

**Proposed Syllabus for M. Sc. Biotechnology
(Two years/Four semesters)**

(Biotechnology)

(To be implemented from the academic session 2009-2010)

**Faculty of Life Sciences
Department of Biotechnology
Guru Ghasidas Vishwavidyalaya
Bilaspur (C. G.)-495009**

M. Sc. BIOTECHNOLOGY (FOUR SEMESTERS)

Semester - I

Code	Subject	End Semester exam	Internal Assessment	Attendance/Seminar/Interaction	Total	Passing Marks (%)
LBTM- 101	Cell Biology & Genetics	60	30	5 + 5 =10	100	40
LBTM-102	Microbial Genetics and Physiology	60	30	5 + 5 =10	100	40
LBTM-103	Tools and Techniques in Biotechnology	60	30	5 + 5 =10	100	40
LBTM-104	Biomolecules	60	30	5 + 5 =10	100	40
LBTM-105	Laboratory-I (Based on LBTM -101 & 104)	60	30	5 + 5 =10	100	40
LBTM-106	Laboratory-II (Based on LBTM -102 & 103)	60	30	5 + 5 =10	100	40
Total					600	

Semester - II

Code	Subject	End Semester exam	Internal Assessment	Attendance/Seminar/Interaction	Total	Passing Marks (%)
LBTM-201	Bioprocess Engineering & Technology	60	30	5 + 5 =10	100	40
LBTM-202	Molecular Biology & Genomics	60	30	5 + 5 =10	100	40
LBTM-203	Basic Enzymology and Enzyme Technology	60	30	5 + 5 =10	100	40
LBTM-204	Computer Applications and Biostatistics	60	30	5 + 5 =10	100	40
LBTM-205	Seminar	50			50	40
LBTM-206	Laboratory III (Based on LBTM -201 & 203)	60	30	5 + 5 =10	100	40
LBTM-207	Laboratory IV (Based on LBTM -202 & 204)	60	30	5 + 5 =10	100	40
Total					650	

Semester - III

Code	Subject	End Semester exam	Internal Assessment	Attendance/Seminar/Interaction	Total	Passing Marks (%)
LBTM-301	Recombinant DNA Technology	60	30	5 + 5 =10	100	40
LBTM-302	Biology of Immune System	60	30	5 + 5 =10	100	40
LBTM-303	Plant Biotechnology	60	30	5 + 5 =10	100	40
LBTM-304	Animal Biotechnology	60	30	5 + 5 =10	100	40
LBTM-305	Applied and Industrial Biotechnology	60	30	5 + 5 =10	100	40
LBTM-306	Laboratory V (Based on LBTM -301 & 302)	60	30	5 + 5 =10	100	40
LBTM-307	Laboratory VI (Based on LBTM -303, 304 & 305)	60	30	5 + 5 =10	100	40
Total					700	

Semester - IV

Code	Subject	End Semester exam	Internal Assessment	Attendance/Seminar/Interaction	Total	Passing Marks (%)
LBTM- 401	Major Elective	60	30	5 + 5 =10	100	40
LBTM-402	Enterpreneurship & Management in Biotechnology	60	30	5 + 5 =10	100	40
LBTM-403	Project Dissertation on Elective Paper & Viva	120	80		200	40
Total					400	

Major Elective (Optional) Papers: One to be selected

Code	Subject	End Semester exam	Internal Assessment	Attendance/Seminar/Interaction	Total	Passing Marks (%)
LBTM-401	Advanced Environmental Biotechnology	60	30	5 + 5 =10	100	40
LBTM-401	Microbial Biotechnology	60	30	5 + 5 =10	100	40
LBTM-401	Advanced Plant and Agriculture Biotechnology	60	30	5 + 5 =10	100	40
LBTM-401	Medical Biotechnology	60	30	5 + 5 =10	100	40

NOTE: - List of Practical will be supplied at the Start of every Semester and will depend upon the availability of infrastructure facility and resources in the Department.

SEMESTER – I

LBTM-101: CELL BIOLOGY AND GENETICS

- Unit-I** General structure of Cell. Historical origins of cell biology: The discovery of cell, development of the cell theory. The molecular evolution. Chemical bonds and functional groups in biological.
- Unit-II** Steps in cell cycle, yeast as model system, cell division control and regulation yeast *cdc* gene. Genes for social control of cell, Proto-oncogenes.
Cell signalling: Exocrine, Endocrine, Paracrine and Synaptic strategies of Chemical signalling, surface receptor mediated transduction (DAG, Ca²⁺, c-AMP, G-Proteins)
- Unit-III** The structural and functional organisations of cell membrane, ionic transport (Passive and active transport) the extracellular matrix of eukaryotes, cell wall. Structure and functions of endoplasmic reticulum, golgi complex, ribosome lysosomes, peroxisomes (glyoxysomes), plastids and mitochondria. Biogenesis of mitochondria and chloroplast.
- Unit-IV** Cytoskeleton and cell motility: Microtubules, microfilaments and intermediate elements. Nuclear ingredients: Nuclear membrane Nature of the genetic material, Proteins associated with nuclei. Packaging of genetic material: nucleosome model, Organisation of chromatin: chromosome structure.
- Unit-V** History, scope of Genetics. Mendelian Laws of inheritance, variations of Mendelian analysis. Linkage and Crossing over. Linkage mapping. Sex determination and sex linked inheritance, Development, population and evolutionary genetics.
- Books**
1. Cell (A Molecular approach): Cooper, G. M.
 2. Cell and Molecular Biology (1996) Karp, G.
 3. Cell Biology (1993) Sadava D. E.
 4. Cell and Molecular Biology (1995) Kish V. M. and Kleinsmith L. J.
 5. Cell and Molecular Biology : deRobertis and deRobertis

