DEPARTMENT OF LIFE SCIENCES AND BIOTECHNOLOGY

SCHOOL OF LIFE SCIENCES & BIOTECHNOLOGY

C.S.J.M. UNIVERSITY, KANPUR

Learning Outcome Based Curriculum

M.Sc. Life Sciences (Revised as per NEP 2020)

(Introduced from Academic Year 2022-23)

13/5/22

Prof. B N Mishra (Online) – External

Prof. Ram Narain (Online) – External

1. Preamble-

Under the academic and research development programme, the Department of Life Sciences was established in the main residential campus of Chhatrapati Shahu Ji Maharaj University (formerly Kanpur University), Kanpur in year 1983 to impart and promote multi- and interdisciplinary higher education in Life Sciences by utilizing the modern concepts of teaching and research at bachelors, masters and doctoral level. Life sciences is the scientific study of living things, including plants, animals, humans and microorganisms like bacteria. Those pursuing careers in the life sciences typically have degrees in biology, ecology, environmental science, life science or a related subject like chemistry. Careers in the life sciences are diverse and one can apply to many industries. For example, these scientists may work in different sectors as:

Biomedical Scientist: - Biomedical scientists examine medical samples, for example, of blood and tissue, helping doctors to diagnose and treat diseases. They use their knowledge and test results to advice and support doctors and other medical staff.
Research Assistant: - A research assistant is a researcher employed, often on a temporary contract, by a university or a research institute, for the purpose of assisting in academic research. Research assistants are not independent and not directly responsible for the outcome of the research and are responsible to a supervisor or principal investigator.
Biotechnologist: - Biotechnologists combine biology, the science of living things, with technology. They research and develop the use of biology to solve problems in areas such as health care, the pharmaceutical and chemical industries, agriculture, food production and environmental protection
Biochemist: - Biochemists study the chemistry of life. They investigate life's processes at the level of molecules, using their knowledge to identify and solve biological problems. They research and develop new products and processes to benefit a wide range of areas, including food processing, pharmaceuticals, health care and agriculture.
Computational Biologist: - Computational biology involves the development and application of data-analytical and theoretical methods, mathematical modelling and computational simulation techniques to the study of biological, behavioral, and social systems. The field is broadly defined and includes foundations in computer science, applied mathematics, animation, statistics, biochemistry, chemistry, biophysics, molecular biology, genetics, genomics, ecology, evolution, anatomy, neuroscience, and visualization
Microbiologist: - Microbiologists study the biology and chemistry of microbes. They apply their knowledge to solve problems in areas like agriculture, food production, the water industry, medicine and pharmaceuticals, and to manage and protect the environment.
Clinical Research Associate: - Clinical research associates organize and run trials to test the safety of new medicines and to see if they work well. They choose and set up sites where tests take place, supervise trials and monitor the quality of data from the trials.
Industrial Pharmacist: - Industrial pharmacists are involved in the discovery and development of safe, effective drugs and medicines. They can work at any stage of the process, including research, development, clinical trials, overseeing production, quality testing, marketing and applying to have the drug legally registered.

1. Learning Outcomes based approach to Curriculum Planning:

The learning outcomes based curriculum framework for MSc Life Sciences defines understanding and knowledge of the subject as well as the technical and practical aspects such as students graduating in Life Sciences demonstrate the requisite skills required to function as a competent

biologist after acquiring the degree. The curriculum developed, teaching –learning outcomes and the assessment strategies are such that the students are able to apply their knowledge and training of different aspects of cutting edge research and technology to solve the biological problems for human welfares.

2. Postgraduate Attributes in Life Sciences:

- Develop highly skilled and knowledgeable members of the society that can use their enhancements for solving real life problems.
- Develop outlook and attitude, develop the current skills and abilities, and learn new capabilities to contribute as global citizens.
- Develop a research oriented, problem and critical thinking outlook towards to different problems and have ability to think through in out of box innovative manner using skills and training imparted to them.
- Enhance student's academic career of the students, increase their employability, and train them as entrepreneurs.
- Enhance abilities to develop a positive approach and requisite soft skills, socialisticapproach, team contributors and leadership qualities for successful career and personal life choices.
- Provide highly skilled and knowledgeable human resources for all domains of scientific quests such as agricultural sector, food industry, dairy industry, medical and paramedical field,pharmaceutical, space research and research institutes.

3. Vision Statement of MSc program

Our vision is to become global leader in the field of Biological Sciences and to create excellence in research, promote innovation and encourage entrepreneurial activity and disseminating knowledge by providing inspirational learning to produce professional leaders for serving the society.

4. Mission Statement

The mission of the Life Sciences programme is to provide:

1. A learning environment that encourages post graduate student about holistic biology and the its applications in different fields of science
2. Fundamental research training for students who will become future leaders in science, medicine, and industry;
3. Create awareness about the significance and scope of Life Sciences amongst students and local and global citizens through research, awareness programs, conferences, seminar organizations.
4. Conduct research that advances the frontiers of knowledge in the field of Life Sciences.

5. Programme Outcome:

The aim and objectives of the Life Sciences program essentially focus todevelop skills of student for a successful career.

PO.1: Domain knowledge: Demonstrate knowledge of basic concepts, principles and applications of the specific science discipline.

PO.2: Resource Utilization: Cultivate the skills to acquire and use appropriate learning resources including library, e-learning resources, and ICT tools to enhance knowledge base and stay abreast of recent developments.

PO.3: Analytical and Technical Skills: Ability to handle/use appropriate tools/techniques/equipment with an understanding of the standard operating procedures, safety aspects/limitations.

PO.4: Critical thinking and Problem solving: Identify and critically analyze pertinent problems in the relevant discipline using appropriate tools and techniques as well as approaches to arrive at viable conclusions/solutions.

PO.5: Project Management: Demonstrate knowledge and scientific understanding to identify research problems, design experiments, use appropriate methodologies, analyze and interpret data and provide solutions. Exhibit organizational skills and the ability to manage time and resources.

PO:6: Individual and team work: Exhibit the potential to effectively accomplish tasks independently and as a member or leader in diverse teams, and in multidisciplinary settings.

PO.7: Effective Communication: Communicate effectively in spoken and written form as well as through electronic media with the scientific community as well as with society at large. Demonstrate the ability to write dissertations, reports, make effective presentations and documentation.

PO.8: Environment and Society: Analyze the impact of scientific and technological advances on the environment and society and the need for sustainable development.

PO.9: Ethics: Commitment to professional ethics and responsibilities.

PO.10 Life-long learning: Ability to engage in life-long learning in the context of the rapid developments in the discipline.

6. Programme Specific Outcomes:

PSO.1 To demonstrate competency in factual content and interpretation of the major biological concept areas of cell and molecular biology, genetics, organismal biology, and evolution and ecology etc.

PSO.2 To demonstrate the ability to identify significant biological research questions, develop research protocols, and properly analyze research questions through the use of the scientific methods.

PSO.3 To enhance analytical and quantitative skills and demonstrate an understanding of basic computational and statistical techniques in the field of Life Sciences.

PSO.4 To define and demonstrate utility of basic laboratory skills in the animal and plant biology research with ethics.

PSO.5 They are trained to operate advance and sophisticated instruments that help quantify and analyze the computer generated data hence develop employability skills.

PSO.6 Communicate deep biological concepts through effective written and oral presentation.

CHHATRAPATI SHAHU JI MAHARAJ UNIVERSITY, KANPUR

STRUCTURE OF SYLLABUS FOR THE

PROGRAM: M.Sc., SUBJECT: LIFE SCIENCES

Syllabus Developed by			
Name of BoS Convenor / BoS Member	**Designation**	**Department**	**College/University**
Prof S K Awasthi	Dean, Faculty of Life Sciences	Life Sciences & Biotechnology	CSJM University Kanpur
Prof. Nand Lal	Professor, Head & Convenor	Life Sciences & Biotechnology	CSJM University Kanpur
Prof. Neelam Pathak	External Expert	Biochemistry	RMLAU, Ayodhaya
Prof. Ram Narain	External Expert	Biotechnology	VBS Purvanchal University, Jaunpur
Prof. B N Mishra	External Expert	Biotechnology	Instt. Of Engineering &Technology, Lucknow
Prof. Varsha Gupta	Professor	Life Sciences & Biotechnology	CSJM University Kanpur
Prof. Rolee Sharma	Professor	Life Sciences & Biotechnology	CSJM University Kanpur
Dr. Shilpa Deshpande Kaistha	Associate Professor	Life Sciences & Biotechnology	CSJM University Kanpur

IST YEAR / IST SEM						
COURSE CODE	**TYPE**	**COURSE TITLE**	**MIN CREDITS**	**CIA**	**ESE**	**MAX. MARKS**
L010701T	CORE	Biochemistry	4	25	75	100
L010702T	CORE	Microbiology	4	25	75	100
L010703T	CORE	Cell Biology	4	25	75	100
L010704T	CORE	Genetics	4	25	75	100
	MINOR ELECTIVE*	Physiology of Exercise	4	25	75	100
		Drug Delivery System				
		Indian Ethos and Values				
L010705P	PRACTICAL	Life Sciences Practicals-1	4	25	75	100
		Research project				
	TOTAL		24			600
IST YEAR / IIND SEM						
L010801T	CORE	Molecular Biology	4	25	75	100
L010802T	CORE	Immunology and Immunotechnology	4	25	75	100
L010803T	CORE	Bio Physics and Structural Biology	4	25	75	100
L010804T	ELECTIVE	Animal Physiology	4	25	75	100
L010805T		Plant and Microbial Physiology				
L010806P	PRACTICAL	Life Sciences Practicals-2	4	25	75	100
L010807R		Research project	8	25	75	100
	TOTAL		28			600
IIND YEAR / IIIRD SEM						
L010901T	CORE	Developmental Biology	4	25	75	100
L010902T	CORE	Computational Biology Bioinformatics and Biostatistics	4	25	75	100
L010903T	ELECTIVE (ANY FOUR)	Molecular Genetics & Genetic Engineering	4	25	75	100
L010904T		Molecular Cancer Biology				
L010905T		Neurophysiology				
L010906T		Enzymology and Enzyme Technology	4	25	75	100
L010907T		Pluripotent Stem Cells & Reproduction	4	25	75	100

CHHATRAPATI SHAHU JI MAHARAJ UNIVERSITY, KANPUR

STRUCTURE OF SYLLABUS FOR THE

PROGRAM: M.Sc., SUBJECT: LIFE SCIENCES

L010908T		Ecology & Biodiversity	4	25	75	100
L010909T		Redox Biology				
		Dissertation				
	TOTAL		24			600
IIND YEAR / IVTH SEM						
L011001T	ELECTIVE (ANY FOUR)	Neural and Behavioural Biology	4	25	75	100
L011002T		Plant Biotechnology	4	25	75	100
L011003T		Molecular Parasitology	4	25	75	100
L011004T		Radiation Biology	4	25	75	100
L011005T		Microbial Biotechnology	4	25	75	100
L011006T		Nano-Biotechnology	4	25	75	100
L011007T		Hormone Action & Metabolic Disorder	4	25	75	100
L011008R		Dissertation	8	25	75	100
	TOTAL		24			500
GRAND TOTAL			100			2300

NOTE:

1. *A MINOR ELECTIVE FROM OTHER FACULTY SHALL BE CHOSEN IN 1ST YEAR (EITHER Ist / IInd SEMESTER) AS PER AVAILABILITY.
2. In both years of PG program, there will be a Research Project or equivalently a research-oriented Dissertation as per guidelines issued earlier and will be of 4 credit (4 hr/week), in each semester. The student shall submit a report/dissertation for evaluation at the end of the year, which will be therefore of 8 credits and 100 marks
3. Research project can be done in form of Internship/Survey/Field work/Research project/ Industrial training, and a report/dissertation shall be submitted that shall be evaluated via seminar/presentation and viva voce.
4. The student straight away will be awarded 25 marks if he publishes a research paper on the topic of Research Project or Dissertation.

