

Syllabus for
Master of Science in Life Sciences
Under Choice Based Credit System

Academic Session:
w.e.f 2020-2022



For
All Constituent/ Affiliated Colleges Under
Binod Bihari Mahto Koyalanchal University, Dhanbad

Members of Board of Studies of CBCS Post Graduate Syllabus as per Guidelines of Binod Bihari Mahto Koyalanchal University, Dhanbad.

1. Chairman
2. External Expert Members
3. Members
4. Invited Members
5.

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COURSE STRUCTURE

Semester wise Course/ Examination structure for Science faculty

Semester	Paper Code & name	Credits L-T-P	Lectures + Tutorials**	Full Marks	End Semester Marks	Mid Semester (Internal) Marks*
I	LSC-F-101 Tools and techniques in Life Sciences	3-2-0	45 lectures+ 30 Tutorials	100	70	30
	LSC-C-102 Biochemistry and Metabolism	3-2-0	45 lectures+ 30 Tutorials	100	70	30
	LSC-C-103 Cell and Molecular biology	3-2-0	45 lectures+ 30 Tutorials	100	70	30
	LSC-C/P-104 Practical based on 101,102 &103	0-0-5	75 Lectures	100	70	30
II	LSC-S-205 Immunology	3-2-0	45 lectures+ 30 Tutorials	100	70	30
	LSC-C-206 Genetics	3-2-0	45 lectures+ 30 Tutorials	100	70	30
	LSC-C-207 Microbiology	3-2-0	45 lectures+ 30 Tutorials	100	70	30
	LSC-C/P-208 Practical based on 205,206,207	0-0-5	75 Lectures	100	70	30
III	LSC-A-309 Bioinformatics & Biostatistics	3-2-0	45 lectures+ 30 Tutorials	100	70	30
	LSC-C-310	3-2-0	45 lectures+ 30	100	70	30

	System Physiology		Tutorials			
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	LSC-C-311 Developmental Biology	3-2-0	45 lectures+ 30 Tutorials	100	70	30
	LSC-C/P- 312 Practicals based on 309,310,311	0-0-5	75 Lectures	100	70	30
IV	LSC-E-413A Animal Biotechnology General or LSC-E-413B Plant Biotechnology General or LSC-E-413C Industrial Biotechnology	3-2-0	45 lectures+ 30 Tutorials	100	70	30
	LSC-E-414A Applied Animal Biotechnology or LSC-E-414B Applied Plant Biotechnology or LSC-E-414C Bioprocess Technology	3-2-0	45 lectures+ 30 Tutorials	100	70	30
	LSC-E/P-415A/ LSC-E/P-415B/ LSC-E/P-415C Practicals based on A/B/C	0-0-5	75 lectures	100	70	30
	LSC-D-416***	0-0-5	75 Lectures	100	70	30

	A/B/C					
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* Written 20 marks + Day to Day assignments include extracurricular activities carrying 5 marks+ Attendance carrying 5 marks

** Tutorials in the form of Flipped classroom, Self-study etc.

*** Elective options and dissertation topics (student wise) shall be distributed at the commencement of Semester III. Dissertation work shall be carried out in house. However, Lab Visits or short visit to nearby Institute or Laboratory shall be arranged for exposure purpose.

- Introduction, literature survey and references part shall be completed in Semester III itself.
- Material and methods, theoretical analyses, result and discussion shall be completed in Semester IV.

Semester I

LSC –F-101	TOOLS & TECHNIQUES IN LIFE SCIENCES	credit 3-2-0
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Unit 1: **Lectures 11**

- 1.1. Spectrometry: Laws of photometry, Beer Lambert's law, Concepts of spectroscopy, Visible and UV spectroscopy
- 1.2. Mass Spectroscopy, Advanced spectroscopic techniques viz. ICPMS, AAS. Circular dichroism, and NMR spectroscopy.
- 1.3. Structure determination of biomolecules using X-ray crystallography.
- 1.4. Chromatography – Dialysis, Principles of partition chromatography, paper, thin layer, ion exchange and affinity chromatography, gel permeation chromatography, HPLC and FPLC

Unit 2: **(Lectures 10)**

- 2.1 Principles and application of centrifugation-Concepts of RCF
- 2.2 Differential and density gradient centrifugation, analytical ultra-centrifugation,
- 2.3 Determination of molecular weights and other applications, subcellular fractionation

Unit 3: **(Lectures 11)**

- 3.1 Electrophoretic techniques – Principles of electrophoretic separation.
- 3.2 Continuous, zonal and capillary electrophoresis
- 3.3 Different types of electrophoresis: native, agarose and SDS-PAGE. Pulse field gel electrophoresis, EMSA

Unit 4: **(Lectures 13)**

- 4.1. Molecular Biology techniques- Hybridization and blotting (Northern, Southern and Western), PCR, RT-PCR, Real time PCR, DNA chip, Microarray, RNA seq.
- 4.2. Molecular markers, sequencing - classical Next Generation Sequencing.

4.3. Microscopy, flow Cytometry and immunofluorescence microscopy, detection of molecules in living cells, in situ localization by techniques; FISH and GISH.

Text Book (s):

1. Principles of Biochemistry and molecular biology by K. Wilson and J. Walker, Cambridge University Press. Current edition.
2. Biophysical Chemistry Principles and Techniques,
AvinashUpadhyay & KakoliUpadhyay & NirmalenduNath, Current edition

Reference Book (s)

1. **1. Principles of Instrumental analysis by D. A. Skoog and J. J. Leary, Saunders College Publishing, Philadelphia. Current edition**
2. Manual (Sambrook and Russel)
3. Life Science in Tools & Techniques (BisenPrakash S.)
4. Biological Tools & Techniques (A textbook for UG/PG students of Life Sciences) Edition: First, Publisher: Kalyani Publishers, New Delhi, ISBN: 978-93-272-7560-5 AnantaSwargiary
5. Biophysics: Tools and Techniques 1st Edition by Mark C. Leake

LSC –C-102	BIOCHEMISTRY & METABOLISM	credit 3-2-0
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Unit 1:

Lectures 8

Bioenergetics

- 1.1. Thermodynamics - Mathematical description of thermodynamic functions, first, second and the third law.
- 1.2. Isothermal Process, entropy, enthalpy, reversible and irreversible processes free energy and chemical potential, Gibbs free energy, coupled reactions.
13. The Nernst potential, Donnan equilibrium.

Unit 2:

(Lectures 8)

Chemistry of Biomolecules

- 2.1. Concept and properties of Biomolecules
- 2.2. Protein: Structure and biological function
- 2.3. Carbohydrates: Structure and biological function
- 2.4. Lipids: Structure and function
- 2.5. DNA Structure and Properties

Unit 3:

(Lectures 14)

Metabolism

- 3.1. Glycogen metabolism, gluconeogenesis, pentose phosphate pathway.
- 3.2. ATP cycle: glycolysis, Anapleurotic reactions: TCA cycle, oxidative versus photo phosphorylation and regulation of ATP production
- 3.3. β -Oxidation and energetics of fatty acid.
- 3.4. Protein metabolism: Protein turnover, amino acid pool, digestion of dietary proteins, transamination, deamination.