LBTM-102: MICROBIAL PHYSIOLOGY AND GENETICS

- Unit-I** History and Scope of Microbiology, Major characteristics used in microbial taxonomy (numerical and molecular), current methods of microbial identification, cultivation and enumeration of microbes from environment, Ecology of micro-organisms, Ultrastructure of bacteria, algae, protozoa and viruses.
- Unit-II** Nutritional requirements of micro-organisms, mode of nutrition, phototrophy, mixotrophy, saparophytic, symbiotic and parasitic organisms, microbial growth and population kinetics, methodology for measuring growth and growth regulation. Physical and chemical control of microbes.
- Unit-III** Glycolytic pathways, tricarboxylic acid cycle, energy production, oxidative phosphorylation, energetics of chemolithotrops and autotrophs and transport.
- Unit-IV** Gene transfer mechanism in microbe's transformation, transduction, conjugation, and Recombination.
- Unit-V** Basic concepts, action of pathogens, human pathogenic viruses and bacteria, Gram-positive and Gram- negative Bacilli of medical importance. Miscellaneous bacterial agents of disease; DNA and RNA viruses and their diseases, Fungal diseases. Life cycle of some important pathogens like- Malaria, hepatitis, filaria, Kalazar and AIDS.
- Books**
1. Microbiology (1996) Prescott, Harlay and Klein
 2. Biology of Micro-organism: Madigan, Martinko and Parker
 3. Fundamentals of Microbiology (1994) Alcano
 4. Foundations in Microbiology (1996) Talaro K. and Talaro A.
 5. Microbiology: Concept and Applications (1993) Pleczar M. J., Chan E. C. S. and Krieg N. R.
 6. Principles of Microbiology (1994) Atlas , R. M.
 7. Bergey's Manual of Systematic Bacteriology (2001) (2nd ed.) Gornity, G. M.

LBTM-103: TOOLS AND TECHNIQUES IN BIOTECHNOLOGY

- Unit-I** Principles and applications, simple, compound, phase-contrast and fluorescent microscopes. Electron microscopy: SEM and TEM.
Centrifugation Techniques:
Principles, type of centrifuges, density gradient centrifugation in isolation of cells, cell organelles and biomolecules.
- Unit-II** Electromagnetic spectrum, Beer Lambert's Law. Photometry, UV/VIS Spectrophotometry, Infrared spectroscopy, Atomic absorption spectroscopy, ESR and NMR spectroscopy. Mass spectroscopy (LC-MS, GC-MS). Fluorescent spectroscopy.
Applications of different Spectroscopic techniques in Biology.
- Unit-III** Introduction and types of chromatography, paper, thin layer, gas, Gel permeation, ion-exchange, HPLC, FPLC and affinity chromatography and instrumental details of each. Applications of Chromatographic techniques in Biology.
- Unit-IV** Paper and gel electrophoresis, Polyacrylamide gel electrophoresis (native and SDS), Agarose gel electrophoresis, Blotting- Southern, Western and Northern blotting, Immunoblotting, Immunoelectrophoresis, DNA finger printing and ELISA.
- Unit-V** Nature and types of radiations, preparation of labelled biological samples. Detection and measurement of radioactivity, GM counter, Scintillation counter, Autoradiography, Flow cytometry. Safety measures in handling radioisotopes. RIA, non radiolabelling.
- Books**
1. Nuclear Magnetic Resonance: Williams
 2. Biochemical Techniques theory and practice : White R
 3. Analytical Chemistry: Christion G. D.
 4. A Biologist Guide to Principle and Techniques: Willson K. and Gounding K.H.
 5. An Introduction to Practical Biochemistry: Plummer D. T.

LBTM-104: BIOMOLECULES

Unit-I Some important properties of water, The law of mass action, Dissociation of water and its ion product, K_w , buffer and buffering capacity. pH, Bronsted acids, ionization of weak acids and bases, Henderson Hasselbalch equation, Titration curves and buffering action. Law of thermodynamics, Gibb's free energy, Donan's membrane equilibrium.

Unit-II Amino Acids: Structure, properties, classification and functions, naturally occurring modifications of amino acids in proteins, non-protein amino acids.
Structure of Proteins: Primary, Secondary (α -helix, β -Plated and random coils), Ramachandran plots. Tertiary and quaternary Structures of proteins/ enzymes.

Unit-III Carbohydrates: Introduction, classification, types, Optical isomerism, Mutarotation, Basic structure and functions of monosaccharides, Oligosaccharides, polysaccharides, Proteoglycans, Glycoproteins, Peptidoglycans and bacterial cell walls.

Unit-IV Lipids: Classification, Structure, Properties and function of Fatty acids, Phospholipids, Glycolipids, Sphingolipids, Cerebrosides, Steroids, Prostaglandins.

Unit-V Nucleic acids: Structure, properties and functions of DNA and RNA, Secondary and tertiary level organization, Various DNA forms, Conformation, Super coiling, Melting of DNA, Denaturation and Renaturation kinetics.

