1996. Principles of genetics. John Willey, New York.
7. Samba Murthy, A.V.S.S. 1999. Genetics. Narosa Publishing House, New Delhi.
8. Sinnot E W., Dunn L.C., Dobzhansky T. 1958. Principles of genetics. V Democrat Hill, New York.
9. Stansfield W.D .1991. Theory & Problems in genetics III edn McGraw Hill, New York.
10. Strickberger M.W. 1996. Genetics III Edn. McMillan, New York.
11. Winchester A.M. 1967. Genetics Oxford & IBH. New Delhi.

SEMESTER TWO

No. of Hours / Week	Credits
4	4

DSE 01b - IMMUNOLOGY AND VACCINE DEVELOPMENT

Course Objectives:
This paper will introduce the cellular and molecular mechanisms underlying the development of human cancer at the genetic and molecular basis of cellular transformation & complex interactions along with exploring wide-ranging topics related to stem cells and its wide range of applications and technologies.

Course Outcomes:
At the successful completion of the course, the students will be able to:

CO-1. Having a basic understanding of how the interactions within the human immune system tackle disease manifestations.

CO-2. Principles of the innate and adaptive immune system, the mucosal immune system and immunological memory.

CO-3. Understand the antigen receptor structure and the mechanisms of antigen recognition by B-cell and T-cells.

CO-4. Mechanisms of immunoglobulins, B-and T-cell receptors gene rearrangement.

CO-5. Gain knowledge about the major histocompatibility complex and its functions.

CO-6. Understand scientific principles behind T and B Cell-Mediated immune Response.

CO-7. Immune response against infectious agents and tumour cells.

CO-8. Inherited immunodeficiency diseases.

Unit 1:
Introduction: Historical development and milestones in immunology, Primary and secondary lymphoid organs – Lymphatic system, Reticuloendothelial system, Types of immunity, Innate & Acquired. Antigens: Chemical nature & properties, Epitopes, Antigenicity, Immunogenicity, Valency of antigens, Haptens. Antibodies: Structure, Classes, and subclasses, Paratopes, Immunoglobulin variants – Isotypes, Allotypes Idiotypes, Valency of antibody, antibody diversity.
Immune responses: Primary and secondary, class switching. Cellular basis of immunity: Hematopoiesis, Biology of T-cells, and B-Cells. T-cell subsets. T-cell and B-Cell receptors. Structure & functions- MHC antigens in man. Clonal selection, Cytokines – role in immunity.

Unit 2:
Immunological techniques: Preparations, agglutinations, Complement fixation, Immunodiffusion, Immunoelectrophoretic, Immunofluorescence, RIA & ELISA, Western blotting.Monoclonal antibodies – preparations & applications, Disorders of immunity: Immunologicaltolerance, Autoimmunity. Immunodeficiency disorders, SCID, AIDS, Tumor immunology: Tumour-associated antigens & Tumor specificTumour-specific antigens. Immune surveillance, TNFα & β immunotherapy.

Unit 3:

Introduction to vaccinology: vaccines, and vaccination in historical and current perspective. Molecular immunology as applied to vaccine development: recent advances in immunology, impact on vaccine development, identification of B and T cell epitopes through structural characterization and peptide technology. Vaccines: Vaccines and their preparations. BCG, Polio, DPT, HBV, Adjuvants. DNA based vaccines: extending the technology -naked DNA vaccines.

Unit 4:

Live antigen delivery system: attenuated virus as a live vector for expression of immunogens, attenuated poliovirus as a live vector, BCG as a recombinant vaccine vector. Experimental vaccines, HIV-1 vaccines, vaccines against malaria. Commercial and regulatory aspects of vaccine production and distribution, vaccines development: product licensure, the role of the food and drug administration in vaccine testing and licensure.

Recommended Textbooks and References

1. Kuby J. Immunology. 2001. Second Edition. W H Freeman& Company New York.

2. Roitt I M Delves P J. Essential Immunology 10th ed 2001 Blackwell Scientific Publications.

3. https://books.google.co.in/books/about/Cellular_and_Molecular_Immunology_E_Book.html?id=RWYWBAAAQBAJ&redir_esc=y

4. https://archive.org/details/FundamentalImmunology7thEdition2013PDF_201511

SEMESTER TWO

No. of Hours / Week	Credits
4	4

DSE 02a - TISSUE ENGINEERING & REGENERATIVE MEDICINE

Course Objectives:

This course would help students to understand the applications and usage of stem cells in various therapies and would impart information regarding the development of various scaffolds and concepts of tissue engineering for various stem cell-based therapies.

Course Outcomes:

Upon successful completion of this course, students will be able to

CO-1. Understand the role of various growth factors involved in tissue growth

CO-2. Assess the role of different biomaterials used for therapeutics

CO-3. Possess in-depth knowledge on cutting edge technologies of tissue engineering.

CO-4. Knowledge on basics of tissue engineering- growth and differentiation of tissues will be learnt.

CO-5. Knowledge about the growth factors influencing tissue growth will be gained. Fabrication and tailoring of scaffolds and reactors in tissue formation will be studied.

CO-6. Develop Bioartificial organs like the pancreas, renal system using tissue engineering techniques.

