L J SCHOOL OF APPLIED SCIENCES
M.Sc. – Semester I Biotechnology
(MB/BT) - 401: BIOCHEMISTRY & BIOTECHNIQUES

Total Credits – 04 **Total Hours – 60**

Course Outcomes:

At the end of this course the student will:

- The students will be able to apply the concept of biomolecular concepts, metabolic pathways and energy transfer to cellular level.
- Student will gain insight into cutting-edge experimental methods in areas such as fermentation, cell culture, and gene therapy and apply the knowledge to projects of research importance.
- Students will develop Skills in Molecular Biology Techniques, Learn to isolate and purify RNA, DNA (genomic and plasmid), and proteins. Understand and apply DNA and protein sequencing techniques, including genome sequencing strategies.

Course Objectives:

- To understand the concepts of biomolecules, their metabolic cycles and the biochemical reactions. And apply knowledge of biomolecular mechanisms to cellular context. Gain insight into the metabolic pathways and energy transfer.
- Familiarize students with modern experimental methods and techniques in fermentation, cell culture and gene therapy.
- Understand techniques for isolating and purifying RNA, DNA (genomic/plasmid), and proteins.
- Implement DNA and protein sequencing methods, including genome sequencing strategies.

Unit – 1:

(A) Molecules and their Interactions

Structure of atoms, molecules and chemical bonds. Composition, structure and function of biomolecules (carbohydrates, lipids, proteins, nucleicacids and vitamins). Stabilizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobicinteraction, etc.).
Principles of biophysical chemistry (pH, buffer, reaction kinetics, thermodynamics, colligative properties).

(B) Conformation and Stability of DNA and Proteins

Conformation of proteins (Ramachandran plot, secondary structure, domains, motif and folds). Stability of proteins and nucleic acids. Conformation of nucleic acids (helix (A, B, Z), t-RNA, micro-RNA).

Unit – 2: Bioenergetics, Metabolism and Enzyme Catalysis

Bioenergetics, glycolysis, oxidative phosphorylation, coupled reaction, group transfer, biological energy transducers. Metabolism of carbohydrates, lipids, amino acids nucleotides and vitamins.
Secondary metabolites - Biosynthesis of terpenes, phenols and nitrogenous compounds and their roles. Principles of catalysis, enzymes and enzyme kinetics, enzyme regulation, mechanism of enzyme catalysis, isozymes.

Unit – 3: Methods in Biology

Microbial fermentation and production of small and macro molecules.
Tissue and cell culture methods for plants and animals. Transgenic animals and plants, molecular approaches to diagnosis and strain identification.Genomics and its application to health & agriculture, Gene therapy.
Breeding in plants and animals, including marker – assisted selection.
Bioremediation and Biosensors.

Unit – 4: Molecular Biology and Recombinant DNA Methods

Isolation and purification of RNA, DNA (genomic and plasmid) and proteins, different separation methods. Analysis of RNA, DNA and proteins by one and two dimensional gel electrophoresis,Isoelectric focusing gels.
Molecular cloning of DNA or RNA fragments in bacterial and eukaryotic systems.Expression of recombinant proteins using bacterial, animal and plant vectors.
Isolation of specific nucleic acid sequences.
Generation of genomic and cDNA libraries in plasmid, phage, cosmid, BAC and YAC vectors. In vitro mutagenesis and deletion techniques, gene knock out in bacterial and eukaryotic organisms.
Protein sequencing methods, detection of post translation modification of proteins. DNA sequencing methods, strategies for genome sequencing.
Methods for analysis of gene expression at RNA and protein level, large scale expression, suchas micro array based techniques
Isolation, separation and analysis of carbohydrate and lipid molecules
RFLP, RAPD and AFLP techniques.

References:

1. Lehninger Principles of Biochemistry – David L. Nelson and Michael M. Cox,Publisher W. H. Freeman, 2017, 7th Edition.
2. Principles of Biochemistry – Donald Voet, Judith G. Voet, Charlotte W. Pratt, PublisherWiley, 2012, 4th Edition.
3. Biochemistry: International Edition – Stryer, Berg and Tymoczko, Publisher W. H. Freeman,2019, 9th Edition.
4. Enzymes: Biochemistry, Biotechnology, Clinical Chemistry – Trevor Palmer and PhilipBonner, Elsevier Science, 2007, 2nd Edition.
5. Campbell Biology Campbell Biology: Concepts & Connections; Martha Taylor, Eric Simon, Jean Dickey, Kelly Hogan, Jane Reece, Publisher Pearson, 2018, 9th Edition.
6. Life Science: Fundamentals and Practice Part 1& 2 Pranav Kumar, Usha Mina Pathfinder Publication 7th Edition.
7. Biology- Peter Raven, George Johnson, McGraw-Hill Education, 2017, 12th Edition.
8. Prescott's Microbiology - Christopher J. Woolverton, Joanne Willey, and Linda Sherwood, McGraw-Hill, 2011, 8th Edition.
9. Principles and Techniques of Biochemistry and Molecular Biology – Wilson and Walker, Cambridge University Press, 2018, 8th Edition.
10. Biophysical Chemistry (Principles and Techniques) - Upadhyay A, Himalya Publishing House, 2016.
11. Plant Breeding Principles & Methods –B.D. Singh, Publisher Kalyani, 2015
12. Genomes 3 – T.A. Brown, Garland Science; 3rd Edition.
13. Introduction to Plant Tissue Culture-Razdan MK, Oxford & IBH Publishing, 3rd Edition,2019

L J SCHOOL OF APPLIED SCIENCES
M.Sc. – Semester I Biotechnology
(MB/BT) 402: EVOLUTION, BEHAVIOUR & TAXONOMY

Total Credits – 4 **Total Hours – 60**

Course Objectives:

At the end of this course the student will:

- Gain an understanding of taxonomy, biological classification, and evolutionary relationships. Study the historical development of taxonomic systems and their importance in organizing biodiversity.
- Learn fundamental theories of evolution, and understand the key events in the evolutionary timeline.
- Develop a deep understanding of molecular evolution, including the use of molecular tools in phylogeny, classification, and sequence analysis of proteins and nucleotides.
- Acquire knowledge of population genetics, including natural selection, migration, genetic drift, and adaptive radiation. Explore evolutionary mechanisms like convergent evolution, co-evolution, and the neural basis of behaviour.
- Understand the geographic origins and species migration in the Indian subcontinent. Gain insight into the role of organisms in agriculture, including common pathogens affecting crops and livestock.

Course Outcomes:

- To provide knowledge of Taxonomy & biological classification and study of evolutionary relationship and historical progression with taxonomical systems
- To teach fundamental theories of Evolution and understand major events of evolutionary timeline. To impart knowledge of concepts of Molecular evolution and use of molecular tools in phylogeny, classification, and protein/nucleotide sequence.
- To familiarise students with the fundamentals of population genetics and concepts like natural selection, migration, genetic drift, and adaptive radiation. Study isolating mechanisms, convergent evolution, and co-evolution. To explore the neural basis of behaviour and behavioural evolution.
- To provide knowledge of geographic origins, habitats, and species migration in the Indian sub-continent. To familiarize students with the importance of Agriculture and pathogens affecting agricultural industry.

Unit – 1: Diversity of Life Forms & Biological Classifications

Principles and methods of taxonomy: Concepts of species and hierarchical taxa, biological nomenclature, classical & quantitative methods of taxonomy of plants, animals and microorganisms.
Classification of plants, animals and microorganisms. Important criteria used for classification in each taxon. Evolutionary relationships among taxa.

Unit 2: Evolution, Palaeontology and Molecular Evolution

Lamarckism, Darwinism and other evolutionary theories. The evolutionary synthesis. Experiment of Miller (1953); The first cell; Evolution of prokaryotes; Origin of eukaryotic cells; Evolution of unicellular eukaryotes; Anaerobic metabolism, photosynthesis and aerobic metabolism. Comparative anatomy, adaptive radiation, adaptive modifications.

Paleontology and Evolutionary History: Major events in the evolutionary time scale; Stages in primate evolution including Homo.
Molecular Evolution: Concepts of neutral evolution, molecular divergence and molecular clocks; Molecular tools in phylogeny, classification and identification; Protein and nucleotide sequence analysis; origin of new genes and proteins; Gene duplication and divergence.