Unit 4:

(Lectures 15)

Enzymes and enzyme kinetics

- 4.1. Classification of Enzymes, Kinetics: Michaelis-Menten equation, L-B plot, Regulation of enzyme activity, binding site and active site, Factors affecting the rate of enzymatic reaction.
- 4.2. Enzyme kinetics for mono- and bi-substrate reactions, Inhibitions –competitive, uncompetitive mixed and noncompetitive type
- 4.3. Allosteric regulation, covalent modifications, Isozymes, ribozymes, abzymes. Enzyme inhibition and Mechanisms of inhibitors action, Hill and Scatchard plots, regulation by covalent modification (like phosphorylation), regulation by proteolytic cleavage of protein, zymogens with example

Text Book (s):

- 1. Lehninger Principles of Biochemistry, David L. Nelson, Michael M. Cox, Publisher: W. H. Freeman
- 2. Herpers Review of Biochemistry, current edition

Reference Books:

1. Biochemistry by Donald Voet, Publisher: Wiley; current edition
2. Biochemistry, L. Stryer, W.H. Freeman, current edition
3. Biochemistry, J. David Rawan, Neil Patterson, current edition.
4. Methods in Enzymology, Academic Press, current edition.
5. Plant Biochemistry, Boochanan, Oxford University Press, current edition

LSC-C-103

CELL & MOLECULAR BIOLOGY

credit 3-2-0

Unit 1:

(Lectures 08)

- 1.1. Basic concept of structure and function of Cell organelles (mitochondria, chloroplast, lysosome, Golgi apparatus.
- 1.2. Structure of plasma membrane, transport across the membrane
- 1.3. Cell signaling, Signaling molecules; G- protein coupled receptor, Receptor Tyrosine Kinase, Cytokine receptors; Pathways of Intracellular Signal Transduction
- 1.4. Protein targeting; to mitochondria, nucleus, peroxisome and secretory pathway (endoplasmic reticulum, golgi apparatus, lysosome)

Unit 2:

(Lectures 07)

- 2.1. Cell Cycle, Molecular mechanisms of Checkpoint regulation. Apoptosis
- 2.2. Phenotypic characters of a cancer cell; Oncogenes, Tumor Suppressor, Chromosome heterogeneity, micro satellite instability
- 2.3. Epigenetic basis of cancer

Unit 3:

(Lectures 15)

- 3.1. Prokaryotic and eukaryotic genome, Chromatin organization and packaging
- 3.2. DNA reassociation kinetics (Cot curve analysis); Repetitive and unique sequences; Satellite DNA; DNA melting and buoyant density
- 3.3. Nucleosome phasing; DNase I hypersensitive regions; DNA methylation, Telomeres and telomerase, DNA topology, Knots and links, Linking number, Writhing and twisting, DNA supercoiling.

Unit 4:

(Lectures 15)

- 4.1. Prokaryotic DNA Replication, Transcription, Translation.
- 4.2. DNA Replication: Models of Replication, Origin of replication, DNA polymerases, DNA topology, DNA damage and repair.
- 4.3. Transcription: RNA-polymerases, RNA processing, regulation, posttranscriptional control and degeneration, gene silencing.
- 4.4. Translation: Structure of Ribosome, tRNA and mRNA, protein synthesis and regulation in prokaryotes and eukaryotes, protein sorting, signal peptides.

. Text Book (s):

- 1. 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, Current edition .
- 2. Cell and Molecular Biology, DeRobertis, B .I. Publication Pvt. Ltd, Current edition .
- 3. .Molecular Cell Biology, H. Lodish, A.Berk, S.L. Zipursky, P. Matsudaura, D. Baltimore and J. Danell, W.H. Freeman and Company, Current edition.
- 4. Principles of Cancer Biology: International Edition; Lewis J. Kleinsmith, Pearson Higher Education, Current edition.
- 5. Cancer Stem Cells: Identification and Targets, Sharmila A. Bapat, Wiley, Current edition.
- 6. Cancer immunotherapy: immune suppression and tumor growth , George C. Prendergast and Elizabeth M. Jaffee, Academic Press, Current edition.
- 7. Structure and Function in Cell Signalling by John NeLson, Wiley.
- 8. B. Lewin, Genes , Publisher: Prentice Hall, Current edition.
- 9. B.D. Singh, Biotechnology by Kalyani Publishers, Current edition.
- 10. R. C. Dubey, A text book of Biotechnology by S. Chand and Co., India
- 11. J. K. Pal and S. S. Ghaskadbi, Fundamentals of molecular biology by Oxford University Press, Current edition.
- 12. L. Stryer, Biochemistry , Current edition
- 13. S. Cummings, Current Perspectives in Genetics: Insights and Applications in Molecular, Classical, and Human Genetics, Publisher: Brooks Cole, Current edition.

LSC-C/P-104

Practical Paper

Credits 0-0-5

Based on LSC-F-101, LSC-C-102 and LSC-C-103

Tools and techniques in Life Sciences

1. Perform agarose gel electrophoresis and PAGE.
2. Perform Paper Chromatography & Thin Layer Chromatography.
3. Perform spectroscopic estimation of protein and DNA
4. Demonstration of PCR
5. Preparation of different microscopic slides and visualization of the same under microscope.

Biochemistry & Metabolism

1. Estimation of blood glucose, detection of serum- (i) urea, (ii) uric acid, (iii) creatinine, (iv) creatine
2. Blood grouping (ABO – Rh)
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,
8. Quantitative assays – (i) Enzyme assays (ii) ELISA
9. Determination of CMC of biological surfactants.

