Academic Syllabus for
M. Sc. Life Science

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CURRICULUM AND SYLLABUS OF M.Sc. LIFE SCIENCES

FIRST SEMESTER

Sl. No	Sub. Code	Subject	L-T-P	Credits
1	LSC 101	Microbiology	3-1-0	4
2	LSC 102	Biochemistry	3-1-0	4
3	LSC 103	Tools & Techniques in Life Sciences	3-1-0	4
4	LSC 151	Discipline Specific Elective – I	3-0-0	3
5	LSC – L131	Microbiology/ Biochemistry/ Techniques Laboratory	0-0-6	5
		Total		**20**

Select any one DSE from the following:

1.Enzymology and metabolism
2.Applied microbiology
3.Cell biology.
* All optional courses may not be offered at any given time.

SECOND SEMESTER

Sl. No	Sub. Code	Subject	L-T-P	Credits
6	LSC 204	Immunology	3-1-0	4
7	LSC 205	Advanced Molecular Biology	3-1-0	4
8	LSC 206	Environmental Science and Toxicology	3-1-0	4
9	LSC 252	Discipline Specific Elective – II	3-0-0	3
10	LSC-L 232	Molecular Biology/ Immunology Laboratory /Env. Sc Laboratory	0-0-6	5
		TOTAL	**20**	

Select any one DSE from the following:
4. Advances in structural biology
5. Population genetics and Evolution.
6.Proteomics and Genomics
* All optional courses may not be offered at any given time.

THIRD SEMESTER

Sl. No	Sub. Code	Subject	L-T-P	Credits
11	LSC 307	Animal Physiology	3-1-0	4
12	LSC308	Bioinformatics and Biostatistics	3-1-0	4

13	LSC 309	Developmental Biology	3-1-0	4
14	LSC 353	Discipline Specific Elective – III	3-0-0	3
15	LSC L Lab-331	Bioinformatics/Biostatistics/Dev. Biology /PhysiologyLaboratory	0-0-6	5
		TOTAL		**20**

Select any one DSE of the Following:
1.Cell cell signalling
2.Epigenetics
3. Cancer biology
* All optional courses may not be offered at any given time.

	FOURTH SEMESTER		

Sl. No	Sub. Code	Subject	L-T-P	Credits
16	LSC 410	Genetics	3-1-0	4
17	LSC 411	Plant biotechnology	3-1-0	4
18	LSC –RP	Research Project/ Dissertation*	0-0-0	12
		TOTAL		**20**

TOTAL CREDITS: **20+20+20+20= 80**

This semester will cover the dissertation projects and project related topics as well as developing research skills as preparation for PhD.

Project proposal and technical writing for funding agency 2 credits
Timely dissertation submission report 2 credits
Lab/ field work- methodology 4 credits
Lab/ field work- interpretation and analysis of results 2 credits
Dissertation presentation and interaction 2 credits

LIST OF SUBJECTS OFFERED AS OPEN ELECTIVES

(OE 1-7) **Credit [3-0-0]**

Sl.No.	CODE	TOPICS	L-T-P	Credit	Eligible branches
1	OE-1	Fundamentals of cell biology	3-0-0	3	Botany, zoology, biotechnology
2	OE-2	Basic biophysics	3-0-0	3	Physics, Botany, zoology, Env.Sc
3	OE-3	Basic biotechnology	3-0-0	3	Botany, zoology, biotechnology, Chemistry, Env.Sc.
4	OE-4	Introduction to Bioinformatics	3-0-0	3	To all subjects
5	OE-5	Research Methodology	3-0-0	3	To all subjects
6	OE-6	Structural Biology	3-0-0	3	Botany, zoology, biotechnology
7	OE-7	Advanced Techniques	3-0-0	3	Botany, zoology, biotechnology, Chemistry, Env.Sc. Physics. Geology

*** All open elective courses may not be offered at any given time.**

Abbreviations used:

LSC- 101 : LSC refers to Life Sciences ;

1 refers to Semester I; 01 refers to Core Paper 1

LSC 151 : LSC refers to Life Sciences ;

1 refers to Semester I; 51 refers to DSE 1st in the list

LS – L131: Lab refers to Laboratory /Practical;

1 refers to Semester I; 31 refers to Practical paper of Sem 1

LS –RP : RP refers to Research Project.

LSC 204 : : LSC refers to Life Sciences ;

2 refers to Semester II; 04 refers to Core Paper 4

DETAILED SYLLABI OF LIFE SCIENCE

First Semester

LSC 101 MICROBIOLOGY 4 credits [3-1-0]

Unit- 1:

1.1 Introduction to Microbiology; Discovery of the microbial world, controversy over spontaneous generation, Koch's postulate, development of pure culture methods.

1.2 Microbial Taxonomy- low G+C gram positive bacteria; high G+C gram positive bacteria. Yeast and filamentous fungi, Viruses.

1.3 Classification of microbes – Archaebacteria , Eubacteria and Cyanobacteria

Unit- 2:

2.1 Different media types and its significances

2.2 Isolation, characterization and preservation of microbial cultures (Important units of culture typing)

2.3 Growth curve and kinetics, microbial enzymes etc.

Unit- 3:

3.1 Microbial genetics : The basic principles of microbial DNA, replication, transcription and translation.

3.2 Operon systems for gene expression in Prokaryotes – lac and trp operon.

3.3 Different types of vectors-plasmids, cosmids, vector etc; resistance factors

3.4 Chemotherapeutics – mode of action of antibiotics, antifungal & antiviral.

3.5 Antibiotic Resistance.

Essential / Text Book:

1. Microbiology, M.J. Pelczar, E.C.S. Chan and N.R. Kreig, Tata McGraw Hill.

References Book (s)

2. General Microbiology, R.Y. Stanier, J.L. Ingraham, M. L. Wheelis and P.R. Painter, Macmillian.

3. Microbial ecology: Fundamentals and Applications, 4 e, R.M. Atlas and R. Bartha, Pearson Education.

4. Molecular genetics of bacteria, 3 e, L. Snyder and W. Champness, ASM Press.

5. Biotechnology, B.D. Singh, Kalyani Publishers.

6. Gene cloning and DNA analysis: An introduction, T.A. Brown, Blackwell Publishing.

LSC 102 BIOCHEMISTRY 4 credits [3-1-0]

Unit 1:

1.1 Introduction of biomolecules (micro and macro molecules)

1.2 Structure and function of amino acids , Ninhydrin test

1.3 Structure and function of proteins- Ramachandran Plot ; domains,motif and folds.

1.4 Structure and function of carbohydrates.

1.5 Structure and function of lipids – Membrane structure and function.

1.6 Structure and function of Nucleic acids (DNA and RNA)

Unit 2:

2.1 Carbohydrate metabolism : Glycolysis, TCA cycle.

2.2 Anaplerotic reactions and regulation of TCA cycle.

2.3 Glycogen metabolism and pentose phosphate pathway.

Unit 3:

3.1 Photosynthesis and pigments of life :

3.2 Structure and function of Chlorophyll, Hemoglobin and Cytochrome c.

3.2 Electron transport chain.

Text Book (s):

1. Lehninger Principles of Biochemistry, Fourth Edition by David L. Nelson, Michael M. Cox, Hardcover: 1100 pages, Publisher: W. H. Freeman

2. Herpers Review of Biochemistry

Reference Books:

1. Biochemistry by Donald Voet, Hardcover: 1616 pages, Publisher: Wiley; 3 edition

2. Biochemistry, L. Stryer, W.H. Freeman.

3. Biochemistry, J. David Rawan, Neil Patterson.

LSC 103 TOOLS & TECHNIQUES IN LIFE SCIENCES 4 credits [3-1-0]

Unit 1:

1.1 Spectroscopy – Concepts of spectroscopy, Visible and UV spectroscopy, Laws of photometry. BeerLambert's law, Advanced spectroscopic techniques.

1.2 Principles and applications of colorimetry, Mass Spectroscopy,

1.3 Chromatography – Dialysis, Principles of partition chromatography, paper, thin layer, ion exchange and affinity chromatography, gel permeation chromatography, HPLC and FPLC

Unit 2:

2.1 Centrifugation – Principles of centrifugation, concepts of RCF,

2.2 different types of instruments and rotors, preparative, differential and density gradient centrifugation, analytical ultra-centrifugation,

2.3 determination of molecular weights and other applications, sub cellular fractionation

Unit 3:

3.1 Electrophoretic techniques – Principles of electrophoretic separation.

3.2 Continuous, zonal and capillary electrophoresis,

3.3 different types of electrophoresis including paper, cellulose, acetate/nitrate and gel. Electroporation, pulse field gel electrophoresis, EMSA,

3.4 Molecular Biology techniques- Hybridization and blotting, PCR, RT-PCR, Real time PCR, molecular markers, sequencing - classical Next Generation Sequencing.

3.5 Electron Microscopy – Transmission and Scanning , specific staining of biological materials.

Text Book (s):

1. Principles of Biochemistry and molecular biology by K. Wilson and J. Walker, Cambridge University Press.

Reference Book (s)

2. Principles of Instrumental analysis by D. A. Skoog and J. J. Leary, Saunders College Publishing, Philadelphia.

3.Mannual (Sambrook and Russel)

LSC 151 ENZYMOLOGY AND METABOLISM 3 credits [3-0-0]

Unit 1:

1.1Classification of Enzymes

1.2Kinetics: derivation of Michaelis-Menten equation, L-B plot, Regulation of enzyme activity, binding site and active site, Factors affecting the rate of enzymatic reaction,

1.3 Enzyme kinetics for mono- and bi-substrate reactions, Inhibitions –competitive, uncompetitive mixed and noncompetitive type,

1.4Allosteric regulation, covalent modifications, Isozymes, ribozymes, abzymes. Enzyme inhibition and Mechanisms of inhibitors action

Unit 2:

2.1 General Metabolism: Biogenetics and ATP, Oxidative and photo phosphorylation;

2.2 Carbohydrate: Glycolysis, TCA, Gluconeogenesis, Pentose phosphate pathway:

2.3 Mechanism of selective reactions, Radioisotope distribution study and regulation.

2.4 Glycogen metabolism: Break down, synthesis, hormonal control and regulation.

Unit 3:

3.1Fatty acids: oxidation (Even, odd, saturated and unsaturated)

3.2 Metabolism of cholesterol and its regulation. Energetics of fatty acid cycle.

Text Book (s):

1. Methods in Enzymology, Academic Press.

2. Biochemistry by Donald Voet, Hardcover: 1616 pages, Publisher: Wiley

3. Lehninger Principles of Biochemistry; David L Nelson; Albert L Lehninger; Michael M Cox; New York : W.H. Freeman

LSC 152 APPLIED MICROBIOLOGY 3 credits [3-0-0]

Unit-1:

1.1 Recombinant DNA technology Definition, importance and applications of recombinant DNA technology.

1.2 Vector (YAC / BAC) and its significances in industry

1.3 Mobilization of genetic part through extracellular factors (Conjugation, Transformation etc.)

Unit- 2:

2.1 Microbial interaction with plants and animals.

2.2 Exploitation at industrial level (important microbial strains).

2.3 Mechanisms of pathogenesis and clinical manifestations associated with medically important pathogenic micro organisms (bacteria,fungi,parasites and viruses).

Unit- 3:

3.1 Environmental microbiology: Role of micro organisms in the cycling of bioelements (Carbon, nitrogen, Phosphorous etc,)

3.2 Role of Microbes in the degradation of pesticides, petroleum ,hydrocarbon and in mineral recovery.

3.1 Biofertilizers- Biological; Nitrogen fixation- symbiotic and asymbiotic, mass production by Rhizobium, Azotobacter and Cyanobacteria etc.

Text Book (s):

1. Microbiology, M.J. Pelczar, E.C.S. Chan and N.R. Kreig, Tata McGraw Hill.

2. General Microbiology, R.Y. Stanier, J.L. Ingraham, M. L. Wheelis and P.R. Painter, Macmillian.

3. Microbial ecology: Fundamentals and Applications, 4 e, R.M. Atlas and R. Bartha, Pearson Education.

4. Molecular genetics of bacteria, 3 e, L. Snyder and W. Champness, ASM Press.

5. Biotechnology, B.D. Singh, Kalyani Publishers.

6. Gene cloning and DNA analysis: An introduction, T.A. Brown, Blackwell Publishing.

Supplementary Reading:

1. The microbes – An Introduction to their Nature and Importance, P.V. Vandenmark and B.L. Batzing Benjamin Cummings.

2. Microbiology, Tortora, Funke and Chase, Benzamin& Cummings

3. Microbiology, 5th Edition, Lansing M. Prescott

LSC 153 CELL BIOLOGY 3 credits [3-0-0]

Unit 1:

1.1 Structure and Function of Cell and its Organelles: Cell as the unit of life- Development of cell theory.

1.2 Cell types: prokaryotes vs. eukaryotes; from single cell to multi-cellular organism; Prokaryotic cells: Structure, cell-walls and related molecules, outer membrane, flagella, motility,

1.3 cell inclusion endospores, gas vesicles, capsules, slime layers.

Unit 2:

2.1 Cytoskeleton – Structure and functions.

2.2 Membrane system: Biological membranes – architecture & kinetics (transport, ion channels, diffusion, Na-K pump, proton pump).

2.3 Endomembrane system: endoplasmic reticulum, Golgi complex, endosomes, lysosomes.

2.4 nucleus, Chromatin structure, nucleolus, nucleoplasm and nucleosomes.

Unit 3:

3.1Cell Division: Mitosis, meiosis and cytokinetics, animal and yeast cell division, cell cycle control, programmed cell death.

3.2 Cellular communication: Regulation of hematopoiesis, general principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins.

3.3 Cell Signaling: Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways.

Text Book (s):

1. Suggested Cell Biology : An Introduction to the Molecular Biology of the Cell, B. Alberts, D. Bray, A. Johnson, J. Lewis, M. Roff, K. Robert, P. Walter and K. Roberts, Garland Publishing Company

2. Cell and Molecular Biology, DeRobertis, B .I. Publication Pvt. Ltd

3.Molecular Cell Biology, H. Lodish, A.Berk, S.L. Zipursky, P. Matsudaura, D. Baltimore and J. Danell, W.H. Preeman and Company.

4. Suggested Cell Biology : An Introduction to the Molecular Biology of the Cell, B. Alberts, D. Bray, A. Johnson, J. Lewis, M. Roff, K. Robert, P. Walter and K. Roberts, Garland Publishing Company.