Unit – 3: Mechanisms of Population Genetics and Evolutionary

HardyWeinberg Law; concepts and rate of change in gene frequency through natural selection, migration and random genetic drift; Adaptive radiation; Isolating mechanisms; Convergent evolution; Sexual selection; Co-evolution.
Brain, Behavior and Evolution: Approaches and methods in study of behavior; Proximate and ultimate causation; Altruism and evolution-Group selection, Kin selection, Reciprocal altruism;Neural basis of learning, memory, cognition, sleep and arousal; Biological clocks; Development of behavior; Social communication; Social dominance; Use of space and territoriality; Mating systems, Parental investment and Reproductive success; Parental care; Aggressive behavior; Habitat selection and optimality in foraging; Migration, orientation and navigation; Domestication and behavioral changes.

Unit – 4:

(A) History of Indian Subcontinents

Natural history of Indian subcontinent: Major habitat types of the subcontinent, geographic origins and migrations of species. Common Indian mammals, birds. Seasonality and phenology of the subcontinent.

(B) Organisms of Health and Agriculture

Organisms of health and agricultural importance: Common parasites and pathogens of humans, domestic animals and crops.

References:

1. Organic Evolution (Evolutionary Biology) – Veer Bala Rastogi, Scientific International, 2018, 13th Edition.
2. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology-P S Verma and VKAgrawal, Publisher S. Chand, 2005, 14th Edition.
3. Evolution by Futuyma, Publisher Sinauer Associates, 2005, 3rd Edition.
4. Campbell Biology: Concepts & Connections– Martha Taylor, Eric Simon, Jean Dickey, Kelly Hogan, Jane Reece, Pearson, 2018, 9th Edition.
5. Life Science: Fundamentals and Practice Part 1& 2 Pranav Kumar and Usha Mina, Pathfinder Publication 7th Edition.
6. Biology- Peter Raven, George Johnson, McGraw-Hill Education, 2017, 12th Edition.
7. Prescott's Microbiology - Christopher J. Woolverton, Joanne Willey, and Linda Sherwood, McGraw-Hill, 2011, 8th Edition.

L J SCHOOL OF APPLIED SCIENCES
M.Sc. – Semester I Biotechnology
PAPER: (MB/BT) - 403: CELL BIOLOGY

Total Credits – 04 **Total Hours – 60**

Course Objectives:

By the end of this course, the student will:

- Acquire in-depth understanding of cell structure, including the plasma membrane and key mechanisms such as diffusion, osmosis, active transport, ion channels, membrane pumps, and the regulation of intracellular transport.
- Gain Insight into organelle function and cytoskeletal dynamics:
- Understand gene and chromosome organization and the role of heterochromatin, euchromatin, and transposons in gene regulation.
- Develop understanding of cell division and microbial physiology and regulation of physiological responses under stress.

Course Outcomes:

- To provide students with an in-depth understanding of Cell structure and its components and mechanisms like diffusion, osmosis, and active transport. Study ion channels, membrane pumps, and the regulation of intracellular transport.
- To explore the structure and function of various intracellular organelles, and emphasize the cytoskeleton's structure and its role in cellular motility.
- To teach students about the organization of genes and chromosomes, concepts such as operon, DNA, gene families, and the structure of chromatin and chromosomes. Understand the roles of heterochromatin, euchromatin, and transposons in gene regulation.
- To provide students with knowledge of cell division processes, regulation of the cell cycle, and process controls. To explain microbial growth characteristics, strategies of cell division, and stress responses. Gain insight into how regulation of physiological processes by microorganisms.

Unit – 1: Cellular organisation

Membrane structure and function (Structure of model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, membrane pumps, mechanism of sorting and regulation of intracellular transport, electrical properties of membranes).

Unit – 2: Cell structure and function

Structural organization and function of intracellular organelles (Cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, structure & function of cytoskeleton and its role in motility).

Unit – 3: Organization of genes

Organization of genes and chromosomes (Operon, unique and repetitive DNA, interrupted genes, gene families, structure of chromatin and chromosomes, heterochromatin, euchromatin, transposons).

Unit – 4: Cell division and microbial physiology

Cell division and cell cycle (Mitosis and meiosis, their regulation, steps in cell cycle, regulation and control of cell cycle).

Microbial Physiology (Growth yield and characteristics, strategies of cell division, stress response)

References:

1. The Cell: A Molecular Approach – Geoffrey M. Cooper, Publisher Oxford University Press, 2018, Eighth Edition.
2. Cell and Molecular Biology: Concepts and Experiments – Gerald Karp, Publisher Wiley, 2020, Ninth Edition.
3. Molecular Biology of the Cell – Bruce Alberts, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts, and Peter Walter, Publisher Garland Science, Taylor and Francis Group, 2015, Sixth Edition
4. Cell And Molecular Biology – Robertis De. Robertis DE Jr., Wolters Kluwer Publication, 2011, South Asia Edition, Eighth edition.
5. Molecular Cell Biology: International Edition – Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Anthony Bretscher, Hidde Ploegh, Angelika Amon, and Matthew
P. Scott, Publisher W. H. Freeman, 2017, Seventh Edition.
6. Molecular Biology of the Gene – James D. Watson, Tania A. Baker, Stephen P. Bell, Alexander Gann, Michael Levine, and Richard Losick, Publisher Pearson, 2007, Sixth Edition.

L J SCHOOL OF APPLIED SCIENCES
M.Sc. – Semester I Biotechnology
PAPER: (MB/BT) 404: INHERITANCE BIOLOGY (GENETICS)

Total Credits – 04 **Total Hours – 60**

Course Objectives:

By the end of this course, student will:

- Grasp the fundamentals of Mendelian genetics, and the concepts of dominance, segregation, independent assortment, genes, alleles, and complementation tests.
- Have knowledge of advanced genetic concepts such as codominance, incomplete dominance, gene interactions, linkage, and sex-linked traits.
- Be familiar with gene mapping methods, including linkage maps, tetrad analysis, and molecular markers. They will also gain practical knowledge of mapping techniques using somatic cell hybrids and plant populations.
- Understand Extra Chromosomal Inheritance and Genetic Transfer
- Gain knowledge of Human genetics and Quantitative genetics.

Course Outcomes:

- To provide students with a comprehensive understanding of Mendelian principles and its extensions including dominance, segregation, and independent assortment. Introduce concepts of genes, alleles and complementation tests, gene interactions. Study the concepts of linkage, sex-linked traits, and gene interactions.
- To familiarize students with gene mapping methods, linkage maps, tetrad analysis, and use of molecular markers. Teach mapping techniques using somatic cell hybrids and mapping plant populations.
- To teach extra chromosomal inheritance and methods of genetic transfer. To explain gene mapping in microbes and fine structure analysis.
- To provide students with knowledge of human genetics, pedigree analysis, various genetic disorders and their inheritance patterns. To explain quantitative genetics; measure heritability and use QTL mapping to study complex traits.

Unit – 1: Mendelian principles and gene mapping

Mendelian principles: Dominance, segregation, independent assortment.
Concept of gene: Allele, multiple alleles, pseudoallele, complementation tests.
Extensions of Mendelian principles: Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy, linkage and crossing over, sex linkage, sex limited and sex influenced characters.
Gene mapping methods: Linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids, development of mapping population in plants.

Unit – 2: Chromosomal inheritance and microbial genetics

Extra chromosomal inheritance: Inheritance of Mitochondrial and chloroplast genes, maternal inheritance.
Microbial genetics: Methods of genetic transfers – transformation, conjugation, transduction and sex-duction, mapping genes by interrupted mating, fine structure analysis of genes.

Unit – 3: Human genetics

Human genetics: Pedigree analysis, lod score for linkage testing, karyotypes, genetic disorders.
Quantitative genetics: Polygenic inheritance, heritability and its measurements, QTL mapping.

Unit – 4: Mutations and Recombination

Mutation: Types, causes and detection, mutant types – lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants, insertional mutagenesis.
Structural and numerical alterations of chromosomes: Deletion, duplication, inversion, translocation, ploidy & their genetic implications.
Recombination: Homologous and non-homologous recombination including transposition.

References:

1) Principles of Genetics – D. Peter Snustad, Michael J. Simmons, Publisher: Wiley, 2015, Seventh Edition.
2) Genetics: Principles and Analysis – Daniel L. Hartl and Elizabeth W. Jones, Publisher Jones & Bartlett Learning, 2012, Eighth Edition.
3) Genetics – BD Singh, Kalyani Publishers, 2009.