Unit 1:

Tissue Engineering: Introduction, Scope and recent development. Therapeutical applications – Cells as therapeutic agents. Cell numbers and growth rate. Measurement of Cell Characteristics – morphology, number viability, motility, and functions. Measurement of Tissue Characteristics – appearance, cellular component, extracellular membrane component, mechanical measurements and Physical Properties.

Unit 2:

Tissue architecture: Types, Components, and dynamics. Tissue repair, engineering wound healing and Sequence of Events. Basic wound healing applications of growth factors: VEGF/angiogenesis, basic properties, Cell-matrix & cell-cell interactions, telomeres and self-renewal, Control of cell migration in tissue engineering. Tissue dynamics – Dynamic states of tissues, homeostasis is highly prolific tissues and tissue repair. Angiogenesis.

Unit 3:

Biomaterials: Properties of biomaterials, surface, bulk, mechanical and biological properties. Scaffolds & tissue engineering, Types of biomaterials, Biological and synthetic materials, Biopolymers, applications of biomaterials, modifications of biomaterials, Role of nanotechnology.

Unit 4:

Stem cells: Introduction, hematopoietic differentiation pathway potency and plasticity of stem cells. Embryonic stem cells, hematopoietic and mesenchymal stem cells, Stem cell markers, identification and analysis by FACS. Differentiation of stem cells.

Stem cell systems – Liver, Neuronal stem cells, Types & sources of stem cell with characteristics: embryonic, adult, haematopoetic, fetal, cord blood, placenta, bone marrow,

primordial germ cells, and Cancer stem cells induced pluripotent stem cells.

Stem Cell therapy: Molecular therapy. *In-vitro* Organogenesis. Neurodegenerative diseases. Spinal cord injury. Heart disease. Diabetes. Burns and skin ulcers. Muscular dystrophy. Orthopaedic applications. Stem cells and gene therapy. Physiological models. Tissue-engineered therapies. Product characterization. Components. Preservation – freezing and drying. Safety, efficacy, patent protection and regulation of tissue-engineered products. Ethical issues.

Recommended Textbooks and References

1. Meyer, U., Meyer, Th., Handschel, J., Wiesmann, H.P. (Eds.). Fundamentals of Tissue Engineering and Regenerative Medicine, 1st edition, Springer-Verlag Berlin Heidelberg, 2009.

2. Satya Prakash, Dominique Shum-Tim. Stem Cell Bioengineering and Tissue Engineering Microenvironment. 1st edition, World Scientific Pub Co Inc, 2011.

3. Anthony Atala, Robert Lanza, Tony Mikos, Robert Nerem. Principles of Regenerative Medicine. 3rd edition, Academic Press, 2018

SEMESTER TWO

No. of Hours / Week	Credits
4	4

DSE 2b – IPR, BIOETHICS & BIOSAFETY

Course Objectives:

The objective of the course is to always impart knowledge on ethical practices appropriate to the work and to adopt safe working practices relevant to bioindustries & researchfields.

Course Outcomes:

Upon successful completion of this course, the student will be able to

CO-1. Gain awareness about Intellectual Property Rights (IPRs) to protect their ideasCO-2. Devise business strategies by taking account of IPRs

CO-3. Assist in technology up-gradation and enhancing competitiveness.

CO-4. Acquire adequate knowledge in the use of genetically modified organisms and their effect on human health.

CO-5. Recognize the crucial role of IP in organizations of different industrial sectors for product and technology development.

CO-6. Understand the potential role of ownership rights and marketing protection in encouragingor discouraging scientific research.

Unit 1:

Introduction to Intellectual Property: Types of IP: Patents, Trademarks & Copyright, IPR – patentable and non-patentable. IPR in India – Genesis and Development; IPR in abroad.

Unit 2:

Intellectual Property Rights (IPRs): implications for India, WTO, WIPO, GATT, TRIPS. Patenting and the procedures involved in the application for patents and granting of a patent, compulsory licenses, patent search, Patent Cooperation Treaty (PCT), examples of patents in biotechnology, legal implications, traditional knowledge commercial exploitation, protection.

Unit 3:

Bioethics: Introduction to ethics/bioethics; benefits and risks of genetic engineering – ethical aspects of genetic testing – ethical aspects relating to the use of genetic information – genetic engineering and biowarfare. Protection of GMOs IP as a factor in R&D; IP's of relevance to genetic engineering – few Case Studies.

Unit 4:

Biosafety: Introduction & historical background; Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels; Recommended Biosafety Levels for Infectious Agents and Infected Animals.

Biosafety Guidelines: Biosafety guidelines and regulations (National and International) – operation of biosafety guidelines and regulations of Government of India; Definition of GMOs & LMOs; Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs.