Books

1. Cell (A Molecular approach): Cooper , G. M.
2. Cell and Molecular Biology (1996) Karp, G.
3. Cell Biology (1993) Sadava D. E.
4. Cell and Molecular Biology : deRobertis and deRobertis
5. Principles of Microbiology (1994) Atlas , R. M.
6. Principle of Biochemistry: Leninger , A. L.
7. Biochemistry (1995) Lubert Stryer
8. Text Book of Biochemistry (1997) Devlin , Thomas M.
9. Biochemistry (1993) Geoffery, Zubay
10. Harper's Review of Physiological Chemistry(1993) Murray, R. K., Mayes, P. A. Gramner, D. K. and Rowell V. W.
11. Biochemical Techniques theory and practice : White R
12. A Biologist Guide to Principle and Techniques: Willson K. and Gounding K. H.
13. An Introduction to Practical Biochemistry: Plummer D. T.

SEMESTER -II

LBTM-201: BIOPROCESS ENGINEERING AND TECHNOLOGY

Unit-I Introduction to bioprocess engineering, bioreactors, isolation, preservation and maintenance of industrial microorganisms, kinetics of microbial growth and death, media formulation for industrial fermentation, Air and media sterilization. Designing of a fermenter/Bioreactor.

Unit-II Types of fermentation process, analysis of batch fed batch and continuous bioreactions, biotransformation, stability of microbial reactors, analysis of mixed microbial populations, specialized bioreactors (pulsed, fluidized, photo bioreactors etc.) Measurement and control of bioprocess parameters

Unit-III Downstream processing: introduction, removal of microbial cells and solid matters, foam separation, precipitation, filtration, centrifugation, cell disruption, liquid-liquid extraction, chromatography, membrane process, drying and crystallization, effluent treatment

Unit-IV Industrial production of chemicals: alcohols, acids (citric, acetic and gluconic), solvents (glycerols, acetone, butanol), antibiotics (penicillin, streptomycine, tetracycline) amino acids (lysine, glutamic acid), single cell proteins.

Unit-V Food Biotechnology: Food spoilage and preservation process, dairy products, wine, beer and other alcoholic Beverages and formulated plant products, petro crops, food from water, fungal protein food from yeast, hybrid seeds, conventional breeding of plant for food production. Transformation of steroids and non steroid compounds. Mushroom -types, isolation and culture.

- Books**
1. Sullia S. B& Shantharam S: (1998) General Microbiology, Oxford & IBH Publishing Co. Pvt.Ltd.
 2. Glaser A.N & Nilaido.H (1995) Microbial Biotechnology,W.H Freeman & Co.
 3. Prescott & Dunn (1987) Industrial Microbiology 4th Edition, CBS Publishers & Distributors.
 4. Prescott & Dunn (2002) Industrial Microbiology, Agrobios (India) Publishers.
 5. Crueger W. & Crueger A. (2000) A text of Industrial Microbiology, 2nd Edition, PanimaPublishing Corp.
 6. Stanbury P.F, Ehitaker H, Hall S.J (1997) Priciples of Fermentation Technology., Aditya Books (P) Ltd.
 7. S.N.Jogdan (2006) Industrial Biotechnology, Himalaya Publishing House

LBTM-202: MOLECULAR BIOLOGY AND GENOMICS

- Unit-I** Nuclear organization: Chromosomal DNA and particles, nucleosomes. Modern Concept of gene organization. Chromosomal replication, synthesis and processing (DNA replication, Enzymology of DNA replication), DNA repair.
Gene mutation: Types of mutations, Molecular mechanism of mutations Chromosomal mutations: changes in the structure of chromosome and changes in number of chromosomes, polyploidy.
- Unit-II** Transcription and Transcriptional control: Structure of bacterial RNA polymerase, Transcription events, and sigma factor cycle, Eukaryotic RNA polymerase, Promoter sequences, TATA box, Hogness Box, CAAT box, Enhancers, upstream activating sequences, Initiation and termination of transcription factor, RNA processing in Prokaryotes Vs Eukaryotes, Spliceosome. Transcriptomics.
- Unit-III** Translation: Prokaryotic and Eukaryotic translation, the translation machinery, Mechanisms of initiation, elongation and termination, Regulation of translation. Post-translational modifications and intracellular proteins transport
- Unit-IV** Control of gene expression in prokaryotes and eukaryotes, operon model- lac and trp operon, Autogenous regulation, Feedback inhibition, Lytic cascades and lysogenic repression. Molecular Biology of Cancer causes and Genetics of cancer, Tumor suppressor genes and onco genes, anticancer agent (p53 and pRB).
- Unit-V** Whole Genome analysis, DNA microarray. Genome analysis for global patterns of gene expression using fluorescent-labelled cDNA or end-labelled RNA probes. Gene mapping and applications- Transcriptome and Proteome- General Account. Protein sequence analysis by mass spectroscopy. Protein microarrays. Advantages and disadvantages of DNA and protein microarrays.
- Books**
1. Molecular Biology of the Gene (1987) Watson J. D., Hopking N., Robast J. and Steiz, J.
 2. Gene IX: Lewine Benjamin.
 3. The Biochemistry of the nucleic acid (1996) Adams et al
 4. Microbial Genetics: David Fridfelder.
 5. Molecular cell Biology (1999) Lodish, H., Baltimore, D., Berk, A, Zipursky SL, Paul M and Darnell J.
 6. Cell and Molecular Biology (1996) Gerald Karp.