L J SCHOOL OF APPLIED SCIENCES
M.Sc. – Semester I Biotechnology
PR- MB/BT – 401: FERMENTATION TECHNOLOGY IN FOOD AND BEVERAGES (PR)

Total Credits: 03 **Total Hours: 45**

Course Objectives:

At the end of the course, the student will:

- Demonstrate a comprehensive understanding of the biological and chemical principles underlying fermentation processes.
- Analyse various microorganisms involved in food and beverage fermentation and their impact on product quality.
- Examine different fermentation techniques and their applications in the production of various foods and beverages and understand methods to assess and ensure quality standards.
- Investigate the nutritional and health benefits associated with fermented foods and beverages, including their role as probiotics and bioactive compounds.

Course Outcomes:

- To provide a comprehensive understanding of the biological and chemical principles underlying fermentation processes.
- To analyse the roles of various microorganisms involved in food and beverage fermentation,
- To examine different fermentation techniques and their applications in production of various foods and beverages. Assessing and ensuring quality and safety of fermented products by monitoring fermentation parameters and microbial activity.
- To Investigate Health Benefits of fermentation food products.

List of Practicals:

1. Production of red and White Wine
2. Production of Fruit Vinegar
3. Bread fermentation from different types of grains
4. Fermentation of Idli
5. Fermentative production of Yakult
6. Fermentative production of Kefir
7. Fermentative production of Probiotic Curd

8. Production of industrial Alcohol
9. Production of Beer from Dates
10. Fermentative production of Cheese
11. Fermentative production of Tofu
12. Production of Yeast granules.
13. Production of Barley Beer
14. Production of Beer from fruits.

REFERENCES:

1. Industrial Fermentation: Principles, Processes, and Products, James A. Kent, Riegel's
2. Handbook of Industrial Chemistry pp 963-1045 Publisher: Springer Netherlands 9TH Edition 1992
3. Practical Manual on Fermentation Technology, 1/e S. Kulandaivel & S. Janarthanan
4. I K International Publishing House 2012
5. Lab Manual 13 Methods of Analysis of Alcoholic Beverages FOOD SAFETY AND STANDARDS AUTHORITY OF INDIA MINISTRY OF HEALTH AND FAMILY WELFARE GOVERNMENT OF INDIA NEW DELHI 2015
6. Methods in Industrial Microbiology : B. Sikyta Publisher:Ellis Horwood Series in Biological Chemistry and Biotechnology 1983

L J SCHOOL OF APPLIED SCIENCES
M.Sc. – Semester I Biotechnology
PR- MB/BT – 402: BIOCHEMICAL TECHNIQUES IN FOOD INDUSTRY (PR)

Total Credits: 03 **Total Hours: 45**

Course Objectives:

At the end of the course, the student will:

- Gain understanding of biochemical reactions involved in food processing, preservation, enzyme roles, kinetics, and industrial optimization in food processing.
- Learn techniques like spectroscopy, chromatography, and electrophoresis for analyzing food components.
- evaluate the nutritional content and assess the quality and safety of food products.
- Able to explore methods to develop novel and functional foods, including bioactive compounds and fortified products.
- Students will become familiar with regulatory standards in biochemical testing for the food industry.

Course Outcomes:

- To provide a comprehensive understanding of the biochemical principles and reactions involved in food processing and preservation.
- To teach the role and application of enzymes in food processing, including enzyme kinetics and optimization for industrial use.
- To train student in evaluating nutritional contents of various food products and assess food quality and safety and explore methods in developing novel and functional food products, including bioactive compounds and fortified foods.
- Familiarise student with prevalent regulatory standards.

List of Practicals:

1) Introduction to concepts of biochemistry and its calculations (molarity, normality, %w/w, %w/v, %v/v, reagent and buffer preparation and experimental design)
2) Extraction of oil from oilseeds (castor, coconut, Groundnut)
3) Determination of saponification number of oil sample (castor, cottonseed, Groundnut)
4) Determination of iodine number of oil sample (castor, cottonseed, Groundnut)
5) Determination of acid number of oil sample (butter, castor, cottonseed, Groundnut)
6) Qualitative analysis of carbohydrate from Milk and milk products (Glucose, Cane sugar, cellulose)
7) Quantitative estimation of Total Sugar & Sucrose from Raw and packaged Fruit Juice
8) Quantitative estimation of Vitamin C using 2, 6 di-chloro-phenol indophenol method (Titrimetric) (Juice, Fruit and vegetable)
9) Quantitative estimation of Antioxidant activity from food sample using DPPH method (Spectrophotometric)(Mushroom extract)
10) Detection of Adulteration in Milk & milk products (Milk: Urea, starch, soap, nitrates)
11) Detection of Adulteration in various food samples. (Sugar, Chilli powder, Turmeric, Gram Flour)

REFERENCES

1) An introduction to Practical Biochemistry by David T Plummer, McGraw Hill Education; 3rd edition (1 July 2017)
2) A. K. Yusuf A Review of Methods Used for Seed Oil Extraction. International Journal of Science and Research (IJSR) Volume 7 Issue 12. (2018)
3) FSSAI MANUAL OF METHODS OF ANALYSIS OF FOODS - OILS AND FATS Revised 25-05-2016,Under Section 16 (2) (f) of the FSS Act, 2006
4) FSSAI MANUAL OF METHODS OF ANALYSIS OF FOODS-MILK AND MILK PRODUCTS Revised 25-05-2016,Under Section 16 (2) (f) of the FSS Act, 2006
5) FSSAI MANUAL OF METHODS OF ANALYSIS OF FOODS-FRUIT AND VEGETABLE PRODUCTS Revised 25-05-2016,Under Section 16(2)(f) of the FSS Act, 2006
6) FSSAI MANUAL OF METHODS OF ANALYSIS OF FOODS- FOOD ADDITIVES Revised 25-05-2016,Under Section 16 (2) (f) of the FSS Act, 2006
7) FAO Manuals of Food Quality Control 14 / 8, page 194 / Pearson's Composition and Analysis of Foods 9th edn,1991, page 264 and AOAC Official Method 967.21
8) Debnath et al. ANTIOXIDANT ACTIVITIES OF METHANOLIC EXTRACTS FROM TEN PLEUROTUS SPECIES. International Research Journal of Pharmacy; 8(3):44-49 DOI:10.7897/2230-8407.080335 (2017)

L J SCHOOL OF APPLIED SCIENCES
M.Sc. – Semester I Biotechnology
PR- MB/BT – 403: MICROBIAL AND PHYSICO-CHEMICAL CHARACTERIZATION OF WATER AND WASTE WATER (PR)

Total Credits: 03 **Total Hours: 45**

Course Objectives:

At the end of the course, the student will be able to:

- Conduct microbial analysis of water independently and interpret data as per regulation
- Apply knowledge and skills to develop novel techniques and methods for determination and mitigation of pollutants.

Course Outcomes:

- To explain microbial analysis techniques for water and wastewater. Learn methods for physico-chemical water quality assessment.
- Develop practical skills in water sampling and testing.
- Interpret water quality data for environmental compliance.
- Apply knowledge in the treatment and management of water resources.

List of Practicals:

1. Determination of pH by pH meter
2. Determination of Conductivity by Conductivity meter
3. Determination of Hardness by Phenolphthalein Titrimetric method
4. Determination of Total Solids (TS) by gravimetric method
5. Determination of Total Dissolved Solids (TDS) by gravimetric method
6. Determination of Dissolved Oxygen (DO) by Winkler's method
7. Determination of Biological Oxygen Demand (BOD) by Titrimetric method
8. Determination of Chemical Oxygen Demand (COD) by Open & Closed Reflux method
9. Determination of Nitrogen by Kjeldahl method
10. Determination of Chloride by Argentometric method
11. Determination of Sulphate by Turbidimetric method
12. Determination of Total Organic Carbon by Combustion-infrared method
13. Determination of Acidity by Titrimetric method
14. Determination of Alkalinity by Titrimetric method
15. Determination of Phosphate by Stannous chloride method
16. Determination of Coliforms by Most Probable Number (MPN) method
17. Determination of Fungi by Qualitative method
18. Determination of Standard Plate Count (SPC) by Serial Dilution method

L J SCHOOL OF APPLIED SCIENCES
M.Sc. – Semester I Biotechnology

REFERENCES

- Standard Methods for the Examination of Water and Wastewater; 21st Edition, Washington D.C., New York. American Public Health Association (APHA) (2005).