Recommended Textbooks and References

1. Ethics in engineering, Martin. M.W and Schinzinger. R. III Edition, Tata McGraw-Hill, New Delhi. 2003.
2. BARE ACT, Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co.Pvt. Ltd., 2007.
3. Kankanala, K. C. 2007. Genetic Patent Law & Strategy, 1st Edition. Manupatra Information Solution Pvt. Ltd., Noida, India.
4. Jose B. Cibelli, Robert P. Lanza, Keith H. S. Campbell, Michael D.West. 2002. Principles of Cloning, Academic Press, San Diego, Gurdon.
5. Hoosetti, B.B.2002. Glimpses of Biodiversity. Daya, New Delhi.
6. Senthil Kumar Sadhasivam and Mohammed, Jaabir. 2008. IPR, Biosafety and Biotechnology Management. Jasen Publications, Tiruchirappalli, India.
7. http://www.cbd.int/biosafety/background.shtml
   http://web.princeton.edu/sites/ehs/biosafety/biosafetypage/section_3.html

SEMESTER TWO

No. of Hours / Week	Credits
2	2

SEC 02 – CELL AND TISSUE CULTURE TECHNIQUES

Course Objectives:
The objectives of this course are to introduce students to the principles, practices and application of plant tissue culture, animal biotechnology, plant and animal genomics, genetic transformation and molecular breeding of plants and animals. Students will be exposed to primary and secondary animal cell culture systems and their applications in industries.

Course Outcomes:
Upon successful completion of this course, the student will be able to
CO-1. Acquaint with principles, technical requirements, scientific and commercial applications in Plant tissue culture technology.
CO-2. Be familiar with sterile techniques, media preparation
CO-3. Gain knowledge of how plants can be transformed concerning pest resistance, herbicide tolerance.
CO-4. Support methodologies in plant tissue/cell culture, horticulture & floriculture to plant improvement.
CO-5. Isolate animal tissues and prepare primary and secondary cell cultures.
CO-6. Gain the skills in Handling laboratory animals.

Unit 1:
Types of Plant Cultures: Introduction to organogenesis, Production of haploid plants and their applications, Ovary and ovule culture, In vitro pollination and fertilization, Pollen culture, Anther culture, Embryo culture: History and methodology, Embryo rescue after wide hybridization, Applications, Somatic embryogenesis, Endosperm culture and production of triploids, Single-cell suspension cultures and bioreactors, Protoplast isolation and culture, Meristem, axillary and shoot tip culture: micropropagation.

Unit 2:
Applications of Plant Tissue Culture: Somaclonal variation and applications, Somatic Hybridization and its applications, Virus-free plants, Germplasm conservation, Synthetic seeds, DNA transformation methods in plants and applications, Hairy root culture, Secondary metabolite production.

Unit 3:
Study of laboratory equipment's: Stocks and Media preparation, Sterilization techniques in plant tissue culture, Explant selection, treatment and inoculation, Subculture of initiated cultures, Acclimatization of cultures, Extraction of proteins from plants and its estimation, Extraction of DNA/RNA from plants and its estimation, Estimation of peroxidase activity in plants, Study of β – amylase enzyme from germinatedpulses, Demonstration of animal cell culture technique.

Unit 4:
Introduction to Animal cell culture: types; Organ culture, Primary explant cultures, Established cell lines, commonly used cell lines: origin and characteristics, Growth kinetics and cells in culture, Bioreactors for large scale culture of cells, Cell fusion,

Transplantation of cultured cells (Grafting). Applications of animal cell culture: Limitations and ethical issues, Transfection and transgenic animals Expressing cloned products in animal cells, The need to express in animal cells, Overproduction and processing of chosen protein, Production of special secondary metabolites/ products. Production of vaccines using animal cell culture.

Recommended Textbooks and References

1. Freshney, R.I: Culture of Animal cells, Wiley Publications, New York.
2. Edi. John R.W. Masters: Animal cell culture- a practical approach, Oxford University Press, Oxford.
3. Ed.R. Basega: Cell growth and division: A practical approach, IRL Press, Oxford University Press, Oxford.
4. Ed. Martin Clynes: Animal cell culture techniques, Springer- Verlag, New York. F.Grasveld, George V. Kallias: Transgenic Animals, Academic press, Sandiego, USA.
5. Asok Mukhopadhyay: Animal cell technology, IK International Publishing House, New Delhi.
6. Chawla, H. S. (2000). Introduction to Plant Biotechnology. Enfield, NH: Science.
7. Razdan, M. K. (2003). Introduction to Plant Tissue Culture. Enfield, NH: Science.
8. Slater, A., Scott, N. W., & Fowler, M. R. (2008). Plant Biotechnology: An Introduction to Genetic Engineering. Oxford: Oxford University Press.

SEMESTER TWO

No. of Hours / Week	Credits
4	2

PRACTICALS 03 - Immunology & Developmental Biology

List of Experiments

1. Density gradient separation of human blood cells.
2. Blood group typing. Blood cell counting: Total and differential count.
3. Blood Cell counts- Total Leucocyte counts, Differential Leukocyte counts
4. Separation of WBC from the blood by density gradient centrifugation and Identificationof various types of cells
5. Blood smear identification of leucocytes by Giemsa stain
6. Demonstration of Phagocytosis
7. Selection of animals, Preparation of antigens, Immunization and methods of bleeding, serum separation and storage
8. Antibody titer by ELISA method
9. cAMP assay by ELISA.
1. Double diffusion and Slide agglutination.
10. Complement fixation test
11. Isolation and purification of IgG from serum or IgY from chicken egg
12. Dot blot assays
13. Ouchterlony's Double diffusion
14. Single Radial Immuno diffusion (SRID).
15. Representative Pathological slides identification