Cell and molecular biology

2. To observe vacuole, chloroplast and calcium oxalate in plant cell.
3. To observe epithelial cells, nerve cells, shape and number of nuclei in animal and protozoan cell.
4. To observe plasmolysis and deplasmolysis in plant cell
5. To observe mitosis and meiosis in plant cell

6. Study of permanent slides
7. To observe chemotaxis and oxygenotaxis in ciliates

Format for Practical Question Paper

Time: 6 hours		F.M : 70
Q. 1. Perform one experiment from LSC-F-101		12
Q. 2. Perform one experiment from LSC-C-102		12
Q. 3. Perform one experiment from LSC-C-103		12
Q.4. Spotting		10
Q.5. Model/Presentation display		10
Q.6. Practical records		07
Q.7. Viva-voce		07
TOTAL		70

Semester II

LSC –S-205	IMMUNOLOGY	credit 3-2-0
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Unit 1: (Lectures 10)

- 1.1 Introduction to Cellular and Molecular immunology: Innate immune response, adaptive immune response.
- 1.2 Structure and isotypes of antibodies, generation of antibody diversity
- 1.3 Characteristics of antigens
- 1.4 MHC molecules and Antigen processing and presentation, MHC typing

Unit 2: (Lectures 12)

- 2.1. Antigen antibody interaction, Advanced Immunological techniques: FACS, Immunofluorescence, Immunoblotting, ELISA
- 2.2. Development and survival of lymphocytes in bone marrow and thymus, Positive and negative selection of lymphocytes
- 2.3. Humoral and T Cell-Mediated Immunity, Macrophage activation by armed CD4 TH1 cells
- 2.4. Complement system

Unit 3: (Lectures 11)

- 3.1. Vaccine strategies, Course of adaptive response against infection.
- 3.2. Mucosal immune system, Immunological memory; Failures of Host Defense Mechanisms
- 3.3 Inherited immunodeficiency diseases, Acquired immune deficiency syndrome (AIDS)

Unit 4: **(Lectures 12)**

- 4.1. Hypersensitivity: Gell and Coombs classification, Effector mechanisms in allergic reactions and IgE, Hypersensitivity diseases
- 4.2. Transplantation; Mechanisms of graft rejection; Foetus as an allograft and survival of foetus against maternal graft rejection mechanisms.
- 4.3. Autoimmunity- Overview, Organ specific and systemic autoimmune diseases

Text Book (s):

- 1. Richard A. Golds by, Thomas J. Kindt and Barbara A. Osborne, Kuby Immunology I. K. International Pvt Ltd, Current edition.
- 2. Delves, Martin, Burton & Roitt, Suggested Immunology, Current edition.

Reference:

- 1. Janeway, Travers, Walport, and Shlomchik, Immunobiology, the immune system in health and disease, Garland Science Publishing, Current edition.
- 2. L. M. Sompayrac, How the Immune System Works, Wiley-Blackwell; Current edition.
- 3. Cellular and molecular immunology, Current edition, Abbas, Litchman and Pillai

LSC-C-206	GENETICS	credit 3-2-0
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Unit 1: **(Lectures 10)**

- 1.1. Model systems in genetic analysis: E.coli, C.elegans, D. melanogaster, S.cerevisiae, Zebra fish
- 1.2. Mendelian genetics: Mendel's of inheritance, non-mendelian inheritance.
- 1.3. Linkage and crossing over.

Unit 2: **(Lectures 10)**

- 2.1. Gene interactions: Allelic and non-allelic, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy

2.2. Gene mapping methods; Tetrad analysis

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

Unit 3: (Lectures 15)

3.1 Gene Mutation: Types, causes and detection, lethal, conditional, biochemical, loss of function, gain of function, Replica plating

3.2. Numerical and structural changes of chromosomes, polyploidy and their genetic implications in plants.

Unit 4: (Lectures 10)

4.1. QTL analysis; Quantitative inheritance in human

4.2. Population genetics, Hardy-Weinberg Equilibrium

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

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-C-207 **MICROBIOLOGY** **credit 3-2-0**

Unit- 1: (Lectures 15)

General Microbiology

1.1 Milestones of microbiology, 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. Classification of microbes – Archaeobacteria, Eubacteria and Cyanobacteria, Yeast and filamentous fungi

1.3 Life cycle: Entry, replication and egress of DNA and RNA viruses. Phage genetics: Lytic and lysogenic cycles of bacteriophage; Virulent and Temperate phage, Prophage; Study of plaque morphology; mapping of phage chromosome by phage crosses

Unit- 2: (Lectures 12)

Microbial growth and reproduction

- 2.1. Culture media, Isolation, characterization and preservation of microbial cultures
- 2.2. Transfer of genetic material and recombination in bacteria molecular aspects of transformation, conjugation, transduction. Chromosome mapping by interrupted mating experiment.
- 2.3. Microbial growth curve and kinetics

Unit- 3: (Lectures 09)

Microbial genetics

- 3.1. The basic principles of microbial genetic constitution,
- 3.2. Concept of operon: lac, trp and ara
- 3.3. Host pathogen interaction: Genetics of pathogenicity and virulence

Unit 4 (Lectures 09)

- 4.1. Antimicrobials: types and mode of action
- 4.2. Antibiotic Resistance
- 4.3. Bioremediation: use of microbes for treating pollutants (hydrocarbons, oils, heavy metals).

Text Book:

- 1. Microbiology, M.J. Pelczar, E.C.S. Chan and N.R. Kreig, Tata McGraw Hill.
- 2. Microbiology, Prescott, Harley, Klein, McGraw Hill International Edition

References Book (s)

- 1. <https://www.journals.elsevier.com/research-in-microbiology>
- 2. <https://onlinelibrary.wiley.com/journal/20458827>
- 3. <https://www.springer.com/journal/11021>
- 4. <https://microbiologysociety.org/members-outreach-resources/links.html>
- 5. General Microbiology, R.Y. Stanier, J.L. Ingraham, M. L. Wheelis and P.R. Painter, Macmillan, Current edition.

6. Microbial ecology: Fundamentals and Applications, R.M. Atlas and R. Bartha, Pearson Education, Current edition.
7. Molecular genetics of bacteria, 3 e, L. Snyder and W. Champness, ASM Press, Current edition.
8. Biotechnology, B.D. Singh, Kalyani Publishers, Current edition.
9. Gene cloning and DNA analysis: An introduction, T.A. Brown, Blackwell Publishing, Current edition.
10. B. Lewin, Genes , Publisher: Prentice Hall, Current edition

LSC-C/P-208 PRACTICAL PAPER

Credits 0-0-5

Based on LSC-S-205, LSC-C-206 and LSC-C-207

Immunology

1. Study of Antigen- Antibody pattern-ODD
2. Immunoglobulin Y purification
3. Immunoglobulin G purification
4. Study of immunohistochemistry
5. Study of bacterial and viral haemagglutination

Genetics

1. To perform karyotyping using metaphase plates
2. Study of *Drosophila melanogaster* mutants
3. Mathematical problems on Linkage mapping
4. Mathematical problems on Hardy-Weinberg equilibrium

Microbiology

1. To prepare various liquid and solid media used in microbiology experiment.
2. Isolation and identification of bacteria based on Microbial taxonomy: Bergey's manual
3. To isolate and count total heterotrophic bacteria in soil, air and water sample.
4. To perform fungal staining for the study of fungal morphology.
5. To perform simple staining and gram staining of bacteria cells.
6. To test protein hydrolysis by gelatin degradation.