L J SCHOOL OF APPLIED SCIENCES
M.Sc. – Semester I Biotechnology
PR- MB/BT – 404: ENZYMOLOGY AND BIOMOLECULES (PR)

Total Credits: 03 **Total Hours: 45**

Course Objectives:

- Understand the principles and techniques involved in enzyme assays and learn methods for the isolation, purification, and characterization of enzymes.
- Gain hands-on experience with biochemical techniques such as spectrophotometry, chromatography, and electrophoresis.
- Develop skills in the quantification and analysis of biomolecules in biological samples.

Course Outcomes:

At the end of the course, the student will be able to:

- Perform enzyme assays, isolation, purification, and characterization of enzymes.
- Gain proficiency in biochemical methods like spectrophotometry, chromatography, and electrophoresis.
- Develop practical skills in quantifying and analyzing biomolecules in biological samples.

List of Practicals:

1) Isolation of amylase from Mung Bean and beta-glycerophosphatase from Potato.
2) Effect of pH on enzyme activity (Amylase)
3) Effect of temperature on enzyme activity (Amylase)
4) Effect of substrate concentration on enzyme activity (Amylase)
5) Effect of enzyme concentration on enzyme activity (Amylase)
6) Purification of Enzyme using Affinity chromatography (Horseradish peroxidase)
7) Identification of Mutagenic agents by Ames test
8) Separation and purification of carotenoids, chlorophyll A and B from leaf extract using Column chromatography
9) Separation of plant alkaloids by TLC (Curcuminoids from Curcuma longa)
10) Separation of biomolecules using Gel exclusion chromatography (Vitamin B12, p-Nitrophenol, Blue dextran)

REFERENCES

1) An Introduction to Practical Biochemistry by David T Plummer, McGraw Hill Education; 3rd edition (1 July 2017)
2) Principles and Techniques of Biochemistry and Molecular Biology by Keith Wilson and John Walker 7th edition 2010

L J SCHOOL OF APPLIED SCIENCES
M.Sc. – Semester II Biotechnology
MB/BT - 501: DEVLOPMENTAL BIOLOGY & ANIMAL PHYSIOLOGY

Total Credits – 04 **Total Hours – 60**

Course Objectives:

- Grasp the fundamentals molecular, genetic, cellular, and integrative aspects of building an organism and the development of abnormalities in animals and plants
- Understand Morphogenesis, organogenesis in animals and plants
- Will have clear understanding of animal physiology & functions.

Course Outcomes:

- To understand the molecular, genetic, cellular, and integrative aspects of building an organism.
- To gain insight into the Biological development morphogenesis and organogenesis in animals and plants.
- To study the fundamental physiological processes and mechanisms regulating Respiratory, circulatory and excretory systems of the body.
- To study the fundamental physiological processes and mechanisms regulating Digestive, Nervous and Endocrine systems of the body.

Unit-1: Basic concepts of development

Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; mutants and transgenics in analysis of development.
Gametogenesis, fertilization and embryogenesis in animals

Unit – 2: Morphogenesis, Organogenesis in Animals and Plants

Cell aggregation and differentiation in *Dictyostelium*; axes and pattern formation in *Drosophila*, amphibia and chick; organogenesis – vulva formation in *Caenorhabditis elegans*, limb development and regeneration in vertebrates; differentiation of neurons. Metamorphosis.
Establishment of symmetry in plants; seed formation and germination
Shoot and root development; leaf development and phyllotaxy; floral meristems and floral development in *Arabidopsis* and *Antirrhinum.*

Unit – 3: Respiratory, Circulatory and Excretory Systems

Respiratory system and its regulation - Anatomical considerations, transport of gases, exchange of gases,
Cardiovascular system and its regulation, Blood corpuscles, plasma function, blood volume, haemoglobin, haemostasis. anatomy of heart structure, cardiac cycle , ECG and blood pressure.
Excretory system -kidney, urine formation, waste elimination, micturition, regulation of water balance, blood volume, blood pressure, electrolyte balance, acid-base balance.

Unit – 4: Digestive system, Nervous system and Endocrinology

Digestive system - Digestion, absorption, energy balance, BMR.
Nervous system - Neurons, action potential, gross neuroanatomy of the brain and spinal cord, peripheral nervous system, neural control of muscle tone and posture. Sense organs. Endocrinology - Endocrine glands, mechanism of hormone action, endocrine diseases; neuroendocrine regulation
Stress, adaptation, and physical, chemical and neural basis of thermoregulation, acclimatization.

References:

1) Molecular Cell Biology: International Edition – Harvey Lodish, Arnold Berk, Chris
A. Kaiser, Monty Krieger, Anthony Bretscher, Hidde Ploegh, Angelika Amon, and Matthew P. Scott, Publisher W. H. Freeman, 2017, Seventh Edition.
2) Developmental Biology – Scott F. Gilbert, Publisher Sinauer Associates, 2000, Sixth Edition.
3) Principles of Development 5e – Lewis Wolpert Lewis Wolpert, Cheryll Tickle, Alfonso Martinez Arias, Publisher Oxford University Press, 2015, Fifth Edition.

L J SCHOOL OF APPLIED SCIENCES
M.Sc. – Semester II Biotechnology
MB/BT - 502: PLANT PHYSIOLOGY & ECOLOGY

Total Credits – 04 **Total Hours – 60**

Course Objectives:

At the end of the course, the student will be able to:

- Understand plant physiology, biochemistry, metabolism, and responses to biotic and abiotic stresses.
- Analyze environmental influences on organisms, populations, and communities within the biosphere.
- Implement key approaches and strategies in Conservation Biology.

Course Outcomes:

- To examine various aspects of plant physiology, biochemistry and metabolism.
- To learn about plant hormones, sensory photobiology and secondary metabolites. Plant response to various biotic and abiotic stresses.
- To understand the environmental influences on organisms, populations and communities of the biosphere.
- To study the major approaches and strategies of Conservation Biology.

Unit – 1: Photosynthesis, Respiration and Nitrogen Metabolism

Photosynthesis - Light harvesting complexes; mechanisms of electron transport; photo protective mechanisms; CO2 fixation.
Respiration– Citric acid cycle; plant mitochondrial electron transport and ATP synthesis; alternate oxidase. Photorespiration.
Nitrogen metabolism - Nitrate and ammonium assimilation; amino acid biosynthesis.

Unit - 2: Plant hormones, Sensory photobiology and Secondary metabolites

Plant hormones – Biosynthesis, storage, breakdown and transport; physiological effects. Sensory photobiology - Structure, function and action of phytochromes, cryptochromes and phototropins; photoperiodism and biological clocks.
Solute transport and translocation of photoassimilates.
Secondary metabolites - Biosynthesis of terpenes, phenols and nitrogenous compounds and their roles.

Stress physiology – Responses of plants to biotic (pathogen and insects) and abiotic (water, temperature and salt) stresses.

Unit – 3: The Environment, Species interactions, Population and Community ecology

The concept of environment, habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement. Population and community Ecology: Characteristics of a population; population growth curves; population regulation; life history strategies; metapopulation – demes and dispersal, interdemic extinctions, community structure and attributes, species diversity and its measurement, edges and ecotones, ecological succession.

Species Interactions: interspecific interactions of organisms.

Unit – 4: Biogeography, Ecosystem ecology and Applied ecology.

Bio-geographical zones of India, theory of island biogeography.

Ecosystem structure and functions; some Indian ecosystems: terrestrial and aquatic; Environmental pollution and global environmental change.

Biodiversity: status and monitoring; major drivers of biodiversity change; biodiversity management approaches. Rare and endangered species.

Principles and major approaches of conservation management, Indian case studies on conservation (Project Tiger, Biosphere reserves).

References:

1. Ecology and Environment by P. D. Sharma, Rastogi Publications, 2007
2. Ecology by Smith and Smith, Pearson Education, 2014, 9th Edition.
3. Endocrinology by Mac E Hadley, Pearson Prentice Hall, 2007, 6th Edition
4. Essential Cell Biology by Bruce Albert, Dennis Bray, Karen Hopkin, Garland Science, 2013, 4th Edition.
5. Evolution by Monroe W Strickberger, Jones and Bartlett Learning, 2005, 3rd Edition
6. Fundamentals of Ecology by E.P. Odum, Cengage Publications, 2017, 5th Edition
7. Environmental Biology by Verma and Agrawal, S Chand Publishers, 2015
8. Plant Physiology by Lincoln Taiz and Eduardo Zeiger, Sinauer Associates, 2010, 5th Edition
9. Plant Physiology, Ross and Salisbury, Wadsworth Publishing Co. 2006.