No. of Hours / Week	Credits
4	2

PRACTICALS 04 - Cell and Tissue culture Techniques & IPR, Biosafety

List of Experiments

1. Introduction to general requirements of Cell and Animal tissue culture laboratory.
2. Preparation of different culture media for plant cell/ tissue culture
3. Surface sterilization of explants/seeds for callus generation
4. Animal cells: Introduction to cell culture laboratory and work in cell culture.
5. Trypsinizing and counting cells. Seeding cells for growth curve and analysis of cell growth in culture by counting.
6. Contamination of cultures
7. Preparation of media, serum, BSS, PBS, Trypsin etc.,
8. Cell viability assay by Trypan blue dye exclusion method.
9. Cytotoxicity Assay using mammalian cells.
10. Observation of cancer cells (cytology tests) by H & E staining.
11. Preparation of permanent slides Staining – Tissues in stomach/ Lung/ Kidney/ Staining –Plant tissues in stem/leaf/root.
12. Pathological cell, tissue and organ preservation and identification protocols
13. Concept of patent: product / process patents & Terminology
14. Procedure for filing of patent application and types of applications
15. Biosafety levels

Semester Three

SEMESTER THREE

No. of Hours / Week	Credits
4	4

DSC 07 - CANCER AND STEM CELL BIOLOGY

Course Objectives:

This course gives a wide outlook on cancer biology and knowledge on cell regulation under diseased conditions. Further, the subject would provide students with the goals, practices, and accomplishments of contemporary stem cell biology. This Course is intended towards providing basic knowledge of what are stem cells, their types, respective functions, regulation, and their role in revolutionizing the concept of modernregenerative medicine.

Course Outcomes:

Upon successful completion of this course, the student will be able to

CO-1. Understand the processes of cells becoming cancerous owing to cell cycle deregulation and environmental factors

CO-2. Establish embryonic & adult stem cell cultures

CO-3. Understand the ethics behind the usage of stem cells

CO-4. Assess the role of stem cells in drug discovery

CO-5. Develop awareness in interlinking genetic engineering in the field of stem cell Biology.

Unit 1:

Cancer Biology: Introduction, historical perspective, classification, Carcinogenesis, cancer initiation, promotion and progression, Cancer cell cycles, Apoptosis, Genes, and proteins as players in apoptosis, DNA viruses/ cell immortalization. Understanding Cancer as a Disease: a natural history of cancer development Free radicals, antioxidants and metabolic oxidative stress and cancer, Genetic instability and epigenomic changes in cancer (DNA methylation, histone acetylation), Epidemiology of selected cancers.

Unit 2:

Hallmarks of cancer: Tumors: benign tumours vs. malignant tumours, types of cancer, common symptoms, growth signal autonomy, evasion of growth inhibitory growth- inhibitory signals, evasion of apoptosis, unlimited replicative potential, angiogenesis, invasion, and metastasis. Molecular basis of cancer - Cancer Genes: Oncogenes and signal transduction, Transcription factors and cancer, Retroviral oncogenes, Tumor suppressor,Tumor suppressor gene pathways, DNA methylation, epigenetic silencing of suppressorgenes.

Unit 3:

Animal models of cancer: carcinogen-induced models, xenografts, genetically modified models. Current concepts in cancer therapy Strategies of anticancer chemotherapy, Strategies of anticancer gene therapy/translating therapies from the laboratory to the clinic, Gene discovery in cancer research, cancer genome anatomy project, Cancer immunity and strategies of anticancer immunotherapy, stem cells and their applicationsin cancer therapy.

Unit 4:

Stem Cells: Basics, Properties and Classification, Types of Stem cells – Hematopoietic Stem Cells, Mesenchymal Stem Cells, Embryonic Stem Cells, Fetal Stem Cells, Stem cells from adult organs Characteristics. Principles of Isolation, Culture and Characterization of stem cells - Three-Dimensional Cell Culture, Organ Culture, Organotypic Culture. Stem cell markers & their identification.

Recommended Textbooks and References

1. Molecular biology of the cell – 5th Edition by Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter.
2. Textbook of biochemistry for medical students – 7th Edition D.M. Vasudevan, S. Sreekumari, Kannan Vaidyanathan.
3. Genes IX. By Benzamin Benjamin Lewin. R. Lanza, J. Gearhart et al (Eds), Essential ofStem Cell Biology. (2009), Elsevier Academic Press.
4. R. Lanza and I. Klimanskaya, Essential Stem Cells Methods. (2009), Academic Press
5. J. J. Mao, G. Vunjak-Novakovic et al (Ed): Translational Approaches in Tissue Engineering & Regenerative Medicine 2008, Artech House, INC Publications.
6. Robert Lanza et al. Principles of Tissue Engineering, 3rd Edition. Academic Press; 3edition (August 21, 2007)
7. Stein et al. Human Stem Cell Technology and Biology: A Research Guide and Laboratory Manual. Wiley-Blackwell; 1 edition (January 4, 2011).
8. Lanza et al. Handbook of Stem Cells, Two-Volume Set: Volume 1-Embryonic Stem Cells; Volume 2-Adult & Fetal Stem Cells (v. 1). Academic Press (September 28, 2004).