7. Preparation of agar stab and slant
8. MPN
10. Antibiotic sensitivity test
11. IMViC test

Format for Practical Question Paper

Time: 6 hours	F.M : 70
Q. 1. Perform one experiment from LSC-S-205	12
Q. 2. Perform one experiment from LSC-C-206	12
Q. 3. Perform one experiment from LSC-C-207	12
Q.4. Spotting	10
Q.5. Model/Presentation display	10
Q.6. Practical records	07
Q.7. Viva-voce	07
TOTAL	70

SEMESTER III

LSC-A-309 BIOINFORMATICS AND BIOSTATISTICS credit 3-2-0

Unit 1:

Lectures 12

- 1.1 Introduction to computational biology & bioinformatics. Branches of bioinformatics. Nature of biological data. Biological data formats.
- 1.2 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.

1.3 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.

Unit 2:

Lectures 11

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

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

2.3. Introduction of Nanotechnology. Biomedical applications of nanotechnology

Unit 3:

Lectures 10

3.1 Sample and Sampling techniques- random sampling and non-random sampling.

3.2 Probability and Bayes theorem, Binomial, Poisson and Normal distribution

3.3 Measures of central tendency- Mean, Median, Mode. Measures of dispersion- standard deviation, coefficient of variation. Skewness and Kurtosis.

Unit- 4:

Lectures 12

4.1. Hypothesis testing.

4.2. Test of significance based on small samples and large samples ('t' test and 'z' test), Chi-square test, Analysis of variance- One-way and Two-way ANOVA.

4.4. Correlation and regression: Use of Correlation and Regression in biological science.

Suggested reading:

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

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

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

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

5. Modern statistics for the Life Sciences by A. Grafen and R. Hails, Oxford University Press, Current edition.
6. An Introduction to Biostatistics by Thomas Glover and Kevin Mitchell, Waveland PrInc, Current edition.
7. Introduction to Nanotechnology, By Charles P. Poole, Jr., Charles P. Poole, Frank J. Owens, Author Owens, 2003 Wiley Interscience, Current edition.
8. Integrating Biologically-Inspired Nanotechnology into Medical Practice. B.K. Nayak (K.M. Centre for Post Graduate Studies, India), Anima Nanda (Sathyabama University, India) and M. Amin Bhat (Sathyabama University, India), Current edition.

LSC-C-310	SYSTEM PHYSIOLOGY	credit 3-2-0
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Unit 1.

Lectures 11

Basic plant physiology

- 1.1. Photosynthesis in C3 and C4 pathways, Rubisco-activation and catalysis. CAM pathway
- 1.2. Starch sucrose metabolisms and assimilate partitioning, Source-sink relationship and yield , Cyclodextrins and fructans
- 1.3. Nitrogen fixation: Nitrogen fixing organisms -bacteria and Cyanobacteria, Actinorhizal and non-leguminous bacteria, Molecular mechanisms of nitrogen fixation. Energetics of nitrogen fixation, nif genes in Rhizobium, Nod genes and Nod factors.
- 1.4. Phytohormones : Auxin, Gibberellin, Cytokinin, Abscissic acid

Unit 2

Lectures 11

Stress physiology of plant

- 2.1. Water stress: Mechanism of drought tolerance.

2.2. Low temperature and heat stress: Physiological and molecular mechanism of low temperature tolerance, Cellular responses to high temperature: enzyme activities, Heat shock proteins.

2.3. Metal stress: Metal toxicity and tolerance to Aluminum, Manganese, Iron, Zinc Phytochelations. Allelochemicals: Mode of action of chemicals on plant physiological processes

2.3. Salt stress: Effect of high salt concentration, Regulation of salt content

2.4. Ultra violet – B (UV-B radiation): Plant response and effect on photosynthesis and gene expression.

Unit 3

Lectures 10

Animal physiology

3.1. Digestion and assimilation of protein, carbohydrate and lipid

3.2. Physiological actions of gastrointestinal hormones- CCK, pancreaticozymine, gastrin, secretin, motilin

3.3. Internal respiration and gas exchange: O₂ and CO₂ dissociation curve and factors affecting.

3.4. Mammalian hormone secreted by: pituitary thyroid, adrenal glands and pancreas.

Unit 4

Lectures 13

4.1. Types of muscles, ultra structure of myofibrils, Physiology of muscle contraction, Muscle twitch, muscle isometric and isotonic contraction; Cori cycle.

4.2. Types and structure of neurons, nerve conduction in unmyelinated (action potential) and myelinated (saltatory) conduction, Synaptic transmission

4.3. Structure of nephron and mechanism of urine formation

Text Book (s):

1. Guyton and Hall: Text Book of Medical Physiology , W.B. Saunders, Current edition.
2. Ganong: Review of Medical Physiology, Lang Medical Publications, Current edition.
3. Plant Physiology: by F.B. Salisbury and Cleon W. Ross. Words worth publishing company. Belmont California, Current edition

4. Photosynthesis and crop productivity in different environments. J. Cooper, Cambridge, Current edition
5. Plant Physiology, biochemistry and molecular biology. David. T. Dennis and David H. Turnip. Longman scientific technical , Current edition
6. Photosynthesis: A comprehensive treatise . A.S. Raghavendra Cambridge University Press, Current edition
7. Introduction to Plant Physiology by W.G. Hopkins, John Wiley, NY. Current edition
8. Advances in Plant Physiology. Vol.2. A. Hemantaranjan. Current edition

References:

1. Keel et al: Samson Wright's Applied Physiology, Oxford Press, Current edition
2. Murray et al: Harper's Illustrated Biochemistry, Appleton & Lange, Current edition
3. West: Best and Taylor's Physiological Basis of Medical Practice, Williams and Wilkins, Current edition.

LSC-C- 311

DEVELOPMENTAL BIOLOGY

credits 3-2-0

Unit 1:

Lectures 11

Animal developmental biology

- 1.1. Basic concept of development: Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients;
- 1.2. Cell fate and cell lineages in *C.elegans*, genesis and differentiation in animals.
- 1.3. Axes determination in *Drosophila* : Antero-posterior and dorso-ventral.

Unit 2:

Lectures 13

Animal developmental biology

- 2.1. Gametogenesis and fertilization

2.2. Morphogenesis in animals - cell aggregation and differentiation, patterning and shaping of the early embryo.

2.3. Organogenesis - vulva formation in *Caenorhabditis elegans*, eye lens induction, limb development and regeneration in vertebrates, neurogenesis, environmental regulation of normal development.