M.Sc. Life Sciences Course – Structure (As per NEP 2020)

M.Sc. Semester - I **Total Marks : 600**

All Compulsory Courses

S.No.	Course Code	TYPE	Course Title	Marks	CIA	ESE	Credits
1	L010701T	CORE	Biochemistry	100	25	75	4
2	L010702T	CORE	Microbiology	100	25	75	4
3	L010703T	CORE	Cell Biology	100	25	75	4
4	L010704T	CORE	Genetics	100	25	75	4
5	L010705P	PRACTICAL	Life Sciences Practical's	100	25	75	4

Minor elective Paper (from other Faculty)

S.No.	Couse Code	TYPE	Course Title	Marks	CIA	ESE	Credits
1		MINOR ELECTIVE	Open Elective - Physiology of Exercise/Drug Delivery System /Indian Ethos and Value /.....	100	25	75	4
Research Project				--			

Total Credits : 24

M.Sc. Semester - II **Total Marks : 600**

Compulsory Courses

S.No.	Course Code	TYPE	Course Title	Marks	CIA	ESE	Credits
1	L010801T	CORE	Molecular Biology	100	25	75	4
2	L010802T	CORE	Immunology and Immunotechnology	100	25	75	4
3	L010803T	CORE	Bio Physics and Structural Biology	100	25	75	4
Optional courses (any one)							
4	L010804T	ELECTIVE	Animal Physiology	100	25	75	4
		OR					
	L010805T	ELECTIVE	Plant and Microbial Physiology	100	25	75	4
5	L010806P	PRACTICAL	Life Sciences Practical's	100	25	75	4
L010807R Research Project				100	25	75	8

Total Credits : 28

M.Sc. Semester - III

Total Marks : 600

Compulsory Courses

S.No.	Course Code	TYPE	Course Title	Marks	CIA	ESE	Credits
1	L010901T	CORE	Developmental Biology	100	25	75	4
2	L010902T	CORE	Computational Biology, Bioinformatics and Biostatistics	100	25	75	4
Optional (Any Four Papers)							
3	L010903T	CORE	Molecular Genetics and Genetic Engineering	100	25	75	4
4	L010904T	CORE	Molecular Cancer Biology	100	25	75	4
5	L010905T	CORE	Neurophysiology	100	25	75	4
6	L010906T	CORE	Enzymology and Enzyme Technology	100	25	75	4
7	L010907T	CORE	Pluripotent Stem Cells and Reproduction	100	25	75	4
8	L010908T	CORE	Ecology and Biodiversity	100	25	75	4
9	L010909T	CORE	Redox Biology	100	25	75	4
10			Dissertation				

Total Credits : 24

M.Sc. Semester - IV

Total Marks : 600

Optional (Any Four Papers)

S.No.	Course Code	TYPE	Course Title	Marks	CIA	ESE	Credits
1	L011001T	CORE	Neural and Behavioral Biology	100	25	75	4
2	L011002T	CORE	Plant Biotechnology	100	25	75	4
3	L011003T	CORE	Molecular Parasitology	100	25	75	4
4	L011004T	CORE	Radiation Biology	100	25	75	4
5	L011005T	CORE	Microbial Biotechnology	100	25	75	4
6	L011006T	CORE	Nano-Biotechnology	100	25	75	4
7	L011007T	CORE	Hormone Action & Metabolic Disorder	100	25	75	4

Compulsory

S.No.	Course Code		Course Title	Marks	CIA	ESE	Credits
8	L011008T		Dissertation (to be pursued during III and IV Sem.)	200	25	75	8

Total Credits : 24

Chhatrapati Shahu Ji Maharaj University, Kanpur
M.Sc. Life Sciences
Course – Structure w.e.f. July 2022

M.Sc. Life Sciences I[st] Semester Course Title – Biochemistry **Code : L010701T**

Course Objective(s)

1. To provide an advanced understanding of the core principles and topics of the Biochemistry and their experimental basis,
2. To enable the students to acquire a specialized knowledge and understanding of selected aspects by means of a stem/branch lecture series and a research project.
3. To train the candidates for the emerging field of biochemistry.

Marks : 100

S.N.	Topic
1	An overview of Biochemistry, Cellular environment and applicability of basic laws of chemistry and thermodynamics Concept of small and macromolecules. Molecular interactions and its importance in understanding cellular processes.
2	Macromolecules proteins, polysaccharides, lipids. glycoproteins, glycolipids, Lipoproteins, lipopolysaccharides, Protein modifications and their functional implications
3	Primary characterization of proteins, isolation and chromatographic Purification of proteins, ultracentrifugation, sequence determination
4	Structure of amino acids and peptide bonds, Ramachandran Plot. alpha helical and beta-pleated structures, structures of fibroin Proteins like keratin. fibroin, elastin and collagen.
5	Dynamics of protein structure, protein stability, globular proteins and maintenance of specific confirmation, structural motifs commonly found in various proteins and their functional
6	Basic concepts of protein folding, folding pathways role of accessory proteins in protein
7	Structure of hemoglobin, oxygen binding kinetic and its relation to its structure mechanisms of cooperativity in oxygen binding.
8	Monosaccharides and derivatives of sugars, polysaccharides, glycosaminoglycan, proteoglycans, protein glycosylation and its significance
9	Fatty acids, tri-aryl-glycerol, glycerol phospholipids sphingolipids, Cholesterol lipid bilayers
10	Nucleic acid, DNA as a genetic material, Primary and Secondary structure of DNA and RNA, Basic mechanism of DNA replication
11	Introduction of Enzymes, Mechanism of Enzymes action, Unit of an Enzymes, Enzymes inhibition, Ribozymes and Abzymes.

Course Outcome(s)

Students should be able to:

1. Gain fundamental knowledge in biochemistry;
2. Obtain an idea on structure and functioning of biologically important molecules.
3. Understand the molecular basis of various pathological conditions from the perspective of biochemical reactions.
4. Explain principles of enzyme catalysis and catalytic strategies with specific examples
5. Use current biochemical and molecular techniques to plan and carry out experiments

Reference Books:

1. Stryer, L. (2015). Biochemistry (8th ed.). New York: Freeman.
2. Lehninger, A. L. (2012). Principles of Biochemistry (6th ed.). New York, NY: Worth.
3. Voet, D., & Voet, J. G. (2016). Biochemistry (5th ed.). Hoboken, NJ: J. Wiley & Sons.
4. Dobson, C. M. (2003). Protein Folding and Misfolding. Nature, 426(6968), 884-890.

M.Sc. Life Sciences I[st] Semester Course Title – Microbiology **Code : L010702T**

Course Objective(s) The aim of this course is
The aim of the is for each student

1. to study of bacteria, viruses, fungi, protists, archaea, algae and other microscopic life forms and their presence in the air, soil and water, and in our food.
2. to learn their cultivation and their uses in human welfare. Understanding the value of microbes in anthropogenic and sustainable development They can keep the planet healthy by recycling waste and supplying nutrients.
3. explain how microbes affect our daily lives.
4. learn pure culture technique and observe and measure microbial growth.
5. develop core competencies in microbiology: structure and function, information flow, energy transfer and evolution. Manipulate bacteria genetically to address biological questions.

Marks : 100

S.No.	Topic
1	History of microbiology. Theory of spontaneous generation Experiments of Pasteur and Tyndall, Koch's Postulates, Isolation of bacteria from natural sample column, Control of Microbial growth methods and sterilization,
2	The Microbial cell: General organization of cell, Prokaryotes Eukaryotes and Archaea, Cell wall organization in Prokaryotes, Eukaryotes and Archaea, Cell surface appendages, Pilli, locomotion by flagella, chemotactic Movement, Peptidoglycan synthesis - inhibitors in different steps.
3	Role of bacteria in human welfare: Biological concepts - Immunization (Pasteur experiment Antibiosis), (penicillin story), Griffith's experiment, A very and McCarty's experiment, Experiment with viruses
4	Growth and nutrition Growth kinetics, Batch an continuous cultures, Nutritional classification of microorganisms, Nutritional uptake by microorganisms (C.N.P.)
5	Changing concepts in microbiology taxonomy, Earlier systems, Molecular taxonomy, Jaccard's similarly coefficients
6	Metabolic Pathways: Metabolic versatility of microbes, Anaerobic Carbon metabolism: Anaerobic respiration, aerobic respiration, Sulphate respiration, Reference to glycolysis, Fermentation diverse fermentation products, Putrefaction, Methane oxidizing and Methanogenic bacteria, Aerobic Carbon, metabolism TCA cycle alternative metabolic pathways, Nitrogen Fixation, synthesis of amino acids, Regulation of `nif genes, Mycorrhiza.
7	Energy Metabolism: Chemoautotrophs, Hydrogen bacteria, Phototrophic bacteria/Cyanobacteria
8	Microbial Genetics: Modes of genetic exchange in microbes, Transformation, Transduction, Conjugation, Evolutionary Significance, Microbes in Extreme Environment
9	Introduction to Industrial Microbiology: Major industrial products from microbes, Beverages, Antibiotics, Secondary metabolites, Recombinant products.
10	Introduction to Environmental Microbiology. Nature of anthropogenic wastes, Municipal wastes and xenobiotic, Enrichment cultures, Xenobiotic degrading consortia, Bioremediation

Course Outcome(s)
With this study student can

1. understand the basic microbial structure and function and study the comparative characteristics of prokaryotes and eukaryotes and also including structural similarities and differences among various physiological groups of bacteria/archaea.
2. demonstrate theory and practical skills in microscopy and their handling techniques and staining procedures.
3. prepare various culture media and their applications and also perform various physical and chemical means of sterilization.
4. know general microbial techniques for isolation of pure cultures of bacteria, fungi and algae and comprehend the various methods for identification of unknown microorganisms.
5. opt career in various fields of microbiology applications such as Pharmacy, Medicine, clinical research, agriculture, dairy and food industry, and pollution management

References:

1. Microbiology by Michla J. Pelczar, Tata McGraw-Hill
2. Microbiology by Jackquelyn G. Black, Wiley
3. General Microbiology by Roger John, Mark, and Page by Macmillan Press Ltd
4. Microbiology by Kanika Sharma,

M.Sc. Life Sciences I[st] Semester Course Title - Cell Biology **Code : L010703T**

Course Objective(s)

1. To understand the structures and purposes of basic components of prokaryotic and eukaryotic cells and structure and function of macromolecules, membranes, and organelles
2. To know the levels of organization and related functions in different types of cells and intracellular organization.
3. To understand how these cellular components are used to generate and utilize energy in cells and how cellular metabolism and function complete.
4. To understand the cellular components underlying cellular division and growth.
5. To apply their knowledge of cell biology to understand the cytogenetics and chromosomal constitution.
6. Overall, to get an overview of cell evolution, structure and function of cellular components, and basics of cell analysis tools and techniques.

Marks : 100

S.N.	Topic
1	Introduction to the Cell: The evolution of the cell, From molecules to first cell, From Prokaryotes to eukaryotes, From single cells to multicellular organisms
2	The Plasma membrane, Membrane structure And chemistry, Membrane transport of small molecules, Membrane transport of macromolecules and particles; exocytosis and endocytosis
3	Organelles to the eukaryotic cell: The lysosomes, The peroxisomes, The Golgi apparatus, The endoplasmic reticulum, Mitochondria and chloroplast –fine structure and chemistry, The genomes of mitochondria and chloroplast
4	The Cell nucleus, Morphology and functional elements of eukaryotic chromosomes, centromeres and telomere, Chromosomal DNA and its packaging and organization, The complex global structure of chromosomes and functions Euchromatin vs. heterochromatin.
5	The Cell Division Cycle : General strategy of the cell cycle, Molecular basis of cell cycle control, causes and consequences of failure of control, M-phase, Mitosis, Cytokinesis and Karyokinesis
6	The cytoskeleton, the nature of cytoskeleton, Intermediate filaments, Microtubules, Actin filaments, Cilia and centrioles, Cell Junction, Cell Adhesion and Extra-Cellular Matrix : Cell Junction, Cell-Cell Adhesions and cell adhesion molecules, The Extra-Cellular Matrix, Extra-cellular matrix receptors of animals
7	Organization of the cytoskeleton, the fibrous protein of the matrix, Noncollagen component of the extracellular matrix
8	Protein sorting organelle biogenesis and protein secretion, synthesis and targeting, of mitochondria, chloroplast, peroxisomal proteins, translational modification in the ER. Intracellular traffic, vesicular traffic in the secretary pathway, protein sorting in the Golgi, traffic in the endocytic pathways exocytosis.
9	Cell Signalling: General Principles, G-linked cell surface receptors, C^{++}signalling system, Enzyme-linked cell surface receptors, Target cell adaptation/desensitization
10	Excitable cells/tissues : Neuron-structure, types properties, function Transmembrane potential, action potential, conduction of impulse channels – active and passive, voltage and chemical sensitive axoplasmic flow, communication between excited tissues/neurons, cellular and molecular basis of synaptic transmission, neurotransmitters, neurotoxins.