LBTM-203: BASIC ENZYMOLOGY AND ENZYME TECHNOLOGY

- Unit-I** Introduction to Enzymes, enzyme nomenclature, enzyme commission numbers, and classification of enzymes. Isolation and purification of enzymes, preparation of purification chart, Enzyme activity, Specific activity and turn over number, Marker enzymes.
- Unit-II** Enzyme Kinetics: Steady state, pre-steady state, equilibrium kinetics, Michaelis and Menten Equation and its derivation, Different methods to calculate the K_m and V_{max} and their significance.
- Unit-III** Factor affecting enzyme activity and catalysis: pH, substrate and enzyme concentration, temperature, coenzyme and cofactors, Mechanism of action of enzymes involving two/more substrates. Role of metal ions in enzyme catalysis. Enzyme inhibition, different types of inhibitors and activators.
- Unit-IV** Structure and function of enzymes: Lysozyme, chymotrypsin, DNA polymerase, RNase, proteases. Enzyme regulation and control of their activity. Introduction to allosteric enzymes and isozymes.
- Unit-V** Enzyme Technology: Immobilization of enzymes, whole cell immobilization and their application, commercial production of enzymes, RNA-catalysis, Catalytic antibodies -abzymes, Protein and Enzyme engineering: Design and construction of novel enzymes.
- Books**
1. Enzyme Kinetics (1995) Palmer
 2. IUPAC Enzyme nomenclature series.
 3. Enzyme kinetics: Dixon W. B.
 4. General Enzymology :Kulkarni & Deshpande
 5. Enzyme Assays:J. Raymond

LBTM-204: COMPUTER APPLICATIONS & BIOSTATISTICS

- Unit-I** Introduction and definition of biostatistics, concept of variables in biological systems, collection, classification, tabulation, graphical and diagrammatic representation of numerical data, Measure of central tendency: Mean median and mode, and their relationship, Measure of dispersion: quantitative deviations, mean deviation, standard deviation, coefficient of variations. Correlation and regression, linear and quadratic regressions, Concept of Standard errors. Hypothesis testing (null & alternative hypothesis)
- Unit-II** Probability, concept of random experiment, various definition of probability, addition theorem of probability, random variables (discrete and continues), Probability distributions (viz. Binomial, Poisson and Normal) and their applications, Simple random sampling without replacement. Student 't-', 'F' and 'Chi' square distribution (derivations not required) their properties and use. ANOVA.
- Unit-III** Basic knowledge of computers, hardware and software, Generation of Computers and information storages devices. MS-DOS, MS-WORD and MS-EXCEL Application of Different computer software in handling the biostatistical problems and Data-management. Coral draw.
- Unit-IV** Introduction to Bio-informatics: Definition, History and Aims, Introduction to data mining, Computational gene finding - multiple alignment and sequence search (BLAST, FASTA, CLUSTALW). Applications of Bioinformatics.
- Unit-V** Predicting structure and function, Molecular Evolution and phylogenetic trees, Methods for Phylogenetic analysis: Sequence Alignment, Construction of Phylogenetic Tree. , Soft wares (Ssearch, Treeview, Phylip, Rasmol).
- Books**
1. Bioinformatics(2002) Bishop Martin
 2. Molecular databases for protein and sequence and structure studies: Sillince A. and Sillince M.
 3. Sequence Analysis primers : Gribskov, M. and Devereux, J.
 4. Bioinformatics: Sequence and Genome Analysis By David W. Mount, *University of Arizona, Tucson*
 5. Discovering Genomics, Proteomics, & Bioinformatics, Second Edition By A. Malcolm Campbell, *Davidson College*; Laurie J. Heyer, *Davidson College*; With a Foreword by Francis S. Collins
 6. Biostatistics:P.N.Arora ,P.K.Malha
 7. Introductory statistics for Biology: *Mahajan , S. K.*
 8. Statistical Methods : *Mishra and Mishra*

LBTM- 205 SEMINAR

Maximum marks: 50

Every student, who has been enrolled in M.Sc. (Biotechnology) course, shall have to deliver a Seminar on a Recent Topic related to Molecular Biology and Biotechnology, as per the programme of the School of Biotechnology. Seminar will be of 45-minute duration during which the presentation will be followed by questions session by the audience comprising of faculty and students. Every student shall be required to submit the topic of his/her seminar in consultation with the Head of the Department/Faculty members well in advance so that the same may be displayed on the notice board. The speaker has to write an Abstract to be distributed during Seminar in addition to two copies of write-up giving relevant details of the background of the subject, methods used and references/List of sources from where the material for presentation has been collected.

Reference Books for second semester

1. Genetics : *Strickberger M. W.*
2. Genetic Analysis (1996) *Griffiths and Suzuki (6th ed.)*
3. Genetics : Instant notes series.
4. Genetics (1998) *Hart D. L. and Jones E. W.*
5. Genetics : *Gupta P. K.*
6. Genetics : *Gardner.*
7. Microbial Genetics : *David Fridfelder.*
8. Genes VIII : *Lewine Benjamin.*
9. Molecular Biology of the Gene (1987) *Watson J. D. , Hopking N., Robast J. and Steiz,J.*
10. The Biochemistry of the nucleic acid (1996) *Adams et al*
11. Molecular cell Biology (1999) *Lodish, H., Baltimore, D., Berk, A, Zipursky SL, Paul M and Darnell J.*
12. Cell and Molecular Biology (1996) *Gerald Karp.*
13. Enzyme Kinetics (1995) *Palmer*
14. IUPAC Enzyme nomenclature series.
15. Enzyme kinetics : *Dixon W. B.*
16. Statistical Methods: *Gupta , S. K.*
17. Introductory statistics for Biology : *Mahajan , S. K.*
18. Gene cloning I, II and III, *Glover , G. M.*
19. Statistical Methods : *Mishra and Mishra*