L J SCHOOL OF APPLIED SCIENCES
M.Sc. – Semester II Biotechnology
MB/BT - 503: MOLECULAR BIOLOGY

Total Credits – 04 **Total Hours – 60**

Course Objectives:

At the end of the course, the student will be able to:

- Understand the mechanism for DNA replication, repair and recombination. And apply it to will perform PCR to amplify specific DNA sequences, simulating in vitro DNA replication.
- Gain the understanding of RNA Extraction and Quantification and apply it to conduct invitro transcription assays.
- Analyze the presence and size of proteins using techniques like Western blotting, chromatography etc.
- Understand use of Gene control techniques like Luciferase/GFP, CRISPR-Cas9.

Course Outcomes:

- To provide knowledge of genetic material duplication, recombination ensuring genetic integrity and variation.
- To understand transcriptional & post transcriptional machinery involved in RNA synthesis.
- To impart knowledge of translation process, decoding mRNA into proteins, and the subsequent modifications necessary for protein functionality.
- Investigate the regulatory mechanisms for genes are expression ensring cellular function and adaptability.

Unit – 1: DNA replication, repair and recombination

Unit of replication, enzymes involved, replication origin and replication fork, fidelity of replication, extra chromosomal replicons, DNA damage and repair mechanisms, homologous and site-specific recombination.

Unit 2: RNA synthesis and processing

RNA synthesis and processing - transcription factors and machinery, formation of initiation complex, transcription activator and repressor, RNA polymerases, capping, elongation, and termination, RNA processing, RNA editing, splicing, and polyadenylation, structure and function of different types of RNA, RNA transport.

Unit – 3: Protein synthesis and processing

Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code, aminoacylation of t-RNA, t- RNA-identity, aminoacyl t-RNA synthetase, and translational proofreading, translational inhibitors, Post- translational modification of proteins.

Unit – 4: Control of gene expression at transcription and translation level

Regulating the expression of phages, viruses, prokaryotic and eukaryotic genes, role of chromatin in gene expression and gene silencing).

References:

1) Cell and Molecular Biology: Concepts and Experiments – Gerald Karp, Publisher Wiley, 2020, Ninth Edition.
2) Molecular Biology of the Cell – Bruce Alberts, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts, and Peter Walter, Publisher Garland Science, Taylor and Francis Group, 2015, Sixth Edition.
3) Molecular Cell Biology: International Edition – Harvey Lodish, Arnold Berk, Chris
A. Kaiser, Monty Krieger, Anthony Bretscher, Hidde Ploegh, Angelika Amon, and Matthew P. Scott, Publisher W. H. Freeman, 2017, Seventh Edition.
4) The Cell: A Molecular Approach – Geoffrey M. Cooper Publisher Oxford University Press, 2018, Eighth Edition.
5) Cell and Molecular Biology: Concepts and Experiments – Gerald Karp, Publisher Wiley, 2020, Ninth Edition.
6) Cell and Molecular Biology – Robertis De. Robertis DE Jr., Wolters Kluwer Publication, 2011, South Asia Edition, Eighth edition.
7) Molecular Biology of the Gene – James D. Watson, Tania A. Baker, Stephen P. Bell,
8) Alexander Gann, Michael Levine, & Richard Losick, Publisher Pearson, 2007, 6th Ed.

L J SCHOOL OF APPLIED SCIENCES
M.Sc. – Semester II Biotechnology
MB/BT - 504: CANCER BIOLOGY AND IMMUNOLOGY

Total Credits – 04 **Total Hours – 60**

Course Objectives:

At the end of this course, the student will be able to:

- Gain insight into host parasite interactions and understand the mechanism of pathogen host cellular manipulation.
- Understand cell communication processes and disruptions leading to cancer and explore key signalling pathways in cancer.
- Gain skills to distinguish between adaptive and innate immune systemand evaluate immunological pathways resulting in hypersensitivity and autoimmune disorders.

Course Outcomes:

- To understand the mechanisms of host-parasite interactions, pathogen invasion, survival, manipulation of cellular processes, strategies to avoid detection.
- Explore the molecular mechanisms of cellular communication and disruptions leading to cancer development. Study key signaling pathways such as growth factor signaling, apoptosis regulation, and the role of oncogenes and tumor suppressors.
- Gain comprehensive knowledge of the innate and adaptive immune system, hypersensitivity reactions and autoimmune disorders.
- Investigate immunological pathways that lead to allergic responses and the failure of immune tolerance in autoimmunity, along with potential therapeutic approaches.

Unit – 1: Host parasite interaction and cell-signalling

Recognition and entry processes of different pathogens like bacteria, viruses into animal and plant host cells, alteration of host cell behaviour by pathogens, virus-induced cell transformation, pathogen-induced diseases in animals and plants, cell-cell fusion in both normal and abnormal cells.

Hormones and their receptors, cell surface receptor, signalling through G protein coupled receptors, signal transduction pathways, second messengers, regulation of signalling pathways, bacterial and plant two-component systems, light signalling in plants, bacterial chemotaxis and quorum sensing

Unit – 2: Cellular communication and cancer

Regulation of hematopoiesis, general principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins, neurotransmission and its regulation.
Genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes, cancer and the cell cycle, virus-induced cancer, metastasis, interaction of cancer cells with normal cells, apoptosis, therapeutic interventions of uncontrolled cell growth.

Unit – 3: Innate and adaptive immune system

Cells and molecules involved in innate and adaptive immunity, antigens, antigenicity and immunogenicity. B and T cell epitopes, structure and function of antibody molecules. generation of antibody diversity, monoclonal antibodies, antibody engineering, antigenantibody interactions, MHC molecules, antigen processing and presentation, activation and differentiation of B and T cells, B and T cell receptors, humoral and cell- mediated immune responses, primary and secondary immune modulation, the complement system, Toll-like receptors, cellmediated effector functions, inflammation.

Unit – 4: Hypersensitivity and Autoimmune system

Hypersensitivity and autoimmunity, immune response during bacterial (tuberculosis), parasitic (malaria) and viral (HIV) infections, congenital and acquired immunodeficiency, vaccines.

References:

1) Kuby Immunology- Jenni Punt; Judith A Owen; Sharon A Stranford; Patricia P Jones; Janis Kuby, Publisher W.H. Freeman/Macmillan Learning, 2019, Eighth Edition.

2) Molecular Cell Biology: International Edition – Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Anthony Bretscher, Hidde Ploegh, Angelika Amon, and Matthew P. Scott, Publisher W. H. Freeman, 2017, Seventh Edition.

3) Prescott, Harley, and Klein's Microbiology, J. M. Willey, L. M. Sherwood, C. J. Woolverton, 7th Edition (2008), McGraw Hill Higher Education-USA.

4) Essential Immunology –Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt, Publisher Wiley Blackwell, 2017, Thirteen Edition.

L J SCHOOL OF APPLIED SCIENCES
M.Sc. – Semester II Biotechnology
PR- MB/BT – 501: AGRICULTURAL MICROBIOLOGY AND BIOTECHNOLOGY (PR)

Total Credits – 03 **Total Hours – 45**

Course Objectives:

Students will be able to:

- Conduct soil sampling, analyse and culture microbes to improve soil fertility
- Develop bio-fertilizers and apply them greenhouse or field trials to assess impact on crop productivity and health.
- Apply knowledge of beneficial microorganisms to production of Biocompost, Vermicompost, biofertilizer, Biopesticides and mushrooms.

Course Outcomes:

- To explore the role microorganisms in soil fertility, plant growth, and crop productivity, and its application of microbes in sustainable agriculture.
- To study how harnessing beneficial microbes for biocontrol of plant diseases, bio- fertilization, and biodegradation.
- To understand plant-microbe interactions, symbiotic relationships like nitrogen fixation and mycorrhizal associations and bioremediation of contaminated soils
- To investigate modern biotechnological techniques, such as genetic engineering, pest resistance, and enhanced agricultural productivity.