5. Structure and Function in Cell Signaling by John Nelson, Wiley.

Supplementary Reading:

1. Cell in Development and Inheritance, E.B. Wilson, Macmillan

LSC –L131 MICROBIOLOGY LABORATORY 3 credits [0-0-3]

1. To study the different sterilization techniques and instruments used in microbiology Laboratory.
2. To prepare various liquid and solid media used in microbiology experiment.
3. To isolate and count total heterotrophic bacteria in soil ,air and water sample.
4. To isolate bacterial culture from mixed culture by pour plate ,spread and streak plate method
5. To perform fungal staining for the study of fungal morphology.
6. To perform simple staining and gram staining of bacteria cells.
7. To test starch hydrolysis by amylase activity
8. To test protein hydrolysis by gelatin degradation.
9. Preparation of agar stab and slant
10. To study catalase activity
11. To study motility of bacteria by tube method.
12. MPN
13. Antibiotic sensitivity test
14. IMViC test

15. Isolation of Actinobacteria from soil samples.

16. To study the acid and gas production by bacteria.

LS –L131 BIOCHEMISTRY LABORATORY 3 credits [0-0-3]

1. Estimation of blood glucose, detection of serum- (i) urea, (ii) uric acid, (iii) creatine, (iv) creatinine

2. Blood grouping (ABO – Rh)

3. Determination of urine sample for (i) sugar, (ii) ketone bodies, (iii) protein

4. Estimation of Hb concentration, total W.B.C and R.B.C count in blood

5. Determination of lipid, total cholesterol, LDL and HDL and triglycerides

6. Enzymology – purification of enzyme & its kinetics

7. Study of the cell – (i) Cell culture, lymphocyte isolation & culture, growth rate studies, staining techniques (ii) Cell fractionation, homogenization of the tissue, centrifugation, marker enzyme assays (iii) Microscopy and microphotography.

8. Quantitative assays – (i) Enzyme assays (ii) RIA (iii) ELISA iv) DNA, RNA & proteins

9. Protein fractionation – (i) Salting in and out, gel filtration, electrophoretic separation (ii) Gel filtration affinity based techniques (iii) SDS-PAGE (iv) Electrophoretic separation of LDH isoenzymes

10. Absorption & fluorescence spectroscopy related experiments

11. Determination of CMC of biological surfactants.

Second Semester

LSC 205 IMMUNOLOGY 4 Credits [3-1-0]

Unit 1:

1.1 Basic concepts in immunology, components of the immune system.

1.2 Innate immunity, principles of innate and adaptive immunity, Different lines and layers of defense, Pattern recognition in innate immune system.

1.3 The complement system, Induced innate responses to infections, Antigen recognition by B-cells, the structure of a typical antibody molecule, Interaction between the antibody and specific antigen.

1.4 Diversity of Immunoglobulin: VDJ Recombination; Antigen recognition by T cells , Antigen processing and presentation:

Unit 2:

2.1 MHC, Complement system

Development and survival of lymphocytes, Lymphocytes in bone marrow and thymus,

2.2 Positive and negative selection of lymphocytes, Survival and maturation of lymphocytes, The

2.3 Adaptive Immune Response, T Cell-Mediated Immunity and cytotoxicity, Macrophage activation by armed CD4 TH1 cells,

2.4 Humoral Immune Response;

Unit 4:

4.1 Adaptive Immunity to Infection: Infectious agents and how they cause disease? The course of the adaptive response against infection.

4.2 The mucosal immune system, Immunological memory; Failures of Host Defense Mechanisms,

4.3 Inherited immunodeficiency diseases, Acquired immune deficiency syndrome, Allergy and 4.4 Hypersensitivity, Effecter mechanisms in allergic reactions and IgE, Hypersensitivity diseases, Autoimmunity and Transplantation.

Text Book (s):

1. Delves, Martin, Burton &Roitt, Suggested Immunology, 11th Edition.

2. Richard A. Golds by, Thomas J. Kindt and Barbara A. Osborne, Kuby Immunology I. K. International Pvt Ltd.

Supplementary Reading:

1. Janeway, Travers, Walport, and Shlomchik, Immunobiology, the immune system in health and disease, Garland Science Publishing, 6th Edition, 2005,

2. L. M. Sompayrac, How the Immune System Works, Wiley-Blackwell; 3rd edition.

LSC 206 ADVANCED MOLECULAR BIOLOGY 4 credits [3-1-0]

Unit 1

1.1 DNA Replication: Models of Replication, Origin of replication, DNA polymerases, DNA topology, DNA damage and repair.

1.2 Transcription: RNA-polymerases, RNA processing, regulation, posttranscriptional control and degeneration, gene silencing.

1.3 Translation: Structure of Ribosome, tRNA and mRNA, protein synthesis and regulation in prokaryotes and eukaryotes, protein sorting, signal peptides.

Unit 2:

2.1 Biosignaling: signal perception, molecular mechanisms of signal transduction, regulation of signal transduction pathways in controlling gene expression.

2.2 Transposons and retrotransposons: prokaryotic and eukaryotic transposable elements and their role in evolution.

Unit 3:

3.1 Animal biotechnology: cell culture, Monoclonal antibody, gene therapy,

3.2 Hybridoma technology, methods of vaccination, gene therapy, Application of recombinant DNA technology in medicine and diagnosis. Animal cloning.

3.3 Plant biotechnology: Transgenic plants, herbicide and insecticide resistant plants and there utility in modern day agriculture,

3.4 chloroplast engineering- production of molecular H2 and chloroplast and photo voltaic system.

Text Book (s):

1. B. Lewin, Genes VIII by Hardcover, Publisher: Prentice Hall

2. B.D. Singh, Biotechnology by Kalyani Publishers 2009.

3. R. C. Dubey, A text book of Biotechnology by S. Chand and Co., India

4. J. K. Pal and S. S. Ghaskadbi, Fundamentals of molecular biology by Oxford University Press.

Supplementary Reading:

1. L. Stryer, Biochemistry

2. S. Cummings, Current Perspectives in Genetics: Insights and Applications in Molecular, Classical, and Human Genetics, 2000 Edition Paperback: 170 pages, Publisher: Brooks Cole

LSC 207 ENVIRONMENTAL SCIENCE AND TOXICOLOGY 4 credits [3-1-0] Unit-1:

1.1 Geographical classification and zones. Biogeography and conservation biology Major terrestrial biomes; Structure and composition of atmosphere, hydrosphere, lithosphere and biosphere. Measuring biodiversity: Bioethics and conservation.

1.2 Ecosystem structure and functions, abiotic and biotic components,Major ecosystems.

1.3 Energy flow and models. Food chains, food web, ecological pyramids, types and diversity, Productivity

1.4 Energy flow and mineral cycling (C,N,P).

Unit- 2:

2.1 Concept of habitat and niche; fundamental and realized niche.

2.2 Population Dynamics: Characteristics of a population; population growth curves; population regulation; life history strategies (r and K selection);

2.3 Community dynamics: Nature of communities; community structure and attributes; levels of species diversity and its measurement. Ecological succession: Types; mechanisms; changes involved in succession; concept of climax.

2.4 Environmental pollution, Principles of conservation, major approaches to management.

Energy crisis and Non-conventional sources.

Unit- 3:

3.1Toxicology: Principles, dose-response relationships, toxicity testing.

3.2 Persistence of pesticides and biomagnificatio, Xenobiotics. Bioremediation.

3.3 Environmental toxicology- causes and hazards

3.4 Statistical methods applied for toxicology

Text Book (s):

1. Fundamentals of Ecology by E. P. Odum and G. W. Barrett, Cengage Learning.
2. Environmental Science by S. C. Santra, New Central Book Agency, India.
3. Ecology and Environment by P. D. Sharma, Rastogi Publications, India.
4.Fundamentals of toxicology by Pandey.K,Shukla.J.P and Trivedi,S.P; New Central Book Agency,Kolkata.
5.Basic Toxicology-Fundamentals,Target organs and risk assessment): Hemisphere Publishing Corporation, New York,1991.
6. Introduction to Environmental toxicology by Guthrie,F.E & Parry, J.J, Elsevier, New York,1980.

Supplementary Reading:

1. Ecology by P. J. Russell, S. L. Wolfe, P. E. Hertz, C. Starr and B. McMillan, Cengage Learning

2. Ecology: Principles and applications by J. L. Chapman and M. J. Reiss, Cambridge University Press.

LSC 252 ADVANCES IN STRUCTURAL BIOLOGY 3 credits [3-0-0]

Unit 1:

1.1 A familiarity with the NMR, X-ray, and computational techniques used to study macromolecular structure,

1.2 Motions in macromolecules and the functional importance of dynamics, the basis for various types of macromolecular interactions including protein- protein and protein-nucleic acid interactions,

1.3 Evolutionary relationships of structural features, the determinants of protein structure and an understanding of the current views of protein folding, the chemical basis for interactions with enzyme inhibitors and other ligands.

Unit 2:

2.1 History of Structural Biology: X-ray crystallographic and NMRstructure of Proteins, and Nucleic acids.

2.2 Proposition of DNA double helical structure in understanding the blue-print of life- Watson & Crick model .Other forms of DNA.

Unit 3:

3.1 Nucleosome and Chromatin structure.

3.2 Cytoskeleton structure and protein-protein Network,

3.3 Muscle proteins.

Text Book (s):

1. Textbook of Structural biology by Anders Lilgas, Lars Lilgas, JuiPiskur et al, World Scientific Publisher

2. Advances in structural biology by S. K. Malhotra (Editor), ELSevier.

3. Membrane structural biology by Mary Luckey, Barnes and Noble Publisher.

LSC 252 GENOMICS & PROTEOMICS 3 credits [3-0-0]

Unit 1:

1.1 Definition, classification, and scopes.

1.2 The emergence of proteome concept: structural and functional proteomes, protein structure related to functional kinetics, e.g. prions, bridging genomics to proteomics.

1.3 Transcriptomes: measurement of gene expression.

Unit 2:

2.1Proteome analysis: by methods, 2-D including protein detection on electro-blot membrane,

2.2 mass spectrometry and phosphorylation site analysis.

2.3 Proteomics in relation to animal and plant health and welfare.

Unit 3:

3.1 Transgenic plants- Genetically modified crops.

3.2 Plant Genomics : Construction of molecular maps and collinearity

3.3 Whole Genome sequencing and functional genomics in plants.

3.4 Human genome project.

Text Book (s):

1. A Textbook of Protein and Proteomics, C Subramanian and Nandan Hazare, Dominant Pub.

2. Discovering Genomics, Proteomics and Bioinformatics (2nd Edition), by A. Malcolm Campbell and Laurie J. Heyer.

LSC – L232 BIOTECHNOLOGY LABORATORY

1.Quantitation of nucleic acids (Spectrophotometric, Gel based and Saran wrap method) 2.Analysis of DNA fragments and size determination by agarose gel electrophoresis

3.Restriction digestion and ligation

4.Restriction mapping

5.Southern blotting

6.Western blotting

7.PCR and RT-PCR

8. Optimization of gene expression in E.coli and analysis of expressed product

9. Methods for enzyme immobilization

LSC – L232 MOLECULAR BIOLOGY LABORATORY

1. Determination of Isobestic points

2. Determination of melting point of DNA (Calf thymus, Whale Sperm)

3.Isolation of chromosomal DNA from E.coli and plants.

4. Isolation of RNA from mammalian cells (sources- horse, rat, rabbit etc.)

5. SDS-PAGE of protein.

6. Isolation of plasmid DNA from E.coli.

7. Transformation of E.coli with plasmid.

8. UV induced mutagenesis in E. coli

9. Tissue culture

LSC– L 232 IMMUNOLOGY LABORATORY

1. Study of Blood Groups

2.Study of Antigen- Antibody pattern-ODD

3.Immunoglobulin Y purification

4.Immunoglobulin G purification

5.Study of immunohistochemistry

6.Study of Latex agglutination

7.Study of haem agglutination

Third Semester

LSC -307 ANIMAL PHYSIOLOGY 4 credits [3-1-0]

Unit 1:
1.1 Overview of digestion and absorption of macronutrients
1.2 Gastrointestinal hormones and regulation
1.3. Role of Hemoglobin in transport of gases, Hill reaction

Unit 2:
2.1 Physiology of Urine formation, Counter current mechanism, Hormonal regulation
2.2 Acid-base balance and homeostasis
2.3 Neuron and its types , Axonal transmission
2.4 Physiology of nerve conduction
2.5 Synaptic transmission ,Chemical transmission, neurotransmitters.

Unit 3
3.1 Ultrastructure of skeletal muscle fibers , Muscle proteins
3.2 Sequence of events in contraction and relaxation of skeletal muscle
3.3 Energetics of muscle contraction , Isotonic and isometric contraction
3.4 Cori cycle

Text Book (s):

1. Ganong: Review of Medical Physiology (21st Ed.), Lang Medical Publications, 2003

2. Guyton and Hall: Text Book of Medical Physiology (10th Ed.), W.B. Saunders, 2001

References:

3. Keel et al: Samson Wright's Applied Physiology (13th Ed.), Oxford Press, 1989

4. Murray et al: Harper's Illustrated Biochemistry (26th Ed.), Appleton & Lange, 2003

5. West: Best and Taylor's Physiological Basis of Medical Practice (11th Ed.), Williams and Wilkins, 1981.

LS C 308 BIOINFORMATICS AND BIOSTATISTICS 4 credits [3-1-0]

Unit 1:

1.1 Introduction to computational biology & bioinformatics.Branches of bioinformatics.Nature of biological data. Biological data formats.

1.2 Bioinformatics databases: Literature databases (PubMed), Primary nucleotide sequence databases (NCBI, EMBL, DDBJ), Secondary nucleotide sequence databases (UniGene, SGD etc.), Protein sequence databases (SwissProt/TrEMBL, PIR), Sequence motif databases (Pfam, PROSITE), Structure databases (PDB, NSD, SCOP, CATH), Gene Expression databases.

Unit 2:

2.1 Algorithms and bio-tools: Sequence alignment and database similarity searching. Scoring matrix, BLAST series, FASTA. Pairwise Sequence Alignments and Multiple sequence alignments (ClustalW). Global Alignments – Needleman Wunsch Algorithm, Local Alignments – Smith Waterman Algorithm. Multiple sequence alignments (ClustalW).

2.2 Basic concepts on phylogenetic markers and molecular phylogeny. Structural bioinformatics: prediction of secondary & tertiary structure of proteins, comparative modeling. 4 Vaccine design concept.Human genome and epigenome projects.

2.3 Overview of programming languages in bioinformatics.Basic commands of UNIX.

Other biological tools and resources: EMBOSS, Expasy, OMIM, GOLD etc.

Unit 3:

3.1 Collection and presentation of data Collection of biological data: sampling, aim, techniques-random sampling and non-random sampling.

3.2 Classification of data, frequency distribution and tabulation.Graphical representation- bar diagram, pie diagram, frequency curve, histogram, Ogive.