SEMESTER THREE

No. of Hours / Week	Credits
4	4

DSC 08 – MEDICAL GENETICS AND RARE DISEASES

Course Objectives:

The objective of the course is to introduce molecular and gene technology from an evolutionary perspective, and about the methods that are used in the area. The possibilities and limitations of the gene technology are discussed. Looking at the vast implications, topics on Bioethics and Biosafety, implicit in such a technology will also be covered.

Course Outcomes:

Upon successful completion of this course, the student will be able to:

CO-1. To demonstrate the ability to approach a scientific report in a systematic manner

CO-2. To be able to highlight the significance of specific signaling pathways in rarediseases.

CO-3. To demonstrate understanding of the role of neutrophils in infection-induced necrosis.

CO-4. To be able to discuss the role of proteins involved in the cardiovascular system and how they affect inflammation.

CO-5. To demonstrate understanding of how neural component modulates tissue regeneration.

Unit 1:

Molecular Medicine: Introduction, Basic Principles in Human Pathology, General pathology–cell injury causes. Reversible injury – Types, morphology, swelling, hyaline, fatty change; Irreversible injury – Types of necrosis, apoptosis, calcification, dystrophic, Metastasis.

Unit 2:

Molecular basis of genetics: Concepts of disease, Monogenetic Disorders, Multifactorial Disorders. Molecular Basis of Diseases - Mechanisms of Host Defence, Complement System in Health and Disease, Molecular mechanisms of bacterial, viral, and parasite pathogenesis. Molecular Patho mechanism: Specific disease Systems - Cardiovascular system (Myocardial infarction, respiratory system (tuberculosis), nervous system (parkinsonism), bone and joints (arthritis), muscle (ALS).

Unit 3:

Bioimaging and cell analysis: FACS analysis, Fluorescence microscopes and confocal laser scanning microscopes, fluorescent dyes. Molecular Analysis - STR genotyping, DNA methylation analysis, Chromatin immunoprecipitation analysis of histone modifications, Proximity Ligation Assay (PLA) in solution *in situ*, differentiation of stem cells and digital image analysis.

Unit 4:

Genomic and Epigenomic Medicine: High throughput sequencing - SOLiD, Illumina, 454FLX. chromatin immunoprecipitation (ChIP), assessing a cancer drug's effect on the epigenetic status at promoters and enhancers. HTS (ChIP-Seq). Proximity Ligation Assay

(PLA) both in solution and *in situ*, Human Proteome Atlas, personal genome project (PGP) and current personalized medicines.

Recommended Textbooks and References

1. John M. Davis. Animal Cell Culture: Essential Methods. Wiley; 1 edition (June 13, 2011)
2. Textbook of Microbiology by R. Ananthanarayan and C.K. Jayaram Paniker (Nov 1990)
3. Robbins. Basic Pathology, 8/e 2007. Saunders 2007
4. Parakrama Chandrasoma. Concise Pathology. McGraw-Hill Publishing Co; 3rd edition (June 25, 1997)
5. Peter John Wood. Understanding Immunology. Prentice-Hall; 2 edition (8 Feb 2006)
6. Prescott, *et. al*. Microbiology. William C. Brown; 4Rev Ed edition (September 1998)
7. Tizard. Immunology: An Introduction. Brooks Cole; 4 edition (December 8, 1994)
8. Roitt's Essential Immunology, Tenth Edition (Essentials). Wiley-Blackwell;10 edition (August 16, 2001).
9. James G. Cappuccino and Natalie Sherman. Microbiology: A Laboratory Manual, 7/e. Pearson Education 2007
10. B DISTRICTS. Manual of Molecular and Clinical Laboratory Immunology: 7th Edn. ASM Press; 7th revised edition (2006).

SEMESTER THREE

No. of Hours / Week	Credits
4	4

DSC 09 – CONCEPTS OF RADIOBIOLOGY

Course Objectives:

The objective of the course is to impart knowledge on principles of radiation protection and biology. Radiation effects on cellular, organ, system and levels throughout the body are among the principles and concepts covered. Emphasis on the theories and principles of tolerance dose, time-dose relationships, fractionation schemes, and their application in radiation therapy clinical practice.

Course Outcomes:

Upon successful completion of this course, the student will be able to

CO-1. They can demonstrate radiation protection practices and fundamentals of radiation biology.

CO-2. Describe the direct and indirect interactions of radiation with cells and the molecular mechanisms underlying cellular radiosensitivity.

CO-3. Explain how the cell cycle, repair, repopulation, and reoxygenation affect tissue radiosensitivity and the elements of a cell survival curve.

CO-4. Distinguish between cell survival curves of varying LET radiations, hypoxic and aerated cells, and cell cycle phases.

CO-5. Determine the immediate and long-term effects of radiation on living tissue.

C0-6. Explain the consequences of whole-body radiation.

CO-7. Explain how radiation affects the developing embryo and fetus at each stage.

Unit 1:

Introduction to Radiation Biology: Quantities and Units – Exposure, absorbed dose, Equivalent dose, Effective dose, Collective dose, Principles of radiation dosimetry, Direct and indirect effects. Interaction of X-Radiation with Matter - Sources of ionizing radiation, Types of ionizing radiation, Particulate radiations, Linear energy transfer, Radiation dose and units.