Course Outcome(s)

1. Students will learn how cellular information is passed on in eukaryotes and prokaryotes, how cells work together in a complex manner in biological system.
2. Students will gain the concept of cellular basic of life as a key mechanism of regulation of genes in the cellular development and cell fate.
3. The students will be able to understand how the cell functions as a unit of life.
4. Candidate shall be able to design and comprehend experimental strategies for analyzing the cell and cell functions from a variety of organisms.
6. Students will be skilled in the techniques and experiments that contributed to the understanding of molecular mechanisms of the cellular processes.

Reference Books:

1. Molecular Cell Biology, J. Darnell, H. Lodish and D. Batlimore Scientific American Book, Inc., USA.
2. Molecular Biology of the Cell, B. Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts and J.D. Watson, Garland Publishing Inc., New York.
3. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009. The World of the Cell. 7[th]edition. Pearson Benjamin Cummings Publishing, San Francisco.
4. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.

M.Sc. Life Sciences Ist Semester Course Title – Genetics **Code: L010704T**

Course Objective(s)

1. To provides fundamental knowledge of how organisms, populations and species relate to their progeny.
2. To provide some of the most incisive analytical approaches that are now being used across the spectrum of the biological disciplines.
3. To impart knowledge about the human chromosome constitution that would help in applying basic principles of chromosome behavior to disease context.
4. Overall, this course will highlight extension of Mendelian Genetics, dosage compensation, evolution of the concept of gene and its amalgamation with molecular biology and study of genetic diseases.

Marks - 100

S.No.	Topic
1	Introduction and scope of Genetics
2	Chromosome Structure: Centromeres, Telomeres.
3	DNA replication Meselson and Stahl Experiment, Cairns Experiment, OkazakiExperiment, Basic mechanism of DNA replication.
4	Cell division and Cell cycle Mitosis, Meiosis, Chromosomal basis of inheritance
5	Basic Principles of Mendelian Inheritance Segregation and Independent Assortment, Alleles and Multiple Alleles, Human pedigrees and inheritance
6	Gene Interaction: Sex determination and Sex linked in heritance, Sex determination in humans, Drosophila and other animals, Sex- determination in plants, Sex-linked genes and dosage compensation of X-linked genes. Human genetics: pedigree analysis.
7	Linkage analysis and gene mapping eukaryotes, Coupling and repulsion phases, Crossover and recombination
8	Fine Structure of gene and gene concept: Complementation and recombination,
9	Chloroplast and Mitochondrial in heritance Yeast, *Chlamydomonas / Neurospora* and higher plants
10	Bacterial Genetics: Transformation, Conjugation, Transduction
11	Mutations, Spontaneous and induced mutations, Chromosomal Mutation and aberrations, Change in chromosome number: polyploidy Evolutionary history of bread wheat, Aneuploids - nullisomics, monosomics, and trisomics, Somatic aneuploids, Changes in chromosome structure, Properties of chromosomes for detection of structural changes, Main type of changes — deletions, duplications, inversions, translocations. Mechanism of chromosome mutations genetic andcytological features of deletions, duplications, inversions and translocations,
12	Population genetics: application of Mendel's laws to whole population, Calculation of allele frequencies, Hardy-Weinberg principal for. Calculating recessive gene frequency, Calculating frequency of sex-linked alleles

Course Outcome(s)

Genetics course will open up several avenues for students in terms of research and employability.

1. Enable students for extensive use of model organisms, many of which will be used to teach this course.
2. By observing genetic mutations, students can correlate phenotype with genotype, understand genetic interaction and their molecular basis.
3. Students will be able to set hands on genetic crosses to understand recessive and dominant, segregation, pattern of inheritance and finally evaluating statistical significance by counting the progeny as statistical analysis
4. Students will learn how genetic information is passed on in eukaryotes and prokaryotes, how genes work together in a complex manner in biological system and any alteration can lead to major phenotypic change.
5. Students will appreciate the concept of epigenetics as a key mechanism of regulation of gene expression steering development and cell fate that can ultimately be affected in disease condition.

Reference Books:

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2006). Principles of Genetics. VIII Edition John Wiley & Sons.
2. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. IX Edition. Benjamin Cummings.
4. Russell, P. J. (2009). Genetics- A Molecular Approach. III Edition. Benjamin Cummings.
5. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. IX Edition. Introduction to Genetic Analysis, W. H. Freeman & Co.

M.Sc. Life Sciences I[st] Semester Course Title – Life Sciences Practical's **Code : L010705P**

Marks - 100

S.No.	Topic
1	pH buffers etc
2	Absorption measurements
3	Protein estimations
4	Enzyme kinetics
5	Carbohydrates and lipid analysis
6	Protein purification
7	Chromatography (a) TLC, (b) P C, (c) GLC
8	Microbial diversity
9	Bacterial growth curve/kinetics
10	Bacterial staining and identification
11	Sectioning of tissues (Plant and animal)
12	Staining of different plant cell types
13	Study of different plant groups using permanent slides
14	Radiation induced cell damage
15	Methods for culturing and studying *Drosophila melanogaster*
16	Analysis of mutants for body colour, eye colour, eye shape, wing size, wing shape and wing hair.
17	Induction and detection of sex linked recessive lethal mutation in Drosophila
18	Induction and detection of somatic mutation and mitotic recombination in Drosophila.
19	Mouse bone marrow chromosome preparation.
20	Induction and detection of chromosome mutation in mouse bone Marrow metaphase cells.
21	Isolation of subcellular components: biochemical fractionation
22	Stereo taxing and survival surgery
23	Electrodes and their implantation
24	Poly graphic recording
25	Identification of different areas of the brain and their coordinates

Reference Books:

1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8[th]edition.Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009. The World of the Cell. 7[th]edition. Pearson Benjamin Cummings Publishing, San Francisco.

Semester – II

M.Sc. Life Sciences IInd Semester Course Title – Molecular Biology **Code: L010801T**

Course Objective(s)

The aim of this course is

1. To gain a better picture of the cellular environment with greater understanding of how cellular processes are regulated at the molecular level.
2. Learn the mechanisms and regulation of genome maintenance and gene expression, emphasizing how molecular structure influences function.
2. Understanding the multiple layers of regulation involved in the flow of genetic information.

Marks - 100

S.No.	Topic
1	Macromolecules and Organization : DNA, RNA : Structure, Types, Conformation, Denaturation, Renaturation
2	Chromatin structure, nucleosome
3	Genes and genome organization
4	Transposons and retrotransposons
5	Process DNA Replication – mechanism and enzymes involved, Prokaryotes/eukaryotes
6	RNA world and RNA Replication
7	Mechanism of transcription and enzymes involved, Prokaryotes/eukaryotes
8	RNA processing, capping, polyadenylation, splicing, editing
9	Genetic code and translation
10	Regulation Transcriptional regulation – Prokaryotes/eukaryotes
11	Translational regulation
12	Gene silencing, RNA interference.
13	Molecular basis of mutations
14	Repair of DNA damage
15	Recombination of DNA – Site Specific, homologous, transposition
16	Methods used to recombinant DNA research

Course Outcome(s)

1. The course has been devised to familiarize students with Molecular Biology which chiefly deals with interactions among various systems of the cell, including those between DNA, RNA and proteins and learning how these are regulated.
2. To gain an understanding of chemical and molecular processes that occurs in and between cells.
3. To gain insight into the most significant molecular and cell-based methods used today to expand our understanding of biology.
4. Will be able to design and implement experimental procedures using relevant techniques such as applications of molecular biology knowledge for recombinant DNA technology.

Reference Books:

1. Krebs JE, Goldstein ES and Kilpatrick ST (2014) Lewin's Gene XI, Jones and Barlett Publishers.
2. RF Weaver Molecular Biology, 5th edition (2012) McGraw Hill Higher Education
3. Watson JD, Baker TA, Bell SP, Gann A, Levine M & Losick R (2014) Molecular Biology of the Gene, 7th Edition, Cold Spring Harbor Laboratory Press, New York.
4. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.
5. Sambrook J, Fritsch EF and Maniatis T. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press.

M.Sc. Life Sciences IInd Semester Course Title – Immunology and Immunotechnology

Code : L010802T

Course Objective(s)

1. To enable understanding the molecular and cellular basis of the development and function of the immune system
2. To get into the basic mechanisms, distinctions and functional interplay of innate and adaptive immunity,
3. Know the cellular/molecular pathways of humoral/cell-mediated adaptive responses including the role of major histocompatibility complex.
4. Identification of its biological, clinical and therapeutic implications of immunology.

Marks - 100

S. No.	Topic
1	Introduction to Immune System, organs, cells and molecules involved in innate and adaptive immunity, Mechanisms of barrier to entry of microbes/pathogens
2	Haematopoiesis and its regulation: Differentiation of stem cells to different cellular elements in blood, role of cytokines.
3	Introduction to inflammatory reaction chemokines, adhesion molecules, migration of leukocytes to the site of infection, phagocytosis and microbicidal mechanism, Immediate hypersensitivity role of eosinophils and mast cells, Asthma, IgE receptor, prostaglandins and leukotrienes
4	Receptors of innate immunity Toll – like receptors and sensing of PAMPs, signal transduction, opsonization, Fc receptors
5	Antigens, antigenicity and immunogenicity B and T cell epitopes
6	Antibody structure and function (classification of immunoglobulins, immunoglobulin domains concept of variability, isotypes, allotypes and idiotypic markers), Antigen-antibody interactions
7	Immunoglobulin genes, VJ/VDJ rearrangements and genetic mechanisms responsible for antibody diversity, affinity maturation, allelic exclusion Class switching, receptor and soluble forms of immunoglobulin
8	Hybridoma, monoclonal antibodies and antibody engineering
9	Immunological Techniques (antibody generation, detection of molecules using ELISA, RIA, Western blot, immunoprecipitation, flow cytometry, immunofluorescence microscopy etc.)
10	The complement system classical and alternative pathways
11	Major Histocompatibility Complex genetic organization of H2 and HLA complexes. Class I and Class II MHC molecules, structure and function Antigen processing and presentation pathways
12	Differentiation and activation of B cells, BCR and pre BCR, receptor editing, T cell help
13	T cell receptors αβ_ and γδ T cells, receptor diversity, Activation of T cells APC- T cell interaction, Th1/Th2 cells cytokines. T cell differentiation in thymus, thymic selection and tolerance to self, MHC restriction, super antigens
14	Cell-mediated effect or functions: cytotoxic T cells, Natural Killer Cells, ADCC, NK cell receptors, inverse correlation with target MHC expression, missing self-hypothesis, cytotoxicity reaction
15	Topics like Applications of immunological principles (vaccines and diagnostics) tumour and transplantation Immunology and diseases of relevance to the immune system (autoimmunity and immunodeficiency) etc. would be discussed in context of the basic immunological mechanisms as assignments /tutorials

Course Outcome(s)

1. Explain the cellular and molecular aspects of lymphocyte activation, homeostasis, differentiation and memory.
2. Understand the molecular basis of complex, humoral (cytokines, complement) and cellular processes involved in inflammation and immunity, in states of health and
3. Describe basic and state-of disease. -the-art experimental methods and technologies.
4. Integrate knowledge of each subsystem to see their contribution to the functioning of higher-level systems in health and disease including basis of vaccination, autoimmunity, immunodeficiency, hypersensitivity and tolerance.