3.3 Statistics of location and dispersion Measures of central value- Mean, Median, Mode.

3.4 Measures of dispersion- standard deviation, coefficient of variation.Skewness and Kurtosis.

Unit- 4:

4.1 Sampling statistics and testing of hypothesis Procedure for testing hypothesis.

4.2Test of significance based on small samples and large samples (‘t’ test and ‘z’ test), Chi-square test,

4.3 Analysis of variance- One-way and Two-way ANOVA.

4.4 Correlation and regression Use of correlation in biological science – purpose, positive correlation, negative correlation, calculating correlation coefficient, significance.

4.5 Use of Regression in Biological Sciences – purpose, coefficient of regression (b), Regression line (Y on X and X on Y).

Text Book (s):

1. Bioinformatics: Principles and Applications by Z. Ghosh and B. Mallick, Oxford University Press.

2. Bioinformatics: Sequence and Genome Analysis by D.W. Mount, Cold Spring Harbor Laboratory

3. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins by A.D. Baxevanis and B.F.F. Ouellette, Wiley-interscience.

4. Understanding Bioinformatics by Marketa Zvelebil and Jeremy Baum, Garland Science.

5. Modern statistics for the Life Sciences by A. Grafen and R. Hails, Oxford University Press. 4.

6.An Introduction to Biostatistics by Thomas Glover and Kevin Mitchell, Waveland PrInc

LSC 309 DEVELOPMENTAL BIOLOGY 4 credits [3-1-0]

Unit 1:

1.1 Basic Concepts of Development: Potency, commitment, specification, induction, competence, determination and differentiation;

1.2 Morphogenetic gradients; cell fate and cell lineages; stem cells,

1.3 Gametogenesis, fertilization and early development: cell surface molecules in sperm-egg recognition in animals;

1.4 Embryo sac development and double fertilization in plants; zygote formation, cleavage, blastula formation, gastrulation and formation of germ layers in animals;

1.5 Embryogenesis, and establishment of symmetry in plants; seed formation and germination.

Unit 2:

2.1Cell Aggregation and Differentiation; Axes and pattern formation in Drosophila,

2.2 Organogenesis, development and regeneration in vertebrates; metamorphosis;

2.3 Morphogenesis and Organogenesis in Plants:

2.4 Organization of shoot and root apical meristem; shoot and root development,

2.5 Programmed cell death, aging and senescence.

Unit 3:

3.1 Plant Physiology: Osmoregulation, Solute transport and photo assimilate translocation;

3.2 Photosynthesis: Light harvesting complexes; mechanisms of electron transport; CO2 fixation,

3.3 Respiration and photorespiration: Citric acid cycle, plant mitochondrial electron transport and ATP synthesis, alternate oxidase, photorespiratory pathway;

3.4 Plant hormones and Sensory photobiology; Responses of plants to biotic (pathogen and insects) and abiotic (water, temperature and salt) stresses.

Text Book (s):

1. Developmental Biology by S.F. Gilbert, Sinauer Associates Inc.

2. Plant Physiology, Lincoln Taiz and Eduardo Zeiger, Sinauer Associates Inc.

LSC 353 APPLIED BIOINFORMATICS LABORATORY

1.Visualizing and understanding biological data formats, such as genbank flat file, genpept, fasta, nexus, pdb etc.

2.Exploring nucleotide and protein databases: GenBank, EMBL, DDBJ, PIR-PSD, SwissProt, TrEMBL/GenPept.

3.Visualizing and understanding 3D structure of macromolecules by molecular viewers: RasMol, Cn3D, Swiss-PDB Viewer Sequence comparisons & alignment Estimating protein secondary structure and physical attributes:

4.Proteolytic digestion mapping, molecular weight and amino acid composition determination, isoelectric point estimation, hydrophobicity and hydrophobic moment determinations, surface probability and antigenicity mapping, and secondary structure prediction.

5.Introduction to molecular phylogenetics: Clustering techniques, Hierarchial& non-hierarchial, Bootstrapping, Interpretation of phylogenetic trees.

6. Comparative genomics and gene prediction Pattern matching Designing of primers for PCR;

7.Identification of restriction enzyme maps for molecular biology applications and other genomics and proteomics analysis tools embedded in the Genomics Workbench Prediction of secondary & tertiary structure of proteins Immunoinformatics concepts and tools Structural bioinformatics (Homology modeling) Molecular docking and

8.Drug design Vaccine design Exploring EMBOSS series, NCBI tools and other tools .

Text Book (s):

Bioinformatics: Principles and Applications by Z. Ghosh and B. Mallick, Oxford University Press.

LSC 353 CELL CELL SIGNALING 3 credits [3-0-0]

Unit 1:

1.1 Cell signaling: Hormones and their receptors,

1.2 cell surface receptor, signaling through G-protein coupled receptors,

1.3 signal transduction pathways, second messengers, regulation of signaling pathways,

1.4 bacterial and plant two-component signaling systems, bacterial chemotaxis and quorum sensing.

Unit 2:

2.1 Cellular communication: Regulation of hematopoiesis,

2.2 general principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions,

2.3 extracellular matrix, integrins, neurotransmission and its regulation.

Unit 3:

3.1 Cancer : Genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes,

3.2 cancer and the cell cycle, virus-induced cancer, metastasis,

3.3 interaction of cancer cells with normal cells, apoptosis,

3.4 therapeutic interventions of uncontrolled cell growth.

Unit 4:

4.1 Specific pathways:- Chromatin Regulation; Ras, MAPK and Ras-MAPK Signaling;

4.2 Apoptosis/Autophagy, PI3K/Akt Signaling, Translational Control; Ca, cAMP& Lipid Signaling,

4.3 Cell Cycle/Checkpoint, DNA Damage, Jak/Stat Pathway, NF-κB Signaling, TGF-β/Smad Signaling, Lymphocyte Signaling, Neuroscience, Tyrosine Kinase/Adaptors, Angiogenesis, Vesicle Trafficking, Cytoskeletal Signaling, Adhesion,

4.4 Glucose Metabolism, Wnt/Hedgehog/Notch, Stem Cell/Lineage Markers, Nuclear Receptors.

Text Book (s):

1. Molecular Biology of the cell by Bruce Alberts et al, Garland Science Com

2. Molecular cell Biology by Lodish et al, W H Freeman and Company

3. Structure and Function in Cell Signalling by John NeLSon, Wiley.

4. The biochemistry by Ernst J. M. Helmreich, Oxford Uni Press

LSC 353 EPIGENETICS 3 credits [3-0-0]

Unit 1:

1.1Epigenesis and development: Concept of epigenetics,

1.2 Epigenetic mechanisms and regulation of gene expression;

1.3DNA-Methylation, Epigenome, Methylome.

Unit 2:

2.1 Histone Code: histone modifications (acetylations, methylations, phosphorylations, sumoylations, uniquitylation etc.) and enzymatic mechanisms.

2.2 DNA-methyltransferases, Histone acetylases, histone deacetylases, (Histone) protein arginine methyltransferases and demethylases, (Histone) protein lysine methyltransferases and demethylases.

Unit 3:

3.1 Transcriptional silencing by polycomb group proteins and regulation by trithorax group proteins.

3.2 Histone variants, chromosome inheritance, X-chromosome inactivation.

3.3 Genomic imprinting, germ line and pluripotent stem cells.

Unit 4:

4.1 Epigenetic of human disease and epigenetic determinants of cancer.

4.2 Nuclear transplantation and the reprogramming of the genome.

4.3 RNA interference and regulation of gene expression (RNAi, microRNA, heterochromatin assembly).

4.4Position-effect Variegation, heterochromatin formation and gene silencing in Drosophila **Text Book (s):**

1. Epigenetics by C. David Allis, Thomas Jenuwein, Danny Reinberg and Marie-Laure Caparros, Cold Spring Harbor Laboratory Press, CSH Press, NY, USA.

2. Epigenetics by JörgTost (Editor), Caister Academic Press.

LSC353	CANCER BIOLOGY	3 credits [3-0-0]

Unit 1:

1.1Introduction to mammalian cell culture and applications; what is Cancer?

1.2 Profile of a Cancer Cell; How Cancers Spread; Identifying the causes of Cancer:

1.3Chemicals and Cancer ,

1.4Radiation and Cancer ,

Unit 2:

2.1Infectious Agents and Cancer, Heredity and Cancer; Oncogenes, Tumor Suppressor Genes and Cancer

2.2 Overview; Chromosome heterogeneity, micro satellite instability, Epigenetic basis of cancer, DNA-methylation and histone modifications associate to cancer;

2.3Cancer stem cell: identification, property and therapeutic implication; tumor evolution, escape from non-immune and immune surveillance.

2.4 Immunoediting, role of immunological ignorance and tolerance in tumor escape, Regulatory lymphocytes in cancer;

2.5 Cancer Screening, Diagnosis, and Treatment; Preventing Cancer.

Text Book (s):

1. Principles of Cancer Biology: International Edition; Lewis J. Kleinsmith, Pearson Higher Education

2. Cancer Stem Cells: Identification and Targets, Sharmila A. Bapat, Wiley

3. Cancer immunotherapy: immune suppression and tumor growth , George C. Prendergast and Elizabeth M. Jaffee, Academic Press

Third Semester

LSC 410	GENETICS	4 credits [3-1-0]

Unit 1:

1.1Mendel's Law of segregation, Law of independent assortment, Extensions of Mendelism: Codominance, incomplete dominance,

1.2 Gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy,

1.3 linkage and crossing over, sex linkage, sex limited and sex influenced characters.Gene mapping methods: Linkage maps, tetrad analysis.

1.4 1Extra chromosomal inheritance: Inheritance of Mitochondrial and chloroplast genes, maternal inheritance.

Unit 2:

2.1 Mutation: Types, causes and detection, mutant types – lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants, insertional mutagenesis. 3.3 Deletion, duplication, inversion, translocation, ploidy and their genetic implications.

Unit 3:

4.1 Molecular tools in phylogeny, classification and identification; Protein and nucleotide sequence analysis; origin of new genes and proteins;

4.2 Populations, Gene pool, Gene frequency; Hardy-Weinberg Law; concepts and rate of change in gene frequency through natural selection, migration and random genetic drift;

Text Book (s):

1. Principles of Genetics, E J Gardner, John Wiley & Sons Inc

2. Principles of Genetics, D.P. Snustad& M.J. Simmons, John Wiley and Sons Inc

3. The Science of Genetics, Alan G. Atherly, Jack R. Girton, John F. McDonald, Saunders College Pub.

Supplementary Reading:

1. Genetics: From Genes to Genomes by L. Hartwell, Leroy Hood, Michael Goldberg, Ann Reynolds, Lee Silver, Ruth Veres publisher: McGraw-Hill

2. Medical genetics by Lynn B. Jorde, John C. Carey, Michael J. Bamshad and Raymond L. White.

LSC 411 PLANT BIOTECHNOLOGY 4 credits [3-1-0]

Unit 1:

1.1 Introduction of plant cell and tissue culture,Tissue culture media Single and suspension culture, Organogenesis & Embryogenesis, embryo culture .

1.2 Haploid production and homozygous diploid lines; cryopreservation and germplasm conservation; protoplast isolation, culture and fusion;

Unit 2 :

2.1 Cloning vector for higher plant transformation, Agrobacterium tumefaciens Ti and Ri plasmids, basis of tumor formation, hairy root, mechanisms of DNA transfer, role of virulence genes.

2.3 Viral vectors. Direct gene transfer. Transformation of monocots; transgene stability and gene silencing, selection of clones.

2.4 Expression of cloned genes: genetic markers, reporter genes.

Unit 3:

3.1 Chloroplast transformation: vectors, mechanisms, advantages and limitations, homoplastomic line development.

3.2 Metabolic engineering and industrial products;

3.3plant secondary metabolites, control mechanisms and applications of industrially important secondary metabolites

3.4 Marker-aided breeding RFLP maps; Linkage analysis;

3.5 RAPD markers; STS, SSCP, SCAR, AFLP, QTL and microsatellites; Molecular assisted selection.

Recommended Books :

1. T, J. Fu, G. Singh and W.R. Curtis (Eds): Plant Cell and Tissue Culture for the Production of Food Ingredients. Kluwer Academic/Plenum Press. 1999.

2.H.S. Chawla: Plant Biotechnology,2nd Edition, Oxford & IBH publishing co.pvt.ltd

3. R.J. Henry: Practical Application of Plant Molecular Biotechnology. Chapman and Hall. 1997.

4. P.K. Gupta Elements of Biotechnology. Rastogi and Co. Meerut. 1996

5. Plant Biotechnology,M.K.Razdan,2nd Edition,Oxford & IBH publishing co.pvt.ltd

6. Plant Biotechnology: J. Hammond, P. McGarvey and V Yusibov (Eds):, Springer Verlag, 2000.

DETAILED SYLLABI OF OPEN ELECTIVES

LSC-OE(1) FUNDAMENTALS OF CELL BIOLOGY 3 credits [3-0-0]

Unit 1:

1.1 Structure and function of cell and its organelles. Cell as the unit of life- Development of cell theory.

1.2 Cell types: prokaryotes vs. eukaryotes; from single cell to multi-cellular organism; Prokaryotic cells: Structure, cell-walls and related molecules, outer membrane, flagella, motivity, cell inclusion endospores, gas vesicles.

1.3 Cell architecture, cyto-skeletal components, microtubules and microfilaments, motility and motor motions, actomyosin complex.

Unit 2:

2.1 Biological membranes – architecture & kinetics (transport, ion channels, diffusion, Na-K pump, proton pump).

2.2 Endomembrane system: endoplasmic reticulum, Golgi complex, endosomes, lysosomes

2.3 Cell nucleus, Chromatin structure, nucleolus, nucleoplasm.

Unit 3:

3.1 Energy Transduction and Bioenergetics: Mitochondria, ATP, Chemiosomes, ATPase,

3.2 Gap junctions

3.3 Chloroplast –photosynthetic electron transport, Calvin cycle.

Unit 4:

4.1 Cell division: Mitosis, meiosis and cytokinetics, animal and yeast cell division,

4.2 cell cycle control, programmed cell death . Cell cycle: G0/G1, S, G2 and M phages, duration of different phages and the methods for their determination .

4.3 Protein localization: Synthesis of secretory &membrance protein, import into nucleus, mitochondria, chloroplast & peroxisome; Receptor-mediated endocytosis.

Text Book (s):

1. Suggested Cell Biology : An Introduction to the Molecular Biology of the Cell, B. Alberts, D. Bray, A. Johnson, J. Lewis, M. Roff, K. Robert, P. Walter and K. Roberts, Garland Publishing Company .
2. Cell and Molecular Biology, DeRobertis, B .I. Publication Pvt. Ltd .
3. .Molecular Cell Biology, H. Lodish, A.Berk, S.L. Zipursky, P. Matsudaura, D. Baltimore and J. Danell, W.H. Freeman and Company.