SEMESTER III

LBTM-301: RECOMBINANT DNA TECHNOLOGY

- Unit-I** Isolation of DNA and RNA. Quantification of nucleic acids. Radiolabelling of nucleic acids: End labelling, nick translation, labelling by primer extension, DNA sequencing: Maxam-Gilbert (Chemical) and Sanger- Nicolson (dideoxy/ enzymatic) sequencing method, Pyrosequencing.
- Unit-II** Restriction endonucleases: Types of restriction endonucleases, classification and uses. Restriction mapping. DNA modifying enzymes: Nucleases, Polymerases, Phosphatases and DNA ligases.
- Unit-III** Prokaryotic host. Plasmid vectors, Bacteriophage, other vectors, expression vectors, Construction of genomic and c-DNA libraries, Joining of DNA Fragments to vectors, Homo polymer tailing, cohesive and blunt end ligation, adaptors, linkers.
- Unit-IV** Selection, screening and analysis of recombinants. Principle of hybridization. Northern blotting, Southern blotting, Western blotting. Polymerase chain reaction, Restriction fragments length polymorphism, RAPD, AFLP, MAP.
- Unit-V** Vector Engineering and codon optimization, host engineering. Strategies of gene delivery, *in vitro* translation, expression in bacteria and yeast, expression in insects and insect cells, expression in mammalian cells, expression in plants. Chromosome engineering, Targeted gene replacement, gene editing, gene regulation and silencing.
- Books**
1. Principles of Gene manipulation(1994) Old R.N. and Primrose S.B.
 2. From Genes to Clones (1987) Winnaeker E.L.
 3. Recombinant DNA (1992) Watson J.D., Witreowski J., Gilman M. and Zooller M.
 4. An Introduction to GeNETIC Engineering: Nicholl, D.S.T.
 5. Molecular Biotechnology (1996) Pasternak
 6. The Biochemistry of Nucleic acid(1996)Adam et al
 7. Genetic Engineering (1998)Janke k. swtlow

LBTM-302: BIOLOGY OF IMMUNE SYSTEM

- Unit-I** Introduction: Phylogeny of Immune system, innate and acquired immunity, Clonal nature of immune response. Organisation and structure of lymphoid organs. Nature and Biology of antigens and super antigens.
- Unit-II** Antibody structure and function, antigen and antibody interactions, Major histocompatibility complex, HLA. Generation of antibody diversity and complement system.
- Unit-III** Cells of immune system: Hematopoiesis and differentiation, lymphocyte trafficking, B-lymphocyte, T-lymphocytes, macrophages, Dendritic cells, natural killer and lymphokine activated killer cells. Eosinophils, neutrophils and mast cells. Activation of B and T-lymphocytes. Cell mediated cytotoxicity: mechanism of T cell and NK cell mediated lysis, antibody dependent cell mediated cytotoxicity and macrophage mediated cytotoxicity.
- Unit-IV** Antigen processing and presentation, generation of humoral and cell mediated immune responses, cytokines and their role in immune regulation, T- cell regulation, MHC- regulation, Immunological tolerance, Hypersensitivity, Autoimmunity, Immunosenescence.
- Unit-V** Transplantation, Immunity to infectious agents (intracellular parasites, helminths & viruses,) Tumor Immunology, AIDS and other immunodeficiencies. Hybridoma Technology and Monoclonal Antibodies.
- Books**
1. Essentials of Immunology: Roitt. I. M
 2. Immunology (V or VI edition): Kuby J.
 3. Advanced Immunology (1991) Male D., Champion B. Cooke A. and Owen M.
 4. Principle and practice of Immunoassay (2nd ed.) Christopher P. Price and David J.
 5. Kuby Immunology Richard A. Goldsby, Thomas J. Kindt and Barbara A. Osborne 6 Ed. 2007 Edition

LBTM-303: ANIMAL BIOTECHNOLOGY

- Unit-I** **Laboratory requirements for animal cell culture:** Sterile handling area. Sterilization of different materials used in animal cell culture, Aseptic concepts. Instrumentation and equipments for animal cell culture. History of cell culture. Primary and secondary cell culture.
- Unit-II** **Media and reagents:** Types of cell culture media, Ingredients of media, Physiochemical properties, Antibiotics, growth supplements, Foetal bovine serum; Serum free media, Trypsin solution, Selection of medium and serum, Conditioned media, Other cell culture reagents, Preparation and sterilization of cell culture media, serum and other reagents.
- Unit-III** Different types of cell cultures, Trypsinization, Cell separation, Continuous cell lines, Suspension culture, Organ culture. Development of cell lines, Characterization and maintenance of cell lines, stem cells, Cryopreservation, Common cell culture contaminants.
- Unit-IV** **Stem cell research:** Current status and application in medicine. Application of animal cell culture for *in vitro* testing of drugs; Application of cell culture technology in production of human and animal viral vaccines and pharmaceutical proteins. Production of recombinant hemoglobin, blood substituents, Artificial blood, General account of *in vitro* regulation of blood cells production.
- Unit-V** **Gene transfer technology in animals:** Viral and non-viral methods, Production of transgenic animals and molecular pharming, current status of production of transgenic animals. Animal cloning: Techniques, relevance and ethical issues.