Reference Books:

1. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6th edition Saunders Publication, Philadelphia.
2. Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology. 11th edn Wiley-Blackwell Scientific Publication, Oxford.
3. Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edn, W.H. Freeman & Company, NY.
4. Murphy K, Travers P, Walport M. (2008). Janeway's Immunobiology. 7th edn Garland Science Publishers, NY.
5. Peakman M, and Vergani D. (2009). Basic and Clinical Immunology. 2nd edn, Churchill Livingstone Publishers, Edinberg.
6. Richard C and Geiffrey S. (2009). Immunology. 6th edition. Wiley Blackwell Publication.

M.Sc. Life Sciences IInd Semester Course Title – Biophysics and Structural Biology Code : L010803T

Course Objective(s)

1. To develop the skills of the application of basic and advanced techniques employed in quantitative and qualitative analysis of biomolecules.
2. To get ready contender for position in industry utilizing the logical methods, utilized in R & D, quality control, administrative capacities in pharmaceuticals, chemical companies and food industries.

Marks - 100

S. No.	Topic
1	Introduction, Interaction in biology systems
2	How cells are studied: Microscopy, Purification of cells and their parts, Cell separation and culture, flow cytometry, Fractionation of cell contents
3	Structure of Biomolecules and confirmations of proteins and nucleic acids
4	Secondary, tertiary and quaternary structure of protein
5	Primary and secondary structure of RNA and DNA
6	Method of conformational analysis and prediction of conformation
7	Thermodynamics and kinetics of conformational transition of Proteins
8	Protein folding, techniques for studying Macromolecular structure
9	Ultra centrifugation, Sedimentation velocity and equilibrium – determination of molecular weights
10	Microscopy: light microscopy, fluorescence microscopy, Phase contrast microscopy; Electron microscopy
11	UV Visible Spectroscopy, Fluorescence Spectroscopy
12	Circular Dichroism, Spectroscopy
13	Symmetry, space group crystal lattices, brag's law in real & reciprocal space
14	Nuclear Magnetic Resonance
15	Tracing cellular molecular with radioactive isotopes and antibodies

Course Outcome(s)

Students will be able to

1) explain mechanistically isolation, purification, quantification techniques of biomolecules.
2) perform procedure to characterize the biomolecules.
3) perform of characterization of cells and cellular components using microscopy and flow cytometry

Reference Books:

1. Principles of physical Biochemistry, van Holde, KE, Johnson, WC, Ho, PS Prentice Hall, Inc., 1998.
2. Proteins, Creighton, TE.; WH Freeman & Co., 1993
3. Crystallography Made Crystal Clear: A Guide for User"s of Macromolecular Models, Rhodes, G.; Academic Press, 1999
4. Techniques for the Study of Biological Structures and Function, Vol 2, Candor, CR and Schimmel, PR; WH Freeman & Co., 1990
5. Random walks in Biology, Berg, HC; Princeton University Press, 1993

Optional course (any one)

M.Sc. Life Sciences IInd Semester Course Title – Animal Physiology **Code : L010804T**

Course Objective(s)

1. Study of animal physiology for understanding and evaluating underlying biological processes.
2. To describe the chemistry and physics behind basic body functions, from how molecules behave in cells to how systems of organs work together.
3. To understand what happens in a healthy body in everyday life and what goes wrong when someone gets sick.

Marks : 100

S.No.	Topic
1	Tissue system and their functions, Epithelial tissue, Connective tissue, muscular tissue and Nervous tissue
2	Principles of physiology : relationship between structure and function, Adaptation, Acclimatization, Acclimation, Homeostasis, Feedback-control systems, Conformity and Regulation
3	Methods for exploring physiological mechanisms : Molecular techniques Cellular techniques, Biochemical techniques, Techniques for studying behaviour
4	Molecule, Energy and Biosynthesis- Types, Interactions and function
5	Comparative account of the nervous system in invertebrates and vertebrates
6	Endocrine system Glands and Hormones Secretory mechanisms, Endocrine and Neuro-endocrine systems, Cellular mechanism of hormone action, Physiological effects of hormones
7	Muscle and animal movement : Electrophysiology and biochemistry of contraction in skeletal cardiac and visceral muscles
8	Circulatory systems: general plan, electrical and mechanical Properties of myogenic and neurogenic hearts. Heart cycle including electrocardiogram, Hemodynamic, Cardiovascular response to extreme conditions like exercise, diving and haemorrhage Neural control of cardiovascular system Immune responses
9	Respiratory system: respiratory pigments, transport of gases in blood, regulation of body pH, respiratory response to extreme conditions like hypoxia, diving and exercise. Physiology of (mammals) and neural control of breathing
10	Excretory system: Osmoregulation, osmoregulators, Conformers, Obligatory exchanges of ions and water Osmoregulation in water and terrestrial environment. Physiology of mammalian and non – mammalian kidneys
11	Digestive system : Acquisition of Energy, Types of feeding, Digestion (motility and Secretions), Metabolism and absorption, Physiology of gastrointestinal system (mammals) including neural and hormonal regulatory mechanisms
12	Energetics of metabolism expenditure : Body size and metabolic rate, Energetics of locomotion, body rhythms and energetic, energetic of reproduction
13	Thermoregulation Temperature dependence of metabolic rate, determinants of body heat and temperature thermal biology of ectotherms, heterotherms and endotherms
14	Reproductive system, Asexual and sexual reproductive system, Gonads, gametes, Gametogenesis and hormonal control, Fertilization, Capacitation

Course Outcome(s)

Students shall be able to

1. To study and compare the functioning of organ systems across the animal species
2. Understand the comparative functioning of different systems in animals.
3. To acquire deeper knowledge about the fundamental processes and mechanisms that serve and control the various functions of the body
4. To enhance knowledge and appreciation of mammalian physiology including human

References:

1. ESSENTIAL OF ANIMAL PHYSIOLOGY BY S.C. RASTOGI,
2. ANIMAL PHYSIOLOGY AND RELATED BIOCHEMISTRY BY H.R. SINGH,
3. ANIMAL PHYSIOLOGY BY GOYALAND SHASTRY,
4. DR.P.B. REDDY'S, TEXTBOOK OF MEDICAL PHYSIOLOGY BY GUYTON AND HALL,

Or

Semester - II Course - M.Sc. Life Sciences Course Title – Plant Physiology Code : L010805T

Course Objective(s)

The learning objectives are

1. To educate student about the mechanism and physiology of processes of life in plants.
2. To focus on the plant nutrient uptake and translocation, plant environment continuum, photosynthesis, respiration and nitrogen metabolism.
3. To educate student about the various metabolic pathways leading to the formation of significant molecules and their catabolism. It focuses upon the vital role of each of these molecules in plants.

Marks - 100

S.No.	Topic
1.	Water relations : Properties of water, Properties of solutions, cell water potential, soil - plant – atmosphere continuum
2	Photosynthesis : Light absorption, emission, energy transfer, Z- scheme of photosynthesis, electron transfer, photo-phosphorylation, CO_2 fixation, C_3, C_4, CAM plants, Environment and its impact on photosynthesis
3	Respiration : Complex – I, complex – II, complex- III, complex- IV, Structure and function, Oxidative phosphorylation, Cyanide-resistant respiration
4	Photo - morphogenesis : Phytochromes, Cryptochromes, photo-morphogenesis
5	Transport processes in plant Active and passive transport system, ion channels, driving forces and flow, transport of nutrients across the primary root, transport through sieve element, transport of metabolites from the source to the sink, genetic regulation of transport systems in response to nutrients availability and growth status
6	Mineral nutrition and assimilations of inorganic nutrients : Plant – mycorrhiza association, nitrogen metabolism, sulfur metabolism, phosphate metabolism, calcium, metabolism, assimilation, cations, chloride dynamics
7	Lipid metabolism in plants : Fatty acid biosynthesis, membrane lipid biosynthesis, lipid desaturation, triacylglycerols, complex lipids, cell wall lipids, alkaloids, ceramides
8	Plant Hormones Introduction and concept types of growth regulators, Auxin: the master growth hormone, Avena coleoptiles bioassay, discovery of auxin, distribution in plants, roles, how auxin works? Auxin mutants, auxin perception, auxin binding proteins, signal transduction, auxin-responsive genes/promoters/factors. Model for gene regulation, de – repression of early auxin genes Acid theory. Polar auxin transport – a chemiosmotic model, commercial uses of auxin
9	Gibberellins: Foolish seedling disease, functions of GAs, location, free vs. Conjugated Gas. How GA works? signal transduction and mechanism of action of GAs taking alpha-amylase as an example, commercial applications
10	Cytokinins : location, functions and mechanism of action, Commercial applications
11	Ethylene ; discovery, locations and functions, mutants, mechanism of actions applications
12	Abscisic acid : a natural stress hormone, discovery, location function mutants – VPI, ABA and ABI, mechanism of action
13	Programmed cell death : hypersensitive response, functions, relevance with diseases, apoptosis, Caspases, Importance of PCD in plant development, role of PCD, model of PCD

Course Outcome(s) After this course, the students would be able

1. To understand the various physiological life processes in the plants.
2. To gain insights about the various uptake and transport mechanisms in plants and understand the various processes.
3. To understand the role of various hormones, signalling compounds, channel or transport proteins involved in nutrient uptake in plants.
4. To enrich themselves with the phenomenon of metabolism of primary and secondary metabolites and their role in plants.
5. To use the knowledge for scientific cultivation and improve crop production and food security

References:

1. Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology. John Wiley and Sons. U.S.A. 4th edition.
2. Taiz, L., Zeiger, E., MØller, I.M. and Murphy, A (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6th edition.
3. Bajracharya D. (1999). Experiments in Plant Physiology-A Laboratory Manual. Narosa Publishing House, New Delhi.

M.Sc. Life Sciences IInd Semester Course Title – Life Sciences Practicals – II Code : L010806P

Marks - 100

S.No.	Topic
1	Building of a model of B-DNA
2	Preparation of competent E coli cells
3	Transformation of competent E coli cells with plasmid DNA
4	Isolation of plasmid DNA and agarose gel electrophoresis of DNA
5	Restriction enzyme digestion of DNA
6	Polymerase Chain Reaction (PCR) of DNA
7	Expression of foreign protein in E coli
8	Lytic growth of bacteriophage lambda
9	Plant tissue culture I
10	Plant tissue culture II
11	Plant tissue culture III
12	Basic techniques in animal tissue culture
13	Immunology experiment I
14	Immunology experiment II
15	Immunology experiment III
16	Microbe symbiosis experiment
17	Infectious organisms : demonstrations (Microscopic) Candida, Leishmania, Plasmodium, Entamoeba
18	Plant physiology I
19	Plant physiology II
20	Plant physiology III
21	Plant physiology IV
22	Electrophysiological recordings : action potential, EEG, etc.

M.Sc. Life Sciences Semester — III

M.Sc. Life Sciences IIIrd Semester Course Title – Developmental Biology Code : L010901T

Course Objective(s)

This course aims at making the students

1. Acquainted with the fundamentals and understanding of the mechanisms associated with development, differentiation and structure of human zygote, specific developmental pathways in model animals, developmental events in various plant organs, the metabolic and physiological changes occurring in them.
2. Students will learn the applications of developmental biology which are beneficial in onset of genetic disorders.
3. Learn about cues, role of growth factors and hormones in understanding various developmental pathways.
4. Understand various signaling cascades leading to development maintenance of undifferentiated cells in the body of plants and animals
5. Learn the analysis of mutants that have helped establish roles of various genes in promoting, regulating or suppressing the function.