List of Practicals:

1) Production of Bio compost from kitchen waste
2) Production of Vermicompost.
3) Production of Liquid Bio-fertilizer
4) Production of Solid Bio-fertilizer
5) Production of Plant Growth Promoting Rhizobacteria (PGPR)
6) Soil analysis (Total Organic Carbon and Kjeldahl Nitrogen)
7) Cultivation of Mushrooms
8) Production of Biodiesel
9) Production of Bio Pesticides
10) Production of Bio Insecticides
11) Dye degradation
12) Production of Mycorrhyzae

L J SCHOOL OF APPLIED SCIENCES
M.Sc. – Semester II Biotechnology

REFERENCES

1) Practical Microbiology by Dr. R. C Dubey and Dr. D. K Maheshwari S. Chand Publication 5th edition 2012
2) Essential of Practical Microbiology by Apurba S Sastri and Sandhya Bhat Publisher: Jaypee Brothers Edition: 3rd (Revised Reprint) 2021

L J SCHOOL OF APPLIED SCIENCES
M.Sc. – Semester II Biotechnology
PR- MB/BT – 502: MOLECULAR BIOLOGY (PR)

Total Credits – 03 **Total Hours – 45**

Course Outcomes:

At the end of the course the student will be able to:

- Gain proficiency in performing DNA/RNA extraction, PCR, gel electrophoresios, To provide students with hands-on experience in techniques
- Have expertise in handling techniques like SDS-PAGE, RTPCR.
- Independently perform genomic DNA isolation and quantification from prokaryotic and Eukaryotic systems.

Course Objectives:

- To provide students with hands-on experience in techniques such as DNA/RNA extraction, PCR, gel electrophoresis, and cloning.
- Equip students with use of restriction enzyme in genetic modification, cloning, and plasmid construction.
- Perform 16S gene amplification using gradient Polymerase Chain Reaction.
- Provide knowledge of separation of proteins by SDS-PAGE, RNA extraction and RTPCR.

List of Practicals:

1) Introduction to Molecular Biology: (Use of Micropipette, Reagent and Buffer Solutions Preparation and Experimental Design)
2) Genomic DNA Isolation and quantification from Prokaryotic system
3) Genomic DNA Isolation and quantification from Eukaryotic system (Human Blood)
4) Genomic DNA Isolation and quantification from Eukaryotic system (Plant)
5) Restriction digestion of Lambda (λ) DNA using EcoRI and HindIII enzymes
6) Ligation of Lambda (λ) DNA HindIII digest and observing the efficiency of ligation reaction through agarose gel electrophoresis
7) Isolation of Plasmid DNA from bacterial cells

8) Bacterial transformation and observation of expression of marker genes
9) 16S gene amplification using gradient Polymerase Chain Reaction
10) Isolation and purification of total RNA from animal tissue

REFERENCES

1. Molecular Cloning: Michael R. Green and Joseph Sambrook
   A Laboratory Manual (Fourth Edition) Cold Spring Harbor Laboratory Press 2014.
2. Doyle and Doyle, Focus 12:13–15 Isolation of Plant DNA from Fresh Tissue
   Springer-Verlag Berlin Heidelberg1990
3. Principles and Techniques of Biochemistry and Molecular Biology by Keith Wilson and John Walker 7th edition 2010

L J SCHOOL OF APPLIED SCIENCES
M.Sc. – Semester II Biotechnology
PR- MB/BT – 503: DIAGNOSTIC MICROBIOLOGY AND IMMUNOLOGY (PR)

Total Credits – 03 **Total Hours – 45**

Course Objectives:

- Be able to independently handle key microbial diagnostic techniques for accurate pathogen detection
- Be proficient in handling biological samples responsibly and apply aseptic techniques.
- Interpret test results with clarity for effective decision making and treatment strategies.

Course Outcomes:

- To equip students with knowledge and practical skills in microbiological diagnostic techniques, culture methods, serology, and immunoassays.
- To train students in laboratory safety, aseptic techniques and handling biological samples in clinical microbiology laboratories.
- To develop ability to accurately interpret diagnostic test results.
- To understand the interpretation of results and their relevance to clinical decision-making.

List of Practicals:

1) Urine Analysis
2) Haemoglobin estimation by Sahli's method
3) 'ABO' and 'Rh' blood group systems
4) Dot ELISA
5) Differential count of WBCs by Fields's staining method
6) Antibody testing Covid-19 Rapid cards
7) PF antigen card test
8) Latex test for CRP
9) Estimation of SGPT and SGOT
10) Serological Card Test WIDAL
11) Serological Card test RPR
12) Brucellolis test kit
13) Electrophoresis – Rocket Immuno Electrophoresis

References:

1) Cohen, M. C. (2007). Medical immunology.
2) Hall, A., and Yates, C. (Eds.). (2010). *Immunology*. Oxford University Press, USA.
3) Nieman, D. C. (1997). Exercise immunology: practical applications. *International Journal of Sports Medicine*, *18*(S 1), S91-S100.
4) Rich, R. R., Fleisher, T. A., Shearer, W. T., Schroeder Jr, H. W., Frew, A. J., and Weyand, C. M. (2012). *Clinical immunology e-book: principles and practice*. Elsevier Health Sciences.
5) Paul, W. E. (2012). *Fundamental immunology*. Lippincott Williams and Wilkins.
6) Helbert, M. (2016). *Immunology for Medical Students: Immunology for Medical Students E-Book*. Elsevier Health Sciences.
7) Todd, I., Spickett, G. P., and Fairclough, L. (2015). *Immunology*. John Wiley & Sons.

L J SCHOOL OF APPLIED SCIENCES
M.Sc. – Semester II Biotechnology
PR- MB/BT – 504: BASIC CONCEPTS OF BIOINFORMATICS (PR)

Total Credits – 03 **Total Hours – 45**

Course Objectives:

At the end of the course, the student will:

- Be skilled in working with databases, tools and software used in Bioinformatics
- Be equipped in searching, retrieving and interpreting biological data from various databases.
- Be able to apply knowledge of bioinformatics in research projects of therapeutic importance.

Course Outcomes:

- To introduce students to the fundamental concept, scope and role of bioinformatics in modern research.
- To familiarize students with key bioinformatics databases, tools and software.
- To train students in working with computational methods used in bioinformatics.
- To train them in the skills of database searching and retrieval, molecular sequence analysis, Genomics and proteomics.

List of Practicals:

1) Exploration of the resources available in ncbi and pubmed
2) Retrieval of a genbank entry using an accession number
3) Retrieval and analysis of protein structure and sequence from protein databasez
4) Study Of 3D protein Structure using Rasmol
5) To construct a phylogenetic tree in mega software using 16s rrna gene sequence
6) Homology searching for known sequence from genome database
7) Designing PCR primer for browsed sequence from database
8) Advanced proteomics prediction using various tools on SIB website.

References:

1) Ghosh Z. and Bibekanand M. (2008) Bioinformatics: Principles and Applications. Oxford University Press.
2) Pevsner J. (2009) Bioinformatics and Functional Genomics. II Edition. WileyBlackwell.
3) Campbell A. M., Heyer L. J. (2006) Discovering Genomics, Proteomics and Bioinformatics. II Edition. Benjamin Cummings.

L J SCHOOL OF APPLIED SCIENCES
M.Sc. Semester 3 – Biotechnology
BT – 601: ADVANCED MOLECULAR BIOLOGY AND FORENSIC SCIENCE

Total Credits: 03 **Total Hours: 45**

Course Objectives:

- Students will be able to apply knowledge of molecular biology conecpts in cloning and will gain expertise in GMO detection
- Understand and apply biological DNA markers.
- Develop skills in biomolecules separation and characterization

Course Outcomes:

- Updating the advanced knowledge of Molecular Biology to the novel discoveries and research approaches in various fields.
- Gain expertise in Molecular cloning and GMO detection.
- Understand the role of biological markers - RFLP, RAPD, AFLP, SSLP – VNTRs and SSRs.
- Provide knowledge of separation of proteins by SDS-PAGE, RNA extraction and RTPCR.

Unit: 1 Molecular cloning and GMO detection

Steps in Molecular cloning, Restriction digestion, Ligation, Methods of Gene Transfer: Bacterial transformation, Role GFP in cloning. Study genetics of single-gene disorders, SNP as a tool for identifying genes responsible for the disease, amplifying a specific gene for disease detection. Role of PCR in GMO identification. Detection and Identification of gene using PCR, GMO issues and regulations, Biosafety guidelines in INDIA.

Unit 2: Gene mutation

Spontaneous and Induced, Random and Directed, Transitions and Transversions, Insertions and Deletions.
Different types of Mutagens – Physical, Chemical and Biological (Mutagens: 5-BU, Nitrous acid, EES, Acridine orange, UV and Phage Mu)
Phenotypic Classes of Bacterial Mutants: Morphological, Nutritional, Biochemical, and Conditionally lethal mutants

Unit 3: Forensic Science

Genetic markers – Morphological Markers, Cytological Markers, Biochemical Markers, Molecular Markers (DNA markers).
Types of DNA markers – RFLP, RAPD, AFLP, SSLP – VNTRs and SSRs, DNA isolation from a various sample of human origin.