- Books**
1. Freshney, Culture of Animal Cells, 5th Edition, Wiley-Liss, 2005
 2. Ed. John R.W. Masters, Animal Cell Culture - Practical Approach, 3rd Edition, Oxford University Press, 2000.
 3. Ed. Martin Clynes, Animal Cell Culture Techniques., Springer, 1998.
 4. B.Hafez, E.S.E Hafez, Reproduction in Farm Animals, 7th Edition, Wiley- Blackwell, 2000.
 5. Louis-Marie Houdebine, Transgenic Animals: Generation and Use, 1st Edition, CRC Press, 1997.

LBTM-304: PLANT BIOTECHNOLOGY

- Unit-I** Introduction to the techniques of plant tissue culture. Concept of cellular totipotency, Nutritional requirements, single cell culture, micro-propagation, somaclonal variation, somatic embryogenesis and production of embryoids.
- Unit-II** Haploid and double haploid production, Protoplast isolation and culture. Somatic hybridization and cybrid production and their applications in crop improvement. Productions of virus free plants using meristem culture.
- Unit-III** Basis of tumor formation, hairy roots, features of Ti and Ri plasmids, mechanisms of DNA transfer, role of virulence genes, use of Ti and Ri as vectors, binary vectors, use of 35S and other promoters, genetic markers, use of reporter genes, methods of nuclear transfer, particle bombardment, electroporation, microinjection, transformation of monocots. Transgene stability and gene silencing. Herbicide and insect resistance.
Plant Genetic Engineering: Transgenic plants, Genetically modified (GM) plants (Bt cotton, Bt Brinjal)
- Unit-IV** Photoregulation and phytochrome regulation of nuclear and chloroplast genes expression, Molecular biology of light and dark reactions of photosynthesis, Genetics of *nif* genes, Molecular mechanism of nitrogen fixation.
- Unit-V** Plant secondary metabolites: Control mechanisms and manipulation of alkaloids and industrial enzymes (Shikimate and PHA pathway), biodegradable plastics, therapeutic proteins, Edible vaccines, purification strategies. Green house Technology. Biotic and Abiotic stress.
- Books**
1. Plant Tissue Culture by MK Razdan & SS Bhojwani (1996) Elsevier
 2. Plant Physiology by L Taiz & E Zeiger 4th Edition (2006) Sinauer Associates Inc, Publishers
 3. Experiment in Microbiology, Plant pathology and Tissue culture by K.R. Aneja, Wishwa Prakashan
 4. Genetic Transformation of Plants, Edited by Jackson, J.F.; Linskens, H.F. , Springer 2003
 5. Plant Biotechnology and Transgenic Plants, Edited by Kirsi Marja Oksman-Caldentey, Wolfgang Barz Marcel Dekker 2002
 6. Plant Tissue Culture Concepts and Laboratory Exercises, Second Edition, Robert N Trigiano, Dennis J Gray, CRC Press November 1999

LBTM-305: APPLIED AND INDUSTRIAL BIOTECHNOLOGY

- Unit-I** Bioreactor Design, parts and their functions. Types of reactor. Upscaling of the fermentation process. Regulation of fermentation process. Quorum sensing in Bioprocess. Genetic modification of industrial microorganism. Metabolites from micro-organisms- amino acids and antibiotics, microbial polysaccharides
- Unit-II** Fertilizers: *Azospirillum*, *Azolla*, *Rhizobium*, *Frankia*, VAM. Petrocrops, Single cell proteins (SCP), aquaculture. Improvement of nutritional value of seed storage proteins. Genetic engineering of plant for virus, pest and herbicide resistance, Biopesticide and Biofertilizers.
- Unit-III** Medical application of r-DNA technology, human disorders associated with defects in protein/enzyme biosynthesis. DNA probes and their application in diagnostics of genetic and other disorders. Detection of HIV, hepatitis virus in human. Quantitative assay of viral DNA by branched DNA and PCR methods. Introduction to basic concepts of Nanobiotechnology.
- Unit-IV** Environmental Pollution - types of pollution methods for management of the pollution, Environmental management, waste water treatment, degradation of xenobiotics in Environment, Bioremediation of xenobiotics and heavy metals, Ozone depletion, green house effect and acid rains and their impact and biotechnological approaches of management. Use of microbes: Mineral beneficiation and oil recovery
- Unit-V** Basic Concepts of Intellectual Property: Introduction to intellectual property rights; Intellectual property laws; Trade Related Aspects of Intellectual Property Rights. Forms of IPR like patent, design and copyright trademark, IPR Laws. Bioethics: Necessity of bioethics, different paradigms of bioethics- national and international, Ethical issues against molecular technologies
- Books**
1. Principles of Gene manipulation (1994) Old R.N. and Primerose S.B.
 2. Recombinant DNA (1992) Watson J.D., Witreowski J., Gilman M. and Zooller M.
 3. An Introduction to Genetic Engineering : Nicholl, D.S.T.
 4. Molecular Biotechnology (1996) Pasternak
 5. The Biochemistry of the nucleic acid (1996) Adam et al
 - 6.. Genetic Engineering (1998) Janke K. Setlow
 7. Advanced Immunology (1991) Male D.,Champion B. Cooke A. and Owen M.
 8. Principle and practice of Immunoassay (IInd ed.) Christopher P. Price and David J. Newman.
 9. Plant tissue culture: Gamborg and Phillip.
 10. Basic and Agricultural Biotechnology (1993) Purohit and Mathur