Marks : 100

S. No.	Topic
1	Animal Developmental Biology: Principles of Developmental Biology; Questions and approaches in Developmental Biology; Evolution of developmental patterns; Basics of experimental embryology; Genomic equivalence; Signaling cascades involved in the control of developmental program with specific examples.
2	Early embryonic development; Cleavage—Types and mechanism; Gastrulation movements involved; Cell specification w.r.t. amphibian, chick; Phenomenon of the Organizer w.r.t. amphibians- Progressive determination - Regional specificity of induction; Pattern formation- French flag model and polar coordinate model; Regeneration- Epimorphic e.g. salamander limbs, Morphallactic e.g. Hydra, Compensatory e.g. mammalian liver; Tetrapod limb development- Axes formation; Coordination of the three axes.
3	*Dictyostelium discoideum* as a model organism- Life cycle, Pattern formation, cAMP signaling during development pattern formation; *C. elegans* as a model system: Invariant cell lineage, vulval development; *Drosophila* as a model system- Anterior/posterior, Dorsal/ventral polarity development; Applications of developmental biology- Programmed cell death-Apoptosis, Autophagy, Necrosis.
4	Basics of plant evolution and life; Basic plant architecture: Cell and tissue structures; cell division plane and pattern; tissue, cell, and organ polarity; Model plants for development and agricultural research: Genetic model, genomic model, transformable/transgenic model; specific advantages and disadvantages of different model plants.
5	Embryonic pattern formation and polarity development: Development of embryo from the zygote, cell division pattern, initiation of shoot apical meristem (SAM), root apical meristem (RAM); development of embryonic polarity, hormonal regulation of polarity development. Shoot Apical Meristem and organ size control: Initiation and organization of SAM, roles, and interaction of CUC, NAM, STM, WUS, auxin, and cytokines in SAM initiation and size control.
6	Root-apical meristem and radial patterning: Initiation and organization of RAM, the role of SHR, SCR, ethylene, and auxin organization of radial patterning.
7	Leaf development, shape, and dorsoventral patterning: positioning of leaf on SAM; patterning, stomata density, and distribution control, trichome development. Flower development and organ patterning: Organization of floral organs, ABC model, modification of floral organs, boundary genes; homeotic genes of plants, The transition from the vegetative and reproductive stage, photoperiodic, vernalization, GA, and autonomous pathways. Development of reproductive organs: Development of gametophytes and gametes, meiosis, developmental control, pollination, fertilization.

Course Outcome(s)

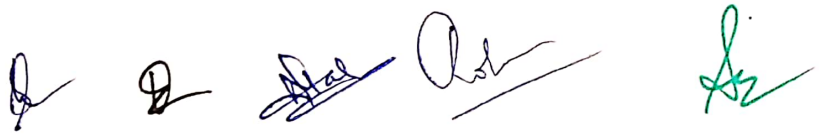
The students shall be able to understand

1. Understanding of growth, development and reproduction as well as understand the Physiological and metabolic changes happening along with the environmental impact in plants. Students will understand the development of an organism, and organization of the single cell becomes an organized grouping of cells in plants and animals.
2. Develop the understanding of growth, development and reproduction in animals and plants as well as understand the physiological and metabolic changes happening along with the environmental impact.

3. Learn about different aspects of development in model animals and plant development, like leaf, root and flower and genes controlling their function.
4. Understand seed dormancy, vernalization for flowering and its applications in maximum utilization of land.
5. Understand various commercialised applications evolved from basic studies for improving several aspects of plants affecting growth and yield parameters.

References:

1. Dickinson, W.C. 2000 Integrative Plant Anatomy. Harcourt Academic Press, USA.
2. Esau, K. 1977 Anatomy of Seed Plants. Wiley Publishers.
3. Fahn, A. 1974 Plant Anatomy. Pergmon Press, USA and UK.
4. Salisbury, F.B. and Ross, C.W. 1991 Plant Physiology, Wadsworth Publishing Co. Ltd.
5. Taiz, L. and Zeiger, E. 2006 Plant Physiology, 4th edition, Sinauer Associates Inc .MA, USA
6. The Arabidopsis Book, ASPB publication (available freely at www.aspb.org)
7. Biochemistry and Molecular Biology of plants Ed. Buchanan, Gruissem, & Jones, ASPB publication.
8. Molecular Life of Plants, Ed. Jones, Ougham, Thomas, and Waaland., Wiley- Blackwell/ASPB publication.
9. Developmental Biology (Developmental Biology Developmental Biology)" by Scott F Gilbert & Susan R Singer
10. Developmental Biology: A Very Short Introduction by Lewis Wolpert
11. Developmental Biology by Scott F Gilbert
12. A Text Book of Embryology (Developmental Zoology) by N Arumugam
13. Developmental Biology by Dr M A Subramanian
14. Developmental Biology by Dr Vinita Shukal and Dr KV Sastry
15. Biologia Del Desarrollo/ Developmental Biology by Scott F. Gilbert.
16. Cell and developmental biology by Shastry, Tomar and Singh,
17. Elements of Developmental biology by P.C. Jain



M.Sc. Life Sciences III[rd] Semester Course Title – Computational Biology, Bioinformatics and Biostatistics

Code : L010902T

Course Objective(s)

1. To impart knowledge to students on the most import skill which is required in this era for any scientific worker.
2. To cover the era of computerized biology information, review of relevant definitions in molecular biology, overview of challenges of molecular biology and genomics and proteomics.
3. To familiarize students with basics of computer system, hardware, software, and networking.
4. To provide students with the structural and functional details of biomolecules especially proteins and nucleic acids.
5. To get the confidence to use computer programs for the daily design of experiments, data collection, and analysis of results. The mandatory hands-on exercises on the computer applications.

Marks - 100

S. No.	Topic
1	**Introduction to Bioinformatics and Computational** Biology with historical background, major developments, Operating systems, Linux commands, File transfer protocols ftp and telnet, Data file formats, Data life cycle, Database management system models, Basics of Structured Query Language (SQL), Data types. scalars and collections, operators. Program control flow constructs, Library Functions String specific functions, User defined functions, File handling
2	Biological databases, Biological sequences, Genome specific databases, data query and data mining, Boolean operators; Problems and Applications to biological problems
3	Nucleic acid sequence analysis, alignment, similarity searches including remote similarity searches, secondary structure elements, motifs, Sequence Analysis, Pair-wise alignment, Dynamic programming algorithms for computing edit distance, string similarity, shotgun DNA sequencing, end space free alignment Multiple sequence alignment, Algorithms for Multiple sequence alignment, Generating motifs and profiles, Local and Global alignment, Needleman and Wunsch algorithm, Smith Waterman algorithm, BLAST, PSIBLAST and PHIBLAST algorithms
4	Protein sequence analysis; alignment, similarly searches including remote similarity searches, secondary structure elements, motifs, Protein Secondary structure and tertiary structure prediction methods, Homology modeling, abinitio approaches, Threading, Critical Assessment of Structure Prediction,Peptide mass fingerprinting
5	Genomics and annotation, Applications of informatics techniques in genomics and proteomics: Assembling the genome_STS content mapping for clone contigs
6	RNA, secondary structure, small non-coding RNAs
7	Evolutionary analysis; use of the PHYLIP package, tree construction, Introduction to phylogenetics, Distance based trees, UPGMA trees, Molecular clock theory, Ultrametric trees, Parsimonious trees, Neighbour joining trees, trees based on morphological traits, Bootstrapping
8	Aim Scope and elementary idea of statistics in Biology, Tabulation and diagrammatic representation of statistical data. Concepts of statistical population and sample, elementary account of sampling methods, frequency distribution. Measures of central location and dispersion, measure of skewness and Kurtosis.
9	Probability – definition simple theorems on probability, conditional probability Discrete and continuous variables, Standard distributions – Bionomical, poisson normal. Correlation and regression – Least square method of fitting linear and quadratic regression, standard errors of estimate ,correlation coefficient.
10	Basic ideas of sampling distribution Statistical estimation and Test of significance, confidence limit. Some commonly used tests of significance. Normal tests students 't' text, x^2 and F tests. Analysis of variance.

Course Outcome(s)

1. This paper will lead to make students understand about the fundamentals of computer systems, hardware and software which will be utilized in learning the advances of the course.
2. The course will make students advanced in understanding the molecular interactions inside cell especially the structural details of protein and nucleic acids.
3. Students will specifically gain knowledge about the genomic and proteomic tools and techniques for understanding intermolecular interactions.

4. Students will be able to develop training in the field of Bioinformatics with specific emphasis for fulfilling expectations of Pharmacy, Chemical and Biotech industry.

Reference Books:

1. Bioinformatics: Sequence and Genome Analysis, Mount, D.W. (2nd Ed., 2001), Cold Spring Harbor Laboratory Press, NY, USA.
2. Bioinformatics for Dummies, Claverie J.M., Notredame C., (2nd Ed., 2007), Wiley Publishing, Inc., New York, USA.
3. P.K. Sinha, P. Sinha. Foundation of Computing. BPB Publications.
4. S. Harisha. Fundamentals of Bioinformatics. I.K. International Publications, New Delhi.
5. Arthur M. Lesk, Introduction to Bioinformatics, Oxford University Press, New Delhi.
6. M. Campbell & L.J. Heyer, Discovering Genomics, Proteomics & Bioinformatics, CSHL Press.
7. Research Methodology and Biostatistics: A comprehensive Guide for Health Care Professionals, By Sharma Suresh
8. Biostatistics and Computer Applications by G.N. Rao, N.K. Tiwari
9. Biostatistics: Basic Concepts and Methodology for the Health Sciences. By Wayne W. Oaniel

Optional (Any Four Papers)

M.Sc. Life Sciences III[rd] Semester Course Title – Molecular Genetics & Genetic Engineering

Code : L010903T

Course Objective(s)

1. To demonstrate the innovative utilization of manipulating enzymes, various cloning and expression vectors and analysis of genomic sequences.
2. To interpret the applications of genetic engineering in biotechnological research.
3. To educate the students in strategizing research methodologies employing recombinant DNA techniques.

Marks - 100

S. No.	Topic
1	Gene Concept, Structure and Organization
2	Transcriptional control regions of eukaryotic and prokaryotic genes
3	Restriction and Modifying enzymes
4	Cloning Vectors - Plasmids, phage vectors, yeast vectors, artificial chromosomes
5	cDNA synthesis and construction of cDNA libraries
6	Genomic libraries and their construction
7	Identification and analysis of recombinant DNA clones
8	DNA sequencing methods
9	Genome Sequencing and Analysis
10	Methods to study gene expression
11	**PCR** and its application
12	Generation of mutation and mutants. Random mutations, Targeted mutations
13	RNA interference and gene silencing, gene knockouts
14	Transgenic systems, genome editing

Course Outcome(s)

The students shall

1. Recall the principles of genetic engineering and the vectors used in cloning, methods of introduction of gene and expression
2. Appreciate the different cloning strategies and their expression
3. Know about implementation of genetic engineering for different purposes including industries
4. Investigate the different strategies of recombinant DNA technology and resolve the problems encountered

Reference Books:

1. Krebs JE, Goldstein ES and Kilpatrick ST (2014) Lewin's Gene XI, Jones and Barlett Publishers.
2. RF Weaver Molecular Biology, 5th edition (2012) McGraw Hill Higher Education
3. Watson JD, Baker TA, Bell SP, Gann A, Levine M & Losick R (2014) Molecular Biology of the Gene, 7th Edition, Cold Spring Harbor Laboratory Press, New York.
4. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edn. Blackwell Publishing, Oxford, U.K.
5. Sambrook J, Fritsch EF and Maniatis T. (2001). Molecular Cloning - A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press.

M.Sc. Life Sciences III[rd] Semester Course Title – Molecular Cancer Biology **Code : L010904T**

Course Objective(s)

1. To provide basic knowledge of cancer genomics;
2. To become familiar with relevant technologies, public databases and informatics methods that is used to determine driver mutations and oncogenic pathways
3. To provide the rationale for personalized cancer treatment;
4. To provide basic information regarding underlying biology of common cancers.