4. Supplementary Reading:

1. Cell in Development and Inheritance, E.B. Wilson, Macmillan

LSC-OE(2)	BASIC BIOPHYSICS	3 credits [3-0-0]

Unit 1:

1.1 Thermodynamic Principles: Laws of thermodynamics, Details of thermodynamic variables and functions.

1.2 Application of these laws in Life Science with examples.

Unit 2:

2.1 Basic atomic and radiation physics.

2.2 Electromagnetic properties of light and basic molecular physics.

2.3 Interaction of UV, VIS and IR radiation and LASER with bio-molecules and living system, Bio- and chemi luminescence, photochemical reaction.

Unit 3:

3.1 Thermal changes in cells and tissues, thermal

3.2 Biological transport processes, Nernst potential and Donnan potential – surface potential and potential across bio-membranes, biological energy conversion.

3.3 Electromagnetic energy spectrum – their effects on the molecules and method of studying them, Raman, NMR, NOESY and TOCSY, ESR spectroscopy

and Mass spectrometry, and their biological applications, optical rotatory dispersion, fluorescence, phosphorescence spectroscopy, circular dichroism, X-ray diffraction (structure of DNA, RNA and Proteins),

Unit 4:

4.1 ultrastructure determination, electron microscopy – transmission and scanning.

4.2 Concept of liquid crystals, Principal component analysis,

4.3 Matrices, analysis of spectral data with MetLab.

4.4 Radioactivity: Radio emission, law of radioactive decay, production of radio isotopes for medical use, electromagnetic radiation, interaction of radiation with matter, exponential attenuation, half value thickness, photo electric, Compton and pair production process and their significance in radiology, radiation units, detection and measurements of radiation ; Introduction of ultrasonic wave: Ultrasonic wave motion, wave characteristics, intensity, and ultrasound properties in body. Use of ultrasound in biological field.

Text Book (s):

1. Biochemistry by L. Stryer, W.H. Freeman and Co.

2. A biologists physical chemistry by J. G. Morris, Edward Arnold (Publishers) Ltd.

Supplementary Reading:

1. Textbook of Biophysical Chemistry by U. N. Dash, MacMillan

2. A Textbook of Biophysics by R.N. Roy, New Central Book Agency.

LSC-OE(3) BASIC BIOTECHNOLOGY 3 credits [3-0-0]

Unit 1:

1.1 Definition and scope of biotechnology; branches of biotechnology;

1.2 Bioprocess technology for the production of cell biomass and primary/secondary metabolites, such as baker's yeast, ethanol, citric acid, amino acids, exopolysacharides, antibiotics and pigments etc;

1.3 Regeneration of plants and totipotency;

1.4 Plant products of industrial importance;

1.5 Biochemistry of major metabolic pathways and products; Autotrophic and heterotrophic growth; Plant growth regulators and elicitors;

Unit 2:

2.1 Cell suspension culture development;

2.2 Production of secondary metabolites by plant suspension cultures; Hairy root cultures and their cultivation;

2.3 generation of transgencies and their application in agriculture; Cloning in animals;

2.4 Genetic engineering; transgenic animaLS; Animal cell preservation;

2.5 Genomics and its application to health and agriculture, including gene therapy

Text Book (s):

1. Introduction to Biotechnology (2nd Edition); William J. Thieman and Michael A. Palladino; Benjamin Cummings (2008).

2. Introduction to Plant Biotechnology; H.S. Chawla; Science Publishers, 2002

LS-OE(4) INTRODUCTION TO BIOINFORMATICS 3 credits [3-0-0]

Unit 1:

1.1 Basic concepts, Introduction to biological databases and tools.

1.2 Sequence and structure databases. Sequence alignments: Pairwise and Multiple Sequence Alignment,

1.3 Methods and algorithms used in alignment tools: Methods for doing Multiple Sequence Alignments: CLUSTALW and PILEUP. BLAST series and FASTA.

Unit 2:

2.1 Phylogenetic analysis: Concept and methods: Distance based (Fitch and Margoliash& UPGMA) and character based methods (Parsimony).

2.2 Prediction of genes and tools.

Unit 3:

3.1 Structural bioinformatics and molecular modelling.

3.2 Human genome and epigenome projects.

3.3 Introduction of protein structure and prediction.

Unit 4:

4.1 Useful biological tools and resources for biological research, eg. EMBOSS, Expasy, OMIM, GOLD etc.

4.2 Introduction to bio-programming languages.Some basic commands of UNIX.

Text Book (s):

1. Bioinformatics: Principles and Applications by Z. Ghosh and B. Mallick, Oxford University Press.

2. Bioinformatics: Sequence and Genome Analysis by D.W. Mount, Cold Spring Harbor Laboratory Press.

3. Fundamentals of statistics by S.C. Gupta, Himalaya Publishing House

4. Biostatistical analysis by J. H. Zar, Prentice Hall.

5. Quantitative Zoology by G. G. Simpson, A. Roe and Dover Publications.

LSC-OE(5)	RESEARCH METHODOLOGY	3 credits [3-0-0]

Unit 1:

1.1 Collection and presentation of data Statistics- definition, function, scope and limitations.

1.2 Collection of biological data – sampling, aim, techniques, random sampling and non-random sampling.

1.3Classification of data- frequency distribution and tabulation.Tabulation of data and graphical representation- bar diagram, pie diagram, frequency curve, histogram, Ogive.

1.4 Statistics of location and dispersion Measures of central value- Mean, Median, Mode.

1.5 Measures of dispersion- standard deviation, standard error, coefficient of variation.

1.6 Normal distribution, Skewness and Kurtosis.

Unit 2:

2.1Sampling statistics and testing of hypothesis Sampling distribution, Sampling error, standard errors, degrees of freedom.

2.2 Test of significance based on large samples- procedure for testing hypothesis.

2.3Correlation and regression Use of correlation in biological science – purpose, positive correlation, negative correlation, calculating correlation coefficient, significance, other types of correlation. Use of Regression in Biological Sciences – purpose, regression coefficient Y, Regression line.

Unit 3: ‘t’ test, Chi square and ANOVA Student ‘t’ test for mean, Chi-square test, Analysis of variance- One-way and Two-way ANOVA.

Unit 4: Use of computers in Bio-statistics Use of computer in Bio-Statistics- Computation of Median, Variance, Standard Deviation, and Correlation Coefficient etc. Application of statistical packages- MS Excel, SPSS etc.

Text Book (s):

1. Fundamentals of statistics by S.C. Gupta, Himalaya Publishing House

2. Biostatistical analysis by J. H. Zar, Prentice Hall.

3. Modern statistics for the Life Sciences by A. Grafen and R. Hails, Oxford University Press

4. An Introduction to Biostatistics by Thomas Glover and Kevin Mitchell, Waveland PrInc.

LSC-OE(6) STRUCTURAL BIOLOGY 3 credits [3-0-0]

Unit 1:

1.1 A familiarity with the NMR, X-ray, and computational techniques used to study macromolecular structure,

1.2 motions in macromolecules and the functional importance of dynamics, the basis for various types of macromolecular interactions including protein- protein and protein-nucleic acid interactions,

1.3 The determinants of protein structure and an understanding of the current views of protein folding, the chemical basis for interactions with enzyme inhibitors and other ligands.

Unit 2:

2.1History of Structural Biology: X-ray crystallographic and NMRstructure of Proteins, and Nucleic acids.

2.2 Proposition of DNA double helical structure in understanding the blue-print of life- Watson & Crick model.Fine structure of Proteins- fibrous, globular and membrane proteins,

2.3 Nucleosome and Chromatin structure.

2.4Cytoskeleton structure and protein-protein Network,

2.5Muscle proteins.Structure of Heart, Lung and Brain.

Text Book (s):

1. Textbook of Structural biology by Anders Lilgas, Lars Lilgas, JuiPiskur et al, World Scientific Publisher

2. Advances in structural biology by S. K. Malhotra (Editor), ELSevier.

3. Membrane structural biology by Mary Luckey, Barnes and Noble Publisher.

LSC –OE (7) ADVANCED TECHNIQUES 3 credits [3-0-0]

Unit 1:

1.1 Spectroscopy – Concepts of spectroscopy, Visible and UV spectroscopy,

1.2 Laws of photometry. BeerLambert's law, Principles and applications of colorimetry.Mass Spectroscopy

1.3 Chromatography – Dialysis, Principles of partition chromatography, paper, thin layer, ion exchange and affinity chromatography, gel permeation chromatography, HPLC and FPLC

Unit 2:

2.1 Centrifugation – Principles of centrifugation, concepts of RCF,

2.2 Different types of instruments and rotors, preparative, differential and density gradient centrifugation, analytical ultra-centrifugation,

2.3 Determination of molecular weights and other applications, subcellular fractionation

Unit 3 :

3.1 Electrophoretic techniques – Principles of electrophoretic separation.

3.2 Continuous, zonal and capillary electrophoresis, different types of electrophoresis including paper, cellulose, acetate/nitrate and gel.

3.3 Electroporation, pulse field gel electrophoresis, EMSA, DNA fingerprinting, and foot printing.

Unit 4:

4.1 Molecular Biology techniques- Hybridization and blotting, PCR, RT-PCR, Real time PCR, RFLP, AFLP.

4.2 Chromosome walking, chromosome jumping, DNA microarray, chips and RIA. Methods of DNA sequencing: Sangers sequencing, 454 sequencing.

4.3 Analysis of SINES and LINES.Genomic insulators.

4.4 Electron microscopy – Transmission and scanning, freeze fracture techniques, specific staining of biological materials.

4.5 Spectroscopic techniques: Absorption, Florescence, ORD, CD, X-ray diffraction, X-ray absorption, and NMR.

Text Book (s):

1. Principles of Biochemistry and molecular biology by K. Wilson and J. Walker, Cambridge University Press.

2. Principles of Instrumental analysis by D. A. Skoog and J. J. Leary, Saunders College Publishing, Philadelphia.

CURRICULUM AND SYLLABUS OF M.Sc. LIFE SCIENCES

FIRST SEMESTER

Sl. No	Sub. Code	Subject	L-T-P	Credits
1	LS 101	Microbiology	3-1-0	4
2	LS 102	Biochemistry	3-1-0	4
3	LS 103	Bio Analytical Tools & Techniques	3-1-0	4
4	LS – DSE(1)	Discipline Specific Elective – I	3-1-0	4
5	LS-OE(1)	Open Elective – I(Computer Science)from other department	3-0-0	3
6	LS – Lab-104	Microbiology/ Biochemistry Laboratory	0-0-6	6
		Total		**25**

Select any one DSE from the following:

1.Enzymology and metabolism
2.Applied microbiology
3.Cell biology.
* All optional courses may not be offered at any given time.

SECOND SEMESTER

Sl. No	Sub. Code	Subject	L-T-P	Credits
1	LS 205	Immunology	3-1-0	4
2	LS 206	Molecular Biology and Biotechnology	3-1-0	4
3	LS 207	Environmental Science and Biostatistics	3-1-0	4
4	LS – DS	Discipline Specific Elective – II	3-1-0	4

	E(4)			
5	LS-OE(2)	Open Elective – II (Environmental- IPR and Patenting)- from other department	3-0-0	3
6	LS–Lab-208	Biotechnology/ Molecular Biology/ Immunology Laboratory	0-0-6	6
		TOTAL		**25**

Select any one DSE from the following:
4. Advances in structural biology
5. Population genetics and Evolution.
6.Proteomics and Genomics
* All optional courses may not be offered at any given time.

		THIRD SEMESTER		

Sl. No	**Sub. Code**	**Subject**	**L-T-P**	**Credits**
1	LS309	Mammalian Physiology	3-1-0	4
2	LS310	Applied Bioinformatics	3-1-0	4
3	LS311	Developmental Biology	3-1-0	4
5	LS–Lab-312	Bioinformatics/Biostatistics/Dev. Biology Laboratory	0-0-6	4

6	LS – DSE(3)	Discipline Specific Elective – III	3-1-0	4
7	LS - OE(3)	Open Elective – III (Entrepreneurship and Skill development)- from other department.	3-0-0	3
9		Short-term Industrial/Research Experience (SIRE)	0-0-3	2
		TOTAL		**25**

Select any one DSE of the Following:
1.Cell-cell signaling
2.Epigenetics
3. Cancer biology
* All optional courses may not be offered at any given time.

FOURTH SEMESTER

Sl. No	Sub. Code	Subject	L-T-P	Credits
1	LS413	Genetics	3-1-0	4
4	LS414	Plant biotechnology	3-1-0	4
2	LS - RP	Research Project	0-0-8	5
3	LS – S&TW	Seminar & Technical Writing	0-0-3	2
5	LS – DSE(4)	Discipline Specific Elective – IV	3-1-0	4
6	LS - VV	Comprehensive Viva – Voce	0-0-0	2

TOTAL	21

TOTAL CREDITS: **25+25+25+21= 96**

Select any one of the following (DSE):

1.Man and Microbes

2. Research methodology

3. Recombinant DNA Technology

* All optional courses may not be offered at any given time.

LIST OF SUBJECTS OFFERED AS OPEN ELECTIVES (OE 1-7) Credit [3-0-0]

Sl. No.	CODE	TOPICS	L-T-P	Credit	Eligible branches
1	OE-1	**Fundamentals of cell biology**	**3-0-0**	**3**	**Botany,zoology,biotechnology**
2	**OE-2**	**Basic biophysics**	**3-0-0**	**3**	**Physics,Botany,zoology,Env.Sc**
3	**OE-3**	**Basic biotechnology**	**3-0-0**	**3**	**Botany,zoology,biotechnology, Chemistry,Env.Sc**
4	**OE-4**	**Introduction to Bioinformatics**	**3-0-0**	**3**	**To all subjects**
5	**OE-5**	**Research Methodology**	**3-0-0**	**3**	**To all subjects**
6	**OE-6**	**Structural Biology**	**3-0**	**3**	**Botany,zoology,biotechnology**

			-0		
7	**OE-7**	**Advanced Techniques**	**3-0-0**	**3**	**Botany,zoology,biotechnology, Chemistry,Env.Sc.Physics. Geology**

*** All open elective courses may not be offered at any given time.**

Abbreviations used:

LS- 101 : LS refers to Life Sciences ;

1 refers to Semester I;

01 refers to Paper 1

LS-DSE(1) : LS refers to Life Sciences ;

DSE refers to Discipline Specific Elective;

1 refers to 1st in the list

LS – Lab-104: Lab refers to Laboratory /Practical;

1 refers to Semester I;

04 refers to Paper 4

LS –OE(1) : OE refers to Open Elective and 1 refers to 1st in the list of Open Electives

LS –RP : RP refers to Research Project.

LS – S& TW : S& TW refers to Scientific and Technical Writing.

LS –VV : VV refers to Viva- voice.