SEMESTER IV

LBTM 401 MAJOR ELECTIVE PAPER (Any one of the following to be selected)

1. Microbial Technology
2. Advanced Plant and Agriculture Biotechnology
3. Medical Biotechnology
4. Advanced Environmental Biotechnology

LBTM-402: ENTREPRENEURSHIP AND MANAGEMENT IN BIOTECHNOLOGY

- Unit-I** Introduction – Meaning – nature and characteristics of Management, Scope and Functional areas of management. Management V/s Administration – Roles of Management, Levels of Management. Evolution of management thought: early, contemporary and modern.
- Unit-II** Nature, purpose and importance of planning process. Types of plans .Decision making. Importance of planning – steps in planning & planning premises. Hierarchy of plans. Components of planning.
- Unit-III** Nature and purpose of organization. Principles of organization, Types of organization. Departmentation Committees. Centralization Vs Decentralization of authority and responsibility. Nature and importance of staffing–Process of Recruitment and Selection.
- Unit-IV** Meaning and nature of directing: Understanding, Supervision, motivation and leadership. Leadership styles, Motivation Theories (Abraham Maslo, Herzberg and Victor Hvrom’s). Communication – Meaning and importance. Meaning and steps in controlling – Essentials of a sound control system – Methods of establishing control (in brief).
- Unit-V** Structure of a Biotechnology Company. Start-up of Biotechnology Company, New Product Development. Market Research. Sales & Marketing Principles. Intellectual Property Principles in Biotechnology. Health Care Overview and Role of Government in Biotechnology. Ethical and Other Legal Issues in Biotechnology

Books

1. Principles of Management – P.C.Tripathi, P.N.Reddy – Tata McGraw Hill,
2. Dynamics of Entrepreneurial Development & Management – Vasant Desai – Himalaya Publishing House
3. Entrepreneurship Development – Poornima.M.Charantimath – Small Business Enterprises – Pearson Education – 2006 (2 & 4).
4. Management Fundamentals – Concepts, Application, Skill Development – Robers Lusier – Thomson –
5. Entrepreneurship Development – S.S.Khanka – S.Chand & Co.
6. Management – Stephen Robbins – Pearson Education/PHI – 17th Edition, 2003.

LBTM- 403 PROJECT DISSERTATION AND VIVA

Maximum marks: 200

Every student will be required to undertake a research project based on any of the areas of animal, plant or microbial biotechnology and bioinformatics preferably related to major elective paper. The project report will be submitted in the form of dissertation duly certified by the supervisor of School of Biotechnology or at national institutes and Universities in India, by seeking the placement. The project will be presented for evaluation at the end of semester by external expert.

MAJOR ELECTIVE PAPERS

LBTM-401: MICROBIAL BIOTECHNOLOGY

Unit-I Microbial biotechnology, scope and techniques, Bioprospecting of microbial diversity, Isolation and preservation of industrially important microorganisms. Genomics, Transcriptomics, Proteomics, Metabolomics, metagenomics and Systems Biology

Unit-II Production of proteins and enzymes in bacteria yeast and fungus, recombinant and synthetic vaccines. Microbial polysaccharides and polyesters

Microbes as biocontrol agents microbial insecticides
(Baculoviruses, entomopathogenic fungi, *Bacillus thuringiensis*,
Bacillus sphaericus, *Bacillus popilliae*, Microbe derived inhibitors.

Unit-III Microbial biomass production, utilization of plant biomass by microorganisms (lignocellulose biodegradation), ethanol production, amino acids, antibiotics. Biotransformation of steroid and non steroid compounds, metabolic engineering.

Unit-IV Biology of nitrogen fixation, preparation of different, Types of inoculants (nitrogen fixers phosphate solubilizers, plant growth promoting rhizobacteria, PGPR, composting.

Unit-V Introduction to the use of microbes in environmental applications, Bioremediation, bioaugmentation, Bioemulsifiers, biosurfactants, MEOR, Leaching of ores. Microbial fuels (Methane, Hydrogen)

Books

1. Microbial Biotechnology (1995) Alexander n. Glazer Hiroshi Nikaido W.H. Freeman and Company
2. Molecular Biotechnology: Principles and Applications of Recombinant DNA –Bernard R.
3. Glick and Jack J. Pasternak ASM Press. Washington, D.C (1994).
4. Fungal Ecology and Biotechnology (1993) Rastogi Publications, Meerut.

LBTM-401: ADVANCED PLANT AND AGRICULTURE BIOTECHNOLOGY

- Unit-I** Basic techniques and tools in Plant Tissue Culture. Establishment of plant tissue culture lab: equipment, culture vessels, surface sterilization of various explants, pretreatment of explant, subculture and repeated transfer of explants and cultures. Composition of various tissue culture media and their preparation. Establishment of callus, suspension cultures, organogenesis and embryogenesis, Meristem tip culture, Hardening of plants, Techniques of anther, embryo and ovule culture. Protoplast isolation, culture and fusion. Artificial seed (synthetic seed) Cell line selection using selection pressure, Production of secondary metabolites, Cryopreservation.
- Unit-II** Biotechnology for Crop Improvement. Conventional methods for crop improvement (Pedegree breeding, Heterosis breeding, Mutation breeding). Tissue culture in crop improvement, Micropropagation for virus-free plants, Somaclonal variation, Somatic hybridization, Haploids in plant breeding,
- Unit-III** Genetic engineering for increasing crop productivity by manipulation of Photosynthesis, Nitrogen fixation, Nutrient uptake efficiency. Genetic engineering for biotic stress tolerance (Insects, fungi, bacteria, viruses, weeds). Genetic engineering for abiotic stress (drought, flooding, salt and temperature)
- Unit-IV** Genetic engineering for quality improvement of Protein, lipids, carbohydrates, vitamins & mineral nutrients, Plants as bioreactor, Molecular breeding, constructing molecular maps, Molecular tagging of genes/traits. Marker-assisted selection of qualitative and quantitative traits. Physical maps of chromosomes. The concept of gene synteny. The concept of map-based cloning and their use in transgenics
- Unit-V** Plant Metabolic Engineering. The concept of secondary metabolites, Historical and current views, Importance of secondary metabolites in medicine and agriculture, Introduction to various pathways, Flavanoid pathway, Terpenoid pathway, Polyketoid pathway