Unit 2:

Radiation lesions: in DNA, Major types of DNA repair, Damage recognition and signaling, Consequences of unrepaired DNA damage: chromosome damage, Radiobiological definition of cell death, Survival curves and models, Cell cycle effects, Relative biological effectiveness (RBE), Cellular repair exemplified in survival curves.

Unit 3:

Cellular hyper-radio sensitivity: (HRS) and induced repair (IRR), other molecular targets: bystander (epigenetic) effects, Radiation sensitizers, Radiation protectors. Cellular and tissue response, Acute tissue responses, Late tissue responses, Predicting normal tissue response, Therapeutic ratio, Whole-body irradiation.

Unit 4:

Epidemiological studies: in radiation-exposed populations, Mechanisms of radiation-induced cancer, Radiation effects in the developing embryo and fetus, Radiation-induced heritable diseases. Predicting the response of tumors: Predicting normal tissue response, combined radiation and drug treatments, Clinical radiobiology of commoncancers.

Recommended Textbooks and References

1. Fliedner, T.M., Friesecke, I., Beyrer, K., Medical management of radiation accidents-manual on the acute radiation syndrome. British Institute of Radiology Supplement (2001).

2. Albert van der Kogel, Michael C. Joiner 2009 Michael C. Joiner Basic Clinical Radiobiology 4TH Edition.

3. Handbook Of Radiobiology, 2016.Kuppusamy Thayalan.

4. https://www.ebooks.com/624229/elements-of-radiobiology/selman-joseph/

SEMESTER THREE

No. of Hours / Week	Credits
4	4

DSE 03a - SEQUENCE ANALYSIS & PHARMACOGENOMICS

Course Objectives:
Gene sequences and the rest of the genome play an important role in determining how an organism functions normally and reacts when situations change. The details of this data reveal basic information such as gene and protein structures or may lead us to major discoveries like gene-disease associations.

Course Outcomes:
After the successful completion of the course, the students will be able to:
CO-1. This paper teaches the bioinformatics skills used in academic, biotech, and pharmaceutical laboratories for analyzing individual DNA and protein sequences.

CO-2. To describe the effect of plasma and tissue protein binding on pharmacokinetic parameters

CO-3. To understand the time course of drug accumulation in the body during a constant rate infusion and the concept of steady state.

CO-4. To formulate a compartmental model for a given drug.

CO-5. To understand the roles of transporters in drug absorption, distribution, and elimination.

CO-6. To understand the functional outcome of drug action based on receptor-ligand binding.

Unit 1:
Biological Literature Information access: Origins and History - Main Sub-disciplines of Bioinformatics, Knowledge on freeware and commercial software. Importance of hardware and software creations. Sequencing Databases.

Unit 2:
Data-alignment and applications: Collecting and Storing Sequence Data: Sequence assembly; Submission of Sequences; Sequence accuracy; Sequence databases; Sequence formats; Conversion between formats; EST databases; SNP databases; Annotation and Archival. Sequence alignment and applications: Uses: Choice to be made for alignment; Scoring matrices; Homology and related concepts; Dot Matrix methods; Dynamic programming methods for global and local alignments tools- FASTA, BLAST, statistical and biological significance.

Unit 3:
Nucleic acid sequence analysis: Reading frames; Codon Usage analysis; Translational and transcriptional signals; Splice site identification; Gene prediction methods; RNA fold analysis. Second-generation sequencing techniques – Pyrosequencing and Virtual terminator Sequencing.

Unit 4:

Multiple Sequence alignment and applications: Uses; Methods available- Iterative alignment, Progressive alignment – Clustal W, T-Coffee; Profile Methods – Gribskov profile, PSI-BLAST, HMM; Clustering and Phylogeny.

Methods for Phylogeny analysis: Distance and Character based character-based methods; Motif detection; Protein family databases; Use of Structure-based sequence alignment.
Protein sequence analysis: Compositional analysis; Hydrophobicity profiles; Amphiphilicity detection; Moment analysis; Transmembrane prediction methods; Secondary structure prediction methods.

Recommended Textbooks and References

1. Current Protocols in Bioinformatics, Edited by A.D. Baxevanis *et al*, Wiley Publishers. 2005.
2. Computational Molecular Biology by P. A. Pevzner, Prentice Hall of India Ltd. 2004
3. Bioinformatics by David W. Mount, Cold Spring Harbor Laboratory Press. 2001
4. Fundamental concepts of Bioinformatics by D.E. Krane and M.L Raymer, Pearson Education. 2003

SEMESTER THREE

No. of Hours / Week	Credits
4	4

DSE 03b – APPLICATIONS OF GENOMICS AND PROTEOMICS

Course Objectives:

The objective of the course deals with various aspects of bioinformatics applications generating useful biological information on genome structure, function, and evolutionary relationships. The paper teaches the bioinformatics skills used in academic, biotech, and pharmaceutical laboratories for analyzing individual DNA and protein sequences.

Course Outcomes:

Upon successful completion of this course, the student will be able to

CO-1. The career prospects in genomics and proteomics have been steadily increasing with more and more use of information technology in the field of molecular biology.

CO-2. Understand the fundamental biochemical mechanisms are tightly regulated

C0-3. understand alterations of molecular signals in biochemical pathway leads to disease like cancer.