Marks - 100

S. No.	Topic
1	Introduction to cancer, cancer incidence and mortality; origin of neoplastic cells; cancer as cellular disease; tumor cell growth kinetics
2	Oncogenes and tumor suppressor genes
3	Environmental carcinogens; carcinogen metabolism
4	Chemical carcinogenesis; initiation, promotion and progression
5	Mechanism of ultraviolet radiation carcinogenesis (melanoma and non-melanoma skin cancer)
6	Animal models of cancer research; a thymus nude mice model; syngeneic mouse model, transgenic mouse model etc.
7	Heredity and cancer; genetic basis of carcinogenesis (e.g. APC mutation and colon cancer)
8	Viral carcinogenesis mechanism
9	immunological aspects of cancer; leukemia
10	Deregulated cell cycle progression in cancer
11	Aberrant cell signaling in cancer
12	Anti-apoptotic mechanisms for the survival of cancer cells
13	Tumor angiogenesis and its molecular mechanisms
14	Mechanisms of cancer invasion and metastasis
15	Cancer therapeutics: surgery, radiation and chemotherapy
16	Chemoprevention of cancer

Course Outcome(s)

1. Understanding genomic basis of cancer
2. Explaining key technologies and interact with public databases;
3. Understanding biology of various cancers and role of environment in carcinogenesis.

Reference Books:

Graham Dellaire, Jason N. Berman and Robert J. Arceci, (2013), Cancer Genomics: from Bench to Personalized Medicine, 1st Edition; Academic Press.

M.Sc. Life Sciences IIIrd Semester Course Title – Neurophysiology **Code : L010905T**

Course Objective(s)

1. To provide the student with neuro-physiological principles, concepts and mechanisms useful for understanding the nervous system and its aberrations in pathologies that impact upon the functioning of the individual.
2. To understand the function of major brain structures and will have learned signs and symptoms of
3. some important neurological disease processes that illustrate principles of brain function

Marks - 100

S. No.	Topic
1	Neuron, glia, structure and function general, ionic distribution, transmembrane potential, membrane, lipids, myelination, channels, receptor, action potential generation, propagation, synapse, neurotransmitter release, axoplasmic transport
2	Neurotransmitter synthesis and its regulation, receptor type, properties, second messengers
3	Coding of information, sensation, adaptation, denervation, hypersensitivity, sensitization
4	Reflex, properties, types, myotatic reflex, conditioned and unconditioned reflex, learning, motor control and decerebrate rigidity, injury to brain
5	Development and evolution of brain, organization of nervous system anatomy, cyto-architecture; brainstem, cerebrum, cerebellum, reticular formation, cortex; spinal cord, vertebral column, CSF, blood brain barrier, touch. pain. heat. itch etc.
6	Methods to study, sympathetic and parasympathetic nervous system; ascending and descending tracts
7	Gross to cellular study stimulation lesion, unit studies, anatomical, histological, biochemical, micro-dialysis, micro-iontophoresis, molecular studies, in vivo and in vitro cell culture studies

Course Outcome(s)

The students will be able to

1. Describe neuro physiological concepts, principles and mechanisms underlying normal functioning and explain their relationships to normal and pathological functioning of the individual
2. Identify key components of the etiology, the epidemiology and the clinical characteristics of common neurological conditions associated with malfunctioning of brain structures and appreciate factors leading to a differential diagnosis
1. Identify key components of the medical treatment, surgical interventions and rehabilitation associated with common neurological conditions and understand the impact of such treatment on the functional outcome of clients

Reference Books:

1. Principles of Neural Science by Eric R. Kandel, James Harris Schwartz, Thomas M. Jessell
2. Fundamental Neuroscience by Larry R. Squire, Floyd E. Bloom, Susan K. McConnell
3. From Neuron to Brain by John G. Nicholls, A. Robert Martin, Bruce G. Wallace, Paul A. Fuchs.
4. Development of the Nervous system by Dan H. Sans, Thomas A. Reh, William A. Harris
5. The Central Nervous System: Structure and function by Per Brodal
6. Textbook of Medical Physiology by AC Guyton.

M.Sc. Life Sciences IIIrd Semester Course Title – Enzymology and Enzyme Technology

Code : L010906T

Course Objective(s) The objectives of this course are to

1. build upon knowledge of biochemical principles with specific emphasis on different metabolic pathways and enzymes involved in executing these reactions.
2. make the students aware of enzyme kinetics, applications of enzymes.

Marks - 100

S. No.	Topic
1	**Structure and Function of Enzymes:** A Brief history of enzymology, relationship of enzymology with other sciences Structure of enzymes, Monomeric and oligomeric enzymes, cofactors, metal ions and coenzymes, enzymes, abzymes, ribozymes. Hypotheses of enzyme substrate interaction Active sites of enzymes, specificity of enzyme action, Types of specificity E C. Classification of enzymes. oxidoreductases, transferases, hydrolases, lyases, Isomerases, ligases, Multifunctional enzymes. K cat, Enzyme unit, specific activity, unit of enzyme activity Solution of practical problems
2	**Principles of Enzyme Kinetics :-** Basic principles of chemical catalysis covalent catalysis, General Acid Base catalysis, metal ion catalysis Co-ordinated catalysis
3	**The Steady-State Kinetics of an enzyme catalyzed reaction:** Michaelis and Menten, van Styke Cullen, Brigs, Haldane works, the main principle of steady state **The Kinetic of single substrate enzyme reactions: The** initial reaction state and substrate concentration relationship, Deviation of steady state rate equation. The method of King and Altman. Kinetics of two substrate enzyme reaction kinetics of allosteric enzymes. Enzyme inhibition reversible and irreversible inhibitions Competitive noncompetitive uncompetitive and mixed enzyme inhibition. **Regulation of enzyme activity:** Partial proteolysis covalent modification, allosteric regulation, The dependence of enzyme activity on temperature and pH.
4	**Application of Enzymology :** Enzyme extraction and purification alternative enzymes , enzyme engineering and modeling, Enzymes in industry and medicine, Enzyme immobilization-techniques and applications

Course Outcome(s)

On completion of this course, students should be able to:

1. Understand the basics and applied aspects of enzymes
2. Describe the Nomenclature and classifications of enzymes.
3. Describe the mechanism of enzyme action, enzyme kinetics and factors affecting its.
4. Commercial application of enzymes in living organisms and industry.

Reference Books:

1. Stryer, L. (2015). Biochemistry (8th ed.). New York: Freeman.
2. Lehninger, A.L. (2012). Principles of Biochemistry (6th ed.). New York, NY: Worth.
3. Voet, D., & Voet, J.G. (2016). Biochemistry (5th ed.). Hoboken, NJ: J. Wiley & Sons.
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.

M.Sc. Life Sciences III[rd] Semester Course Title – Pluripotent Stem Cells & Reproduction

Code : L010907T

Course Objective(s)

This course aims

1. To acquaint with the properties and understanding of stem cells. Role and niche of stem cells in various systems and control mechanisms.
2. To learn derivatization, trans differentiation, induced pluripotency and different in vitro technologies for better control on stem cells.

Marks - 100

S. No.	Topic
1	Introduction Stem Cells, embryonic stem cells in vitro fertilization and pre-implantation genetic diagnosis, adult stem cells, homeostasis and regenerative medicine, the microenvironment, its role in cell fate decisions and cancer, the immune system and the hematopoietic stem cell lineage tree, developing induced pluripotent stem cells
2	Pluripotent stem cells, types - totipotent, multipotent, oligopotent and unipotent
3	Stem Cell Engineering Principle and applications, embryonic stem cells, deviation and culture of ES cells, genetic engineering and reprogramming of stem cells, iPS cells
4	Stem cell niches and overview of cell signaling, stem education, Trans-differentiation, Growth Factors and Paracrine mechanism and action of stem cells, and trans-differentiation of stem cells, regulation of stem cell niche in different adult tissues, characterization and use of specific adult stem cells, development of instructive biomaterials, commercialization of stem cell based therapies
5	Molecular facets of pluripotency, mechanism of self-renewal and differentiation, ES cell cycle control, Somatic cell nuclear transfer technology, Induced pluripotent stem cells, Stem cell origin of cancer. Cancer stem cells, Pathways involved in stem cells and cancer stem cells
6	Bone marrow microenvironment, Hematopoietic stem cell mobilization and differentiation, mesenchymal stem cells and their properties, Hematopoietic and mesenchymal stem cells: Isoaltion, ex vivo expansion, characterization, transcription regulation and differentiation, Side population phenotypes, endothelial progenitor cells, Multipotent adult progenitor cells, Differentiation of stem cells in-vivo and ex-vivo, Differentiation of mesenchymal stem cells into osteoblast, adipocyte, chondrocyte lineages, Transdifferentiation of mesenchymal stem cell into various lineages, differentiation into endothelial cells and stem cell mediated angiogenesis
7	Stem cells in treating various diseases, Mechanism of treatment and their regenerative ability, Pre-clinical and clinical applications of stem cells, chemokine reactions, cause of success and failure in treatment, stem cells and tissue engineering: Its applications Politics, religion and moral/ ethical issues

Course Outcome(s)

After this course, student will

1. Develop the understanding of stem cells, types of stem cells, describe the medical uses for stem cells.
2. Learn the properties that defines a stem cell? Different types of stem cells, usage of stem cells to understand and treat diseases. Methods of production and maintenance of stem cells with biological niche.

Reference Books:

1. Knoepfler, Stem Cells: An Insider's Guide, World Scientific Publishing Company
2. Harris J. Quigley M. Chan S., Stem Cells: New Frontiers in Science & Ethics, World Scientific Publishing Co Pte Ltd

M.Sc. Life Sciences III[rd] Semester Course Title – Ecology and Biodiversity **Code : L010908T**

Course Objective(s)

Students will learn

1. to recognize the value and interaction in between abiotic and biotic components the relationship between abiotic and biotic components of the environment
2. to elaborate the conservation of biological diversity; the sustainable use of the components of biological diversity.
3. to develop an understanding of the differences in the structure and function of different types of ecosystems and develop an appreciation of the natural world through direct experience with local ecosystems.
4. developing and improving skills in scientific writing, basic mathematics, statistics, and use of computer spreadsheets and learn techniques of data analysis and methods of presenting scientific information.
5. Develop an appreciation of the modern scope of scientific inquiry in the field of Ecology.

Marks : - 100

S. No.	Topic
1	General Ecology and Ecological considerations
2	Ecology of individual organisms, population ecology, community ecology, ecosystem ecology
3	Bio-diversity, spatial and temporal dimension,
4	Bio-diversity and Population Biology,
5	Theoretical aspects of Genetic Issues at population level
6	Fragmentation of Habitat: Consequences for Ecology and Biodiversity
7	Eco-functions of Biodiversity at Community/Eco-system/Landscape Level
8	Inventorying & monitoring of Biodiversity.
9	Conservation of Biodiversity, Problems in Protected Areas
10	Problems of Rehabilitation of Degraded Ecosystems
11	Problems and Principles of In situ and Lx Situ Biodiversity conservation.
12	Biodiversity anti agriculture/Fisheries Development.
13	Biodiversity and Industrial Development
14	Biodiversity conservational Practices and Ethnic Cultures
15	Biodiversity and Global natural and cultural changes.

Course Outcome(s)

Students shall

1. master core concepts and methods from ecological sciences and their application in environmental problem solving.
2. appreciate the ethical, cross-cultural, and historical context of environmental issues and the links between human and natural systems.
3. apply systems concepts and methodologies to analyze and understand interactions between social and environmental processes.
4. reflect critically about their roles and identities as citizens, consumers and environmental actors in a complex, interconnected world.
5. demonstrate proficiency in quantitative methods, qualitative analysis, critical thinking, and written and oral communication needed to conduct high-level work as interdisciplinary scholars and/or practitioners.