DETAILED SYLLABI OF LIFE SCIENCE

LS 501 MICROBIOLOGY 3 credits [3-0-0]

Unit- 1:

1.1 Introduction to Microbiology; Discovery of the microbial world, controversy over spontaneous generation, Koch's postulate, development of pure culture methods.

1.2 Microbial Taxonomy- low G+C gram positive bacteria; high G+C gram positive bacteria. Yeast and filamentous fungi, Viruses.

1.3 Classification of microbes

Unit- 2:

2.1 Different media types and its significances

2.2 Isolation, characterization and preservation of microbial cultures (Important units of culture typing)

2.3 Growth curve and kinetics, microbial enzymes etc.

Unit- 3:

3.1 Microbial genetics : plasmids, cosmids, vector etc; resistance factors

3.2 Chemotherapeutics – mode of action of antibiotics, antifungal & antiviral.

Essential / Text Book:

1. Microbiology, M.J. Pelczar, E.C.S. Chan and N.R. Kreig, Tata McGraw Hill.

References Book (s)

2. General Microbiology, R.Y. Stanier, J.L. Ingraham, M. L. Wheelis and P.R. Painter, Macmillian.

3. Microbial ecology: Fundamentals and Applications, 4 e, R.M. Atlas and R. Bartha, Pearson Education.

4. Molecular genetics of bacteria, 3 e, L. Snyder and W. Champness, ASM Press.

5. Biotechnology, B.D. Singh, Kalyani Publishers.

6. Gene cloning and DNA analysis: An introduction, T.A. Brown, Blackwell Publishing.

LS 102	BIOCHEMISTRY	4 credits [3-1-0]

Unit 1:

1.1 Introduction of biomolecules (micro and macro molecules)

1.2 Structure and function of proteins, carbohydrates, nucleic acids & lipids

Unit 2:

2.1 Carbohydrate metabolism : Glycolysis, TCA cycle.

2.2 Anaplerotic reactions and regulation of TCA cycle.

2.3 Glycogen metabolism and pentose phosphate pathway.

Unit 3:

Classification of enzymes, kinetics, regulation and immobilization

Text Book (s):

1. Lehninger Principles of Biochemistry, Fourth Edition by David L. Nelson, Michael M. Cox, Hardcover: 1100 pages, Publisher: W. H. Freeman

2. Herpers Review of Biochemistry

Reference Books:

1. Biochemistry by Donald Voet, Hardcover: 1616 pages, Publisher: Wiley; 3 edition
2. Biochemistry, L. Stryer, W.H. Freeman.
3. Biochemistry, J. David Rawan, Neil Patterson.

LS 103 BIO ANALYTICAL TOOLS & TECHNIQUES 4 credits [3-1-0]

Unit 1:

1.4 Spectroscopy – Concepts of spectroscopy, Visible and UV spectroscopy, Laws of photometry. BeerLambert's law,

1.5 Principles and applications of colorimetry, Mass Spectroscopy,

1.6 Chromatography – Dialysis, Principles of partition chromatography, paper, thin layer, ion exchange and affinity chromatography, gel permeation chromatography, HPLC and FPLC

Unit 2:

2.1 Centrifugation – Principles of centrifugation, concepts of RCF,

2.2 different types of instruments and rotors, preparative, differential and density gradient centrifugation, analytical ultra-centrifugation,

2.3 determination of molecular weights and other applications, subcellular fractionation

Unit 3:

3.1 Electrophoretic techniques – Principles of electrophoretic separation.

3.2 Continuous, zonal and capillary electrophoresis,

3.3 different types of electrophoresis including paper, cellulose, acetate/nitrate and gel. Electroporation, pulse field gel electrophoresis, EMSA,

4.1 Molecular Biology techniques- Hybridization and blotting, PCR, RT-PCR, Real time PCR, molecular markers, sequencing - classical Next Generation Sequencing

Text Book (s):

1. Principles of Biochemistry and molecular biology by K. Wils1.1on and J. Walker, Cambridge University Press.

Reference Book (s)

2. Principles of Instrumental analysis by D. A. Skoog and J. J. Leary, Saunders College Publishing, Philadelphia.

Mannual (Sambrook and Russel)

LS –DSE(1-1) ENZYMOLOGY AND METABOLISM 4 credits [3-1-0]

Unit 1:

1.1 Kinetics: derivation of Michaelis-Menten equation, L-B plot, Regulation of enzyme activity, binding site and active site, Factors affecting the rate of enzymatic reaction,

1.2 Enzyme kinetics for mono- and bi-substrate reactions, Inhibitions –competitive, uncompetitive mixed and noncompetitive type,

1.3 Allosteric regulation, covalent modifications, Isozymes, ribozymes, abzymes. Enzyme inhibition and Mechanisms of inhibitors action

Unit 2:

2.1 General Metabolism: Biogenetics and ATP, Oxidative and photo phosphorylation;

2.2 Carbohydrate: Glycolysis, TCA, Gluconeogenesis, Pentose phosphate pathway:

2.3 Mechanism of selective reactions, Radioisotope distribution study and regulation.

2.4 Glycogen metabolism: Break down, synthesis, hormonal control and regulation.

Unit 3:

3.1Fatty acids: oxidation (Even, odd, saturated and unsaturated)

3.2 Metabolism of cholesterol and its regulation. Energetics of fatty acid cycle.

Text Book (s):

1. Methods in Enzymology, Academic Press.

2. Biochemistry by Donald Voet, Hardcover: 1616 pages, Publisher: Wiley

3. Lehninger Principles of Biochemistry; David L Nelson; Albert L Lehninger; Michael M Cox; New York : W.H. Freeman

LS –DSE(1-2) APPLIED MICROBIOLOGY 4 credits [3-1-0]

Unit-1:

1.1 Recombinant DNA technology Definition, importance and applications of recombinant DNA technology. Vector (YAC / BAC) and its significances in industry

1.2 Mobilization of genetic part through extracellular factors (Conjugation, Transformation etc.)

Unit- 2:

2.1 Microbial interaction with plants and animals.

2.2 Exploitation at industrial level (important microbial strains)

Unit- 3:

3.1 Biofertilizers- Biological; Nitrogen fixation- symbiotic and asymbiotic, mass production by Rhizobium, Azotobacter and Cyanobacteria etc.

Text Book (s):

1. Microbiology, M.J. Pelczar, E.C.S. Chan and N.R. Kreig, Tata McGraw Hill.

2. General Microbiology, R.Y. Stanier, J.L. Ingraham, M. L. Wheelis and P.R. Painter, Macmillian.

3. Microbial ecology: Fundamentals and Applications, 4 e, R.M. Atlas and R. Bartha, Pearson Education.

4. Molecular genetics of bacteria, 3 e, L. Snyder and W. Champness, ASM Press.

5. Biotechnology, B.D. Singh, Kalyani Publishers.

6. Gene cloning and DNA analysis: An introduction, T.A. Brown, Blackwell Publishing.

Supplementary Reading:

1. The microbes – An Introduction to their Nature and Importance, P.V. Vandenmark and B.L. Batzing Benjamin Cummings.

2. Microbiology, Tortora, Funke and Chase, Benzamin& Cummings

3. Microbiology, 5th Edition, Lansing M. Prescott

LS –DSE(1-3)	CELL BIOLOGY	4 credits [3-1-0]

Unit 1:

1.4 Structure and Function of Cell and its Organelles: Cell as the unit of life- Development of cell theory.

1.5 Cell types: prokaryotes vs. eukaryotes; from single cell to multi-cellular organism; Prokaryotic cells: Structure, cell-walls and related molecules, outer membrane, flagella, motivity,

1.6 cell inclusion endospores, gas vesicles, capsules, slime layers.

Unit 2:

2.1 Cell Architecture: Cyto-skeletal components, microtubules and microfilaments,

2.2 motility and motor motions, actomyosincomplex ,

2.3 Extra-cellular matrix.

Membrane system: Biological membranes – architecture & kinetics (transport, ion channeLS, diffusion, Na-K pump, proton pump).

Endomembrane system: endoplasmic reticulum, Golgi complex, endosomes, lysosomes. Cell nucleus, Chromatin structure, nucleolus, nucleoplasm.

Unit 3:

3.1Cell Division: Mitosis, meiosis and cytokinetics, animal and yeast cell division, cell cycle control, programmed cell death.

3.2 Cell cycle: G0/G1, S, G2 and M phages, duration of different phages and the methods for their determination,

3.3 Cell cycle synchronization, arrest and delay in case of diseases.

Unit 4:

4.1Protein localization: Synthesis of secretory &membrance protein, import into nucleus,

4.2 mitochondria, chloroplast & peroxisome; Receptor-mediated endocytosis.

4.3 Cellular communication: Regulation of hematopoiesis, general principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins.

Unit 5:

5.1 Cell Signaling: Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors,

5.2 signal transduction pathways, second messengers, regulation of signaling pathways, bacterial and plant two-component systems, light signaling in plants, bacterial chemotaxis and quorum sensing.

5.3 Specific pathways: Chromatin Regulation; Ras, MAPK and Ras-MAPK Signaling; Apoptosis/Autophagy, PI3K/Akt Signaling, Translational Control; Ca, cAMP& Lipid Signaling, Cell Cycle/Checkpoint, DNA Damage.

Text Book (s):

1. Suggested Cell Biology : An Introduction to the Molecular Biology of the Cell, B. Alberts, D. Bray, A. Johnson, J. Lewis, M. Roff, K. Robert, P. Walter and K. Roberts, Garland Publishing Company

2. Cell and Molecular Biology, DeRobertis, B .I. Publication Pvt. Ltd

3.Molecular Cell Biology, H. Lodish, A.Berk, S.L. Zipursky, P. Matsudaura, D. Baltimore and J. Danell, W.H. Preeman and Company.

4. Suggested Cell Biology : An Introduction to the Molecular Biology of the Cell, B. Alberts, D. Bray, A. Johnson, J. Lewis, M. Roff, K. Robert, P. Walter and K. Roberts, Garland Publishing Company.

5. Structure and Function in Cell Signaling by John Nelson, Wiley.

Supplementary Reading:

1. Cell in Development and Inheritance, E.B. Wilson, Macmillan

LS –LAB(104) MICROBIOLOGY LABORATORY 3 credits [0-0-3]

1. To study the guidelines for working in microbiology laboratory.
2. To acquaint with the instrument used in microbiology laboratory
3. To study the various aseptic techniques used in microbial experiment.
4. To prepare various liquid and solid media used in microbiology experiment.
5. To isolate and count total heterotrophic bacteria in soil sample.
6. To isolate and count total heterotrophic microbes from air.
7. To isolate and count total heterotrophic bacteria in water sample.
8. To isolate pure culture from mixed culture by streak plate method
9. To perform fungal staining for the study of fungal morphology.
10. To perform simple staining and to compare the morphological shape and arrangements' of bacteria cells.
11. To perform gram staining or differential staining to study the bacterial morphology and distinguish between gram positive and gram negative bacteria.
12. To test starch hydrolysis by amylase activity
13. To test protein hydrolysis by gelatin degradation.
14. Preparation of agar slant
15. To study catalase activity
16. To study motility of bacteria by tube method.
17. MPN
18. Antibiotic sensitivity test
19. IMViC test
20. Isolation of Actinobacteria from soil samples.

LS –LAB (104) BIOCHEMISTRY LABORATORY 3 credits [0-0-3]

1. Estimation of blood glucose, detection of serum- (i) urea, (ii) uric acid, (iii) creatine, (iv) creatinine and (v) bile pigment
2. Blood grouping (ABO – Rh)
3. Determination of urine sample for (i) sugar, (ii) ketone bodies, (iii) protein
4. Estimation of Hb concentration, total W.B.C and R.B.C count in blood
5. Determination of lipid, total cholesterol, LDL and HDL and triglycerides

6. Enzymology – purification of enzyme & its kinetics

7. Study of the cell – (i) Cell culture, lymphocyte isolation & culture, growth rate studies, staining techniques (ii) Cell fractionation, homogenization of the tissue, centrifugation, marker enzyme assays (iii) Microscopy and microphotography.

8. Quantitative assays – (i) Enzyme assays (ii) RIA (iii) ELISA iv) DNA, RNA & proteins

9. Protein fractionation – (i) Salting in and out, gel filtration, electrophoretic separation (ii) Gel filtration affinity based techniques (iii) SDS-PAGE (iv) Electrophoretic separation of LDH isoenzymes

10. Absorption & fluorescence spectroscopy related experiments

11. Determination of CMC of biological surfactants.

DETAILED SYLLABUS OF SECOND S

LS 205 IMMUNOLOGY 4 Credits [3-1-0]

Unit 1:

1.4 Basic concepts in immunology, components of the immune system,

1.5 Innate immunity, principles of innate and adaptive immunity, Different lines and layers of defense, Pattern recognition in innate immune system.

1.6 The complement system, Induced innate responses to infections, Antigen recognition by B-cells, The structure of a typical antibody molecule, Interaction between the antibody and specific antigen.

Unit 2:

2.2 Diversity of Immunoglobulins: VDJ Recombination; Antigen recognition by T cells , Antigen processing and presentation:

2.3 MHC, Complement system

Unit 3:

3.1 Development and survival of lymphocytes, Lymphocytes in bone marrow and thymus,

3.2 Positive and negative selection of lymphocytes, Survival and maturation of lymphocytes, The

3.3 Adaptive Immune Response, T Cell-Mediated Immunity and cytotoxicity, Macrophage activation by armed CD4 TH1 cells,

3.4 Humoral Immune Response ;

Unit 4:

4.1 Adaptive Immunity to Infection: Infectious agents and how they cause disease? The course of the adaptive response against infection.

4.2 The mucosal immune system, Immunological memory; Failures of Host Defense Mechanisms, 4.3 Inherited immunodeficiency diseases, Acquired immune deficiency syndrome, Allergy and 4.4 Hypersensitivity, Effecter mechanisms in allergic reactions and IgE, Hypersensitivity diseases, Autoimmunity and Transplantation.

Text Book (s):

1. Delves, Martin, Burton &Roitt, Suggested Immunology, 11th Edition.

2. Richard A. Golds by, Thomas J. Kindt and Barbara A. Osborne, Kuby Immunology I. K. International Pvt Ltd.

Supplementary Reading:

1. Janeway, Travers, Walport, and Shlomchik, Immunobiology, the immune system in health and disease, Garland Science Publishing, 6th Edition, 2005,

2. L. M. Sompayrac, How the Immune System Works, Wiley-Blackwell; 3rd edition.

LS 206 MOLECULAR BIOLOGY AND BIOTECHNOLOGY 4 credits [3-1-0]

Unit 1

1.4 Properties and evolution of genetic material, flow of genetic information and Isolation of genes.

1.5 DNA Replication: Models of Replication, Origin of replication, DNA polymerases, DNA topology, DNA damage and repair.

1.6 Transcription: RNA-polymerases, RNA processing, regulation, posttranscriptional control and degeneration, gene silencing.