CO-4. Know the biochemical changes at the protein level during the disease process can be identified using proteomics technology.

CO-5. The use of proteomics techniques for the identification of biomarkers of diagnostics and therapeutic significance.

Unit 1:

Genomics: Definition & types, Eukaryotic and prokaryotic genomes. Genomic databases of model organisms. EST, genome and Bali base database. Comparative genomics: Basic concepts and applications, Comparative genomics databases & understanding the significance of EXPACY TOOLS, NCBI TOOLS, EMBOSS, FASTA, BLAST, Clustal W, ORF Plotting, Gene Finding, Translation using Emboss. Primer and probes designing wares. Functional genomics: Application of sequence-based and structure-based approaches to the assignment of gene functions – e.g., sequence comparison, structure analysis (especially active sites, binding sites) and comparison, pattern identification, etc. Use of various derived active sites, binding sites) and comparison, pattern identification, etc. Use of various derived databases in function assignment, use of SNPs for identification of genetic traits. Gene/Protein function prediction using Machine learning tools viz. Neural network, SVM etc

Unit 2:

Phylogenetic Analysis: Phylogenetics data analysis, Tree building methods, Rooted tree, unrooted tree, Distance method, UPGMA, NJ, Fitch- Margoliash, Minimum Evolution, Character-based methods - Maximum Likelihood and Maximum Parsimony methods, Software's: Phylip. Molecular Clocks and Estimation of Divergence Time.

Unit 3:

Protein sequence analysis: using software's: Emboss, Data mining proteomes, Motif mapping using Prosite, Prodom, protein expression profiling, protein-protein interactions, protein complexes. Mapping protein modifications. Protein secondary structure analysis, Molecular visualization protein 3D structure using Rasmol, PDB file format. Introduction to basic concepts, Molecular recognition by receptor and ligand design, Generation of Rational Approaches in Drug design, Introduction to drug designing, discovering a drug, Target identification and validation, Identifying the lead compound, Optimization of the lead compound.

Unit 4:

Docking methods: introduction, three-dimensional descriptions of binding site environment and Energy calculation, Automatic Docking Method, Three-Dimensional database search Approaches, Design of ligands, Drug-receptor interactions automated structure Construction methods, AUTODOCK.

Recommended Textbooks and References

1. Bioinformatics and Functional Genomics by Pevsner, J., John Wiley and Sons, New Jersey, USA. 2003
2. Principles of Genome Analysis and Genomics (3rd Ed.) by Primrose, S.B. and Twyman,R.M., Blackwell Publishing Company, Oxford, UK.
3. Introduction to proteomics – Tools for the new biology (1st Ed.) by Liebler, D.C., 2002, Human Press Inc., New Jersey, USA.
4. Bioinformatics: Sequence and Genome Analysis by Mount, D., Cold Spring Harbor Laboratory Press, New York. 2004

SEMESTER THREE

No. of Hours / Week	Credits
2	2

SEC 03 – RESEARCH DESIGN AND METHODOLOGY

Course Objectives:

The course was designed in such a way to get hands-on training in the Biochemical methods in the aspect of doing research and to impart the knowledge of Statistics and Design of Experiments to the students. This will help the students to have a focused idea about the research methodologies and how to write research findings with the help of biostatistics and computer.

Course Outcomes:

Upon successful completion of this course, the student will be able to

CO-1. Understand the basic concepts of ethics in the proper conduct of researchCO-2. Understand plagiarism in research and how it should be avoided.

CO-3. Gain a clear idea about the importance of proper data documentation

CO-4. Study applications of statistical tools like Mean, Median, Mode, Standard deviation, Standard error, 't-test and ANOVA in biological research.

CO-5. Explore a selection of test material, design an experiment, different methods of literature collection.

CO-6. Learn how to prepare a dissertation, preparation of articles, communication of articles to journals

CO-7. Students will have a clear idea about the research methodologies that need to be adopted during their research

Unit 1:

Research Formulation and Design: Motivation and objectives – Research methods vs. Methodology. Types of research – Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical, the concept of the applied and basic research process, criteria of good research. Defining and formulating the research problem, selecting the problem, the necessity of defining the problem, the importance of literature review in defining a problem, literature review-primary and secondary sources, reviews, monograph, patents, research databases, web as a source, searching the web, critical literature review, identifying gap areas from literature and research database, development of a working hypothesis.

Unit 2:

Research design: Meaning, Need, Features of Good Design, Concepts, Types. Basic principles of Experimental Design, various methods of Research. The survey, Philosophical, Historical, Experimental, Causal Comparative, Genetic, Case Studies. Tools for Data Collection: Collections of Primary Data, Collection of Data through questionnaire and Schedules, other Observation Interview Methods, Collection of Secondary Data, Selection of the appropriate method for data collection, Case Study, Focus Group Discussion, Techniques of developing research tools, viz. Questionnaire and rating scales etc. Reliability and validity of research tools.

Accepts of method validation: observation and collection of data, methods of data collection, sampling methods, data processing and analysis strategies and tools, data analysis with static package (Sigma STAT, SPSS for student t-test, ANOVA, etc.), hypothesis testing.