Unit 3:

Lectures 10

Plant developmental biology

3.1. Structure of microsporangium, microsporogenesis and development of male gametophyte.

3.2. Structure of ovule, megasporogenesis and development of female gametophyte.

3.3. Pollen-pistil interaction, fertilization and its control.

Unit 4:

Lectures 11

4.1. Endosperm: Development, types, haustoria, ruminant endosperm, xenia, metaxenia

4.2. Embryogenesis in dicot and monocot, Apomixis: causes and significance, Parthenocarpy

4.4. Polyembryony and its induction, Embryology in relation to taxonomy.

Text Book (s):

1. Developmental Biology by S.F. Gilbert, Sinauer Associates Inc, Current edition.
2. Plant Physiology, Lincoln Taiz and Eduardo Zeiger, Sinauer Associates Inc, Current edition.
3. Principles of development, Oxford, Lawrence, Lumsden, Robertson, Meyerowitz, Smith, Current edition.
4. Developmental Biology, Oxford, Lewis Wolpert, Current edition.
5. Human Embryology and developmental Biology, Elsevier, Carlson, Current edition
6. Essential Developmental Biology, J.M.W. Slack, Current edition

LSC –C/P-312 PRACTICALS Credits 0-0-5

Based on LSC-A-309, LSC-C-310 and LSC-C-311

Practicals on Bioinformatics and Biostatistics

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, Hierarchical & non-hierarchical, 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 .

*More practicals may be added/modified from time to time depending on available facilities.

Practicals on System Physiology

1. Estimation serum uric acid
2. Absorption spectra of blood pigment
3. Detection of allantoin in mammalian urine
4. Estimation of blood Sodium, potassium, Calcium
5. Estimation of blood alkaline & acid phosphatases
6. Normal & abnormal constituents of human urine
7. Colorimetric estimation of IAA.
8. Isolation of chloroplast and assay of Hill activity
9. Tetrazolium test of seed viability
10. Estimation of total phenolic content from seeds.
11. Colorimetric estimation of amino groups by Ninhydrin reaction

Practicals on Development Biology

1. Study of the stages of pollen and ovule development.

2. Pollen in vitro germination methods: Sitting drop culture, suspension culture, surface culture.
3. Correlation between fertility (stainability), viability (TTC and FDA staining) and germinability (in vitro) of pollen grains
4. Use of DNA fluorochromes to localize nuclei during pollen and ovule development.
5. Dissection of embryo and endosperm: Study of post-fertilization stages.
6. Histological characterization of SAM and RAM development.
7. Study of T.S. of Testis and Ovary of a mammal
8. Study of different stages of cleavages (2, 4, 8, 16 cell stages); Morula, Blastula
9. Study of chick embryos of 18 hours, 24 hours, 33 hours and 48 hours of incubation

Format for Practical Question Paper

Time: 6 hours	F.M : 70
Q. 1. Perform one experiment from LSC-A-309	12
Q. 2. Perform one experiment from LSC-C-310	12
Q. 3. Perform one experiment from LSC-C-311	12
Q.4. Spotting	10
Q.5. Model/Presentation display	10
Q.6. Practical records	07
Q.7. Vivi-voce	07
TOTAL	70

Semester IV

LSC-E-413A

ANIMAL BIOTECHNOLOGY

Credits 3-2-0

UNIT I

Lectures 10

BASICS REQUIREMENTS FOR CELL CULTURE

- 1.1 Types of cultures -primary and secondary, applications of cell culture
- 1.2 Cell line –definition, types (finite, continuous/established, transformed) and characterization with examples
- 1.3 Cell strains-Characteristics of finite,continuous and transformed cells in culture.
- 1.2 Tumorigenesis assays – histological examination, transplantation, CAM assay, organoid confrontation, filter well invasion, angiogenesis.
- 1.3 Cell culture media – defined media, serum supplementation ,serum-free media.
- 1.4 Types of culture vessels for laboratory scale, pilot scale and large-scale cultures.

UNIT II

Lectures 11

ROUTINE MAINTENANCE OF CELL CULTURES

- 2.1 Phases of cell growth -Feeding and subculture of cells
- 2.2 Microbial contamination of cell culture - tests for bacterial, fungal, viral and mycoplasma contamination .
- 2.3 Cell viability and cytotoxicity tests for cells in culture.
- 2.4 Cryopreservation of cell lines – principle , methodology and applications .
- 2.5 Induction of differentiation – physiological and non-physiological Inducers.

UNIT III

Lectures 12

STEM CELL CULTURE, 3D CULTURE AND TISSUE ENGINEERING TECHNIQUES

- 3.1 Culturing of stem cells – basic principles and methodology .
- 3.2 Induction of stem cell differentiation - Induced pluripotency of adult stem cells and its applications .

3.3 Three dimensional cultures - histotypic and organ culture methods and applications.

3.4 Tissue engineering – Design stages; types of substrate/support materials; cell sources; orientation; tissue-engineered skin, peripheral nerve implant, cartilage, uterus, trachea, urinary bladder; genetically engineered tissues.

UNIT IV

Lectures 12

GENETIC MANIPULATION OF ANIMALS

4.1 Genetic engineering of animal cells – types of origins of replication, promoters, markers and vectors used.

4.2 Methods of transfection; use of baculovirus vectors for production of recombinant proteins

4.3 Cloning of animals – methods and applications.

4.4 Transgenic animals – methodology used for the production of transgenic insects, mice, cattle, sheep, pigs, birds, fish; Applications of transgenic animals .

4.5 Pharming – definition, pharming products and their applications - Animals as disease models for cancer and alzheimer's disease .

4.6 Tools for genetic improvement and conservation of animals-embryo sexing - Molecular diagnostics for animal diseases – infectious diseases.

4.7 Molecular techniques for species conservation - DNA barcoding of animals.

TEXT BOOKS:

1. R. Ian Freshney ,Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications, John Wiley & Sons, USA, Current edition.
2. Portner R. ,Animal Cell Biotechnology, Humana Press, USA, Current edition .
3. Gordon I ,Reproductive Techniques in Farm Animals, CABI, Current edition.
4. Glyn N. Stacey, John Davis ,Medicines from Animal Cell Culture, John Wiley & Sons, USA, Current edition.
5. Twyman RM ,Advanced Molecular Biology, Bios Scientific, Oxford, UK, Current edition.
6. R. Renaville, A. Burny ,Biotechnology in Animal Husbandry, Springer, UK, Current edition.

7. Manjula Shenoy, Animal Biotechnology, Firewall Media, India, Current edition.

Websites

1. www.animalscience.ucdavis.edu
2. www.gslc.genetics.utah.edu
3. www.biotechnology.gov.in
4. www.nature.com
5. www.scientificamerican.com

LSC-E-413-B	Plant Biotechnology	Credits 3-2-0
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Unit 1

Lectures 11

- 1.1. Plant tissue culture: History, Laboratory organization, Sterilization methods, Maintenance of axenic cultures; Media preparation (minerals, vitamins, and natural adjuvants like coconut milk and fruit juice), Hormones, Growth Regulators.
- 1.2. Explants for Tissue Culture: Shoot tip, axillary buds, leaf discs, cotyledons, inflorescence and floral organs.
- 1.3. Micro propagation, Direct and indirect morphogenesis Callus culture, Cell Culture, shoot multiplication, Organogenesis and embryogenesis, embryo culture (somatic and zygotic); Synthetic seed production.