1.7 Translation: Structure of Ribosome, tRNA and mRNA, protein synthesis and regulation in prokaryotes and eukaryotes, protein sorting, signal peptides.

Unit 2:

2.1 Biosignaling: signal perception, molecular mechanisms of signal transduction, regulation of signal transduction pathways in controlling gene expression.

2.2 Transposons and retrotransposons: prokaryotic and eukaryotic transposable elements and their role in evolution.

Unit 3:

3.1 Linkage and crossing over, Genetic recombination and construction of genetic maps in Drosophila, Interference and coincidence, Cytological demonstration of crossing over in Drosophila,

3.2 Mitotic recombination, Intragenic recombination,

3.3 Inheritance of quantitative traits, Continuous and discontinuous variation, Polygenic inheritance,

3.4 Genetic variance, heritability (narrow sense and broad sense). ;

Unit 4:

4.1 Concept and definition of biotechnology: Microbial biotechnology, Culture system (batch, fed batch and continuous culture),

4.2 Fermentor, output optimization, concept of downstream processing for product recovery,

4.3 stain development of microorganisms, fermentation of antibiotics, organic acids and amino acids, single cell protein, microbial fuel production,

4.4 microbial pestisides and biofertilizers. ;

Unit 5:

5.1 Enzyme engineering: Commercial use of enzymes, immobilization techniques and its application,

5.2 various methods of immobilization, enzyme sensors, enzyme reactor and there utility. ;

5.3 Animal biotechnology: cell culture, Monoclonal antibody, gene therapy,

5.4 hybridoma technology, methods of vaccination, gene therapy, Application of recombinant DNA technology in medicine and diagnosis. Animal cloning.

Unit 6:

6.1 Plant biotechnology: Transgenic plants, herbicide and insecticide resistant plants and there utility in modern day agriculture,

6.2 chloroplast engineering- production of molecular H2 and chloroplast and photo voltaic system.

Text Book (s):

1. B. Lewin, Genes VIII by Hardcover, Publisher: Prentice Hall

2. B.D. Singh, Biotechnology by Kalyani Publishers 2009.

3. R. C. Dubey, A text book of Biotechnology by S. Chand and Co., India

4. J. K. Pal and S. S. Ghaskadbi, Fundamentals of molecular biology by Oxford University Press.

Supplementary Reading:

1. L. Stryer, Biochemistry

2. S. Cummings, Current Perspectives in Genetics: Insights and Applications in Molecular, Classical, and Human Genetics, 2000 Edition Paperback: 170 pages, Publisher: Brooks Cole

LS 207 ENVIRONMENTAL SCIENCES AND BIOSTATISTIC 4 credits [3-1-0] Unit-1:

1.2 Geographical classification and zones. Biogeography and conservation biology Major terrestrial biomes; Structure and composition of atmosphere, hydrosphere, lithosphere and biosphere.

1.2 Ecosystem structure and functions, abiotic and biotic components,

1.3 energy flows. Food chains, food web, ecological pyramids, types and diversity.

1.4 Energy flow and mineral cycling (CNP).

Unit- 2:

2.1 Habitat and ecological components Habitat and niche,

2.2 Concept of habitat and niche; fundamental and realized niche.

2.3Population ecology: Characteristics of a population; population growth curves; population regulation; life history strategies (r and K selection);

2.4 Community ecology: Nature of communities; community structure and attributes; levels of species diversity and its measurement.

2.5 Ecological succession: Types; mechanisms; changes involved in succession; concept of climax.

2.6 Environmental pollution, Principles of conservation, major approaches to management.

Unit- 3:

3.1 Collection and presentation of data Collection of biological data: sampling, aim, techniques-random sampling and non-random sampling.

3.2 Classification of data, frequency distribution and tabulation.Graphical representation- bar diagram, pie diagram, frequency curve, histogram, Ogive.

3.3 Statistics of location and dispersion Measures of central value- Mean, Median, Mode.

3.4 Measures of dispersion- standard deviation, coefficient of variation.Skewness and Kurtosis.

Unit- 4:

4.1 Sampling statistics and testing of hypothesis Procedure for testing hypothesis.

4.2Test of significance based on small samples and large samples (‘t’ test and ‘z’ test), Chi-square test,

4.3 Analysis of variance- One-way and Two-way ANOVA.

4.4 Correlation and regression Use of correlation in biological science – purpose, positive correlation, negative correlation, calculating correlation coefficient, significance.

4.5 Use of Regression in Biological Sciences – purpose, coefficient of regression (b), Regression line (Y on X and X on Y).

Text Book (s):

1. Fundamentals of Ecology by E. P. Odum and G. W. Barrett, Cengage Learning.
2. Environmental Science by S. C. Santra, New Central Book Agency, India.
3. Ecology and Environment by P. D. Sharma, Rastogi Publications, India.
4. Fundamentals of statistics by S.C. Gupta, Himalaya Publishing House
5. Biostatistical analysis by J. H. Zar, Prentice Hall.

6. Quantitative Zoology by G. G. Simpson, A. Roe and Dover Publications.

Supplementary Reading:

1. Ecology by P. J. Russell, S. L. Wolfe, P. E. Hertz, C. Starr and B. McMillan, Cengage Learning

2. Ecology: Principles and applications by J. L. Chapman and M. J. Reiss, Cambridge University Press.

3. Modern statistics for the Life Sciences by A. Grafen and R. Hails, Oxford University Press. 4. An Introduction to Biostatistics by Thomas Glover and Kevin Mitchell, Waveland PrInc

LS –DSE(2-1) ADVANCES IN STRUCTURAL BIOLOGY 4 credits [3-1-0]

Unit 1:

1.4 A familiarity with the NMR, X-ray, and computational techniques used to study macromolecular structure,

1.5 motions in macromolecules and the functional importance of dynamics, the basis for various types of macromolecular interactions including protein- protein and protein-nucleic acid interactions,

1.6 evolutionary relationships of structural features, the determinants of protein structure and an understanding of the current views of protein folding, the chemical basis for interactions with enzyme inhibitors and other ligands.

Unit 2:

2.1History of Structural Biology: X-ray crystallographic and NMRstructure of Proteins, and Nucleic acids.

2.2 Proposition of DNA double helical structure in understanding the blue-print of life- Watson & Crick model.

Unit 3:

3.1Fine structure of Proteins- fibrous, globular and membrane proteins,

3.2Nucleosome and Chromatin structure.

Unit 4:

4.1Cytoskeleton structure and protein-protein Network,

4.2 Muscle proteins.

4.3 Structure of Heart, Lung and Brain.

Text Book (s):

1. Textbook of Structural biology by Anders Lilgas, Lars Lilgas, JuiPiskur et al, World Scientific Publisher

2. Advances in structural biology by S. K. Malhotra (Editor), ELSevier.

3. Membrane structural biology by Mary Luckey, Barnes and Noble Publisher.

LS-DSE(2-2)	GENOMICS & PROTEOMICS	4 credits [3-1-0]

Unit 1:

1.4 Definition, classification, and scopes.

1.5 The emergence of proteome concept: structural and functional proteomes, protein structure related to functional kinetics, e.g. prions, bridging genomics to proteomics.

1.6 Transcriptomes: measurement of gene expression.

Unit 2:

2.1Proteome analysis: by methods, 2-D including protein detection on electro-blot membrane,

2.2 mass spectrometry and phosphorylation site analysis.

2.3 Proteomics in relation to animal and plant health and welfare.

Text Book (s):

1. A Textbook of Protein and Proteomics, C Subramanian and NandanHazare, Dominant Pub.

2. Discovering Genomics, Proteomics and Bioinformatics (2nd Edition), by A. Malcolm Campbell and Laurie J. Heyer.

LS – LAB 208	BIOTECHNOLOGY LABORATORY	2 credits [0-0-3].

1.Quantitation of nucleic acids (Spectrophotometric, Gel based and Saran wrap method) 2.Analysis of DNA fragments and size determination by agarose gel electrophoresis

3.Restriction digestion and ligation

4.Restriction mapping

5.Southern blotting

6.Western blotting

7.PCR and RT-PCR

8. Optimization of gene expression in E.coli and analysis of expressed product

9. Methods for enzyme immobilization

LS – LAB 208	MOLECULAR BIOLOGY LABORATORY	2 credits [0-0-3]

1. Determination of Isobestic points

2. Determination of melting point of DNA (Calf thymus, Whale Sperm)

3.Isolation of chromosomal DNA from E.coli and plants.

4. Isolation of RNA from mammalian cells (sources- horse, rat, rabbit etc.)

5. SDS-PAGE of protein.

6. Isolation of plasmid DNA from E.coli.

7. Transformation of E.coli with plasmid.

8. UV induced mutagenesis in E. coli

9. Tissue culture

LS– LAB 208 IMMUNOLOGY LABORATORY 2 credits [0-0-3]

1. Study of Blood Groups

2.Study of Antigen- Antibody pattern-ODD

3.Immunoglobulin Y purification

4.Immunoglobulin G purification

5.Study of immunohistochemistry

6.Study of Latex agglutination

7.Study of haem agglutination

	DETIALED SYLLABUS OF THIRD SEMESTER		

LS -309 ANIMAL PHYSIOLOGY 4 credits [3-1-0]

Unit 1:Nutrition

1.1 Overview of digestion and absorption of macronutrients

1.2 Gastrointestinal hormones and regulation

Unit 2:

2. Role of Hemoglobin in transport of gases, Hill reaction

Unit 3: Excretion

3.1 Physiology of Urine formation

3.2 Counter current mechanism

3.3Hormonal regulation

3.4 Ornithine cycle

3.5 Acid-base balance and homeostasis

Unit 4: Nervous system

4.1 Axonal transmission

4.2 Neuron and its types

4.3 Physiology of nerve conduction

4.4 Synaptic transmission

4.5Chemical transmission, neurotransmitters

4.6 Autonomic nervous system (Sympathetic and parasympathetic)

Unit 5: Muscle

5.1 Ultrastructure of skeletal muscle fibers
5.2 Muscle proteins
5.3 Sequence of events in contraction and relaxation of skeletal muscle
5.4 Energetics of muscle contraction
5.5 Muscle twitch, summation, tetanus and fatigue
5.6 Isotonic and isometric contraction
5.7 Cori cycle

Unit 6: Stress physiology
6.1 Altitude physiology
6.2 Physiologic response to heat and cold
6.3 Thermoregulation

Text Book (s):

1. Ganong: Review of Medical Physiology (21st Ed.), Lang Medical Publications, 2003

2. Guyton and Hall: Text Book of Medical Physiology (10th Ed.), W.B. Saunders, 2001

3. Keel et al: Samson Wright's Applied Physiology (13th Ed.), Oxford Press, 1989

4. Murray et al: Harper's Illustrated Biochemistry (26th Ed.), Appleton & Lange, 2003

5. West: Best and Taylor's Physiological Basis of Medical Practice (11th Ed.), Williams and Wilkins, 1981.

LS 310 BIOINFORMATICS 4 credits [3-1-0]

Unit 1:

1.3 Introduction to computational biology & bioinformatics.Branches of bioinformatics.Nature of biological data. Biological data formats.

1.4 Bioinformatics databases: Literature databases (PubMed), Primary nucleotide sequence databases (NCBI, EMBL, DDBJ), Secondary nucleotide sequence databases (UniGene, SGD etc.),

1.5 Protein sequence databases (SwissProt/TrEMBL, PIR), Sequence motif databases (Pfam, PROSITE),

1.6 Structure databases (PDB, NSD, SCOP, CATH), Gene Expression databases.

Unit 2:

2.1 Algorithms and bio-tools: Sequence alignment and database similarity searching.

2.2 Scoring matrix, BLAST series, FASTA.

2.3 Pairwise Sequence Alignments and Multiple sequence alignments (ClustalW).

2.4 Global Alignments – Needleman Wunsch Algorithm, Local Alignments – Smith Waterman Algorithm.

2.5 Multiple sequence alignments (ClustalW).

Unit 3:

3.1 Basic concepts on phylogenetic markers and molecular phylogeny.

3.2 Comparative genomics and gene prediction tools.

Unit 4:

4.1 Structural bioinformatics: prediction of secondary & tertiary structure of proteins, comparative modeling. Molecular viewers.Concept of in-silico drug design.

4.2 Vaccine design concept.Human genome and epigenome projects.

4.3 Overview of programming languages in bioinformatics.Basic commands of UNIX.

4.4 Other biological tools and resources: EMBOSS, Expasy, OMIM, GOLD etc.

Text Book (s):

1. Bioinformatics: Principles and Applications by Z. Ghosh and B. Mallick, Oxford University Press.

2. Bioinformatics: Sequence and Genome Analysis by D.W. Mount, Cold Spring Harbor Laboratory

3. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins by A.D. Baxevanis and B.F.F. Ouellette, Wiley-interscience.

4. Understanding Bioinformatics by Marketa Zvelebil and Jeremy Baum, Garland Science.

LS 509 DEVELOPMENTAL BIOLOGY 4 credits [3-1-0]

Unit 1:

1.6 Basic Concepts of Development: Potency, commitment, specification, induction, competence, determination and differentiation;

1.7 morphogenetic gradients; cell fate and cell lineages; stem cells,

1.8 Gametogenesis, fertilization and early development: cell surface molecules in sperm-egg recognition in animals;

1.9 embryo sac development and double fertilization in plants; zygote formation, cleavage, blastula formation, gastrulation and formation of germ layers in animals;

1.10 embryogenesis, and establishment of symmetry in plants; seed formation and germination.

Unit 2:

2.1Cell Aggregation and Differentiation; Axes and pattern formation in Drosophila,

2.2 organogenesis, development and regeneration in vertebrates; metamorphosis;

2.3 Morphogenesis and Organogenesis in Plants:

2.4 Organization of shoot and root apical meristem; shoot and root development,

2.5 Programmed cell death, aging and senescence.

Unit 3:

3.1 Animal Physiology: Comparative physiology in the respiratory system in different species, anatomical considerations, transport of gases, exchange of gases, waste elimination, neural and chemical regulation of respiration,

3.2 circulatory system: cardiac cycle, heart as a pump, blood pressure, neural and chemical regulation,

3.3digestive system: Digestion, absorption, energy balance, BMR,

3.4 The nervous system: Neurons, action potential, gross neuroanatomy of the brain and spinal cord, central and peripheral nervous system,

3.5 The excretory system,

3.6 The endocrine system and reproductive system: Endocrine glands, basic mechanism of hormone action, hormones and diseases; reproductive processes, neuroendocrine regulation,

UNIT 4:

4.1 Plant Physiology: Osmoregulation, Solute transport and photo assimilate translocation;

4.2 Photosynthesis: Light harvesting complexes; mechanisms of electron transport; CO_2 fixation,

4.3 Respiration and photorespiration: Citric acid cycle, plant mitochondrial electron transport and ATP synthesis, alternate oxidase, photorespiratory pathway;

4.4 Plant hormones and Sensory photobiology; Responses of plants to biotic (pathogen and insects) and abiotic (water, temperature and salt) stresses.