Unit 3:

Introduction, overview and research: misconduct, rules and regulations in India, data management, mentoring, mentor-mentee responsibilities, authorship guidelines, publication and peer review, intellectual property, plagiarism, patents, collaboration, reporting and representation research, representing images, bias, conflicts of interest, ethical use of animal subjects, protection of human subjects, stem cell ethics, Eco sourcing code of practice, radioactive, chemical and biohazard safety, waste management and disposal, social responsibility.

Unit 4:

Meaning of Interpretation: Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports, Conclusions.

Recommended Textbooks and References

1. Anthony, M., Graziano, A.M. and Raulin, M.L., 2009. Research Methods: A Process of Inquiry, Allyn and Bacon.
2. Carlos, C.M., 2000. Intellectual property rights, the WTO and developing countries: the TRIPS agreement and policy options. Zed Books, New York.
3. Coley, S.M. and Sheinberg, C. A., 1990, "Proposal Writing", Sage Publications.
4. Day, R.A., 1992.How to Write and Publish a Scientific Paper, Cambridge University Press.
5. Fink, A., 2009. Conducting Research Literature Reviews: From the Internet to Paper. Sage Publications.
6. Leedy, P.D. and Ormrod, J.E., 2004 Practical Research: Planning and Design,Prentice-Hall.
7. Savarkar, S.V., 2000. Intellectual property rights and copyrights. Ess Ess Publications.
8. C. Neal Stewart Jr. Research Ethics for Scientists, Wiley-Backwell Publishers, 2011.
9. John D'Angelo. Ethics in Science, Ethical Misconduct in Scientific Research, CRC Press, 2012.

SEMESTER THREE

No. of Hours / Week	Credits
4	2

PRACTICALS 05 - Applications of Genomics & Proteomics

List of Experiments

1. Knowledge of different biological database
2. Protein and gene sequence databases (NCBI, DDBJ, EMBL, SWISS PROT, PIR)
3. Structure databases (MMDB, PDB, FSSP, CATH, SCOP)
4. Pathway Databases (KEGG, BRENDA, METACYC, ECOCYC)
5. Bibliographic database (PUBMED, MEDLINE)
6. Sequence retrieval from the biological database
7. Gene prediction methods 4.
8. Analysis of protein sequence using Expasy.
9. Sequence similarity searching of nucleotide sequences
10. Sequence similarity searching of protein sequences
11. Multiple sequence alignment
12. Dynamic programming method- local alignment
13. Dynamic programming method-global alignment

No. of Hours / Week	Credits
4	2

PRACTICALS 06 - Advanced Molecular Techniques

List of Experiments

1. Isolation of DNA from cell lines.
2. Isolation of RNA from cell lines.
3. Polymerase Chain Reaction and analysis.
4. Agarose gel electrophoresis
5. Protein isolation from the cell lines/ Chick liver samples
6. Western blotting of proteins.
7. Observation of cancer cells (cytology tests) by H & E staining.
8. Isolation of DNA and demonstration of apoptosis of DNA laddering.
9. Isolation of plasma
10. Ligation of restricted fragments.
11. Transformation of the plasmid to Bacteria
12. Restriction Digestion of DNA and plasmids
13. Molecular diagnosis.
14. Preparation of Competent Cells
15. DNA Extraction from Agarose Gel
16. Photographs and charts related to signal transduction mechanisms.

Semester Four

SEMESTER FOUR

DISSERTATION

Course Type	Marks	Credits	L	T	P	C
Project	**300**					**12**

The student shall carryout, a semester long project work under the supervision/mentorship of identified guide (internal or external or both). The project work shall be compiled and submitted in the form of dissertation as per the format. The project work shall be original research work related to the Programme or case studies that provide an analysis of specific research questions/socio-economic issues, etc. leading to a dissertation as partial fulfilment of the degree.

Question Paper Pattern

MODEL QUESTION PAPER **QP CODE:**

JSS Academy of Higher Education & Research, Mysuru
(Deemed to be University)
First Semester M.Sc., (Program) (RS-1) Examination - Year
Subject:

Note: *Draw neat, labeled diagrams wherever necessary.*
Your answers should be specific to the questions asked.

Time: 03 Hours **Max Marks: 70**

I. LONG ESSAYS (Answer any TWO of the following) **2x15=30 Marks**

1.
2.
3.

II. SHORT ESSAYS (Answer any FIVE of the following) **5x6=30 Marks**

4.
5.
6.
7.
8.
9.
10.

III. SHORT ANSWERS (Answer all the following) **5x2=10 Marks**

11.
12.
13.
14.
15.

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MODEL QUESTION PAPER **QP CODE:**

JSS Academy of Higher Education & Research, Mysuru

(Deemed to be University)

First Semester M.Sc., (Program) (RS-1) Examination - Year

Subject:

Note: *Draw neat, labeled diagrams wherever necessary.*

Your answers should be specific to the questions asked.

Time: 02 Hours **Max Marks: 50**

I LONG ESSAYS (Answer any TWO of the following) **2x10=20 Marks**

1.
2.
3.

II SHORT ESSAYS (Answer any FIVE of the following) **5x4=20 Marks**

4.
5.
6.
7.
8.
9.
10.

III SHORT ANSWERS (Answer all the following) **5x2=10 Marks**

11.
12.
13.
14.
15.

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