Unit 2

Lectures 12

- 2.1. In vitro production of haploids: Anther, pollen and gynogenesis culture and their application; Production of homozygous diploid line. In vitro production of triploids.
- 2.2. Protoplast isolation, culture and fusion (somatic hybridization); selection of hybrid cells and regeneration of hybrid plants.
- 2.3. Application of tissue culture in agriculture, horticulture and forestry.
- 2.4. Storage techniques: Equipment, cryopreservation, Seed storage proteins. Achievements and current trends.

Unit 3

Lectures 13

- 3.1. Production of virus free plants; Antisense RNA technique

3.2. Conventional breeding versus transgenesis

3.3. Development of drug, Biopesticides, growth regulators, Biofertilizers. Value addition via bio transformation

3.4. Development of Biocatalyst, Bio fuels, Feed stock Chemicals, Designer Chemicals, biodegradable plastics

3.5. Phyto-remediation

Unit 4

Lectures 09

4.1. Transgenesis in plants: Production of herbicide, insecticide, virus resistant and stress tolerant plants; pr protein and antimicrobial protein.

4.2. Genetic modification for improving crop yield and quality, selection, mutation, polyploidy and clonal selection.

Text Books

1. T, J. Fu, G. Singh and W.R. Curtis Plant Cell and Tissue Culture for the Production of Food Ingredients. Kluwer Academic/Plenum Press. Current edition.

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

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

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

5. Plant Biotechnology, M.K. Razdan, ,Oxford & IBH publishing co.pvt.ltd , Current edition

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

- 1.1. Microbial biomass, enzymes and metabolites. Recombinant products, Transformation processes.
- 1.2. The selection of induced mutants, use of auxotrophs, resistant mutants, revertant mutants.
- 1.3. Modification of the permeability, use of recombination systems, protoplast fusion techniques.

Unit 2: Microbial technology

Lectures 12

- 2.1. The design of batch sterilization processes; Calculation of the Del factor during heating and cooling, HTST.
- 2.2. The scale up of batch sterilization processes, Filter sterilization of air, Sterilization of fermenter exhaust air.
- 2.3. Criteria for the transfer of inoculums, development of inocula for bacterial and mycelial processes. Scale-up and scale-down methods; Scale-up of aeration/agitation regime in stirred tank and air-lift reactors.
- 2.4. Production of microbial enzymes, Fuels and industrial chemicals, Health care products, Use of microbes in mineral beneficiation and oil recovery, Production of fine Chemicals (e.g. Biosurfactants, Spirulina, Yeast), oleo chemicals (Fatty acids, Glycerol, Methol-petrochemicals-perfumery chemicals).

Unit 3: Food technology

Lectures 12

- 3.1. Introduction to Food technology, elementary idea of canning and packing.
- 3.2. Fat-Based Edible products, Pasteurization of food Products. Fat-based Nutraceuticals Technology of Typical Food/ food products (curd, bread, cheese, idli, Agro-products (oilseeds), soya based foods, meat fermentation, vinegar.
- 3.3. Food preservation, Food additive (e.g. amino acids), Food colors, Flavors, and Antioxidants, vitamins, fats and oils.

Unit 4: Chemical and Pharmaceutical technology

Lectures 10

- 4.1. Chemical technology: Transport phenomenon, Heat transfer, Mass transfer.
- 4.2. Pharmaceutical technology: Biotechnology in the Pharmaceutical Industry (Pre-biotechnology products, impact of biotechnology, post-biotechnology products: biologics and biopharmaceuticals)

4.3. Fermentation products in Pharmaceutical industry: Antibodies, Monoclonal Antibodies, Therapeutic proteins, Vitamins, Amino acids, Antibiotics (penicillin, streptomycin), Steroids, Vaccines.

Suggested reading

1. Principles of Fermentation Technology Second Edition Peter F. Stanbury, Allan Whitaker, Stephen J. Hall .Elsevier science ltd, Current edition.
2. Industrial Microbiology: An Introduction. Michael J. Waites, Neil L. Morgan, John S. Rockey Gary Higon. Blackwell Science Ltd, Current edition
3. Modern Industrial Biotechnology & Microbiology. NdukaOkafor, SCIENCE PUBLISHERS, Edenbridge Ltd. Current edition,
4. Microbial Technology . H.J. Peppler and D. Perlman. Academic Press, Current edition.
5. Industrial Microbiology . L E Casida Jr. John Wiley and Sons Inc.
6. Biotechnological Innovations in Chemical Synthesis. BIOTOL. Publishers / Butterworth - Heinemann. Industrial Microbiology by G. Reed (Ed), CBS Publishers (AVI Publishing Co.) Current edition.
7. Biology of Industrial Microorganisms by A.L. Demain. Current edition
8. Genetics and Biotechnology of Industrial Microorgansims by C.I. Hershnergey, S.W. Queener and Q. Hegeman. Publisher. ASM. Current edition
9. Ewesis et al . Bioremediation Principles. Mac Graw Hill. Current edition
10. Manual of industrial Microbiology and Biotechnology by Davis J.E. and Demain A.L. ASM publications, Current edition

LSC-E -414A

Medical biotechnology

Credits 3-2-0

UNIT 1

Lectures 10

DISEASE DIAGNOSIS-PROBE

- 1.1 PCR, LCR immunological assay.
- 1.2 Detection of genetic, Neuro-genetic disorders involving Metabolic and Movement disorders.
- 1.3 Treatment-products from recombinant and non-recombinant organisms, Interferons, Antisense therapy, cell penetrating peptides.
- 1.4 Gene therapy and Immunotherapy; Types and mechanism.

1.5 Detection of mutations in neoplastic diseases MCC, SSCP, DGGE, PTTC.

UNIT 2

Lectures 12

VACCINE BIOTECHNOLOGY

2.1. Instruments related to monitoring of temperature, sterilization, environment, quality assurance and related areas.

2.2. Production techniques - growing the microorganisms in maximum titre, preservation techniques to maintain good antigen quality, freeze drying.

2.3. Introduction to newer vaccine approaches namely sub-unit vaccines, synthetic vaccines, DNA vaccines, virus like particles, recombinant ,vaccines, edible vaccines.

2.4 Nanoparticles in vaccine delivery systems.

UNIT 3

Lectures 11

GENETIC DISORDERS IN HUMAN

3.1 Monogenic disorders: cystic fibrosis .

3.2 Inborn Errors of Metabolism: Phenylketonuria.

3.3 Genetic disorders of various systems:

3.3.1 Hematological: Sickle cell anaemia, thalassemias.

3.3.2 Neurological: Alzheimer's .

3.3.3 Muscular: Deuchenne muscular dystrophy .

3.3.4 Eye: Color blindness .

3.4 Complex traits: polygenic and multifactorial: diabetes mellitus.

Unit 4

Lectures 12

Bioethics, Biosafety, Patent rights

4.1. Intellectual property right: patents, R & D partnership, license agreement and joint venture

4.2. Bioethics: Role of bioethics in research. Prevention of plagiarism, fabrication/manipulation of data, conflict of interest, socio-cultural and behavioral conflicts during the conduct of research. Bioethical norms governing research related to animals and humans.