Unit 4: Separation of Biomolecule and characterization

Enzyme and Cell immobilization, principle, techniques (Adsorption, matrix entrapment, encapsulation, cross-linking, covalent binding) and its commercial applications.
Biomolecule separations, Purification of desired product by different Chromatography methods, Protein purification using SDS-PAGE (sodium dodecyl sulphate–polyacrylamide gel electrophoresis)

References:

1) Biotechnology expanding horizons by B.D. singh
2) Enzyme by Palmer (2001); Horwood publishing series.
3) Fundamental of Enzymology by Price and Stevens (2002): Oxford University Press.
4) Gene cloning and DNA analysis by T. A. Brown
5) Principles of gene manipulation and genomics by S.B Primrose.
6) S. Rastogi and N. Pathak, Genetic Engineering, Oxford University Press, New Delhi, India, 2009.
7) Stanbury PF, Whitaker A and SJ Hall (1995) Principles of Fermentation Technology, (2nd Edn), Pergamon Press

L J SCHOOL OF APPLIED SCIENCES
M.Sc. Semester 3 – Biotechnology
BT – 602: PLANT TISSUE CULTURE

Total Credits: 03 **Total Hours: 45**

Course Objectives:

At the end of this course, the student will be able to:

- Independently conduct plant tissue culture projects.
- Apply understanding of culture methods and aseptic techniques in micro propagation of plants.
- Apply tissue culture concepts for species conservation and crop enhancement.

Course Outcomes:

- To understand the principles, scope and techniques of plant tissue culture.
- To learn culture methods, aseptic techniques and in-vitro propagation of plants.
- Develop skills in genetic engineering and examine commercial application in agriculture and biotechnology.
- Develop skills in culturing variety of important agricultural plants for resolving food crises

Unit: 1 Introduction to Plant Tissue Culture and Laboratory. .

Conventional plant breeding and plant tissue Culture, Benefits of plant tissue culture, History, Basic structure of the plant, Terminology in tissue culture. Design of tissue culture laboratory, Facilities, and Equipment's. Government certification for tissue culture-raised plants.

Unit 2: Culture Media

Constituent of Media, Macronutrients, Micronutrients, Carbon and energy sources, Organic supplements, Growth Regulators, Gelling agents, Composition of commonly used plant tissue culture media, Sterilization of Media storage.

Unit 3: Techniques of Plant tissue culture

Callus culture, Protoplast Culture and Somatic hybridization, Cybrids, Nodal culture, Clonal Propagation (Micropropagation), Primary and Secondary Hardening, Genetic engineering in plants, Molecular breeding and Quantitative train loci. Case study on Musa G-9 Tissue culture.

Unit 4: Genetic Engineering of Plants-Methodology

Gene transfer methods, Virus mediated gene transfer, Agrobacterium-mediated gene transfer, Direct or Vectorless DNA transfer, Physical gene transfer methods, Electroporation, Microinjection, Liposome mediated gene transfer, Biolistic gene gun, Chemical gene transfer method, Polyethylene glycol mediated gene transfer, DEAE mediated gene transfer, Calcium phosphate co-precipitation.

References:

1) White, Philip R. (Philip Rodney), Handbook of plant tissue culture. Lancaster, Pa., The J. Cattell press.

2) Víctor M. Loyola-Vargas Neftalí Ochoa-Alejo, Plant Cell Culture Protocols, springer Protocols, Humana Press, New York, NY.

3) S.S. Bhojwani and M.K. Razdan, Plant Tissue Culture: Theory and Practice, Elsevier publication.

L J SCHOOL OF APPLIED SCIENCES
M.Sc. Semester 3 – Biotechnology

PR - BT – 601:ADVANCED MOLECULAR BIOLOGY AND FORENSIC SCIENCE (PR)

Total Credits: 03 **Total Hours: 45**

Course Objectives:

The student will gain the ability to:

- Conduct single nucleotide polymorphism to detect genetic disorders
- Will be equipped with the ability to immobilize enzymes and cloning
- To carry out DNA fingerprinting and determine molecular size of DNA fragments and perform genotyping analysis using PCR.

Course Outcomes:

- To explain the techniques of cloning and immobilization of enzymes.
- To detect genetic disorders and GMO by different methods.
- To explain the process of DNA fingerprinting.
- To determine the molecular size of DNA fragments

List of Practicals:

1) To detect genetic disorder through the study of Single nucleotide polymorphism.
2) To learn the process of cloning a foreign gene into a vector.
3) Immobilization of Enzymes/Cells by Gel Entrapment Method.
4) To detect GMO (genetically modified organism) by Polymerase Chain Reaction
5) To learn the process of DNA fingerprinting following RFLP, method by restriction digestion of DNA and analysis of digested fragments on agarose gel electrophoresis.
6) To determine the molecular size of three linear double stranded (ds) DNA fragment.
7) Genotyping analysis with the help PCR-based amplification of multiple fragments

References:

1) Biotechnology expanding horizons by B.D. Singh
2) Enzyme by Palmer (2001); Horwood publishing series.
3) Fundamental of Enzymology by Price and Stevens (2002): Oxford University Press.
4) Gene cloning and DNA analysis by T. A. Brown
5) Principles of gene manipulation and genomics by S.B Primrose.
6) S. Rastogi and N. Pathak, Genetic Engineering, Oxford University Press, New Delhi, India, 2009.
7) Stanbury PF, Whitaker A and SJ Hall (1995) Principles of Fermentation Technology, (2nd Edn), Pergamon Press

L J SCHOOL OF APPLIED SCIENCES
M.Sc. Semester 3 – Biotechnology
PR - BT – 602: PLANT TISSUE CULTURE (PR)

Total Credits: 03 **Total Hours: 45**

Course Objectives:

The students will be able to:
- Handle and manage Plant tissue culture laboratory independently
- Gain expertise in slelection, sterilization and micropropagation of plants
- Study effects of hormones on explant.
- Conduct stress studies on some genotypes.

Course Outcomes:

- To impart knowledge of tissue culture media, selection and sterilization of explants
- To explain In vitro callusogenesis and the study of plant hormones on explants
- To impart knowledge of commercial micro propagation of Banana tissue culture techniques
- DNA Isolation and evaluation of phytotoxicity against salinity stress.

List of Practicals:

1) Designing and Management of Plant tissue culture laboratory
2) Preparation of Tissue Culture Media
3) Selection and Sterilization of Explant for Plant tissue culture
4) In vitro Callusogenesis using leaf explant.
5) Study the effect of plant hormones on explant
6) Nodal propagation of tobacco on basal MS media.
7) Commercial micropropagation of Banana tissue culture techniques.
8) Identification of Transgenic BT cotton plants.
9) DNA Isolation from tissue cultured plant
10) Hardening of tissue culture plants.
11) Evaluation of Phytotoxicity of Mung Bean genotypes against Salinity Stress

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References:

1) White, Philip R. (Philip Rodney), Handbook of plant tissue culture. Lancaster, Pa., The J. Cattell press.
2) Víctor M. Loyola-Vargas Neftalí Ochoa-Alejo, Plant Cell Culture Protocols, springer Protocols, Humana Press, New York, NY.
3) S.S. Bhojwani and M.K. Razdan, Plant Tissue Culture: Theory and Practice, Elsevier publication.

L J SCHOOL OF APPLIED SCIENCES
M.Sc. Semester 3 – Biotechnology
WS - BT - 601: CONCEPTS AND APPLICATIONS OF ADVANCED BIOINFORMATICS

Total Credits: 03 **Total Hours: 45**

Course Objectives:

At the end of the course, the student will:

- Gain foundational knowledge of bioinformatics, protein sequences, analysis techniques, and programming algorithms.
- Be able to perform protein structure alignment and comparison, predict specialized structures, and engage in protein modelling and drug design.
- Become proficient in using biological databases DDBJ, KEGG, NCBI and bioinformatics tools such as Raptor X.
- Acquire knowledge and skills in genomics, including tools for separation, isolation, and acquisition of protein structures.