Reference Books:

1. Gaston, K J. & Spicer, J.I. 1998. Biodiversity: An Introduction. Blackwell Science, London, UK.
2. Krishnamurthy, K.V. 2004. An Advanced Text Book of Biodiversity - Principles and Practices. Oxford and IBH Publications Co. Pvt. Ltd. New Delhi.
3. Pandit, M.K. & Grumbine R.E. 2012. Ongoing and proposed hydropower development in the Himalaya and its impact on terrestrial biodiversity. Conservation Biology 26:1061-1071.
4. Sodhi, N.S., Gibson, L. & Raven, P.H. 2013. Conservation Biology: Voices from the Tropics. Wiley-Blackwell, Oxford, UK.
5. Basic Ecology by E.P. Odum,
6. Environmental Biology by P.D. Sharma
7. Environmental Biology and Toxicology by P.D. Sharma,
8. Ecology and Environmental Science by Singh and Kumar

M.Sc. Life Sciences III[rd] Semester **Course Title – Redox Biology** **Code : L010909T**

Course Objective: This course is expected to provide basic exposure to oxido-reductive processes of biological systems wherein student learn in detail about reactive oxygen species and free radicals. The course contents will give the applications of ROS in cell metabolism and also importance of redox signalling in cellular expression of enzymes. The student is expected to study theoretical and practical aspects of redox signalling which will have diverse applications in aging, disease metabolism. Students are taken through online detailed tutorial demonstrations of the same where execution is not possible. Upon successful completion of this course the student will be able to recognize the foundations of next-generation biotechnology and biopharmaceutical industries that are based on redox biology. This course will aspire students to take further training Ph.D. level after their post-graduation.

Marks : - 100

S. No.	Topic
1	Redox Biology, a historical perspective and contemporary concepts
2	Redox metabolism and cellular processes Photosynthesis and Oxidative Phosphorylation
3	Organelle specific pro-oxidant enzymes and their functions
4	Antioxidant systems and redox buffers
5	In vivo and in vitro detection of reactive oxygen species and free radicals
6	Redox signaling in normal physiological processes Protein thiols, their oxidative and nitrosative modifications and cellular functions, Hydrogen peroxide and cell signaling, S-nitrosylation and protein function, Redox status and epigenetic regulation, Redox regulation of cell-cell
7	Emerging concept of redox homeostasis, oxidative stress and human diseases
8	Robustness and pitfall of the "Free Radical theory of Aging"
9	Role of nitric oxide and per oxynitrite in human health and diseases

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

1. Recall background history and major contributions in the field of redox biology and related techniques
2. List important developments in redox process in knowledge gain to better understanding diseases mechanism.
3. Define utility of basic laboratory instruments routinely used in redox biochemical reactions.
4. Describe all protocols and procedures related with redox signalling.
5. Differentiate methods of characterization of cellular homeostasis using Chromosome banding, DNA hybridization, isoenzyme analysis, flow cytometry etc.
6. The students will learn basic concepts of the redox signaling, Protein thiols, reactive oxygen species, free radicals. This initiates the analytical and experimental approach of solving any problem related to redox biology.
7. They are trained to operate automated instruments that help quantify and analyze the computer generated data hence develop hence develop employability skills.

TEXT BOOKS

Claus Jacob (Editor), Paul G. Winyard (Editor).Redox Signaling and Regulation in Biology and Medicine. ISBN: 978-3-527-62759-2 May 2009 514 Pages.

Ruma Banerjee (Editor), Donald Becker (Co-editor), Martin Dickman (Co-editor), Vadim Gladyshev (Co-editor), Stephen Ragsdale (Co-editor).Redox Biochemistry 1st Edition.

M.Sc. Life Sciences Semester — IV

Optional Courses (any three)

M.Sc. Life Sciences IVth Semester Course Title – Neural and Behavioural Biology Code : L011001T

Course objective:
The neural and behavioural biology course is designed to provide comprehensive knowledge of brain function at both molecular and cellular levels in the human brain. It also covers a range of understanding of neuropsychiatric and neurodegenerative diseases. Teaching of brain pathophysiology can offer insight into how defects at the cellular, genetic, or brain circuit level can overall affect brain function. Moreover, this course also covers animal behaviour and neurobiological experimental methods to study brain function. Upon successful completion of the course, students become specialised in neurobiology and behavioural science and can pursue fundamental or translational research.

Marks - 100

S. No.	Topic
1	Special senses, Vision optics, anatomy, transduction of light to electrical energy, Neurophysiology of vision, accommodation, errors, of vision, color vision, visual acquity, visual perception
2	Hearing anatomy, neurophysiology of hearing
3	Neural regulation of body temperature, cardiovascular function, respiration, Neuroendocrine regulation, basis of neuroimmune control, interleukin, etc
4	States of consciousness—sleep-wakefulness behavior, identification, classification of sleep-wakefulness, EEG, EOG, EMG, Neural and neuro-chemical regulation of sleep-wakefulness, effects of sleep loss, functions of sleep, relation of sleep-wakefulness with other functions, biorhythm, clock/per gene regulation
5	Feeding, social, colony formation, hibernating, migratory behaviors
6	Aggression, fight and flight behaviors, stress and adaptation - neural Control
7	Neurogenetics, Narcolepsy, Down's syndrome
8	Ageing, factors affecting, Depression, Schizophrenia, epilepsy, Parkinson's Alzheimer, Neural Modeling/ artificial intelligence/ neural network

Course Outcome
After completing this course, students will be able to:

1. Demonstrate knowledge of, and recognise the relationships between, the structure and function of human brain. Moreover, appreciate the cause of neuropathophysiology at molecular, cellular, and brain circuit level.
2. Analyse basic neuroscience research data involving gene networks and EEG data and infer its significance in neurophysiology.
3. Apply and integrate their knowledge into an understanding of the neural basis of behaviour.

Reference Books:

1. Principles of Neural Science by Eric R. Kandel, James Harris Schwartz, Thomas M. Jessell
2. Fundamental Neuroscience by Larry R. Squire, Floyd E. Bloom, Susan K. McConnell
3. From Neuron to Brain by John G. Nicholls, A. Robert Martin, Bruce G. Wallace, Paul A. Fuchs.
4. Development of the Nervous system by Dan H. Sans, Thomas A. Reh, William A. Harris
5. The Central Nervous System: Structure and function by Per Brodal
6. Textbook of Medical Physiology by A C Guyton.

M.Sc. Life Sciences IVth Semester Course Title – Plant Biotechnology **Code : L011002T**

Course Objective(s)

1. To make students understand about the basics of plant science
2. To equip students with culture techniques and scope of plant biotechnology
3. To provide knowledge on genetic engineering in the improvement of plants for human welfare

Marks - 100

S. No.	Topic
1	Plant Tissue Culture Historical perspective, Totipotency, isolation, maintenance and cultivation of cell cultures, Organogenesis, Somatic embryogenesis, Regulation and applications, Artificial seed production
2	Micropropagation, meristem and shoot tip culture, Production of virus-free plants
3	Somaclonal variation, induction and selection of mutants, disease-, herbicide- and stress tolerant mutants
4	In vitro pollination and fertilization, Embryo culture, and their applications in plant breeding.
5	Haploid production, Androgenesis and gynogenesis, and its applications in genetics and plant breeding
6	Protoplast Culture and Somatic Hybridization, Protoplast isolation, Culture and usage, Somatic hybridization — methods, selection and characterization, and application; Cybrids and somatic cell genetics.
7	Cell cultures for secondary metabolite production; Production of pharmaceutically important compounds, strategies for enhancing secondary metabolite production from cultured cells.
8	Germplasm conservation and cryopreservation.
9	Agrobiology: Agrobacterium-plant interaction, Virulence; Ti and Ri Plasmids; Opines and their significance; T-DNA transfer; Disarming the Ti plasmid. Genetic Transformation, Agrobacteriummediated gene delivery; Co-integrate and binary vectors and their utility; Direct gene transfer- PEG-mediated, electroporation, particle bombardment and alternative methods
10	Screenable/Scorable and Selectable markers, Characterization of transgenics; Chloroplast transformation; Marker-free methodologies, Gene targeting.
11	Molecular Mapping & Marker Assisted Selection (MAS), Quantitative and qualitative traits, MAS for genes of agronomic importance, Molecular polymorphism, RELP, RAPD, STS, AFLP, SNP markers, Construction of genetic and physical map; Gene mapping; QTL mapping
12	Strategies for introducing Biotic and Abiotic Stress Resistance/Tolerance Bacterial resistance; Viral resistance; Fungal resistance, Insects and pathogens resistance; Herbicide resistance, Drought, salinity, thermal stress, flooding and submergence tolerance, Terminator seeds
13	Plants / Plant cells as Biofactories, Concept of biofactories; Fermentation and production of industrial and pharmaceutical biomolecules

Course Outcome(s)

The students shall be able to:

1. demonstrate knowledge for in-depth analytical and critical thinking to identify, formulate and solve the issues related to Biotechnology Industry, Pharma industry, Medical or hospital related organizations, Regulatory Agencies, & Academia.
2. appreciate and execute their professional roles in society as biotechnology professionals, employers and employees in various industries, regulators, researchers, educators and managers
3. establish different types of plant cultures.
4. apply the technical skills learnt to establish nurseries for horticultural and agricultural crops.
5. compare the pros and cons of transgenic plants on environment
6. explain the concepts of intellectual property management and handling of GMOs.

Reference Books:

1. Bhojwani, S.S. and Razdan 2004 Plant Tissue Culture and Practice.
2. Brown, T. A. Gene cloning and DNA analysis: An Introduction. Blackwell Publication.
3. Gardner, E.J. Simmonns, M.J. Snustad, D.P. 2008 8th edition Principles of Genetics. Wiley India.
4. Raven, P.H., Johnson, GB., Losos, J.B. and Singer, S.R. 2005 Biology. Tata MC Graw Hill.
5. Reinert, J. and Bajaj, Y.P.S. 1997 Applied and Fundamental Aspects of Plant Cell, Tissue and Organ Culture. Narosa Publishing House.
6. Russell, P.J. 2009 Genetics – A Molecular Approach. 3rdedition. Benjamin Co.
7. Sambrook & Russel. Molecular Cloning: A laboratory manual. (3rd edition)
8. Slater, A., Scott, N.W. & Fowler, M.R. 2008 Plant Biotechnology: The Genetic Manipulation of Plants, Oxford University Press.

M.Sc. Life Sciences IVth Semester Course Title – Molecular Parasitology Code : L011003T

Course Objective(s)

The course

1. Will provide general concepts of parasitology, knowledge of some parasitic diseases that could be transmitted between animal and man.
2. Will provides a knowledge about how to protect man and domestic animals from parasites, the different biological interrelationship and the host parasite relationship, during the course students studies parasitic and their relation to their host environment.

Marks - 100

S. No.	Topic
1	Introduction to Protozoan parasites *Entamoeba histolynca* and other amitochondriates; Kinetoplastids including Leishmania and Trypanosomes, Apicomplexans e.g. Plasmodium, *Toxoplasma gond''*, Helminthes and nematodes
2	Peculiar organelles of Protozoa cytoskeleton, mitotic spindle, glycosomes, hydrogenosomes
3	Chemotherapeutic targets in protozoan parasites Properties of an effective drug, Classes of drugs, Mechanism of action of drugs
4	Drug Resistance and mechanism in protozoan parasites
5	Host-parasite interactions and Antigenic variation and host evasion
6	Virulence factor in protozoan parasite
7	Genomic organization, transcription, splicing and gene regulation in parasites. Chromosomal, Extra chromosomal
8	Functional genomics of parasites
9	Novel molecular mechanisms in parasites, Replication of kDNA and RNA editing
10	Diagnostic s
11	Immuno-pathogenic mechanism- Innate immunity, functions of complements, receptors for innate immunity, toll like receptors, Adaptive immunity, role of cytokines etc
12	Vaccine targets

Course Outcome(s)

1. Knowledge to identify parasitism, parasites and their examples.
2. Describe disease of mode of diagnosis, control of parasites infections, understanding parasites host relationship student become right use of microscopes, using computer and internet, conducting documentary
3. About some parasites throw out the kingdom.
4. Helpful to develop the ability to work as a member of team to conduct a specific project

Reference Books:

1. KC Carroll, SA Morse, T Mietzner, S Miller. (2016), Jawetz, Melnick and Adelbergs's Medical Microbiology, 27th edition, McGraw Hill.
2. J Owen, J Punt and Sharon Stranford; (2012), Kuby Immunology, 7th edition W.H. Freeman and Co.
3. IT Kudva, NA. Cornick, PJ Plummer, Q Zhang, TL Nicholson, JP Bannantine and BH Bellaire. (2016), Virulence Mechanisms of Bacterial Pathogens, 5th edition, ASM Press.
4. V Kumar, AK. Abbas and JC Aster, (2015), Robbins & Cotran Pathologic Basis of Disease, 9th Edn, Elsevier.
5. K Murphy and K Weaver, (2016), Janeway's Immunobiology, 9th Edition, Garland Science.
6. AK Abbas, (2015), Cellular and Molecular Immunology, 8th Edition, Elsevier.
7. Ananthanarayan and Paniker, Textbook of Microbiology, 8th Edition.
8. Baveja CP, Textbook of Microbiology.