Text Book (s):

1. Developmental Biology by S.F. Gilbert, Sinauer Associates Inc.

2. Plant Physiology, Lincoln Taiz and Eduardo Zeiger, Sinauer Associates Inc.

LS 310 APPLIED BIOINFORMATICS LABORATORY 2 credits [0-0-3]

1.Visualizing and understanding biological data formats, such as genbank flat file, genpept, fasta, nexus, pdb etc.

2.Exploring nucleotide and protein databases: GenBank, EMBL, DDBJ, PIR-PSD, SwissProt, TrEMBL/GenPept.

3.Visualizing and understanding 3D structure of macromolecules by molecular viewers: RasMol, Cn3D, Swiss-PDB Viewer Sequence comparisons & alignment Estimating protein secondary structure and physical attributes:

4.Proteolytic digestion mapping, molecular weight and amino acid composition determination, isoelectric point estimation, hydrophobicity and hydrophobic moment determinations, surface probability and antigenicity mapping, and secondary structure prediction.

5.Introduction to molecular phylogenetics: Clustering techniques, Hierarchial& non-hierarchial, Bootstrapping, Interpretation of phylogenetic trees.

6. Comparative genomics and gene prediction Pattern matching Designing of primers for PCR;

7.Identification of restriction enzyme maps for molecular biology applications and other genomics and proteomics analysis tools embedded in the Genomics Workbench Prediction of secondary & tertiary structure of proteins Immunoinformatics concepts and tools Structural bioinformatics (Homology modeling) Molecular docking and

8.Drug design Vaccine design Exploring EMBOSS series, NCBI tools and other tools **Text Book (s):**

Bioinformatics: Principles and Applications by Z. Ghosh and B. Mallick, Oxford University Press.

LS -DSE (3-1) CELL CELL SIGNALING 4 credits [3-1-0]

Unit 1:

1.5 Cell signaling: Hormones and their receptors,

1.6 cell surface receptor, signaling through G-protein coupled receptors,

1.7 signal transduction pathways, second messengers, regulation of signaling pathways,

1.8 bacterial and plant two-component signaling systems, bacterial chemotaxis and quorum sensing.

Unit 2:

2.1 Cellular communication: Regulation of hematopoiesis,

2.2 general principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions,

2.3 extracellular matrix, integrins, neurotransmission and its regulation.

Unit 3:

3.1 Cancer : Genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes,

3.2 cancer and the cell cycle, virus-induced cancer, metastasis,

3.3 interaction of cancer cells with normal cells, apoptosis,

3.4 therapeutic interventions of uncontrolled cell growth.

Unit 4:

4.1 Specific pathways:- Chromatin Regulation; Ras, MAPK and Ras-MAPK Signaling;

4.2 Apoptosis/Autophagy, PI3K/Akt Signaling, Translational Control; Ca, cAMP& Lipid Signaling,

4.3 Cell Cycle/Checkpoint, DNA Damage, Jak/Stat Pathway, NF-κB Signaling, TGF-β/Smad Signaling, Lymphocyte Signaling, Neuroscience, Tyrosine Kinase/Adaptors, Angiogenesis, Vesicle Trafficking, Cytoskeletal Signaling, Adhesion,

4.4 Glucose Metabolism, Wnt/Hedgehog/Notch, Stem Cell/Lineage Markers, Nuclear Receptors.

Text Book (s):

1. Molecular Biology of the cell by Bruce Alberts et al, Garland Science Com

2. Molecular cell Biology by Lodish et al, W H Freeman and Company

3. Structure and Function in Cell Signalling by John NeLSon, Wiley.

4. The biochemistry by Ernst J. M. Helmreich, Oxford Uni Press

LS –DSE(3-2)	EPIGENETICS	4 credits [3-1-0]

Unit 1:

1.1Epigenesis and development: Concept of epigenetics,

1.2 Epigenetic mechanisms and regulation of gene expression;

1.3DNA-Methylation, Epigenome, Methylome.

Unit 2:

2.1 Histone Code: histone modifications (acetylations, methylations, phosphorylations, sumoylations, uniquitylation etc.) and enzymatic mechanisms.

2.2 DNA-methyltransferases, Histone acetylases, histone deacetylases, (Histone) protein arginine methyltransferases and demethylases, (Histone) protein lysine methyltransferases and demethylases.

Unit 3:

3.1 Transcriptional silencing by polycomb group proteins and regulation by trithorax group proteins.

3.2 Histone variants, chromosome inheritance, X-chromosome inactivation.

3.3 Genomic imprinting, germ line and pluripotent stem cells.

Unit 4:

4.1 Epigenetic of human disease and epigenetic determinants of cancer.

4.2 Nuclear transplantation and the reprogramming of the genome.

4.3 RNA interference and regulation of gene expression (RNAi, microRNA, heterochromatin assembly).

4.4Position-effect Variegation, heterochromatin formation and gene silencing in Drosophila **Text Book (s):**

1. Epigenetics by C. David Allis, Thomas Jenuwein, Danny Reinberg and Marie-Laure Caparros, Cold Spring Harbor Laboratory Press, CSH Press, NY, USA.

2. Epigenetics by JörgTost (Editor), Caister Academic Press.

LS -DSE (3-3)	CANCER BIOLOGY	4 credits [3-1-0]

Unit 1:

1.1Introduction to mammalian cell culture and applications; what is Cancer?

1.2 Profile of a Cancer Cell; How Cancers Spread; Identifying the causes of Cancer:

1.3Chemicals and Cancer ,

1.4Radiation and Cancer ,

Unit 2:

2.1Infectious Agents and Cancer, Heredity and Cancer; Oncogenes, Tumor Suppressor Genes and Cancer

2.2 Overview; Chromosome heterogeneity, micro satellite instability, Epigenetic basis of cancer, DNA-methylation and histone modifications associate to cancer;

2.3Cancer stem cell: identification, property and therapeutic implication; tumor evolution, escape from non-immune and immune surveillance.

2.4 Immunoediting, role of immunological ignorance and tolerance in tumor escape, Regulatory lymphocytes in cancer;

2.5 Cancer Screening, Diagnosis, and Treatment; Preventing Cancer.

Text Book (s):

1. Principles of Cancer Biology: International Edition; Lewis J. Kleinsmith, Pearson Higher Education

2. Cancer Stem CelLS: Identification and Targets, Sharmila A. Bapat, Wiley

3. Cancer immunotherapy: immune suppression and tumor growth , George C. Prendergast and Elizabeth M. Jaffee, Academic Press

FOURTH SEMESTER		

LS 413	GENETICS	4 credits [3-1-0]

Unit 1:

1.1 Introduction to Genetics: Mendelism, Mendel and his experiments,

1.2 Law of segregation, Law of independent assortment,

1.3 Application of laws of probability (product rule, sum rule), Chromosomal basis of segregation and independent assortment.

1.4 Extensions of Mendelism: Codominance, incomplete dominance,

1.5 gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy,

Unit 2:

2.1 linkage and crossing over, sex linkage, sex limited and sex influenced characters.

2.2 Gene mapping methods: Linkage maps, tetrad analysis,

2.3 mapping with molecular markers, mapping by using somatic cell hybrids,

Unit 3:

3.1Extra chromosomal inheritance: Inheritance of Mitochondrial and chloroplast genes, maternal inheritance.

3.2 Mutation: Types, causes and detection, mutant types – lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants, insertional mutagenesis. 3.3 Deletion, duplication, inversion, translocation, ploidy and their genetic implications.

Unit 4:

4.1 Molecular tools in phylogeny, classification and identification; Protein and nucleotide sequence analysis; origin of new genes and proteins;

4.2 Populations, Gene pool, Gene frequency; Hardy-Weinberg Law; concepts and rate of change in gene frequency through natural selection, migration and random genetic drift;

4.3Adaptive radiation;

4.4 Isolating mechanisms; Speciation; Allopatricity and Sympatricity; Convergent evolution. **Text Book (s):**

1. Principles of Genetics, E J Gardner, John Wiley & Sons Inc

2. Principles of Genetics, D.P. Snustad& M.J. Simmons, John Wiley and Sons Inc

3. The Science of Genetics, Alan G. Atherly, Jack R. Girton, John F. McDonald, Saunders College Pub.

Supplementary Reading:

1. Genetics: From Genes to Genomes by L. Hartwell, Leroy Hood, Michael Goldberg, Ann Reynolds, Lee Silver, Ruth Veres publisher: McGraw-Hill

2. Medical genetics by Lynn B. Jorde, John C. Carey, Michael J. Bamshad and Raymond L. White.

LS-414 PLANT BIOTECHNOLOGY 4 credits [3-1-0]

Unit 1:

1.1 Introduction of plant cell and tissue culture:

1.2 Tissue culture media Single and suspension culture, Organogenesis & Embryogenesis, embryo culture and embryo rescue;

1.3 Haploid production and homozygous diploid lines; cryopreservation and germplasm conservation; protoplast isolation, culture and fusion;

1.4 Selection of hybrid cells and regeneration of hybrid plant; symmetric and asymmetric cybrids, production of virus free plants.

Unit 2 :

2.1 Cloning vector for higher plant transformation:

2.2 Agrobacterium tumefaciens Ti and Ri plasmids, basis of tumor formation, hairy root, mechanisms of DNA transfer, role of virulence genes.

2.3 Viral vectors. Direct gene transfer. Transformation of monocots; transgene stability and gene silencing, selection of clones.

2.4 Expression of cloned genes: genetic markers, reporter genes.

Unit 3:

3.1 Application of plant transformation for productivity and performance:

3.2 Herbicide resistance, insect resistance, virus resistance, disease resistance, nematode resistance, 3.3 Abiotic stress post harvest losses, long shelf life of fruits and flowers, carbohydrate composition and concentration during storage.

Unit 4:

4.1 Chloroplast transformation: vectors, mechanisms, advantages and limitations, homoplastomic line development.

4.2 Metabolic engineering and industrial products;

4.3plant secondary metabolites, control mechanisms and applications of industrially important secondary metabolites

4.4 Marker-aided breeding RFLP maps; Linkage analysis;

4.5 RAPD markers; STS, SSCP, SCAR, AFLP, QTL and microsatellites; Molecular assisted selection.

Recommended Books :

1. T, J. Fu, G. Singh and W.R. Curtis (Eds): Plant Cell and Tissue Culture for the Production of Food Ingredients. Kluwer Academic/Plenum Press. 1999.

2.H.S. Chawla: Plant Biotechnology,2nd Edition, Oxford & IBH publishing co.pvt.ltd

3. R.J. Henry: Practical Application of Plant Molecular Biotechnology. Chapman and Hall. 1997.

4. P.K. Gupta Elements of Biotechnology. Rastogi and Co. Meerut. 1996

5. Plant Biotechnology,M.K.Razdan,2nd Edition,Oxford & IBH publishing co.pvt.ltd

6. Plant Biotechnology: J. Hammond, P. McGarvey and V Yusibov (Eds):, Springer Verlag, 2000.

LS-DSE(4-1) MAN AND MICROBES 4 credits [3-1-0]

Unit 1:

1.1 Classification of microorganisms, shape and arrangement, structure and function of internal organelles.

1.2 Microbes in Food and agriculture Fermented foods, food spoilage and food borne diseases.

1.3 Role of microbes in different biogeochemical cycles, biofertilizers and biopesticides.

Unit 2:

2.1 Microbes in medicines Concept of pathogenesis, microbial prophylactic and therapeutic agents.

2.2Microbes in bioenergy and war Role of microbes in bioenergy production. Anthrax bacillus, Clostridium botulinum and aflatoxins

2.3 Microbes in disposal and cleaning up Role of microbes in waste water treatment, biodegradation and bioremediation

Text Book (s):

1. John Postgate. 2000. Microbes and Man. Cambridge University Press.

2. Willey, Sherwood and Woolverton. 2008. Prescott, Harley, and Klein's Microbiology. McGraw-Hill International Edition.7th Edition. Singapore.

3. Pommerville, J.C. 2006. Alcamo's FundamentaLS of Microbiology. Jones and Bartlett International Edition. USA.

LS-DSE(4-2) RECOMBINANT DNA TECHNOLOGY 4 credits [3-1-0]

Unit- 1:

1.1 Introduction to the subject and the tools used in RDT Restriction endonuclease, methyltransferase, ligase, polymerase, kinase, phosphatase, nuclease, transferase, reverse transcriptase,

1.2 linkers, adapters DNA, RNA and protein markers.

1.3 Overview of cloning vectors Plasmids, bacteriophages (Lambda and M13), phagemids, cosmids, artificial chromosomes (YAC, BAC).

1.4 Blotting techniques. Hybridization and Nucleic acid amplification Southern, Northern and Western blotting techniques.Radioactive and non-radioactive probes. Basics of PCR, site directed mutagenesis.

Unit- 2:

1.1 Cloning and selection of clones Basic cloning experiment: Design of cloning strategy and stepwise experimental procedure including application of tools introduced in module I. Complementation, colony and plaque hybridization, restriction, PCR, plus-minus screening, immunoscreening.

1.2 Heterologous gene expression Overview of expression vectors (Bacteria and yeast), vector engineering (fusion tags, antibiotic markers

1.3 DNA Libraries Purpose of constructing DNA libraries. Construction of cDNA and genomic libraries.

1.4 Advanced techniques in RDT Primer extension mapping, S1 mapping, Rnase protection assay, two and three hybrid systems, subtractive hybridization, gel retardation assay, Dnasefootprinting, in vitro transcription and translation, phage display, DNA sequencing (Maxam Gilbert, Sanger's and automated), protein engineering.

Text Book (s):

1. Principles of Gene Manipulation: An Introduction to Genetic Engineering, R.W. Old and S. B Primrose, Blackwell Science Inc.

2. DNA Cloning: A Practical Approach, D.M. Glover and B.D. Hames, IRL Press.

3. Molecular Cloning: A Laboratory Manual, J. Sambrook, E.F. Fritsch and T. Maniatis, Cold Spring Harbor, Laboratory Press.

Supplementary Reading:

1. Molecular Biotechnology: Principles and Applications of Recombinant DNA, B.R. Grick and J.J. Pasternak, ASM Press

2. Molecular and Cellular CelLS Methods in Biology and Medicine, P.B Kaufman, W. Wu, D. Kim and C.J. Cseke, CRC Press.

3. Milestones in Biotechnology: Classic Papers on Genetic Engineering, J.A. Bavies and W.S. Reznikoff, Butterworth Heinemann.