Course Outcomes:

- To provide knowledge about Bioinformatics, biological databases, protein sequence and analysis and programming algorithms.
- To familiarise the student with tools in Bioinformatics like Github, R and Bioconductor, Cloud computational biology using galaxy platform.
- To impart knowledge and skill in the study of Genomics, Transcriptomics, Proteomics, Metagenomics and the tools used for separation, isolation acquisition of protein structure.
- To train students to analyse database using various methods, BLAST.

Unit: 1 Introduction to Bioinformatics.

Introduction, Branches of Bioinformatics, Aim, Scope and Research areas of Bioinformatics.
Genomics, Transcriptomics, Proteomics, Metagenomics,
Application of Genomics: Cancer Genomics, Pharmacogenomics, Comparative Genomics
Data formats in Bioinformatics: FASTA, FASTQ, SAM, VCF

Open-source repositories of tools and pipelines. Introduction to Github, R and Bioconductor, Cloud computational biology using galaxy platform

Unit 2: Biological Nucleotide Databases and their applications

Databases in Bioinformatics- Introduction, Biological Databases, Classification format of Biological Databases, Biological Database Retrieval System.
DNA Data Bank of Japan (DDBJ), EMBL Nucleotide Sequence Database (EMBL-Bank), National Centre for Biotechnology Information (NCBI): Tools and Databases of NCBI, Database Retrieval Tool, Sequence Submission to NCBI, Basic local alignment search tool (BLAST),

Unit 3: Biological protein and metabolic pathway Databases; applications and Tools for protein structure and function prediction

KEGG database, Various metabolic pathways and their functions.
SILVA database, Ramachandran plot, Protein Information Resource (PIR): About PIR, Resources of PIR, Databases of PIR, Data Retrieval in PIR. Swiss-Prot: Introduction and Salient Features. Advanced tools of bioinformatics, Promoter prediction, Secondary structure prediction in RNA and DNA.
Protein structure prediction using Raptor X and other tools. Molecular docking and binding of proteins by small molecules.

Unit 4: Sequence Alignment and Molecular Phylogenetics, Other tools of Bioinformatics

Introduction, Concept of Alignment, Multiple Sequence Alignment (MSA), MSA by CLUSTALW, Scoring Matrices, Percent Accepted Mutation (PAM), Blocks of Amino Acid Substitution Matrix (BLOSUM). Methods of Phylogeny, Software for Phylogenetic Analyses, Consistency of Molecular Phylogenetic Prediction.
Vecscreen for vector contamination checking Restriction site prediction using Webcutter and NEBcutter.
PrimerBLAST for testing primer quality

References:

1) Ghosh Z. and Bibekanand M. (2008) Bioinformatics: Principles and Applications. Oxford University Press.

2) Pevsner J. (2009) Bioinformatics and Functional Genomics. II Edition. WileyBlackwell.

3) Campbell A. M., Heyer L. J. (2006) Discovering Genomics, Proteomics and Bioinformatics. II Edition. Benjamin Cummings.

L J SCHOOL OF APPLIED SCIENCES
M.Sc. Semester 3 – Biotechnology
WS - BT - 602: CONCEPTS AND APPLICATIONS OF ADVANCED ANALYTICAL TECHNIQUES IN BIOSCIENCE

Total Credits: 06 **Total Hours: 90**

Course Objectives:

- Students will be able to apply the understanding of spectroscopic principles to identify organic compounds and predict their behaviour based on various effects in regards to IR, UV-Visible NMR spectroscopy
- Predict quantitative and qualitative nature of biologically important compounds
- Apply the concepts of basic and advanced chromatographic techniques for identification, estimation and separation of molecules and formulate research methodologies involving these techniques.

Course Outcomes:

- To make the students understand the principle, theory and working of various Analytical techniques for interpretation of bio-chemical structure, purity and quantitative evaluation.
- To train the students in handling the IR, UV-visible spectrophotometer and HPLC.
- To explain the interpretation of spectroscopic data independently and analyse the output.
- To provide basic understanding of calibration, working, of the instruments and apply the knowledge in interpretation of the information to unknown samples.

Unit I: UV-Visible Spectroscopy and its Applications:

The electronic spectrum and principle of electronic absorption. Theory of chromophore and factors affecting absorption. Electronic transitions and calculation of λmax. Concept of chromophore, Auxochrome, and factors affecting electronic transition like conjugation, solvent effect, steric effect, effect of functional groups, etc.

Woodward Fieser and Scott rules for calculation of absorption maxima for different organic molecules like dienes, enones, aromatic ketones, aldehydes and esters using empirical values.

Problems based on interpretation of absorption data to identify molecular structure.

Unit II: IR Spectroscopy

The IR spectrum, regions of the IR spectrum. Principle and instrumentation and sampling techniques for IR spectroscopy. Fundamental modes of vibration and types of vibrations for different type of molecules. Types of bonds, absorption of different functional groups.

Hooke's law and its applications, selection rule. Absorption frequencies for different functional groups and factors affecting them – H-bond, mass effect, bond multiplicity, ring size, electronic effects, Resonance, Inductive effect, Tautomerism, etc. FTIR spectroscopic technique.

Interpretation of IR spectra for different molecules and difference between IR and Raman spectroscopy. Problems based on IR spectral data to identify the structure of organic compounds.

Unit III: High Performance Liquid Chromatography and its applications

Introduction to separation techniques in chemical analysis. Principle and theory of chromatography. Types of chromatographic techniques. Principle, Instrumentation and working of High Performance Liquid Chromatography. Theory and important factors involving the efficiency of separation in HPLC.

Theory and practice of HPLC in chemical analysis. Types of HPLC techniques, and detectors used in HPLC methods. Analysis of various chemical, pharmaceutical and biological samples by HPLC. Interpretation of HPLC chromatograms.

Unit IV: Interpretation of Spectroscopic data for structural identification.

Interpretation of IR, UV and HPLC chromatographic spectral data for qualitative and quantitative analysis of different chemical, pharmaceutical and biological samples.

IR Spectroscopy:

1) Sample preparation and analysis of standard organic compounds
2) Analysis of IR spectra for Caffeine, Paracetamol and Metformin

UV – visible spectrophotometry

1) Determination of λmax & Calibration curve of standard samples
2) Calibration and Analysis of Caffeine, Metformin and Paracetamol

HPLC Analysis:

1) Identification and purity analysis of Caffeine, Paracetamol and Metformin

References:

1) Quantitative Chemical Analysis by Daniel C. Harris Eighth Edition published by W. H. Freeman and Company 2014.
2) Analytical Chemistry by Gary D. Christian, Purnendu K. Dasgupta and Kevin A. Schug Seventh Edition Published by John Wiley & Sons, Inc. 2014.
3) Principles of Instrumental Analysis by Douglas A. Skoog, Donald M. West, F. James Holler, Stanley R. Crouch Sixth Edition Published by Cengage Learning, 2016.
4) High Performance Liquid Chromatography, Fundamental Principles and Practice. Ed. W.J Lough & I. W. Wainer, CRC Press, 1995.

L J SCHOOL OF APPLIED SCIENCES
M.Sc. Semester IV - BIOTECHNOLOGY
BT-PRJ/INT – 701 - PROJECT/INTERNSHIP

Credits: 16

Course Objectives:

- To allow student to gain hands-on experience in a professional setting, to apply theoretical knowledge to real-world situations in industry, research, or pathology
- To enhance practical skills relevant to field of study, including laboratory techniques, data analysis, and problem-solving in a professional context.
- To facilitate opportunities for students to build professional relationships and networks within the industry or research community, promoting career development
- To conceptualize a research project, conduct literature study and perform research as per guidelines.
- Teach student to communicate scientific research data into a project report

Course Outcomes:

- Students will gain practical experience in a professional setting, applying theoretical knowledge and skills to real-world situations in industry, research
- Build professional networks within the research community and industry facilitating career development.
- Students will learn to identify specific research goals that contribute to the scientific community and address societal challenges.
- Students will acquire skills to communicate scientific research findings through the preparation of a comprehensive project report.

Students in semester IV will be assessed based on their performance in Industry Internship/Dissertation.
The student may choose to undertake an Internship in the industry/Research Institute/pathology laboratory as per his area of interest and subject of specialization. The student needs to complete a minimum period of 5-6 months of Internship/training under the supervision of the company supervisor.
Alternately, students may choose to take up a Research project/dissertation in the institute under the mentorship of their subject faculty.

Evaluation will be based on the following parameters:

1. Continuous Evaluation Component –
- Continuous evaluation by mentor/supervisor
- Internal presentation
2. External Presentation on the project or Internship topic
3. Viva – voce examination