4.3. Biosafety: Prevention and management of chemical and biological hazards associated with research. Evaluation and interpretation of data sheets, labels etc. for pre-assessment of biological and chemical hazards.

Suggested Reading

1. Human Molecular Genetics – Tom Stratchen & Andrew P. Read. Pub: John Wiley & Sons, Current edition.
2. An introduction to Genetic Analysis – Griffith, Miller, Suzuki, Lewontin, Gelbard. Pub: W.H. Freeman & Co. Current edition
3. Genomes 2 – T.A. Brown, Pub: Wiley-Liss. John W. & Sons. Current edition
4. Colour Atlas of Genetics (2001): Eberhard Passarge Pub : Thieme Current edition
5. Genetics in Medicine Eberhard Passarge Pub: saunders, Current edition
6. A primer of genome science: Greg Gilson, Spencer V Muse Pub: Sinanur Associates Inc. Pvt. Ltd., Sunderland Massachussetts, Current edition
7. Instant Notes: Developmental Biology – RM Twyman Pub: Viva Books Pvt. Ltd. India, Current edition
8. Principles of Development: Lewis Wolpert et al. Pub: Oxford Univ. Press . Genes In, Current edition
9. Medicine– J. Rusko and C.S. Downes. Pub: Chapman & Hall, London, Current edition
10. Human Molecular Genetics – Tom Stratchen & Andrew P. Read. Pub: John Wiley, Current edition
11. Sons Clinical Genetics – A short course– G. N. Wilson. Pub: Wiley-Liss. John W. & Sons. Current edition
12. An Introduction To Genetic Analysis Griffith, Miller, Suzuki Lewontich and Gelbard. Pub: W H Freeman & Com. Current edition
13. Emery's Elements of Medical Genetics– R.F. Mueller, I.D. Young, Pub: Churchill, Livingston Pub. NY. Medical Genetics – L.B. Jonde, J.C. Cary and R.L. Whitel, Pub: Mosby pub. NY , Current edition
14. An Introduction to Human Molecular Genetics– J.J. Pasternak, Pub: Fitzgerald Science Press, Bathesda, Maryland. Current edition

15. Molecular Biology & Biotechnology - Meyer Pub: VCH, Pub. NY Human Genetics: Concept & Application – Ricki Lewis. Current edition

LSC-E-414 B

Applied Plant Biotechnology

Credit 3-2-0

Unit 1

Lectures 11

- 1.1. Vectors for higher plant transformation and cloning.
- 1.2. *Agrobacterium tumefaciens* infection, Basis of tumor and hairy root formation. Mechanism of DNA transfer, Role of virulence genes. Ti and Ri plasmids based vectors
- 1.3. Direct gene transfer, Transformation of monocots, transgene stability, gene silencing and over expression of genes, selection of clones.
- 1.4. Expression of cloned genes: Selectable markers, genetic markers Reporter genes and Promoters.

Unit 2

Lectures 13

- 2.1. Organization and expression of chloroplast genome and mitochondrial genome; Cytoplasmic male sterility; Intergenomic interaction.
- 2.2. Chloroplast transformation; vectors, mechanisms, advantages and limitations, homoplastomic line development.
- 2.3. Metabolic engineering and industrial products
- 2.4. Plant secondary metabolites, Basic biosynthetic pathways, Techniques used in biosynthesis, Control mechanisms, Role of Secondary Metabolites in defense, Interaction between organism using secondary metabolites, Production of bio active secondary metabolites by plant tissue culture and application of industrially important secondary metabolites.

Unit 3

Lectures 10

- 3.1. Marker aided breeding maps, linkage analysis
- 3.2. RFLP, RAPD, AFLP, STS and microsatellites, molecular assisted selection.
- 3.3. Molecular pharming; edible vaccines, plantibodies and peptide hormones

Unit 4

Lectures 11

Bioethics, Biosafety, Patent rights

4.1. Intellectual property right: patents, R & D partnership, license agreement and joint venture

4.2. Bioethics: Role of bioethics in research. Prevention of plagiarism, fabrication/manipulation of data, conflict of interest, socio-cultural and behavioral conflicts during the conduct of research. Bioethical norms governing research related to animals and humans.

4.3. Biosafety: Prevention and management of chemical and biological hazards associated with research. Evaluation and interpretation of data sheets, labels etc. for pre-assessment of biological and chemical hazards.

Suggested reading

- 1. An introduction to Plant Tissue culture by MK Razdan. M.K.. Oxford & IBH Publishing Co, New Delhi, 2003. Current edition
- 2. Plant Biotechnology: An Introduction to Genetic Engineering by Adrian Slater, Nigel W. Scott, Mark R. Fowler. Oxford University Press, Current edition
- 3. Biochemistry & Molecular Biology of Plants. Bob Buchanan, Wilhelm Gruissem, Russell Jones. John Wiley & Sons, Current edition
- 4. Molecular Biotechnology by Glick, B.R. and J.J. Pasternak. Second Edition, ASM Press, Washington, Current edition
- 5. Plant tissue culture by Bhojwani. S.S and Razdan. M.K Current edition
- 6. Plant Propagation by Tissue Culture: Volume 1 & 2. EF George. Exegetics Limited, Current edition
- 7. Plant cell culture, A Practical approach, Edited by R.A. Dixon and R.A. Gonzales. Current edition
- 8. Natural Products: A Laboratory Guide By Raphael Ikan. Academic Press, Current edition
- 9. Chemistry of Natural Products by Sujata V. Bhat, Bhimsen A. Nagasampagi, Meenakshi Sivakumar. Birkhäuser, Current edition.
- 10. Phytochemical Methods A Guide to Modern Techniques of Plant Analysis By JB Harborne. Springer, Current edition

LSC-E-414C

Bioprocess technology

Credits 3-2-0

Unit 1: Introduction to Bioprocess Engineering

Lectures 11

- 1.1. Bioreactors and Membrane Bioreactors, Analysis of batch, Fedbatch and continuous bioreactors, stability of microbial reactors. Specialized bioreactors (pulsed fluidized, photobioreactors, etc).
- 1.2. Biology of Industrial Microorganisms: (Saccharomyces, Aspergillus, penicillia, spore forming bacteria etc), Isolation, Preservation and Maintenance of Industrial Microorganisms, Microbial growth kinetics, Regulation of Metabolism, Substrate Assimilation/Product Secretion.
- 1.3. Media composition and sterilization for Industrial Fermentation ; addition of precursors and metabolic regulators to media, Antifoams; Aeration and agitation -Determination of $k_L a$ values, Fluid rheology, Factors affecting $k_L a$ values in fermentation vessels, Power number, Reynold's number; Air quality Management and Air sterilization

Unit 2: Fermentation technology

Lectures 11

- 2.1. Types of fermentation processes. Surface and submerged liquid substrate fermentation; Solid Substrate Fermentations, Fermentation raw materials, Design of a fermenter: Basic functions of a fermenter for microbial or animal cell culture, Aseptic operation and containment, Body construction & components, Sensor probes, fermenters for animal cell culture, instrumentation and control.
- 2.2. Analysis of mixed microbial populations, Fermentation kinetics and monitoring, Measurement and control of bioprocess parameters.
- 2.3. Fermentation economics-Space requirements, capital investment, Raw materials, highest-yielding strain, automation, Recovery and purification procedures, Heat and power utilization.