LS-DSE (4-3)	RESEARCH METHODOLOGY	4 credits [3-1-0]

Unit 1:

1.1 Collection and presentation of data Statistics- definition, function, scope and limitations.

1.2 Collection of biological data – sampling, aim, techniques, random sampling and non-random sampling.

1.3 Classification of data- frequency distribution and tabulation.Tabulation of data and graphical representation- bar diagram, pie diagram, frequency curve, histogram, Ogive.

1.4 Statistics of location and dispersion Measures of central value- Mean, Median, Mode.

1.5 Measures of dispersion- standard deviation, standard error, coefficient of variation.

1.6 Normal distribution, Skewness and Kurtosis.

Unit 2:

2.1Sampling statistics and testing of hypothesis Sampling distribution, Sampling error, standard errors, degrees of freedom.

2.2 Test of significance based on large samples- procedure for testing hypothesis.

Unit 3:

3.1 Correlation and regression

3.2 Use of correlation in biological science – purpose, positive correlation, negative correlation, calculating correlation coefficient, significance, other types of correlation.

3.3 Use of Regression in Biological Sciences – purpose, regression coefficient Y, Regression line.

Unit 4:

'4.1 t' test, Chi square and ANOVA Student 't' test for mean,

4.2 Chi-square test,

4.3Analysis of variance- One-way and Two-way ANOVA.

Unit 5:

5.1 Use of computers in Bio-statistics Use of computer in Bio-Statistics.

5.2 Computation of Median, Variance, Standard Deviation, and Correlation Coefficient etc.
5.3Application of statistical packages- MS Excel, SPSS etc.

Bio-Instrumentation

Unit 1: Chromatography Paper, TLC, gel filtration, ion-exchange chromatography, affinity chromatography, HPLC and GLC

Unit 2: Microscopy Optical microscopy, Bright field, Dark field, phase contrast and fluorescence microscopy. Electron microscopy: Transmission and scanning electron microscopy. **Unit 3:** Centrifugation Principle of centrifugation, rotors, different types of centrifuges, preparative and analytical centrifugation, ultra centrifugation

Unit 4: Electrophoresis Gel electrophoresis, SDS-PAGE, isoelectric focusing, two-dimensional electrophoresis, 111mmune electrophoresis, capillary electrophoresis

Unit 5: Spectroscopy Atomic Absorption spectrophotometry, Mass spectrometry, NMR.

Text Book (s):

1. Fundamentals of statistics by S.C. Gupta, Himalaya Publishing House

2. Biostatistical analysis by J. H. Zar, Prentice Hall.

3.Principles of Biochemistry and molecular biology by K. WiLSon and J. Walker, Cambridge University Press.

4. Principles of Instrumental analysis by D. A. Skoog and J. J. Leary, Saunders College Publishing, Philadelphia

Supplementary Reading:

1. Modern statistics for the Life Sciences by A. Grafen and R. HaiLS, Oxford University Press

2. An Introduction to Biostatistics by Thomas Glover and Kevin Mitchell, Waveland PrInc

DETAILED SYLLABI OF OPEN ELECTIVES

LS-OE(1) FUNDAMENTALS OF CELL BIOLOGY 3 credits [3-0-0]

Unit 1:

1.4 Structure and function of cell and its organelles. Cell as the unit of life- Development of cell theory.

1.5 Cell types: prokaryotes vs. eukaryotes; from single cell to multi-cellular organism; Prokaryotic cells: Structure, cell-walls and related molecules, outer membrane, flagella, motivity, cell inclusion endospores, gas vesicles.

1.6 Cell architecture, cyto-skeletal components, microtubules and microfilaments, motility and motor motions, actomyosin complex.

Unit 2:

2.1 Biological membranes – architecture & kinetics (transport, ion channels, diffusion, Na-K pump, proton pump).

2.2 Endomembrane system: endoplasmic reticulum, Golgi complex, endosomes, lysosomes

2.3 Cell nucleus, Chromatin structure, nucleolus, nucleoplasm.

Unit 3:

3.1 Energy Transduction and Bioenergetics: Mitochondria, ATP, Chemiosomes, ATPase,

3.2 Gap junctions

3.3 Chloroplast –photosynthetic electron transport, Calvin cycle.

Unit 4:

4.1 Cell division: Mitosis, meiosis and cytokinetics, animal and yeast cell division,

4.2 cell cycle control, programmed cell death . Cell cycle: G0/G1, S, G2 and M phages, duration of different phages and the methods for their determination .

4.3 Protein localization: Synthesis of secretory &membrance protein, import into nucleus, mitochondria, chloroplast & peroxisome; Receptor-mediated endocytosis.

Text Book (s):

5. Suggested Cell Biology : An Introduction to the Molecular Biology of the Cell, B. Alberts, D. Bray, A. Johnson, J. Lewis, M. Roff, K. Robert, P. Walter and K. Roberts, Garland Publishing Company .
6. Cell and Molecular Biology, DeRobertis, B .I. Publication Pvt. Ltd .
7. .Molecular Cell Biology, H. Lodish, A.Berk, S.L. Zipursky, P. Matsudaura, D. Baltimore and J. Danell, W.H. Freeman and Company.

8. Supplementary Reading:

1. Cell in Development and Inheritance, E.B. Wilson, Macmillan

LS-OE(2)	BASIC BIOPHYSICS	3 credits [3-0-0]

Unit 1:

1.3 Thermodynamic Principles: Laws of thermodynamics, Details of thermodynamic variables and functions.

1.4 Application of these laws in Life Science with examples.

Unit 2:

2.1 Basic atomic and radiation physics.

2.2 Electromagnetic properties of light and basic molecular physics.

2.3 Interaction of UV, VIS and IR radiation and LASER with bio-molecules and living system, Bio- and chemi luminescence, photochemical reaction.

Unit 3:

3.1 Thermal changes in cells and tissues, thermal

3.2 Biological transport processes, Nernst potential and Donnan potential – surface potential and potential across bio-membranes, biological energy conversion.

3.3 Electromagnetic energy spectrum – their effects on the molecules and method of studying them, Raman, NMR, NOESY and TOCSY, ESR spectroscopy and Mass spectrometry, and their biological applications, optical rotatory dispersion, fluorescence, phosphorescence spectroscopy, circular dichroism, X-ray diffraction (structure of DNA, RNA and Proteins),

Unit 4:

4.1 ultrastructure determination, electron microscopy – transmission and scanning.

4.2 Concept of liquid crystals, Principal component analysis,

4.3 Matrices, analysis of spectral data with MetLab.

4.4 Radioactivity: Radio emission, law of radioactive decay, production of radio isotopes for medical use, electromagnetic radiation, interaction of radiation with matter, exponential attenuation, half value thickness, photo electric, Compton and pair production process and their significance in radiology, radiation units, detection and measurements of radiation ; Introduction of ultrasonic wave: Ultrasonic wave motion, wave characteristics, intensity, and ultrasound properties in body. Use of ultrasound in biological field.

Text Book (s):

1. Biochemistry by L. Stryer, W.H. Freeman and Co.
2. A biologists physical chemistry by J. G. Morris, Edward Arnold (Publishers) Ltd.

Supplementary Reading:

1. Textbook of Biophysical Chemistry by U. N. Dash, MacMillan
2. A Textbook of Biophysics by R.N. Roy, New Central Book Agency.

LS-OE(3) BASIC BIOTECHNOLOGY 3 credits [3-0-0]

Unit 1:

1.6 Definition and scope of biotechnology; branches of biotechnology;

1.7 Bioprocess technology for the production of cell biomass and primary/secondary metabolites, such as baker's yeast, ethanol, citric acid, amino acids, exopolysacharides, antibiotics and pigments etc;

1.8 Regeneration of plants and totipotency;

1.9 Plant products of industrial importance;

1.10 Biochemistry of major metabolic pathways and products; Autotrophic and heterotrophic growth; Plant growth regulators and elicitors;

Unit 2:

2.1 Cell suspension culture development;

2.2 Production of secondary metabolites by plant suspension cultures; Hairy root cultures and their cultivation;

2.3 generation of transgencies and their application in agriculture; Cloning in animals;

2.4 Genetic engineering; transgenic animaLS; Animal cell preservation;

2.5 Genomics and its application to health and agriculture, including gene therapy

Text Book (s):

1. Introduction to Biotechnology (2nd Edition); William J. Thieman and Michael A. Palladino; Benjamin Cummings (2008).

2. Introduction to Plant Biotechnology; H.S. Chawla; Science Publishers, 2002

LS-OE(4) INTRODUCTION TO BIOINFORMATICS 3 credits [3-0-0]

Unit 1:

1.1 Basic concepts, Introduction to biological databases and tools.

1.2 Sequence and structure databases. Sequence alignments: Pairwise and Multiple Sequence Alignment,

1.3 Methods and algorithms used in alignment tools: Methods for doing Multiple Sequence Alignments: CLUSTALW and PILEUP. BLAST series and FASTA.

Unit 2:

2.1 Phylogenetic analysis: Concept and methods: Distance based (Fitch and Margoliash& UPGMA) and character based methods (Parsimony).

2.2 Prediction of genes and tools.

Unit 3:

3.1 Structural bioinformatics and molecular modelling.

3.2 Human genome and epigenome projects.

3.3 Introduction of protein structure and prediction.

Unit 4:

4.1 Useful biological tools and resources for biological research, eg. EMBOSS, Expasy, OMIM, GOLD etc.

4.2 Introduction to bio-programming languages.Some basic commands of UNIX.

Text Book (s):

1. Bioinformatics: Principles and Applications by Z. Ghosh and B. Mallick, Oxford University Press.

2. Bioinformatics: Sequence and Genome Analysis by D.W. Mount, Cold Spring Harbor Laboratory Press.

LS-OE(5) RESEARCH METHODOLOGY 3 credits [3-0-0]

Unit 1:

1.1 Collection and presentation of data Statistics- definition, function, scope and limitations.

1.2 Collection of biological data – sampling, aim, techniques, random sampling and non-random sampling.

1.3Classification of data- frequency distribution and tabulation.Tabulation of data and graphical representation- bar diagram, pie diagram, frequency curve, histogram, Ogive.

1.4 Statistics of location and dispersion Measures of central value- Mean, Median, Mode.

1.5 Measures of dispersion- standard deviation, standard error, coefficient of variation.

1.6 Normal distribution, Skewness and Kurtosis.

Unit 2:

2.1Sampling statistics and testing of hypothesis Sampling distribution, Sampling error, standard errors, degrees of freedom.

2.2 Test of significance based on large samples- procedure for testing hypothesis.

2.3Correlation and regression Use of correlation in biological science – purpose, positive correlation, negative correlation, calculating correlation coefficient, significance, other types of correlation. Use of Regression in Biological Sciences – purpose, regression coefficient Y, Regression line.

Unit 3: 't' test, Chi square and ANOVA Student 't' test for mean, Chi-square test, Analysis of variance- One-way and Two-way ANOVA.

Unit 4: Use of computers in Bio-statistics Use of computer in Bio-Statistics- Computation of Median, Variance, Standard Deviation, and Correlation Coefficient etc. Application of statistical packages- MS Excel, SPSS etc.

Text Book (s):

1. Fundamentals of statistics by S.C. Gupta, Himalaya Publishing House

2. Biostatistical analysis by J. H. Zar, Prentice Hall.

3. Modern statistics for the Life Sciences by A. Grafen and R. Hails, Oxford University Press

4. An Introduction to Biostatistics by Thomas Glover and Kevin Mitchell, Waveland PrInc.

LS-OE(6) STRUCTURAL BIOLOGY 3 credits [3-0-0]

Unit 1:

1.4 A familiarity with the NMR, X-ray, and computational techniques used to study macromolecular structure,

1.5 motions in macromolecules and the functional importance of dynamics, the basis for various types of macromolecular interactions including protein- protein and protein-nucleic acid interactions,

1.6 The determinants of protein structure and an understanding of the current views of protein folding, the chemical basis for interactions with enzyme inhibitors and other ligands.

Unit 2:

2.1History of Structural Biology: X-ray crystallographic and NMRstructure of Proteins, and Nucleic acids.

2.2 Proposition of DNA double helical structure in understanding the blue-print of life- Watson & Crick model.Fine structure of Proteins- fibrous, globular and membrane proteins,

2.3 Nucleosome and Chromatin structure.

2.4Cytoskeleton structure and protein-protein Network,

2.5Muscle proteins.Structure of Heart, Lung and Brain.

Text Book (s):

1. Textbook of Structural biology by Anders Lilgas, Lars Lilgas, JuiPiskur et al, World Scientific Publisher

2. Advances in structural biology by S. K. Malhotra (Editor), ELSevier.

3. Membrane structural biology by Mary Luckey, Barnes and Noble Publisher.

LS –OE (7) ADVANCED TECHNIQUES 3 credits [3-0-0]

Unit 1:

1.3 Spectroscopy – Concepts of spectroscopy, Visible and UV spectroscopy,

1.4 Laws of photometry. BeerLambert's law, Principles and applications of colorimetry.Mass Spectroscopy

1.3 Chromatography – Dialysis, Principles of partition chromatography, paper, thin layer, ion exchange and affinity chromatography, gel permeation chromatography, HPLC and FPLC

Unit 2:

2.1 Centrifugation – Principles of centrifugation, concepts of RCF,

2.2 Different types of instruments and rotors, preparative, differential and density gradient centrifugation, analytical ultra-centrifugation,

2.3 Determination of molecular weights and other applications, subcellular fractionation

Unit 3 :

3.1 Electrophoretic techniques – Principles of electrophoretic separation.

3.2 Continuous, zonal and capillary electrophoresis, different types of electrophoresis including paper, cellulose, acetate/nitrate and gel.

3.3 Electroporation, pulse field gel electrophoresis, EMSA, DNA fingerprinting, and foot printing.

Unit 4:

4.1 Molecular Biology techniques- Hybridization and blotting, PCR, RT-PCR, Real time PCR, RFLP, AFLP.

4.2 Chromosome walking, chromosome jumping, DNA microarray, chips and RIA. Methods of DNA sequencing: Sangers sequencing, 454 sequencing.

4.3 Analysis of SINES and LINES.Genomic insulators.

4.4 Electron microscopy – Transmission and scanning, freeze fracture techniques, specific staining of biological materials.

4.5 Spectroscopic techniques: Absorption, Florescence, ORD, CD, X-ray diffraction, X-ray absorption, and NMR.

Text Book (s):

1. Principles of Biochemistry and molecular biology by K. Wilson and J. Walker, Cambridge University Press.

2. Principles of Instrumental analysis by D. A. Skoog and J. J. Leary, Saunders College Publishing, Philadelphia.