LBTM-401: MEDICAL BIOTECHNOLOGY

Unit-I Classification of genetic diseases. Chromosomal disorders – Numerical disorders e.g. trisomies & monosomies, Structural disorders e.g. deletions, duplications, translocations & inversions, Chromosomal instability syndromes. Gene controlled diseases – Autosomal and X-linked disorders, Mitochondrial disorders.

Unit-II Molecular basis of human diseases - Pathogenic mutations. Gain of function mutations: Oncogenes, Huntingtons Disease, Pittsburg variant of alpha 1 antitrypsin. Loss of function - Tumour Suppressor. Genomic. Dynamic Mutations - Fragile- X syndrome, Myotonic dystrophy. Mitochondrial diseases

Unit-III Prenatal diagnosis - Invasive techniques - Amniocentesis, Fetoscopy, Chorionic Villi Sampling (CVS), Non-invasive techniques - Ultrasonography, X-ray, TIFA, maternal serum and fetal cells in maternal blood. Diagnosis using protein and enzyme markers, monoclonal antibodies. DNA/RNA based diagnosis Hepatitis, CML - bcr/abl, HIV - CD 4 receptor. Microarray technology- genomic and c DNA arrays, application to diseases.

Unit-IV Clinical management and Metabolic manipulation – PKU, Familial Hypercholesterolemia, Rickets, ADA, Congenital hypothyroidism. Gene therapy - Ex-vivo, Invivo, Insitu gene therapy, Stratagies of gene therapy: gene augmentation

Unit-V Vectors used in gene therapy Biological vectors – retrovirus, adenoviruses, Herpes Synthetic vectors- liposomes, receptor mediated gene transfer. Gene therapy trials – Familial Hypercholesterolemia, Cystic Fibrosis, Solid tumors.
Cell and tissue engineering: Stem cell Potential use of stem cells – Cell based therapies, Nanomedicine.

Books

1. Diagnostic and Therapeutic Antibodies (Methods in Molecular Medicine by Andrew J.T. George (Editor), Catherine E. Urch (Editor) Publisher: Humana Press; edition (2000)
2. Molecular Diagnosis of Infectious Diseases (Methods in Molecular Medicine) by Jochen Decker, U. Reischl Amazon
3. Human Molecular Genetics by T. Strachan, Andrew Read Amazon Sales Rank:
4. Principles of Biostatistics by Marcello Pagano , Kimberlee Gauvreau
5. Essentials of Epidemiology in Public Health, Second Edition by Ann Aschengrau , George R., III Seage

LBTM-401: ADVANCED ENVIRONMENTAL BIOTECHNOLOGY

- Unit-I** Status and Scope of Biotechnology in Environmental protection. Non-conventional energy sources. Environment protection Act: Environmental laws, Environmental policies, Environmental ethics. UN declaration. Environmental protection and conservation. Environmental Impact Assessment, Ecoplanning and Sustainable Development
- Unit-II** Physicochemical and bacteriological analysis of soil and water, Problems associated with soil alkali soils, sodic soils, and solid waste, Fate of insecticides fungicides, pesticides in soil, use of genetically modified (insect-, pest- and pathogen resistant) plants. Ecotoxicology of soil pollutants, Municipal solid waste treatment strategies.
- Unit-III** Waste water constituents, Analysis and selection of flow rates and loadings, Process Selection, Physical unit operations, Chemical unit operations, Fundamentals of biological treatment, Role of biotechnology in water purification systems. Types and kinetics of biological treatment, Advanced waste water treatment, Biological Processes for Industrial and domestic effluent, Treatment, Aerobic Biological Treatment, Anaerobic Biological Treatment.
- Unit-IV** Bioremediation-Biotechnology for clean environment, Biomaterials as substitutes for non-degradable materials, Metal microbe interactions: Heavy Metal Pollution and impact on environment, Microbial Systems for Heavy Metal Accumulation, Biosorption, molecular mechanisms of heavy metal tolerance
- Unit-V** Bioremediation- Biotechnology for clean environment. Bioindicators and biosensors for detection of pollution. Biotechnology for Hazardous Waste Management, Persistent organic pollutants, Xenobiotics, Biological Detoxification of PAH, Biotechniques for Air Pollution Control. Solid Waste Management
- Books**
1. Amann, R.I. Stromley, J. Stahl : Applied & Environmental Microbiology
 2. Dash : Concepts of Ecology
 3. Chattergy : Environmental Biotechnology
 4. Varma & Agarwal : Environmental Biology
 5. B.K. Sharma : Environmental Chemistry
 6. Peavy & Rowe : Environmental Pollution
 7. Asthana & Asthana : Environment Problems & Solutions