M.Sc. Life Sciences IVth Semester Course Title – Radiation Biology **Code : L011004T**

Course Objective:
The course is expected to provide basic knowledge of the biological effects of radiation. The course contents will give an understanding of risks at the cellular level to humans, factors that affect the dose-effect relationship, and more profound knowledge of radiation protection for ionizing and non-ionizing radiation, both in legislation and practical radiation protection technology. Upon successfully completing this course, the student will recognize the foundations of next-generation biotechnology and biopharmaceutical industries based on radiation biology.

Marks - 100

S. No.	Topic
1	interaction of radiation with matter. Different types of radiation. Ionization and excitation. Linear energy transfer, Direct and indirect effects of radiation, Radiation chemistry of water
2	Biological effects of radiations Whole body irradiation and sensitivity of tissue, Units of radiation measurement, Radiation levels and limits
3	Cell Survival curves reproductive integrity, mechanism of cell killing, survival curves in mammalian cells
4	Radio-sensitivity and cell cycle: Variation of sensitivity with cell age, effect of X-rays and high LET radiations, possible implications in radiotherapy
5	Heritable effects of radiations Chromosomal and chromatid aberrations, point mutations Mendelian, chromosomal and multi- factorial diseases, genetic risk assessment, doubling dose, mutation component
6	Modification of radiation induced damage, Radiosensitizers, Radio-protectors, Normal tissue radioprotection, Mechanisms of action, sulfhydryl compounds, WR series, dose reduction factor (DRF)
7	Non-targeted effects of radiations. Bystanders effects, chromosomal instability, adaptive response
8	Mechanisms for the repair of DNA, Repair of DNA breaks, Repair of base damage photo reactivation, excision repair, post-replication recovery, Base excision repair, nucleotide excision repair (NER), transcription coupled repair (TCR) and bulk DNA repair
9	Radiation induced signaling pathways: Radiation induced gene expression, Signaling abnormalities in cancer. Effects of signaling abnormalities on radiation responses
10	Radiation carcmogenesis Initiation, promotion, progression, Dose response for radiation induced cancers, Importance of age at exposure and time since exposure, Second tumors in radiation therapy patients

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

1. Describe direct and indirect interactions between radiation and cells.
2. Describe the molecular basis of cellular radiosensitivity.
3. Explain the influence of cell cycle, repair, repopulation and reoxygenation on tissue radiosensitivity.
4. Describe the components of a cell survival curve.
5. Differentiate between cell survival curves of varying LET radiations, hypoxic
6. Identify the acute and late effects of radiation on living tissue.
7. Describe the effects of whole body radiation.
8. Describe the long-term effects of radiation.
9. Explain the effects of time, dose and fractionation on long-term side effects and treatment effectiveness.

Reference Books:

1. Kenneth Chadwick (2020) Understanding Radiation Biology: From DNA Damage to Cancer and Radiation Risk.
2. C.S. Sureka, Christina Armpilia (2017) Radiation Biology for Medical Physicists
3. John T. Lett & Howard Adler (2013) Advances in Radiation Biology: Kindle Edition, Academic Press
4. Radiation Biology of Medical Imaging. Editor(s): Charles A. Kelsey PhD, Philip H. Heintz PhD, Daniel J. Sandoval MS, Gregory D. Chambers MS, Natalie L. Adolphi PhD, Kimberly S. Paffett MS. ISBN:9780470551776

M.Sc. Life Sciences IVth Semester **Course Title – Microbial Biotechnology** **Code : L011005T**

Course Objective(s)

1. Production of a range of value-added products though microbes
2. Target the selection and manipulation of micro-organisms with the objective of improving process control, product quality, safety, consistency and yield.
3. To learn how students can enhance properties of the food such as taste aroma shelf-life, texture and nutritional value of foods as well as Preservation of food
4. To highlight the roles and characteristics of microorganisms in field of biotechnology.
5. To study in detail, the growth, genetic organization of microorganisms and impact of environment on their growth.
6. To evaluate explicitly, the metabolic pathways, role of microbes in public health; insight into the physical and chemical control of microorganisms.

Marks : 100

S. No.	Topic
1	Microbial biotechnology Scope, techniques, microbes as moving factories for macromolecules
2	Isolation, identification and selection of microbial strains
3	Determination of optimal nutrition requirements (Classical and modern approaches)
4	Strain improvement to increase product formation.
5	Maintenance and preservation of microbial cultures
6	Aerobic carbon utilization of renewable and non-renewable substrates; Anaerobic carbon utilization Waste management - treatment of solid and liquid waste Bioremediation of xenophobic pollutants
7	Production of proteins in yeast, SCP production
8	Production of recombinant and synthetic vaccines
9	Production of enzymes, vitamins, and amino acids from microorganisms
10	Microbial biomass and fuel production, algal biomass
11	Microbial production polysaccharides, and organic acids, solvents, Biosurfactants, Biodegradable plastics
12	Food and Beverages production using microbes
13	Antibiotics and Secondary metabolite production from microorganisms.
14	Microbial recovery of metals
15	Microbial fertilizers, pesticides, bio inoculants, biological control agents

Course Outcome(s)

Students

1. advances in food safety, food security, value-added products, human nutrition and functional foods, plant and animal protection, and overall fundamental research in the agricultural sciences
2. shall contribute/serve in disease prevention and therapy, diagnostics, agriculture and horticulture, food production and preservation.
3. could serve as human resource for the production of proteins and enzymes, medicinal, polymers, enzyme inhibitors, surfactants, bioherbicides, biopesticides, and many more industries.

Reference Books:

1. MICROBIOLOGY BY MICHAL J, PELCZAR
2. MICROBIOLOGY BY PD SHARMA
3. MICROBIOLOGY BY JACQUELYN G. BLACK
4. MICROBIOLOGY BY KANIKA SHARMA,

M.Sc. Life Sciences IVth Semester Course Title – Nanobiotechnology **Code : L011006T**

Course Objective(s)

1. To provide the foundational knowledge of the Nanoscience and related fields.
2. To acquire an understanding the Nanoscience and Applications
3. To understand in broad outline of Nanoscience and Nanotechnology.
4. To emphasize on the biotechnological applications of the nanomaterials especially their design and application in drug delivery.
7. To address the industrial needs through interdisciplinary training that bridges gap and meets the demand f pharmaceutical and chemical industry.

Marks - 100

S. No.	Topic
1	Properties and characterization of Nanomaterials, Bionanomachines and their basics
2	Nanomaterials and bio system interaction, Synthesis of biomolecules and interphase systems, Prtein and DNA based nanostructures, roteins as transducers and amplifiers of biomolecular recognition events, Nanobioelectronic devices and polymer nanocontainers, Microbial production of nanoparticles, Hybrid conjugates of gold nanoparticles, Use of DNA molecules in nanomachines and compuring
3	Bio Medical nanotechnology (Diagnostic. Delivery, and therapeutics), Nanotoxicology
4	Functional principles of nanobiotechnology: Information driven nano assembly, energetic, role of enzymes in chemical transformation, allosteric motion and covalent modification in protein activity regulation, structure and functions of biomaterials
5	Bio Nano machines and their basics Negligible gravity and inertia, atomic granulity, thermal motion, water environment and their importance in bio nano machines, The role of proteins —amino acids — nucleic acids — lipid and polysaccharides in modern biomaterials. Overview of
6	Bio molecular Motors ATP synthetase and flagellar motors, Traffic across membranes potassium channels. ABC Transporters and Bacteriorhodopsin, Biomolecular sensing, self-replication machine — phase, Bio nanotechnology, protein folding, self-assembly, self-organization, molecular recognition and flexibility of biomaterials
7	Role of nanotechnology in biological therapies, application in cancer therapy and nanomedicine . Introduction and rationale for nanotechnology in cancer therapy - passive targeting of solid tumours, pathophysiological principles and physiochemical aspects of delivery system - active targeting strategies in cancer with a focus on potencial nanotechnology application multifunctional nanoparticles for cancer therapy

Course Outcome(s)

After completing this course, students will be able

1. To explain about the background on nanoscience and its applications.
2. To understand the synthesis of nanomaterials and their application and the impact of nanomaterials on environment.
3. To apply their learned knowledge to develop Nanomaterial's.
4. To apply Nanotechnology and may apply their skills in research laboratories and pharmaceutical industries.

Reference Books:

1. Guozhong Cao. Ed Nanostructures and Nanomaterials: Synthesis, Properties, and Applications, World Scientific Series in Nanoscience and Nanotechnology
2. Introductory Nanoscience: Physical and Chemical Concepts": Masaru, Kuno, Garland Science.
3. Bharat Bhushan, Handbook of Nanotechnology, Springer.
4. Hari Singh Nalwa, Handbook of Nanostructured Biomaterials and their Applications In Nanobiotechnology, Journal of Nanoscience and Nanotechnology.

M.Sc. Life Sciences IVth Semester Course Title – Hormone Action & Metabolic disorder

Code : L011007T

Course Objective(s)

This course aims

1. To study endocrine system in terms of structure, function & its role in regulating metabolism, growth reproduction in different organisms with reference to disorders resulting from dysfunction
2. Give vast amounts of information and knowledge regarding the metabolism and endocrinology

Marks : 100

S. No.	Topic
1	Characteristics of hormone system, Classification.
2	Molecular basis of hormone action, hormone receptors, cAMP, protein kinase other intracellular messenger like Ca^{++} and phosphoinositides.
3	GTP binding proteins, phospholipase, inositol triphosphate and diacyl glycerol.
4	Assay of hormones.
5	Mechanism of action of insulin receptors and tyrosine kinase growth factors.
6	Diabetes regulation of insulin/glucagon and its significance.
7	Hormonal regulation of carbohydrate, fat and protein metabolism.
8	The hypothalamus and pituitary, over and under secretion of pituitary hormones.
9	Hormones and cancer.
10	Thyroid hormone — Mechanisms of action and pathophysiology.
11	Hormones regulating calcium metabolism, calcium as a second messenger, calmodulin.
12	Classification and mechanism of action of catecholamines, neurohormones and substance P. Biomedical importance.
13	Hormones of the gonads, testosterone and estrogens mechanism of action and pathophysiology.
14	Gastrointestinal and neural hormone like secretion like secretion, substance P, neurotensin their mechanism of action.

Course Outcome(s)

1. Understanding the common endocrine disorders, metabolic regulations, their management
2. Describing new advances in medicine for treating the hormonal imbalance at different levels
3. Studying thoroughly the genetic and psychiatric abnormalities associated with metabolic changes
4. To study the chemical nature of hormones and its quantitative action in relation to different disorders
5. Analyzing the role of hormones as a regulatory factor in the living system, the neurotransmitters and their relation with some diseases and drug addiction

Reference Books:

1. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Harcourt Asia PTE Ltd. /W.B. Saunders Company.
2. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition. John Wiley & Sons, Inc.

Compulsory

M.Sc. Life Sciences IVth Semester

Course Title – Dissertation (to be pursued during III and IV Sem) Code : L011008T Marks - 200

13/5/22

Prof BN Mishra (Online) – External

Prof. Ram Narain (Online) – External