Unit 3: Downstream processing

Lectures 12

- 3.1. Cell disruption methods for intracellular products, Removal of microbial cells and solid matter, foam reparation, precipitation, filtration (micro and ultrafiltration), centrifugation, cell disruptions, liquid-liquid extraction, supercritical extraction, chromatographic and electrophoretic separations: Whole broth processing ;Drying and crystallization, disposal of effluents; Introduction to Process Analytical Technology (PAT) and Quality by Design (QbD).
- 3.2. Whole cell Immobilization and their Industrial Applications, Immobilized enzymes in aqueous and non-aqueous media, bioconversion and Biotransformation.
- 3.3. Industrial Production of Enzymes (amylase, proteases, lipases), Alcohol (ethanol), Acids (citric, acetic and gluconic), Amino acids (lysine, glutamic acid), Single Cell Protein, Bio-polymer.

Unit 4: Bioethics, Biosafety, Patent rights

Lectures 11

- 4.1. Intellectual property right: patents, R & D partnership, license agreement and joint venture
- 4.2. Bioethics: Role of bioethics in research. Prevention of plagiarism, fabrication/manipulation of data, conflict of interest, socio-cultural and behavioral conflicts during the conduct of research. Bioethical norms governing research related to animals and humans.
- 4.3. Biosafety: Prevention and management of chemical and biological hazards associated with research. Evaluation and interpretation of data sheets, labels etc. for pre-assessment of biological and chemical hazards.

Suggested reading

1. “Bioprocess Engineering” Shuler and Kargi, Prentice Hall Publication, Current edition
2. “Biochemical Engineering Fundamentals” James E Bailey and David F Ollis, McGraw Hill, Current edition
3. “Bioprocess Engineering Principles” Doran, Elsevier, Current edition
4. Ganguli, P. Intellectual property rights: Unleashing the knowledge economy. New Delhi: Tata McGraw-Hill Pub. Current edition
5. Complete Reference to Intellectual Property Rights Laws. Snow White Publication Oct. Current edition
6. Kuhse, H. Bioethics: An anthology. Malden, MA: Blackwell. Current edition
7. Recombinant DNA Safety Guidelines, Department of Biotechnology, Ministry of Science and Technology, Govt. of India. Retrieved from <http://www.envfor.nic.in/divisions/csurv/geac/annex-5.pdf>
8. Alonso, G. M. (2013). Safety Assessment of Food and Feed Derived from GM Crops: Using Problem Formulation to Ensure “Fit for Purpose” Risk Assessments. Retrieved from <http://biosafety.icgeb.org/inhousepublications/>
9. Guidelines for Safety Assessment of Foods Derived from Genetically Engineered Plants. 2008. Collection biosafety reviews.

LSC-E/P-415B	PRACTICAL (Animal Biotechnology)	Credits 0-0-5
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1. To provide the practical background and training in animal cell culture and molecular techniques related to animal biotechnology
2. Preparation and sterilization of reagents and media for cell culture.

3. Primary culture of chick embryo fibroblasts.
4. Cell counting using haemocytometer.
5. Viability test - Dye exclusion assay.
6. Subculture and Cryopreservation of cell lines.
7. Karyotype preparation.
- 8 . Mitotic metaphase chromosome preparation from bone marrow of mouse/rat.
9. C , G-banding of mitotic chromosomes of mouse/rat.
10. Fluorescence banding of mitotic chromosomes of mouse/rat.
11. Exposure of cells to carcinogens and transformation assay (focus assay or soft agar assay).
12. Isolation of DNA from mammalian blood or spleen.
13. WSSV detection by PCR.
14. VNTR Genotyping.
15. Comet assay for assessing genotoxicity.

LSC-E/P-415B	Practical (Plant Biotechnology)	Credits 0-0-5
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1. Isolation of a plant gene
2. Cloning of plant gene in cloning vector
3. Cloning of gene into destination vector or binary vector
4. Transformation of Agrobacterium with recombinant primary vector
5. Selection of transformed Agrobacterium
6. Callus induction/tissue culture
7. Single cell suspension culture
8. Plant cell transformation with the help of Agrobacterium
9. Selection of transformant plant cells
10. Conformation of insert into plant cell.

LSC-E/P-415C	Practicals (Industrial Biotechnology)	Credits 0-0-5
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1. Screening of Process variables :Plackett-Burman design practice

2. Demonstration of reactor studies : Batch, fed-batch, and continuous flow reactor analysis and residence time distribution.
3. Determination of Thermal Death Point (TDP) and Thermal Death Time (TDT) of microorganisms for design of a sterilizer.
4. Monitoring of dissolved oxygen during aerobic fermentation.
5. Preservation of industrially important bacteria by lyophilization.
6. Product concentration by vacuum concentrator.
7. Mushroom cultivation and its analysis.
8. Production of wine from grapes
9. Enrichment and Selective isolation of *Salmonella*, *Shigella*, *Staphylococcus aureus* from spoiled or contaminated foods
10. Bacteriological analysis of milk : MBRT

Format for Practical Question Paper

Time: 6 hours		F.M : 70
Q. 1. Perform one experiment from LSC-E-313A/B/C		15
Q. 2. Perform one experiment from LSC-C-314A/B/C		15
Q.3. Spotting		10
Q.4. Model/Presentation display		10
Q.5. Practical records		10
Q.6. Vivi-voce		10
TOTAL		70

DETAILED SYLLABI OF OPEN ELECTIVES

LSC-OE(1)

BASIC BIOTECHNOLOGY

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 transgenics 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; William J. Thieman and Michael A. Palladino; Benjamin Cummings. Current edition

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

LSC-OE(2)	STRUCTURAL BIOLOGY	credits 3-0-0
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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, Current edition
2. Advances in structural biology by S. K. Malhotra (Editor), Elsevier. Current edition
3. Membrane structural biology by Mary Luckey, Barnes and Noble Publisher. Current edition

LSC –OE (3)

ADVANCED TECHNIQUES

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